388 George St, Sydney, Australia

1. INTRODUCTION

PROJECT SUMMARY

The building is a 35 storey commercial tower with 30,000m^2 (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
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IEA – SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards

2. CONTEXT AND BACKGROUND

BACKGROUND

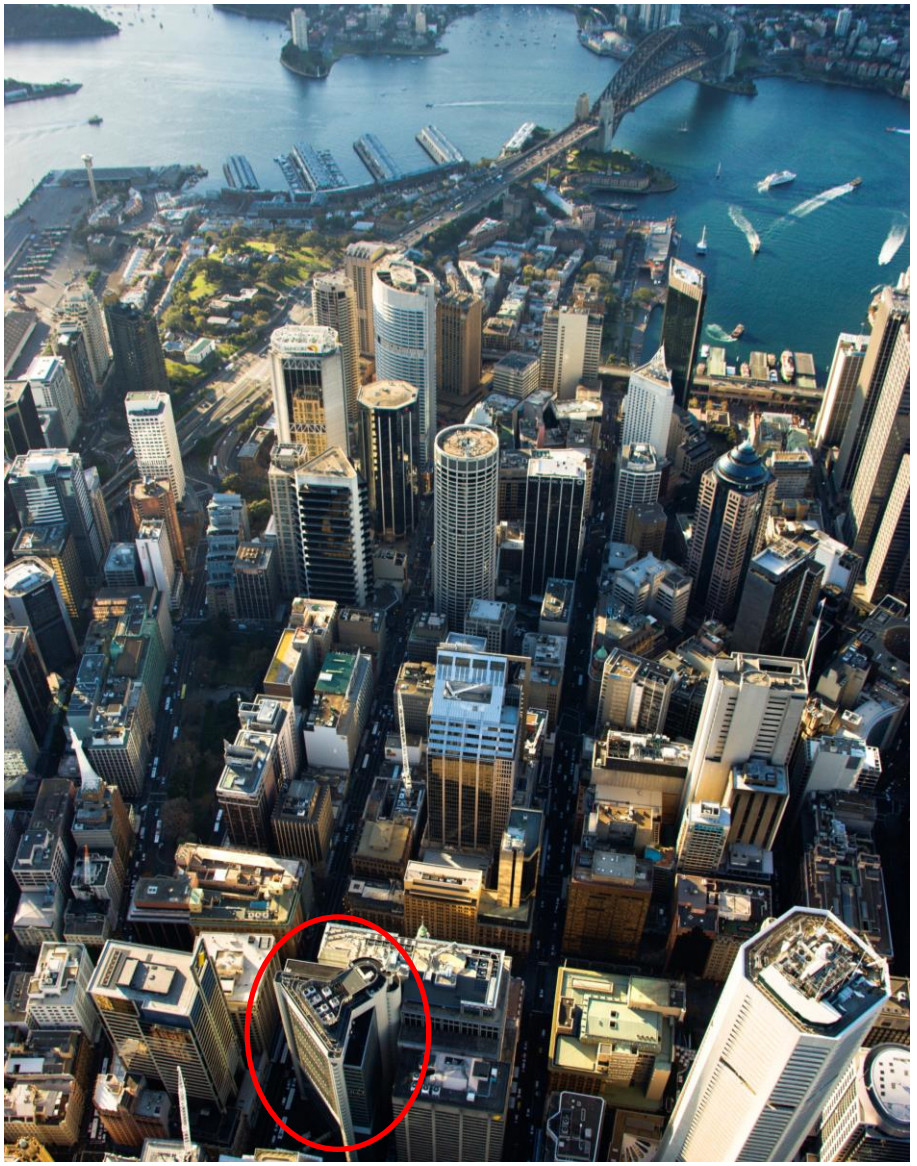
- *The is located in the Sydney CBD. Sydney is a temperate climate with warm to hot summers, and cool to cold winters.*
- *The building is surrounded on all sides by buildings of similar size and scale, providing shading to the various facades throughout the day.*

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 day light control with perimeter daylight harvesting.*
- *Potential energy savings of 300MJ/sqm/ann or 70 kg CO_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.

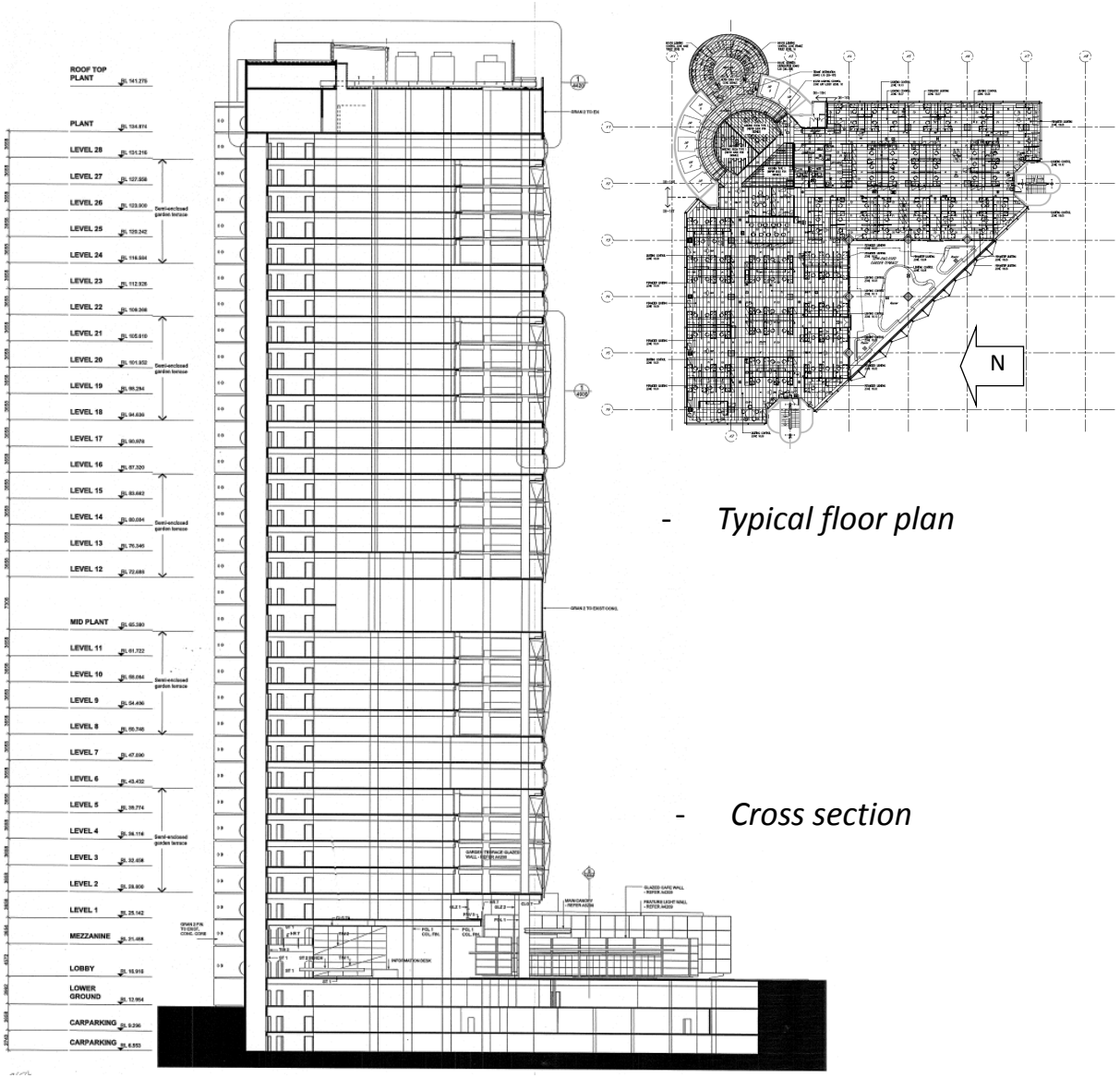
After undertaking design and modelling of the improvements the tenancy issues resulted in only some of the upgrade work being undertaken.

