1. INTRODUCTION
PROJECT SUMMARY
The building is a 35 storey commercial tower with 30,000m² (NLA) located in the Sydney Central Business District. The building was constructed in 1975, with major renovations in 1996 and 2008.

SPECIAL FEATURES
The project included a major refurbishment of the building services including mechanical, lighting, BMS, energy and water systems.

- Innovative features considered during the renovation include tri-generation with absorption chillers, blackwater treatment, and intelligent lighting systems

OWNER: Brookfield Multiplex
TENANT: AIG

Brochure author: Lester Partridge
Contact: Lester.Partridge@aecom.com

IEA – SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards
2. CONTEXT AND BACKGROUND

BACKGROUND
• The is located in the Sydney CBD. Sydney is a temperate climate with warm to hot summers, and cool to cold winters.
• The building is surrounded on all sides by buildings of similar size and scale, providing shading to the various facades throughout the day.

OBJECTIVES OF THE RENOVATION
• The existing building was rated less than 2.5 Stars on the NABERS rating scheme for energy performance. The renovation was intended to raise the star rating to a minimum of 4.5 Stars by upgrading the mechanical and electrical services.

SUMMARY OF THE RENOVATION
• High COP chiller replacement
• Upgrade of BMS from 1996 technology
• Use of VSDs and high efficiency motors
• Reduction in lighting power usage and installed intelligent daylight control with perimeter daylight harvesting.
• Potential energy savings of 300MJ/sqm/ann or 70 kg CO\textsubscript{2}/sqm/ann
• Other options considered included CHP system and blackwater treatment
3. DECISION MAKING PROCESSES

The building owners were Brookfield Multiplex and the major tenant was AIG. At the time AIG (being in the insurance industry) recognised the importance of climate change and the impact of climate change on insurance payouts. As a consequence the company sought to upgrade its tenancies to be more energy efficient and reflect expected standards.

The existing building was originally rated at 2.5 Star NABERS with no Green Star rating. The scope was to improve this to a 4.5 Star NABERS Energy (Target 5 Star) and 5 Star Green Star rating.

After undertaking design and modelling of the improvements the tenancy issues resulted in only some of the upgrade work being undertaken.

The building is currently sitting at 4.5 Stars with no trigen or upgrade to tenant lighting or on-floor AC.

With respect to the Green Star, the building has achieved:

- 5 Green Star Design
- 4 Star Green Star As Built
4. BUILDING ENVELOPE

**Roof construction**: \( U \)-value: 0.32 W/m\(^2\).K
- Materials: (Interior to exterior):
  - Mineral fibre slab: 100 mm
  - Cast concrete slab: 150 mm
  - Total: 250 mm

**Wall construction 1**: \( U \)-value: 2.17 W/m\(^2\).K
- Materials: (Interior to exterior):
  - Gypsum Plasterboard: 13 mm
  - Airgap: 2 mm
  - Lightweight metallic cladding: 15 mm
  - Total: 28 mm

**Wall construction 2**: \( U \)-value: 2.71 W/m\(^2\).K
- Materials: (Interior to exterior):
  - Concrete block: 110 mm

**Windows**: \( U \)-value: 2.56 W/m\(^2\).K
- Double glazed, gas filled cavity
- Materials: (Interior to exterior):
  - Clear float: 4 mm
  - Argon filled cavity: 0.76 mm
  - Green Tint: 6 mm
  - Total: 10.76 mm
5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY
The overall approach to the design was to improve the overall energy performance through new technology and improved control.

EXISTING BUILDINGS SERVICES
- Chilled Water Refrigeration
- Gas Fired Heating
- Variable Air Volume
- T8 Lighting
- 1996 BMS Technology
6. ENERGY PERFORMANCES

Energy vs Greenhouse Gas Emissions

- Energy
- Greenhouse Gases

5 Star NABERS kgCO₂ Target
6. ENERGY PERFORMANCES

Energy vs Greenhouse Gas Emissions

- **Energy**
- **Greenhouse Gases**

5 Star NABERS kgCO₂ Target

Actual
6. ENERGY PERFORMANCES

Energy vs Greenhouse Gas Emissions

- Energy
- Greenhouse Gases

<table>
<thead>
<tr>
<th>Energy (MJ/sq.m pa)</th>
<th>Greenhouse Gas Emissions (kgCO₂/sq.m pa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>Modelled - Existing</td>
</tr>
</tbody>
</table>

