

Exemplary Weather Energy Index 10 and 3 Storey Offices and Supermarket

Model Details and Methodology

Summary

The **Exemplary Weather Energy Index** (EWE Index) is a means of accurately assessing a building’s energy consumption as a Key Performance Indicator (KPI). By providing an adjustment factor responsive to the immediate past weather conditions, it allows the Building Manager to know whether the HVAC energy consumption is on target or needing attention to return to cost effective operation.

The EWE Index is defined as the energy consumption difference calculated by comparing the simulation results using the Real Time Year or Month (RTY or RTM) with those of the climatically indicative standard Reference Meteorological Year - Type B (RMY-Bⁱ). It is a simulation index of the monthly HVAC consumption in the actual weather conditions compared with those consumptions in indicative or reference climatic conditions.

Real Time Year data is useful for the following purposes:

- Model calibration using real time weather data coincident with other empirical measures like solar system output or building energy consumption or temperature (especially if unconditioned);
- Building or system monitoring for underperformance to indicate the need for early restorative action;
- Adjustment (normalisation) of actual output or energy consumption in the real year to reflect reasonably anticipated outcomes in the climatically average year (i.e. relative to the long term weather norms and/or trends).

The **EWE Index** is published monthly by Exemplary Energy as a service to industry.

Enquiries, critiques and requests for use of the weather data employed (RTYs) contact Trevor Lee, Director (Buildings) at trevor.lee@exemplary.com.au.

Table of Contents

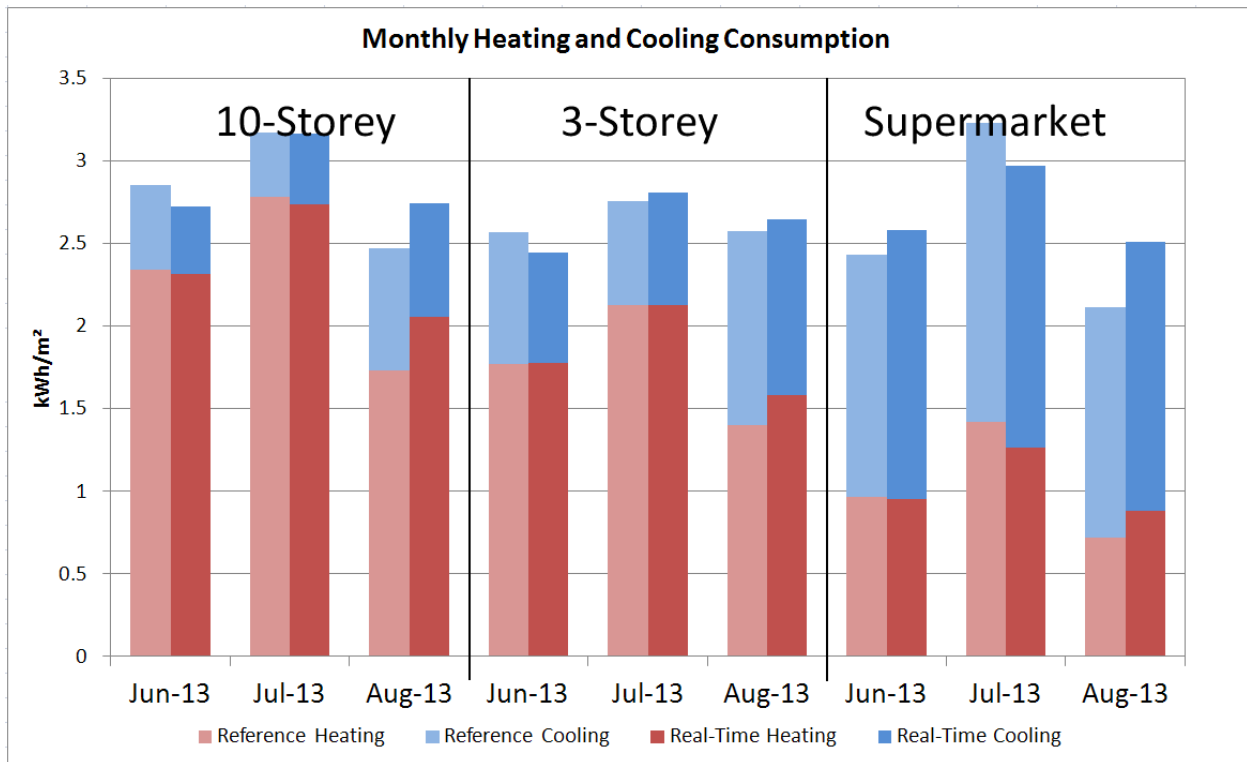
| | |
|---|---|
| Model Details and Methodology..... | 1 |
| Summary | 1 |
| Table of Contents | 1 |
| Sample Results | 2 |
| Exemplary Weather Energy Index (EWE Index) BCA Compliant Building Models - Descriptions | 4 |
| Offices – 10 and 3 Storeys | 4 |
| Supermarket..... | 6 |