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



- *Typical floor plan*

- *Cross section*

4. BUILDING ENVELOPE

Roof construction : *U-value: 0.32 W/m².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/m².K*

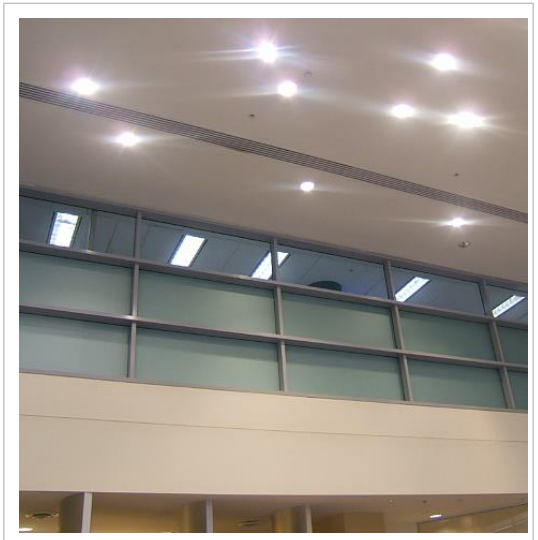
Materials . (Interior to exterior):	
Gypsum Plasterboard	*13 mm*
Airgap	
Lightweight metallic cladding	*15 mm*
Total	*28 mm*

Wall construction 2: *U-value: 2.71 W/m².K*

Materials . (Interior to exterior):	
Concrete block	*110 mm*

Windows : *U-value: 2.56 W/m².K*
Double glazed, gas filled cavity

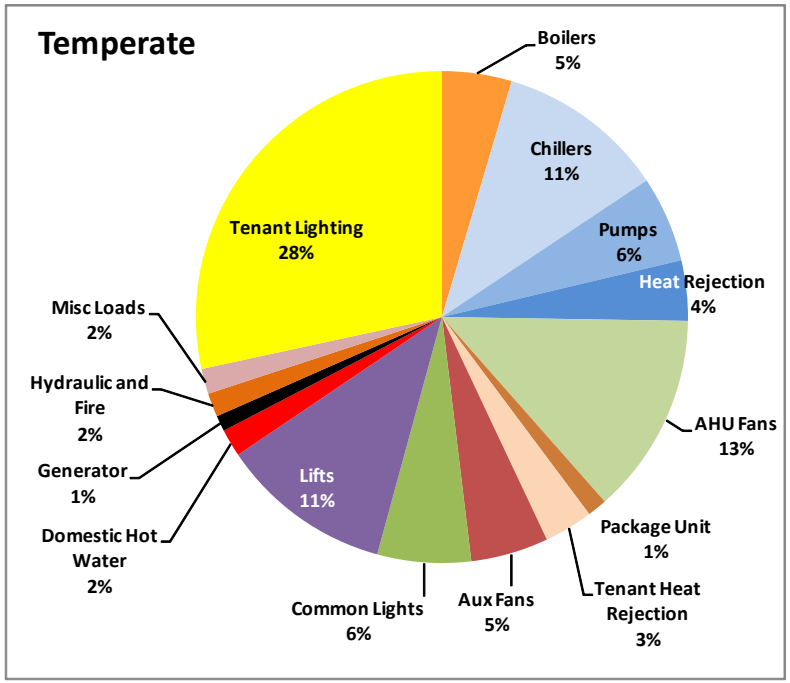
Materials . (Interior to exterior):	
Clear float	*4 mm*
Argon filled cavity	*0.76 mm*
Green Tint	*6 mm*
Total	*10.76 mm*