[Diagram showing energy and greenhouse gas emissions comparison]

[SHC International Energy Agency]

[AECOM]
CHILLERS

Replaced with Machines that have:
• Variable Speed Compressors
• High Coefficients of Performance
• Extended Evaporator Vessels

Reference: www.automatedbuildings.com
STRATEGIES

PUMPS & FANS

- Variable Speed Pumping Circuits
- Install VSDs
- High Efficiency Motors
STRATEGIES

BASE BUILDING – COMMON AREA LIGHTING:

• Amenities areas: 15 → 10 W/m²
• Foyer areas lamp replacement
• Tungsten halogen → Compact fluorescent
• Plantroom and car park

TENANCIES – OPEN PLAN AREAS:

• 12 → 5.9 W/m²
• Intelligent control:
  • PIR: Motion
  • PE: Daylight
STRATEGIES

DAYLIGHTING

- Photoelectric cells

Daylight Factor >2.5
STRATEGIES

LIGHTING – ZONING

- PIR cell Switching afterhours
6. ENERGY PERFORMANCES

Energy vs Greenhouse Gas Emissions

- Energy
- Greenhouse Gases

Actual | Modelled - Existing | Modelled - New

Energy (MJ/sq.m pa) | Greenhouse Gas Emissions (kgCO₂/sq.m pa)

0 | 0
100 | 20
200 | 40
300 | 60
400 | 80
500 | 100
600 | 120
700 | 140
160 | 160
TRI-GENERATION

ELECTRICITY  GAS  HOT WATER  CHILLED WATER

GENERATOR  ABSORPTION CHILLER

Graph showing load (W/m²) against annual hours with lines for Singapore, Sydney, and Electrical. The graph highlights 'Tri-gen 1'.
## TRI-GENERATION

### Greenhouse Gas Factor (kgCO₂/kWh)

<table>
<thead>
<tr>
<th></th>
<th>Tropical (Singapore)</th>
<th>Temperate (Sydney)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Total Building Energy and Greenhouse Gas Emissions

#### Sydney

<table>
<thead>
<tr>
<th></th>
<th>Total Building Energy</th>
<th>Greenhouse Gas Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electricity kWh/m²</td>
<td>Gas kWh/m²</td>
</tr>
<tr>
<td>Without Tri-gen</td>
<td>78.8</td>
<td>7.73</td>
</tr>
<tr>
<td>With Tri-gen</td>
<td>53.0</td>
<td>75.6</td>
</tr>
<tr>
<td>Reduction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Singapore

<table>
<thead>
<tr>
<th></th>
<th>Total Building Energy</th>
<th>Greenhouse Gas Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Electricity kWh/m²</td>
<td>Gas kWh/m²</td>
</tr>
<tr>
<td>Without Tri-gen</td>
<td>135</td>
<td>1.10</td>
</tr>
<tr>
<td>With Tri-gen</td>
<td>88</td>
<td>92.5</td>
</tr>
<tr>
<td>Reduction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. ENVIRONMENTAL PERFORMANCE

- **GREENHOUSE GAS EMISSIONS**

- **WATER CONSUMPTION**
  - Water Efficient Fittings
  - Fire Test Recycling
  - Cooling Towers (6 cycles of Concentration)
  - Blackwater Treatment (Considered)

<table>
<thead>
<tr>
<th></th>
<th>Per Annum</th>
<th>Pre-Upgrade</th>
<th>Post Upgrade</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Tenant Costs</td>
<td></td>
<td>$299k</td>
<td>$153k</td>
<td>$146k</td>
</tr>
<tr>
<td>Base Building CO₂</td>
<td></td>
<td>4,900 tonnes</td>
<td>2,500 tonnes</td>
<td>2,400 tonnes</td>
</tr>
<tr>
<td>Tenancy CO₂</td>
<td></td>
<td>4,700 tonnes</td>
<td>2,400 tonnes</td>
<td>2,300 tonnes</td>
</tr>
</tbody>
</table>

Saving at least 12.6 Million litres p.a

![Graph showing water usage and savings](image-url)
8. MORE INFORMATION

RENOVATION COSTS

- Do Nothing Case
- Level 1 - Tune up and minor refurb
- Level 2 - Intermediate refurb
- Level 3 - Major Refurbishment
- Level 4 - Complete Refurbishment
- Level 5 - Knock down rebuild