Sample Results

The EWE Index for Canberra and Sydney of three archetypal BCA Section J compliant buildings in Australia – two office scales (10 and 3 storeys) and a supermarket are provided below:

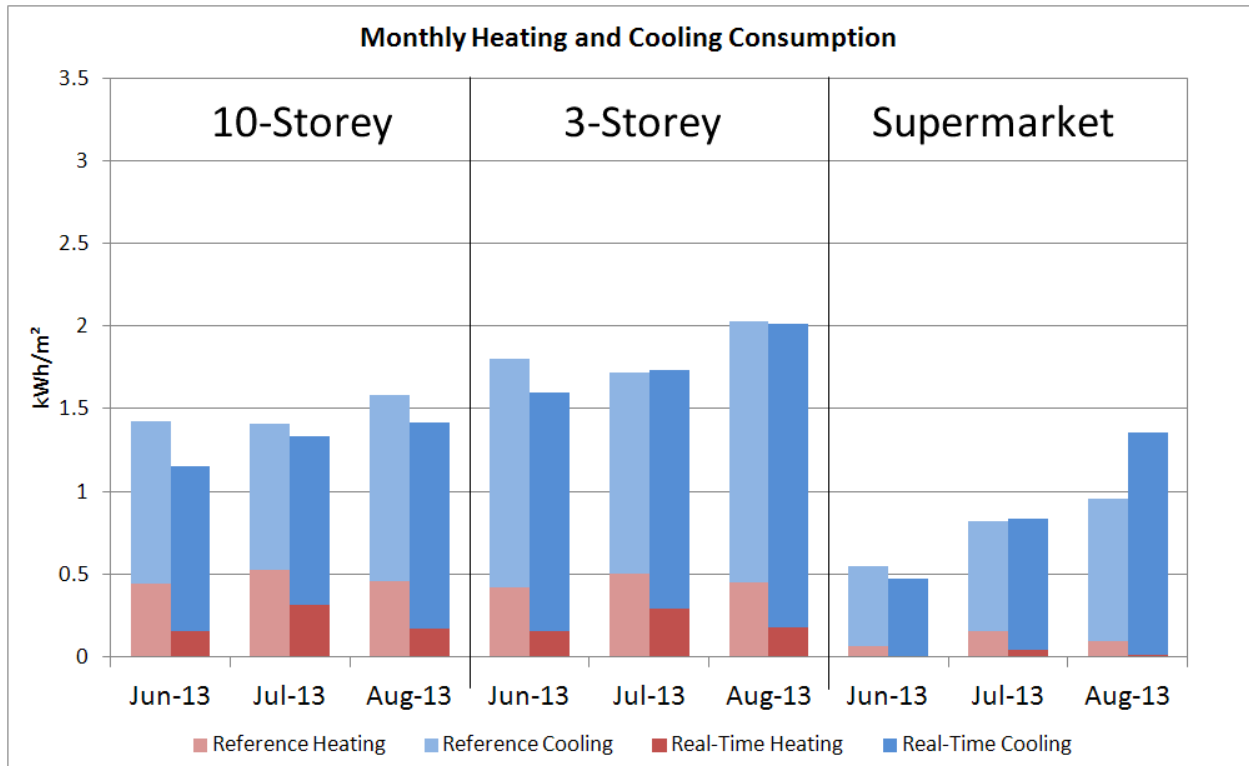
Canberra

| Weather Energy Index | 10-storey Office | | 3-storey Office | | Supermarket | |
|----------------------|------------------|---------|-----------------|---------|-------------|---------|
| | Cooling | Heating | Cooling | Heating | Cooling | Heating |
| Jun | -19% | -1% | -15% | 0% | 11% | -1% |
| Jul | 9% | -2% | 8% | 0% | -6% | -11% |
| Aug | -7% | 19% | -9% | 13% | 16% | 23% |



Sydney

| Weather Energy Index | 10-storey Office | | 3-storey Office | | Supermarket | |
|----------------------|------------------|---------|-----------------|---------|-------------|---------|
| | Cooling | Heating | Cooling | Heating | Cooling | Heating |
| Jun | 2% | -65% | 4% | -62% | -4% | -90% |
| Jul | 16% | -41% | 18% | -42% | 19% | -75% |
| Aug | 11% | -63% | 16% | -61% | 56% | -87% |



Exemplary Weather Energy Index (EWE Index) BCA Compliant Building Models - Descriptions

This section comprises the detail descriptions of the chosen the archetype BCA2009-compliant 10-storey and 3-storey office, and the BCA2010-compliant supermarket model. The three virtual models were created using the DesignBuilder software (www.designbuilder.com.au/) and simulate the buildings' annual energy consumption using the US Department of Energy (DOE) building simulation software EnergyPlus (www.eere.energy.gov/buildings/energyplus/).