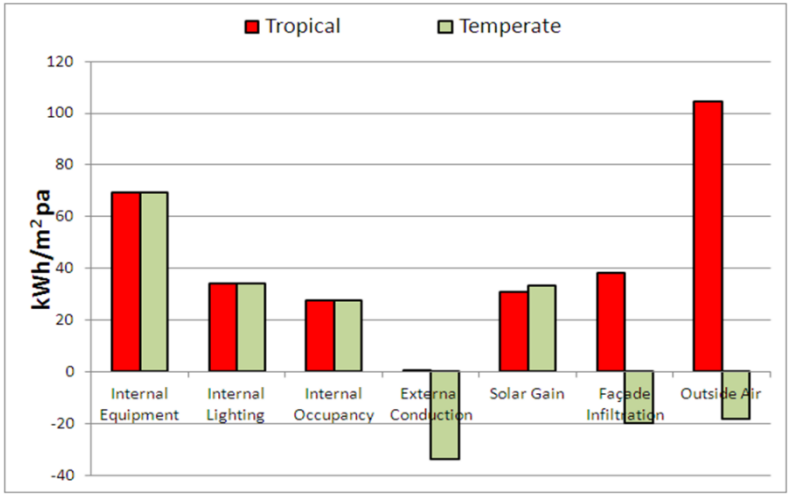


5. BUILDING SERVICES SYSTEM

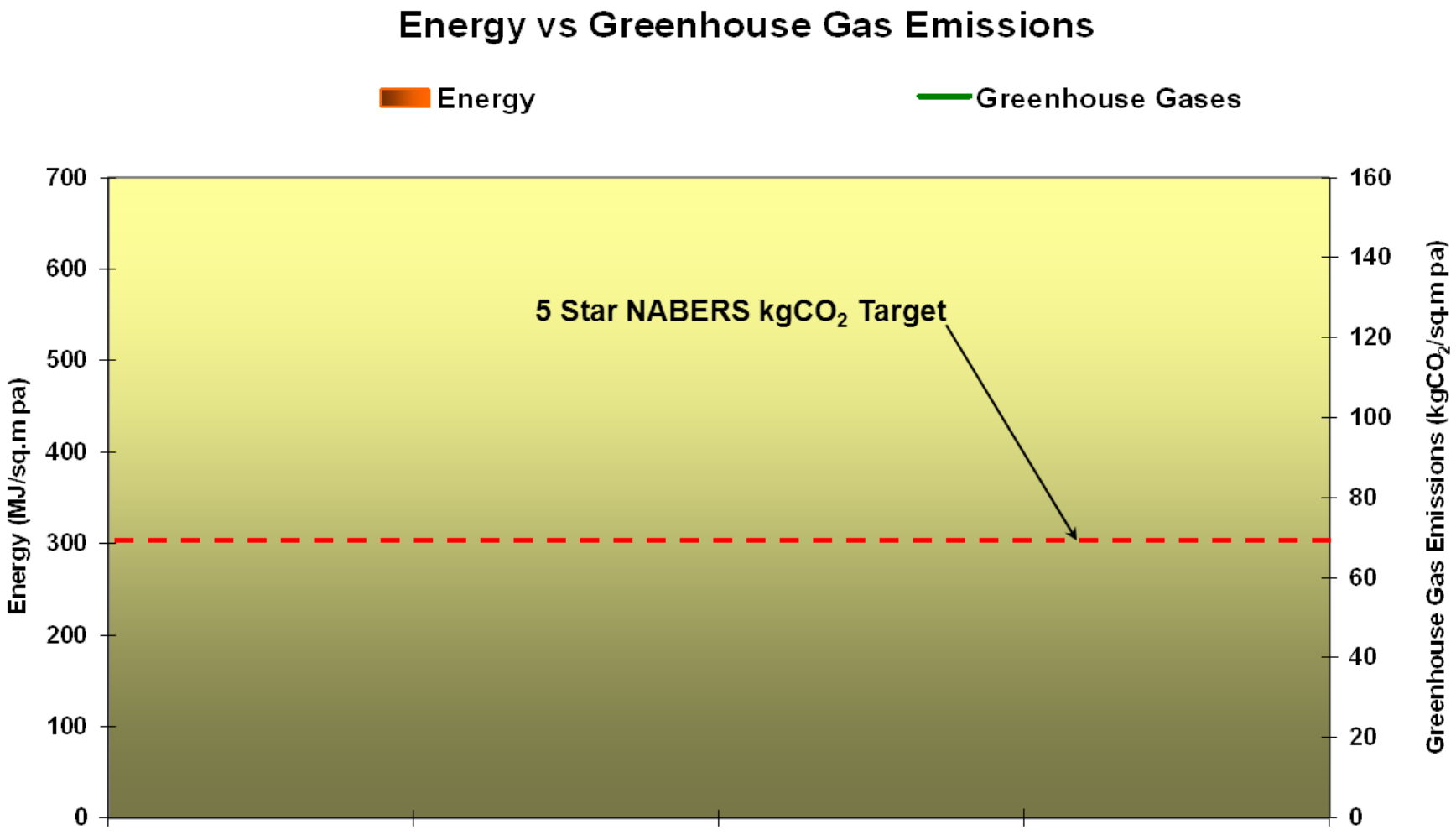
OVERALL DESIGN STRATEGY
The overall approach to the design was to improve the overall energy performance through new technology and improved control.

