Sydney’s Latitude East ranks among Australia’s five most efficient buildings. Latitude East’s performance stems from relatively standard building systems that are designed, implemented and controlled for maximum energy savings rather than green bells and whistles such as trigeneration, wind power or solar photovoltaics.

### Latitude East

<table>
<thead>
<tr>
<th>Building at a Glance</th>
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<tbody>
<tr>
<td>Name: Latitude East</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Owner</td>
</tr>
<tr>
<td>Principal Use</td>
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<tr>
<td>Employees/Occupants</td>
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<tr>
<td>Conditioned Space</td>
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<tr>
<td>Substantial Completion/Occupancy</td>
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<tr>
<td>Occupancy</td>
</tr>
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Latitude East’s central atrium with glass elevators, exposed elevator structure and glass-enclosed stairs results in a dramatic central space and helps unify the nine floors of commercial office space.

The National Australian Built Environment Rating System (NABERS) gave Latitude East its top rating, five out of five stars. Its energy-saving strategies have led to a building that emits 40% less carbon dioxide than the benchmark required for the top NABERS rating.

Latitude East is the final building built at World Square near the heart of Sydney’s commercial business district. World Square is a city block bounded by George Street, Liverpool Street, Pitt Street and Goulburn Street. The site consists of a large multilevel underground parking area, a shopping center, restaurants, cafes, hotels, office buildings and residential apartment towers.

Latitude East has nine levels of commercial office space with a central atrium and approximately 247,578 ft² of air-conditioned space. It is built on top of a large common basement and two retail levels. The plant room is located on the top floor. The building team sought to build a high quality, energy-efficient office building that would meet the operational efficiency requirements to receive a 4.5 NABERS rating.

Waterman designed the mechanical, electrical, plumbing and fire protection services. We were commissioned by Brookfield for these consulting services and worked closely with them and the rest of the design team.

Energy modeling firm AECOM conducted energy simulations using IES Virtual Environment software according to the NABERS Energy Commitment Agreement for predicting the energy use of the building. IES software is compliant with ANSI/ASHRAE Standard 140–2001, Standard Method of Test for Evaluation of Building Energy Analysis Computer Programs.
Energy-Efficient Design

The key design elements that contribute to the energy efficiency of the building fall into two categories:

- The building form, including a central atrium and the façade and
- The air conditioning, ventilation, building management control system (BMCS) and lighting design.

Waterman worked together with Brookfield, the architect, façade engineer and energy modeling consultant to:

- Maximize natural light via the external façade and via the central atrium;
- Provide adequate shading to reduce solar loads and glare; and
- Reduce heat transmission.

The building team checked different shading configurations and glazing options for their effect on the cooling and heating loads of the building. The shade from the existing buildings adjacent to Latitude East prompted the team to minimize external shading elements, particularly on the north and west façades. The architectural concept design also strongly influenced the shading decision.

The team selected glazing that offers a reasonable shading factor, but does not reduce daylighting (see Lighting Design, p. 20). Double glazing improves the glazing R-value and reduces heat transmission.

Air-Conditioning Systems

Central chillers, an air-handling plant located in the roof plant room, and boilers serve the building. The system includes:

- Two high-efficiency water-cooled screw chillers with variable-speed drives (VSDs);
- A lighting control system uses photovoltaic cells to adjust high-efficiency T5 fluorescent lights based on the amount of available daylight. The building team selected glazing that provides some shading, but does not reduce daylighting.
Chillers. Cooling load calculations indicated that the building load at Latitude East was in the vicinity of 3,000 kW, prompting a design using two chillers at 1,500 kW cooling capacity each.

- The team based its chiller selection on the following energy-efficiency specifications:
  - A chilled water operating setpoint of 59°F to 45°F;
  - A condenser water temperature of 85°F; and
  - A minimum coefficient of performance (COP) at various load conditions from 100% to 10% (Table 1).

<table>
<thead>
<tr>
<th>Load %</th>
<th>COP</th>
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<tbody>
<tr>
<td>100</td>
<td>6.2</td>
</tr>
<tr>
<td>90</td>
<td>6.8</td>
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<td>80</td>
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<td>40</td>
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<td>30</td>
<td>9.1</td>
</tr>
<tr>
<td>20</td>
<td>7.6</td>
</tr>
<tr>
<td>10</td>
<td>5.7</td>
</tr>
</tbody>
</table>

The higher chiller setpoint represents a slight shift from traditional practice in Australia where a higher chiller setpoint improved efficiency at all loads. It also reduced pump motor power.

Latitude East is part of Sydney’s World Square, a city block that includes retail stores, restaurants, office buildings, apartments and hotels. The site was previously home to the Anthony Hornden & Sons department store, which opened in 1905 and was called The Palace Emporium.

Isidora 3000 - W Santiago & Residences
Isidora 3000 is quite an innovative and visionary building which was awarded the 2009 South American Hotel & Tourism Investment Conference Prize for “Best Project in South America.” Its design was the work of various world-leading designers, and it includes W Santiago, one of the trendiest hotels in the world and the first one in South America. The hotel has 196 stylish rooms, including suites which provide a breathtaking view of Santiago and the Andes. Such vanguard required comfort and LG can provide.