Offices – 10 and 3 Storeys

This section describes the structure and services for the BCA2009 compliant versions of the 10 and 3 storey offices.

| Attribute | 10 Storey | 3 Storey |
|---------------------------|-------------|---------------|
| Area (m ²) | 10,000 | 2,000 |
| Ratio of length to width | 1:1 | 2:1 |
| Storeys | 10 | 3 |
| Floor to Floor Height (m) | 3.6 | 3.6 |
| Car Park | Underground | Open car park |

Table 1 – Summary of the two office building models

General information for both office models

- Floor Plan: carpeted open office areas with central core (lifts, ducts, stairs, toilets, kitchenettes);
- Replication: all floors identical in plan and infiltration (i.e. revolving doors and no separate foyer)
- Zones: 4 perimeter zones 3.6 m deep; remainder is a single internal zone; unconditioned core
- Occupancy density: 1 person per 10 m² NLA, from 7am to 9pm (scheduled from 5% to 100%)
- Ventilation: 7.5 L/sec per person; exhaust through central core
- Lifts: energy allowance 20 MJ/m² annual
- Hot water: energy allowance 20 MJ/m² annual
- Internal loads: 15 W/m² for NLA Zones, 5 W/m² for Core Zone. This Core Zone load was chosen to account for appliances in the kitchenette and toilets

10-Storey

- Floor Area = 1,000 m² GFA per floor; 900 m² NLA per floor
- Core area = 10 m x 10 m
- Ground Floor: (insulated as required) suspended slab over basement car park

3-Storey

- Floor Area = 667 m² GFA per floor; 600 m² NLA per floor
- Core area: length = 11.6 m; depth = 5.8 m
- Ground Floor: (insulated as required) suspended slab over open car park