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





6. ENERGY PERFORMANCES



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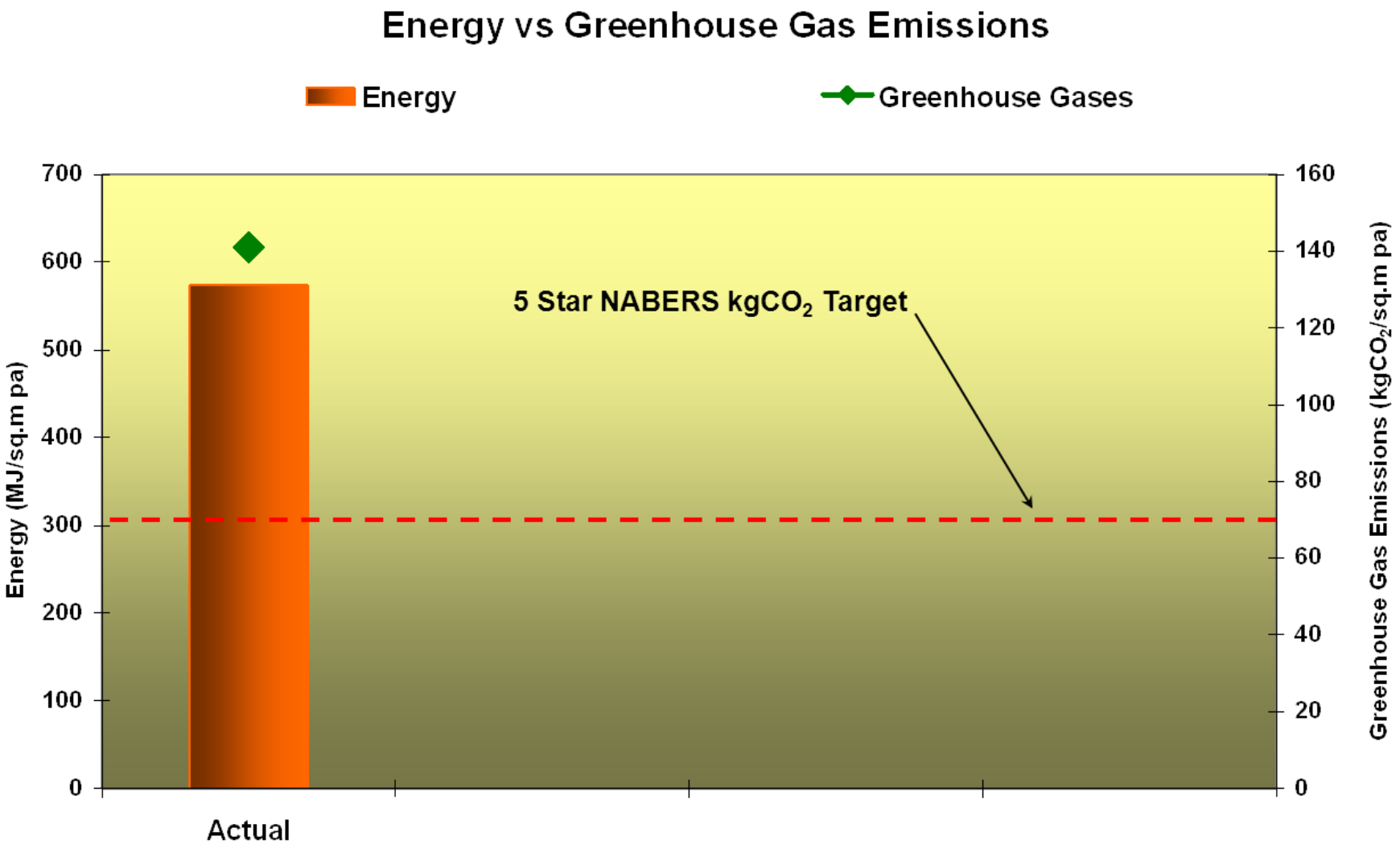
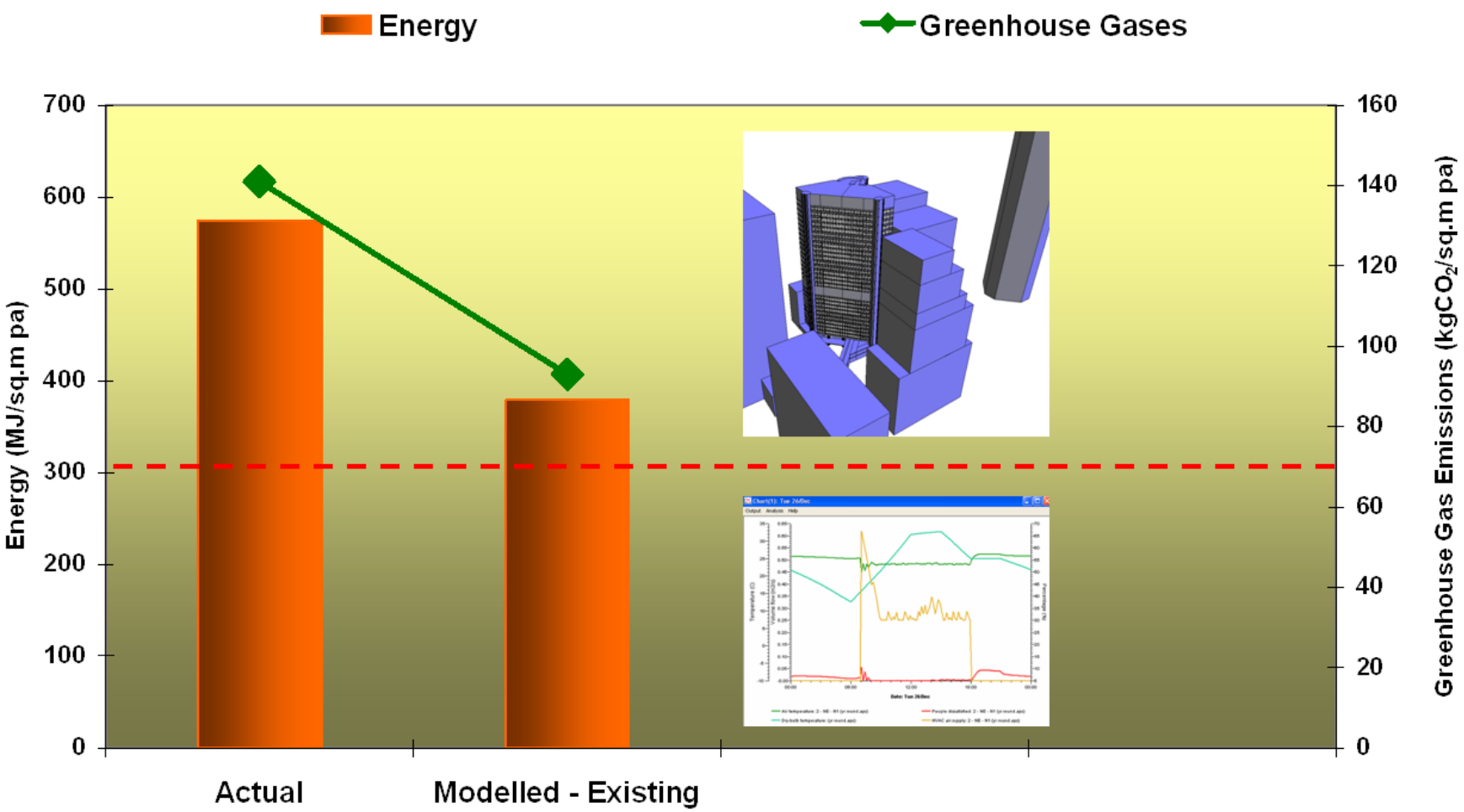
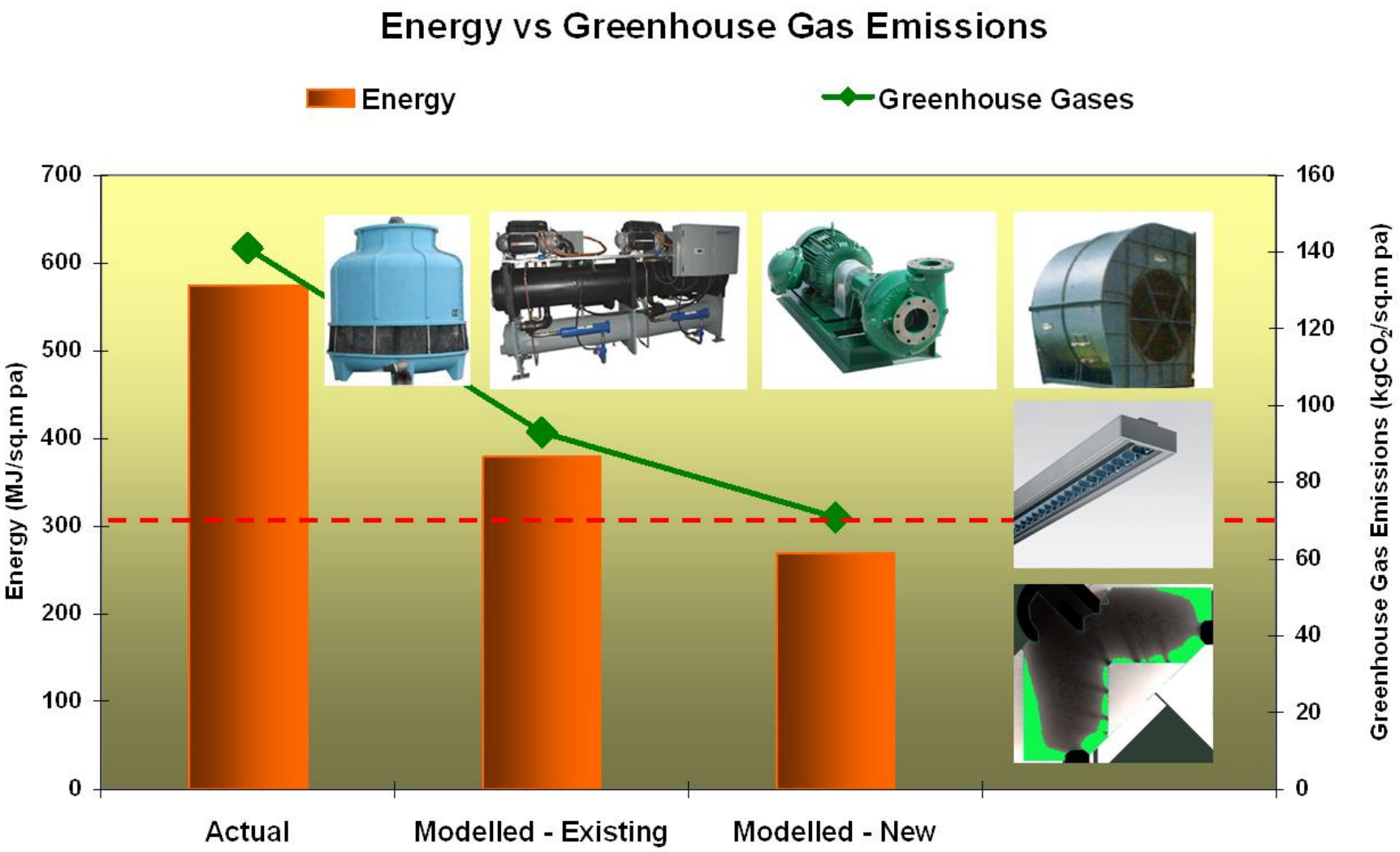