Justice Center
The Justice Center is the largest building in Santiago and expands over a space of 375,000 sq ft, comprised of 8 buildings, 10 floors each. It celebrates 200 years of the country’s freedom, represents Chile’s development and offers judicious solutions to a city of near 6 million individuals. Its significance and history has called for LG’s HVAC system.

Titanium La Portada
This is the tallest building in Chile, being 429 ft tall, with 54 floors, including 1 underground, over a total floor space of 1.390,000 sq ft. It is an architecture of the latest technology, a LEED certified green building, and is able to withstand an earthquake of up to 9.0 on the Richter scale. Due to its sheer size and complexity, it had to choose LG when it came to HVAC system.
chilled water design temperatures are typically 54°F to 43°F. The higher chilled water temperatures improved energy efficiency in two areas.

First, the higher chilled water supply temperature directly increases the efficiency of the refrigeration cycle and chiller COP. The building team selected the highest possible chilled water supply setpoint that did not adversely affect the dehumidification ability of the air-handling unit cooling coils or the overall cooling coil selection including air and water pressure drop.

Second, using a higher chilled water ΔT makes it possible to reduce the flow rate for the chilled water pumps. The team determined that the 40°F split was a good solution for chiller and AHU coil operation allows for a reduction in the chilled water pump motor power by approximately one-third.

Air Distribution. Ductwork risers deliver air to each floor from the central air-handling units. The higher chilled water design temperatures are typically 54°F to 43°F. The higher chilled water temperatures improved energy efficiency in two areas.

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Three electrical submeters track energy used by the building’s elevators and escalators. Additional submeters track building systems’ energy consumption, providing data that helps building managers identify and resolve problems.
Multiple variable air volume terminal boxes (VAVs) on each floor then modulate the airflow to control zone temperatures.

In Australia, VAV systems are generally designed for a minimum airflow rate of approximately 0.98 cfm/ft² with the VAV boxes at full capacity. This design aims to ensure reasonable air movement when the VAV boxes are at minimum turndown (airflow).

However, often this practice allows for a minimum VAV turndown of only approximately 70%. The turndown rate can vary based on diffuser manufacturer, selection, spacing, and layout. Unfortunately, this typically means that the VAV boxes do not always have enough modulation range to control temperature unless the VAV boxes are also fitted with electric zone reheat.

Latitude East uses standard light air boot/troffer type air diffusers. Laboratory testing and the calculation of the Air Diffusion Performance Index (ADPI) helped determine the optimum diffuser performance in accordance with ASHRAE Standard 113-2005.

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This enabled lower VAV turndowns, resulting in two energy benefits:
• Electric reheats were not required in the VAV boxes for temperature control.
• Reduced flow rates at low loads decrease AHU fan energy use.

The lower VAV turndown has lowered energy use and has succeeded in keeping tenants comfortable.

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—Bill Wilson, Management Analyst, City of Encinitas Public Works Department
Other Air-Conditioning Energy Strategies. In addition, the following key strategies were used to improve energy efficiency:

- Outdoor air economy cycles based on enthalpy;
- Night purge/cooling based on enthalpy;
- Minimizing air and water friction losses by generously sizing ductwork and pipework;
- Chilled water temperature reset, and
- Condenser water relief.

Using outdoor air economy cycles is not a new energy-saving technique. Unfortunately, building managers sometimes disable this option after construction because of operating problems. In normal mode, the air supplied to a space is a combination of the required minimum airflow (for example, 30%) plus return air (for example, 70%). Traditionally, the economy mode involves:

- Measuring the outdoor air temperature (dry bulb); and
- Comparing it to the return air temperature (dry bulb).

If the outdoor air is less than the return air temperature, then the system switches to the economy cycle;

- The economy cycle mode consists of 100% outdoor air and 0% return air; and
- The lower on coil temperature reduces the load on the AHU.

Unfortunately, this method does not account for the latent load of air, resulting in times when economy mode requires more cooling than normal mode. Clearly, this is not a particularly energy-efficient strategy.

The typical solution to this problem involves the use of enthalpy sensors. However, the enthalpy sensors on the market were often not very accurate and/or not very reliable.

At Latitude East, the design called for enthalphy control of economy cycles, but instead of enthalphy sensors, the system uses temperature sensors on the market were often not very accurate and/or not very reliable.

WHAT IS NABERS ENERGY?

Formerly known as the Australian Building Greenhouse Rating System (ABGR), NABERS Energy is an Australian rating system that accounts for all energy sources used in a building over a 12-month period. Other factors considered in determining the rating include the rentable floor area, hours of occupancy and other variables.

The rating focuses on the greenhouse gas (CO₂) emissions resulting from all energy sources. Ratings range from one to five stars in half-star increments, with one star representing a poorly performing building, four stars representing an excellent building and five stars representing an exceptional building.