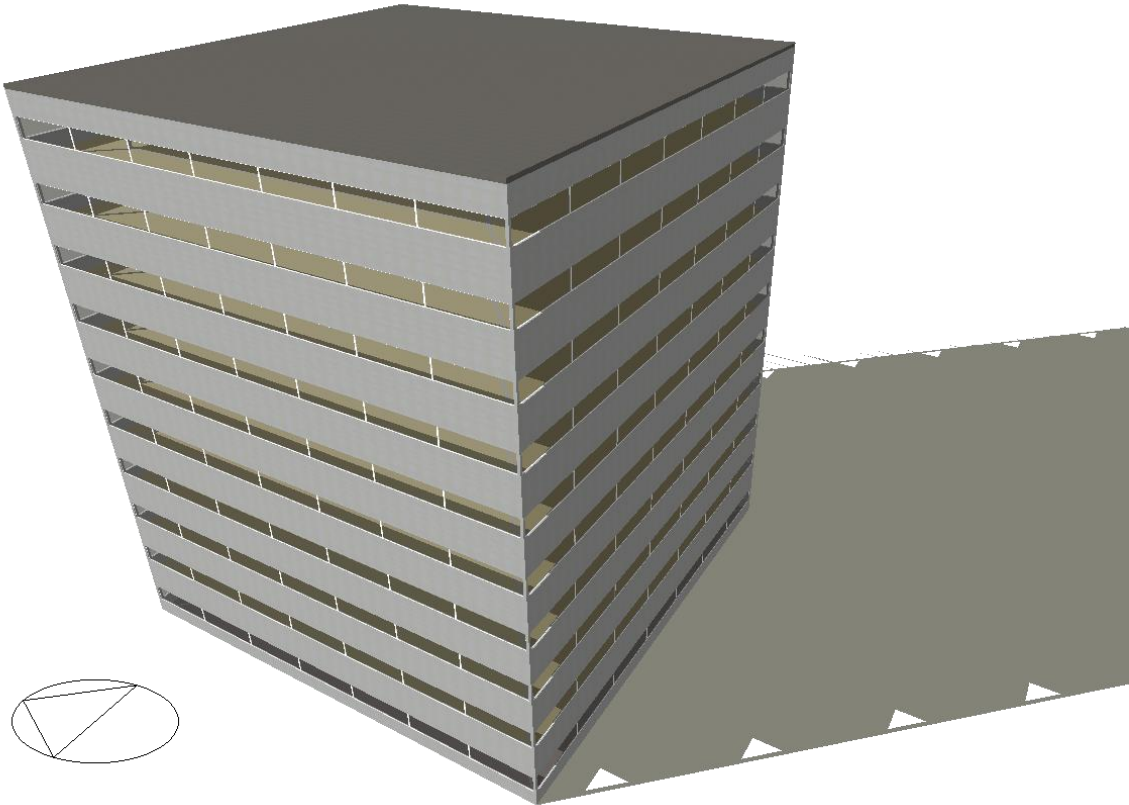


Figure 1 – Perspective view of the 10-storey office building model

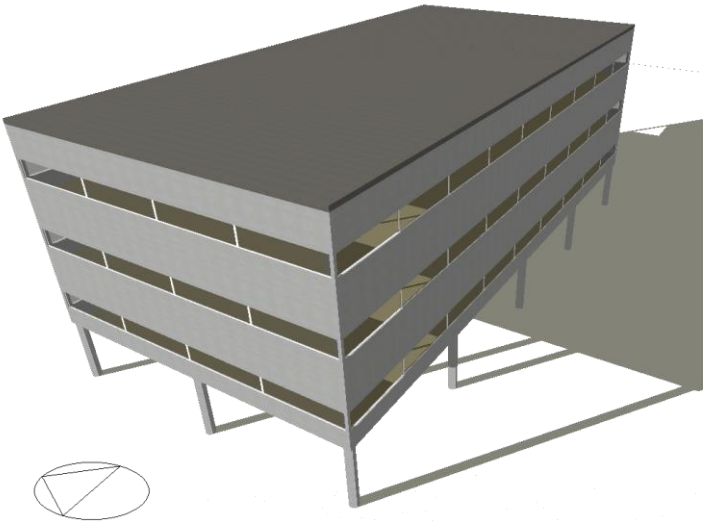


Figure 2 - Perspective view of the 3-storey office

DTS Building Construction

The building models have been constructed according to the BCA 2009 minimum Deemed-To-Satisfy (DTS) Section J energy efficiency requirements for climate zone 5 (Sydney) and 7 (Canberra), a summary is listed below.