Energy vs Greenhouse Gas Emissions



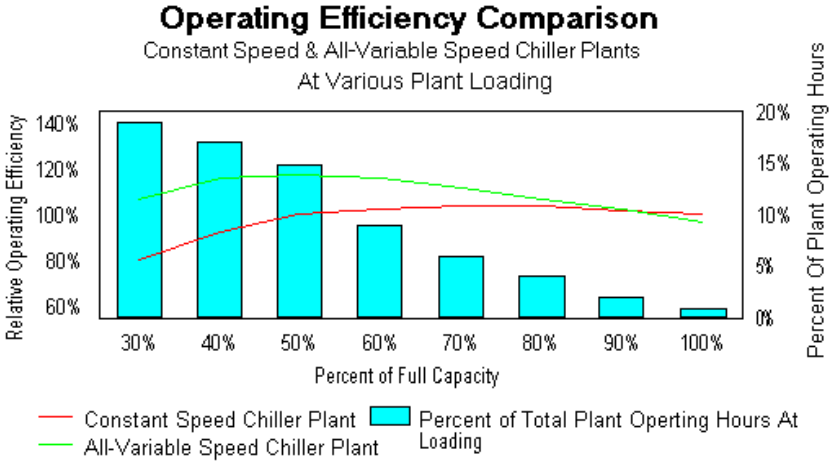

Energy vs Greenhouse Gas Emissions
Energy
Greenhouse Gases
Energy (MJ/sq.m pa)
Greenhouse Gas Emissions (kgCO2/sq.m pa)
700
600
500
400
300
200
100
0
160
140
120
100
80
60
40
20
0
Actual
Modelled - Existing
Modelled - New

STRATEGIES

CHILLERS

Replaced with Machines that have:

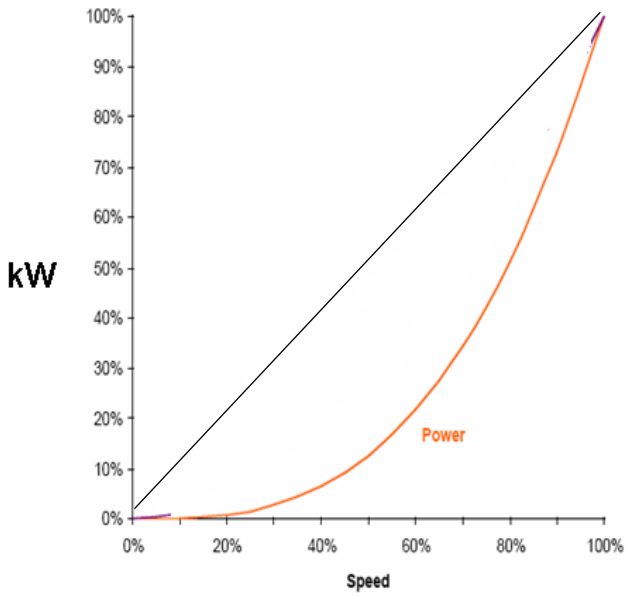
- Variable Speed Compressors
- High Coefficients of Performance
- Extended Evaporator Vessels



STRATEGIES

PUMPS & FANS

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



STRATEGIES

BASE BUILDING –
COMMON AREA LIGHTING:

- Amenities areas: 15 → 10 W/m^2
- Foyer areas lamp replacement
- Tungsten halogen → Compact fluorescent
- Plantroom and car park

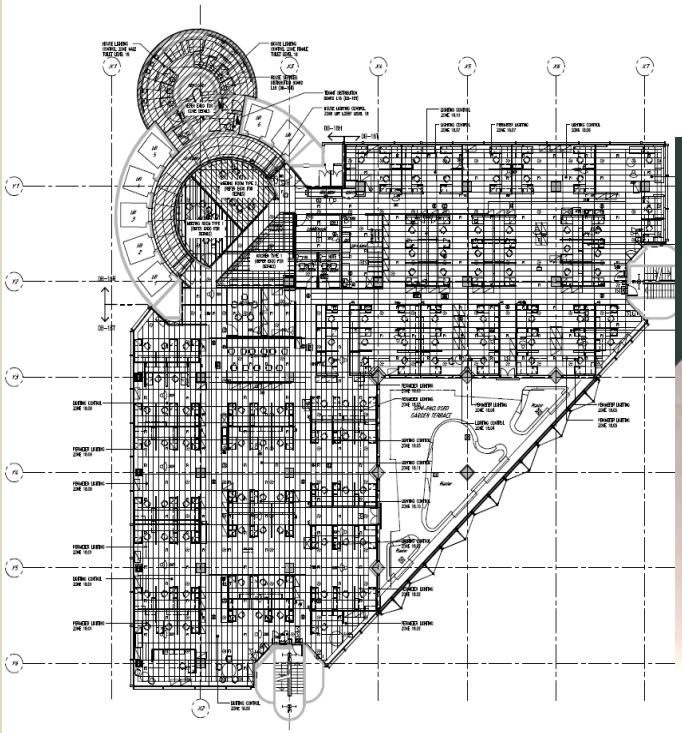
TENANCIES –
OPEN PLAN AREAS:

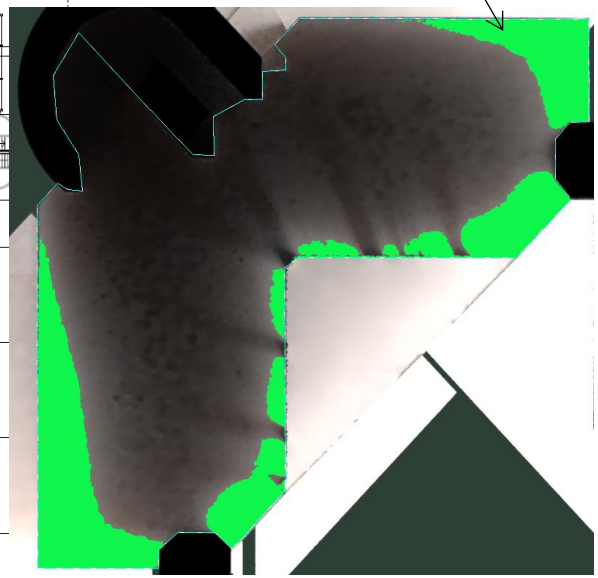
- 12 → 5.9 W/m^2
- Intelligent control:
- PIR: Motion
- PE: Daylight

STRATEGIES

DAYLIGHTING

- Photoelectric cells

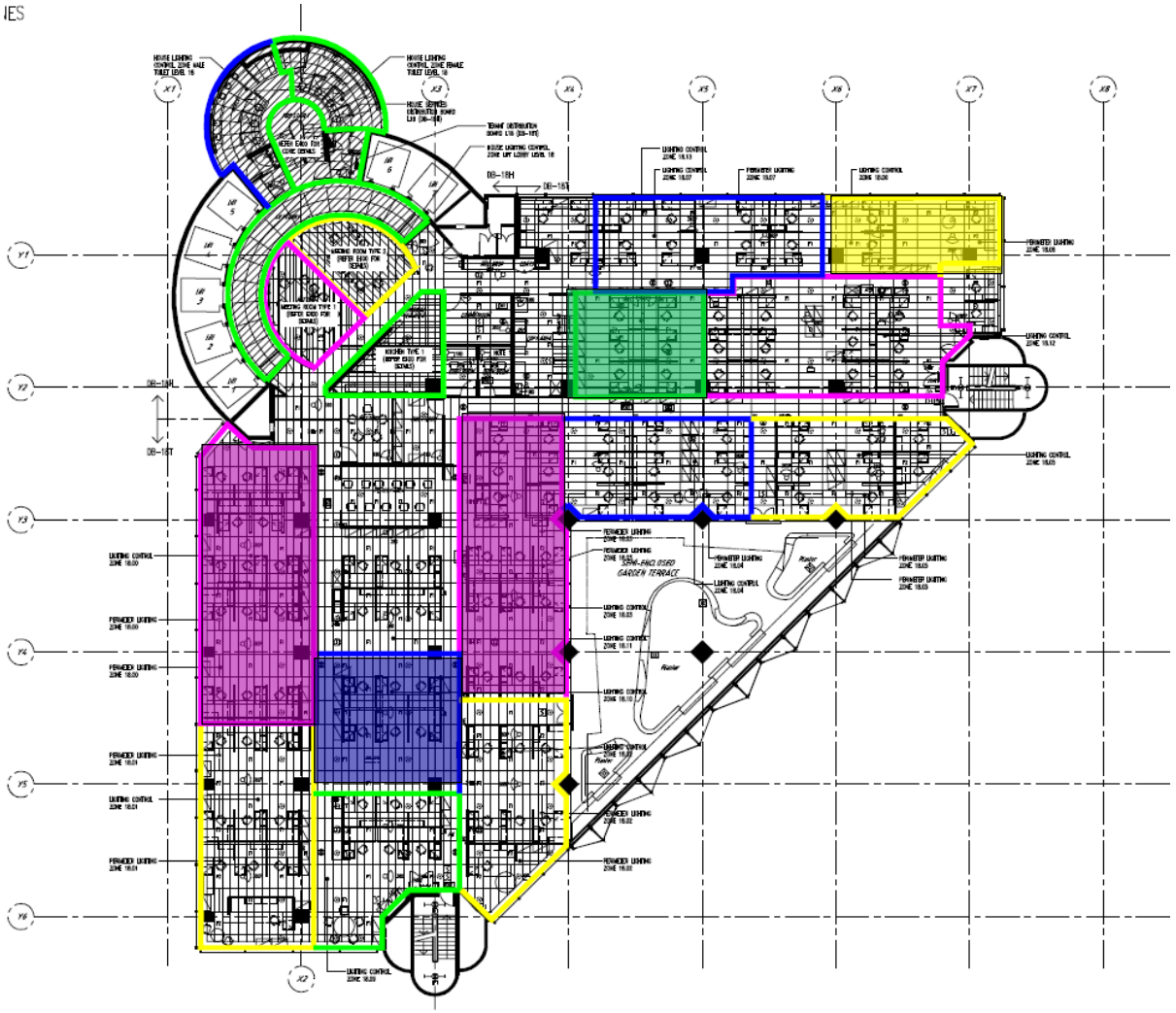


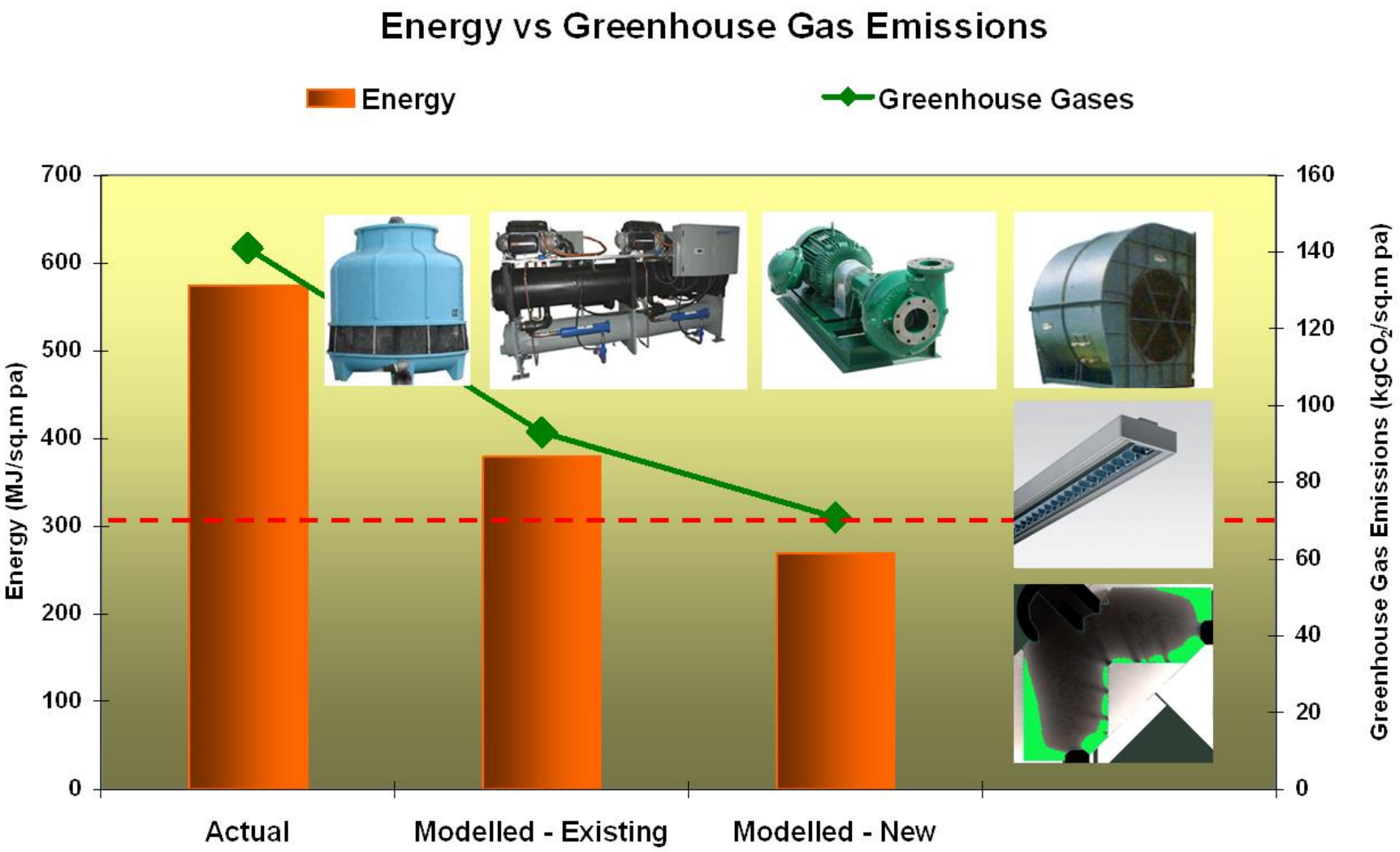


STRATEGIES

LIGHTING – ZONING

- PIR cell Switching afterhours