All ratings account for variations in geographic location to provide normalized results that enable direct comparison between buildings in different climates. Two key energy criteria that affect ratings are energy efficiency and the type of energy consumed.

This criteria presents what some consider a loophole in terms of determining how green an actual building is, because an inefficient building can receive a five-star rating if a high proportion of its energy is from green power (renewable energy) sources that are accredited by the Australian government. Green power can be purchased through regular electricity providers at a small premium.

Therefore, caution should be taken when interpreting a building’s NABERS energy rating to ensure that the building itself is energy efficient. Accordingly, NABERS ratings show the amount of “normal” and “green” power used in the rating.

In 2007, the 1939 Masonic Temple was reborn as the Renaissance Providence Hotel. As Steve Beretta tells it, guest comments about poor air conditioning comfort became frequent and widespread. Taco worked with Steve to troubleshoot the HVAC, closed loop system and determined that corrosive iron oxide gunk was fouling the system’s components.

The clear solution. The hotel installed two 4900 Series Air and Dirt Separators to eliminate air microbubbles, sand, dirt and rust in the system. With its patented Pall Ring design, the 4900 Series removes solid particles and air microbubbles as small as 18 x 10⁻⁵m, delivering superior performance that’s tested and certified by Defl Hydraulics. As a bonus, the 4900 saves money, energy, and component wear.

The proof is in hand. “As the quality of the system water improved,” says Steve, “the air conditioning improved.” We’re glad we could help, Steve. That’s why we’re all in business.
and humidity sensors and a psychrometric calculation. This approach provides a more energy-efficient solution with more accurate and reliable results.

Night purge works on a similar principle to the economy cycle. It involves running the AHUs at night without the use of chillers when the enthalpy conditions are favorable outdoors. The ductwork and pipework systems in a typical building can add significant resistance and increase the power used by fans, AHUs and pumps. This resistance, or pressure loss, is wasted energy.

At Latitude East, all ductwork and pipework systems are slightly oversized, reducing friction by 20%, which saves energy. This does not mean that we will not continue using the latest green trends if and where appropriate. However, we will be more diligent in considering the relatively standard alternatives, which could provide significant benefits.

Lighting Design
The building team maximized natural light to enhance the indoor environment and connect occupants to the outdoors. Photoelectric cells linked to a lighting control system in typical office areas, slot diffusers in the light fittings provide air supply. All ductwork was slightly oversized to reduce friction by 20% and save energy.
Air-handling unit fans using more energy than anticipated due to incorrect balancing damper positions, dirty filters or other restrictions; and

- Chillers not operating efficiently due to a variety of reasons such as reduced refrigerant charge.

The parking garage is shared by the World Square buildings. Energy consumed by the parking garage lighting and ventilation systems is billed to Latitude East based on the number of parking spaces allocated to the building.

These meters send data back to a centralized monitoring and reporting system that is independent to the BMCS.

The energy submetering system can assist with energy management. Tracking the actual use of each system with the energy simulation results can identify any anomalies, which can be investigated. Typical examples include:

- Air-handling unit fans using more energy than anticipated due to incorrect balancing damper positions, dirty filters or other restrictions; and
- Chillers not operating efficiently due to a variety of reasons such as reduced refrigerant charge.

The parking garage is shared by the World Square buildings. Energy consumed by the parking garage lighting and ventilation systems is billed to Latitude East based on the number of parking spaces allocated to the building.

These meters send data back to a centralized monitoring and reporting system that is independent to the BMCS.
This metering system has helped building management fine-tune the building after construction. Mostly small incremental improvements have reduced the building’s energy use by more than 10% compared to energy use at the end of construction and commissioning.

**Energy Target Versus Actual**

The building team set out to obtain a 4.5 star NABERS Energy rating (What is NABERS Energy?, p. 18) without the use of green power sources such as on-site or purchased solar or wind power. The energy model indicated that the building would qualify for either 4.5 or five stars, depending on a number of factors, including occupant density and hours, plant operation and operating hours.

To qualify for the top NABERS Energy rating of five stars, buildings must meet maximum emissions criteria, which is 15 lbCO₂/ft² per year for Sydney. Latitude East emits 8 lbCO₂/ft² per year, 40% less than the five star greenhouse gas emissions benchmark. This is achieved without the use of green power. (Emissions figures are normalized to account for various Australian climates and to allow for realistic comparisons.)

As of March 8, 2010, Latitude’s energy performance placed the building in the top five performing NABERS-rated base buildings that do not use or purchase green power.

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**Building Team**

- Building Owner/Representative: Brookfield
- Architect: Crone Partners Architecture Studios
- General Contractor: Brookfield
- Mechanical, Electrical Engineer; Lighting Design: Waterman AHW
- Hydraulic and Fire Services Engineer: Waterman AHW
- Energy Modeler: AECOM
- Structural Engineer: Taylor Thomson Whitting

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**About the Authors**

Scott Walkden-Brown is a director at Waterman Group in Sydney, Australia. Godfrey Frederick is the business development manager for the Waterman Group in Australia.

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