| BCA Climate Zone | Insulation (Total R-Value) | | | DTS Fenestration | | | |
|------------------|----------------------------|-------|--------|-------------------------------|-------|-----------------|--------------------------------------|
| | Ceilings | Walls | Floors | U-Value (W/m ² .K) | SHGC | Glazing Ratio % | Glazing Type |
| 5 | 3.2 | 1.8 | Nil | 5.8 | 0.623 | 33.6 | Green 6mm |
| 7 | 3.2 | 1.8 | 1.5 | 2.7 | 0.616 | 34.0 | Green 6mm / Air gap 13mm / Clear 3mm |

Table 2 – BCA2009-compliant insulation and fenestration for office

The external wall was constructed as 75mm concrete with bulk insulation, a nominal air gap and 10mm plasterboard as the internal lining board.

DTS Lighting

The lighting level for the open office area is 10 W/m² and 5W/m² for the core zone. This Core Zone lighting was chosen to represent 10W/m² (kitchenette/toilets) and 8W/m² for stairs with a substantial fraction of the core zone assumed to be the unlit areas of lift well, ducts, pipes etc.

DTS HVAC System

Both office models have the same HVAC system: a fan coil unit with no economiser, no night cycle, 250 Pa fan pressure, 70% fan efficiency, 90% pump efficiency. The chiller CoP for the 10-storey office is 5.5 and 4.2 for the 3-storey model (set by the BCA), 95% overall chilled water system efficiency, 80% boiler efficiency with 75% overall hot water system efficiency.

Supermarket

This section describes the structure and services for the BCA2010 compliant version of the supermarket.

- NLA: 4,000m²
- Ceiling height 4.2m
- Roof 10° metal deck
- Floor: Concrete slab on ground with PVC tiles or sheet vinyl as floor covering depends on the internal zone purpose.
- Zones: There are six purpose-defined zones (Produce, Sales, Bakery, Deli, Office and Dry Storage). The yellow walls in **Error! Reference source not found.** are virtual partitions. Virtual partitions divide the space for control and simulation purposes without splitting the space with physical partitions.
- Occupancy density: 1 to 3.3 person per 10 m² NLA in the main shopping areas, from 8am to midnight (scheduled from 5% to 25% of the maximum shop capacity)

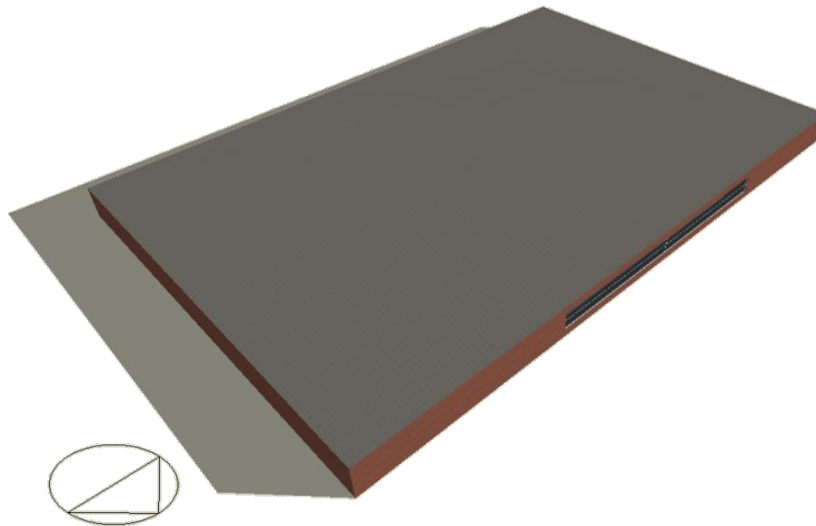


Figure 3 - Perspective View from the North-West

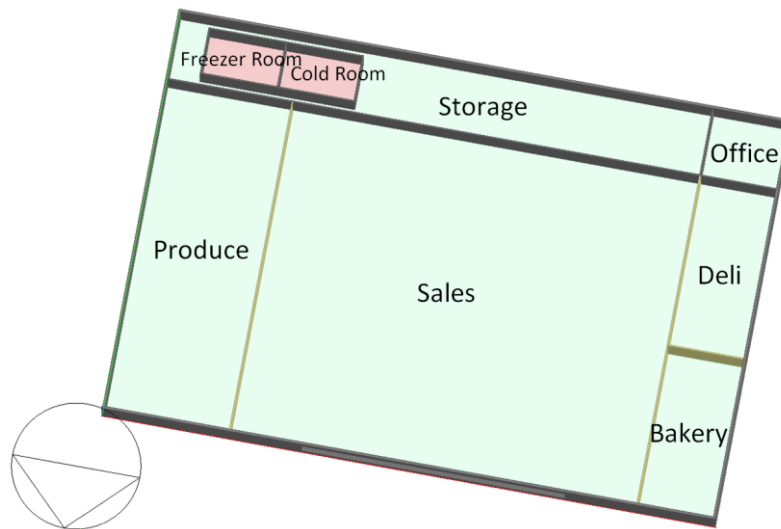


Figure 4 – Perspective Plan showing designated areas within the Supermarket

Building Construction

The supermarket model has been constructed according to the BCA 2010 requirements for climate zones 5 and 7, a summary is listed below:

| BCA Climate Zone | Insulation (Total R-Value) | | | DTS Fenestration | | | |
|------------------|----------------------------|-------|--------|-------------------------------|------|-----------|--------------|
| | Ceilings | Walls | Floors | U-Value (W/m ² ·K) | SHGC | Glazing % | Glazing Type |
| 5 | 3.2 | 2.8 | Nil | 5.8 | 0.82 | 37 | clear 6mm |
| 7 | 3.7 | 2.8 | 1.0 | 5.8 | 0.82 | 34 | clear 6mm |

Table 3 – BCA2010-compliant insulation and fenestration for Supermarket

The external wall was constructed as 110mm concrete with bulk insulation, nominal air gap and 10mm plasterboard as the internal lining board.

To comply with BCA2010, single layer **clear 6mm** glass set in standard commercial aluminium frames is chosen. The U-Value is 5.8 (W/m²K) and the SHGC is 0.82. The Glazing Calculator was then used to determine the maximum complying height.

| BCA Climate Zone | Height of Window (m) | Total Width of Window (m) | Window Area (m ²) |
|------------------|----------------------|---------------------------|-------------------------------|
| 5 | 2.25 | 53 | 119.25 |
| 7 | 2.06 | 53 | 109.18 |

Table 4 – Supermarket glazing sizes

DTS Lighting

The supermarket zone areas and the DTS (BCA2010 TableJ6.2a) lighting power densities are listed in **Error! Reference source not found.** The type of lighting is not required to be specified in the simulation software.

| | Produce | Sales | Bakery | Deli | Office | Dry Storage |
|-------------------------------------|---------|-------|--------|------|--------|-------------|
| Lighting Energy (W/m ²) | 22 | 22 | 22 | 22 | 8 | 9 |

Table 5 – BCA2010 compliance lighting requirement for the supermarket

DTS HVAC System

A ducted direct expansion heat pump Constant Air Volume HVAC system has been chosen for this supermarket model. The fan pressure is 700 Pa and 70% efficiency, cooling CoP is 3.4, heating CoP is 1.7. Return air is via a ceiling plenum. Details of the system are shown below:

Walk-In Cool Room and Freezer Room

The tables below show the calculated size of the Cool Room and the Freezer Room that are adjacent to each other in the Supermarket.

| Room | CoP | Compressor (W) | Pressure (Pa) | Fan Efficiency | Fan Power (W) |
|---------|------|----------------|---------------|----------------|---------------|
| Cold | 1.65 | 858 | 200 | 0.5 | 138.1 |
| Freezer | 1.36 | 1,418 | 200 | 0.5 | 60.6 |

Table 6 – Cold room and freezer room compressor and fan sizes in the Supermarket

ⁱ RMYs can be generated using a range of weightings for the weather elements to select climate conditions pertinent to the energy performance of specific building types. See [Lee, 2011](#).