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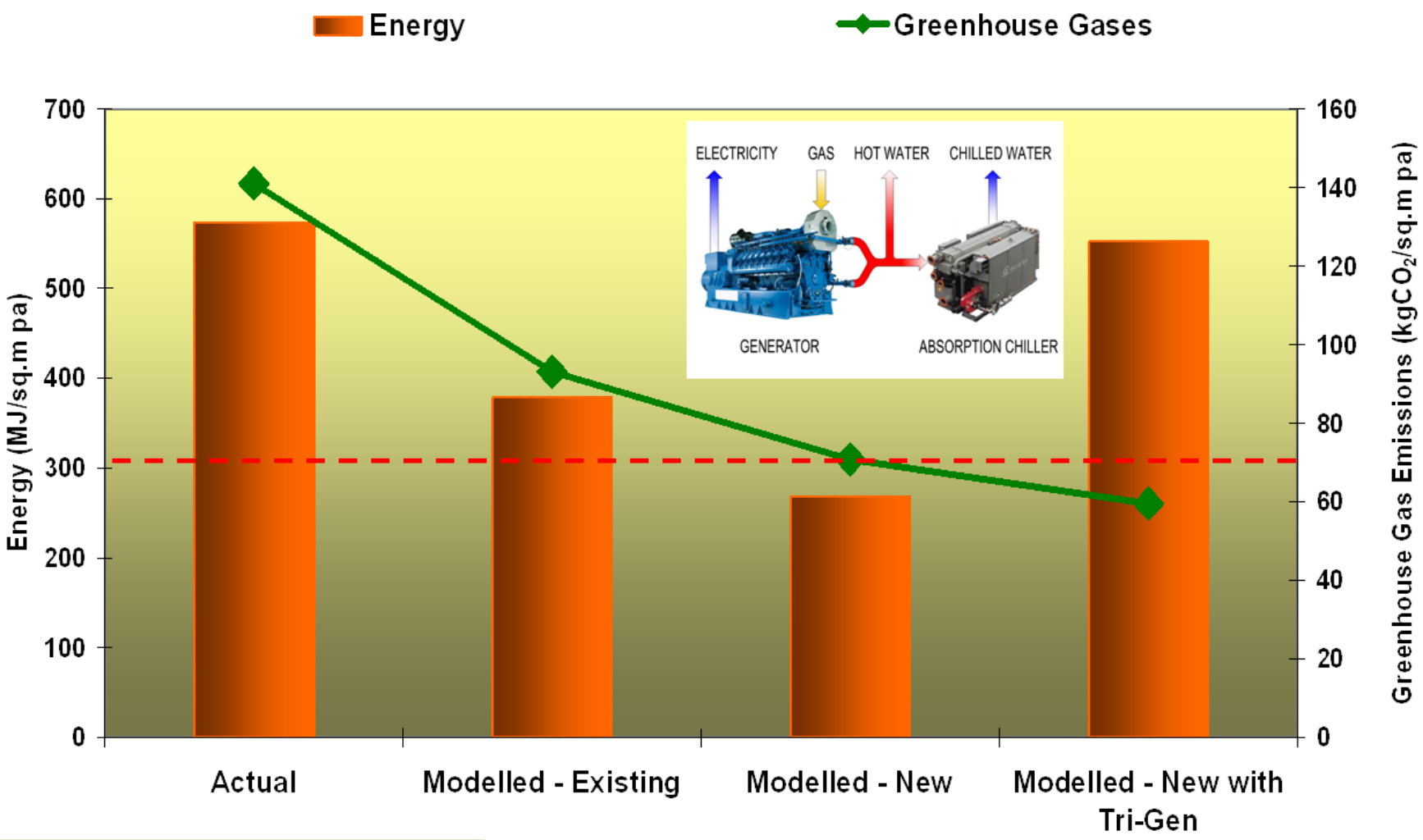
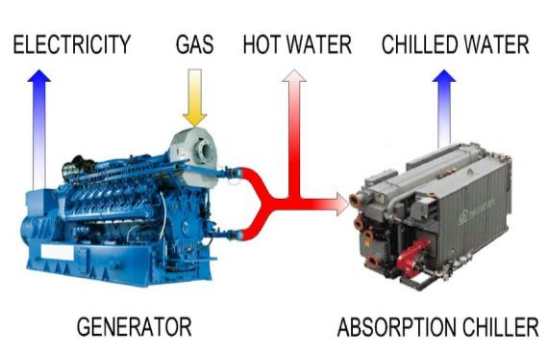
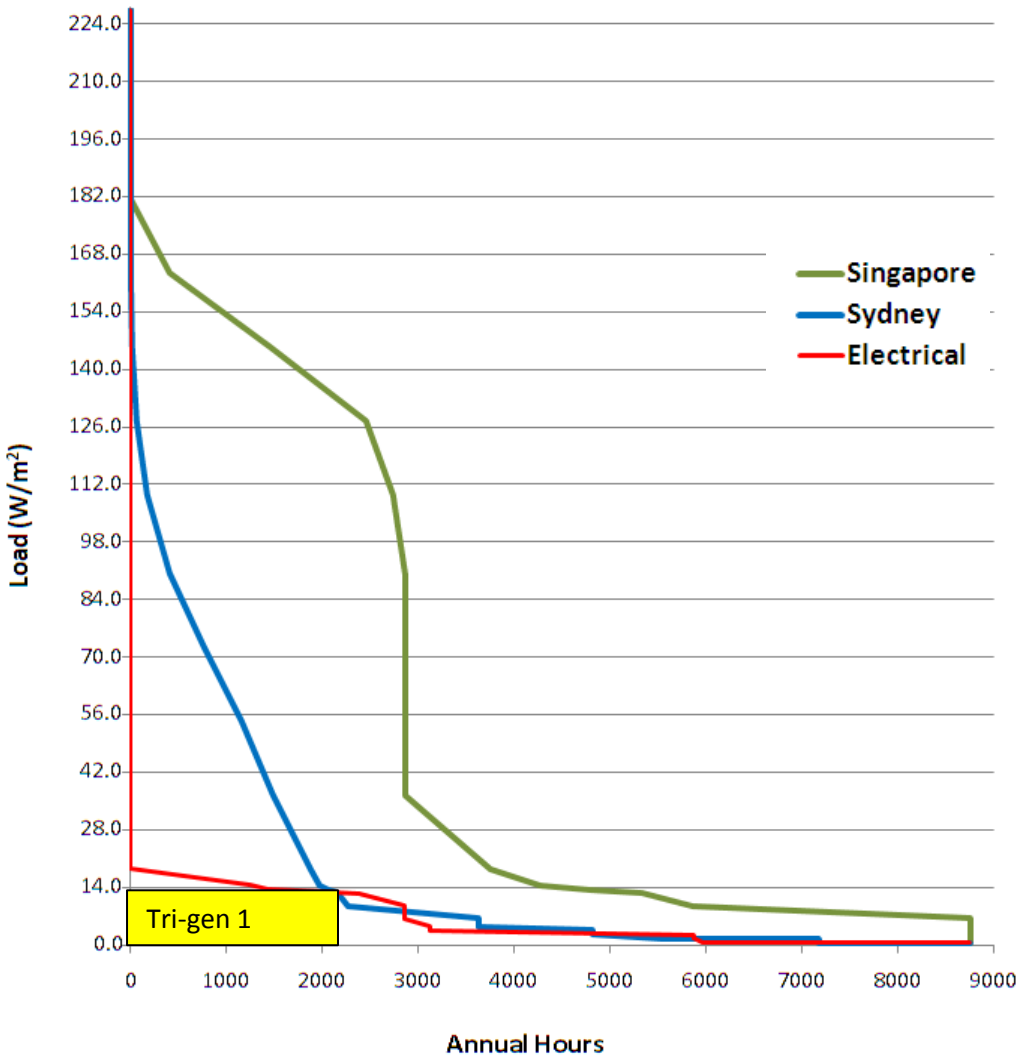


TRI-GENERATION





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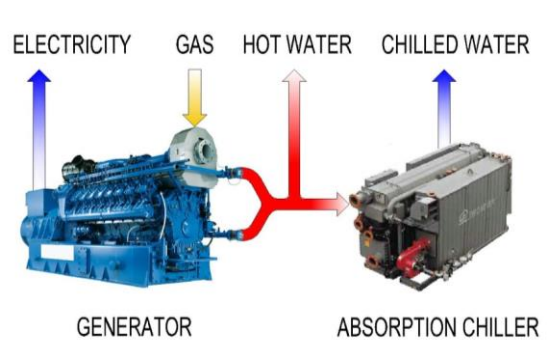
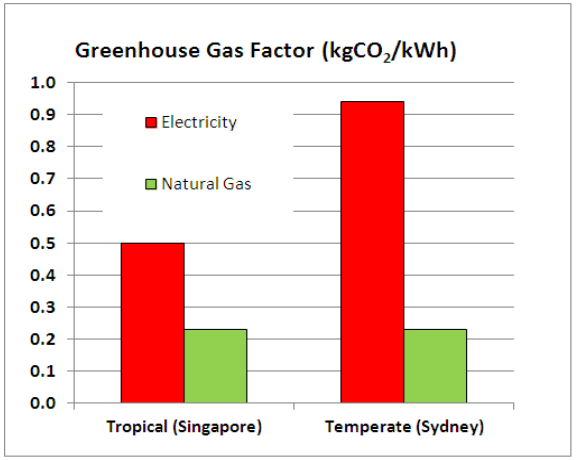




Sydney	Total Building Energy			Greenhouse Gas Emissions
	Electricity	Gas	Total	
	kWh/m^2	kWh/m^2	kWh/m^2	kgCO$_2$/m^2
Without Tri-gen	78.8	7.73	86.5	75.9
With Tri-gen	53.0	75.6	129	67.2
Reduction				11.5%

Singapore	Total Building Energy			Greenhouse Gas Emissions
	Electricity	Gas	Total	
	kWh/m^2	kWh/m^2	kWh/m^2	kgCO$_2$/m^2
Without Tri-gen	135	1.10	136	70.1
With Tri-gen	88	92.5	181	81.0
Reduction				-15.4%

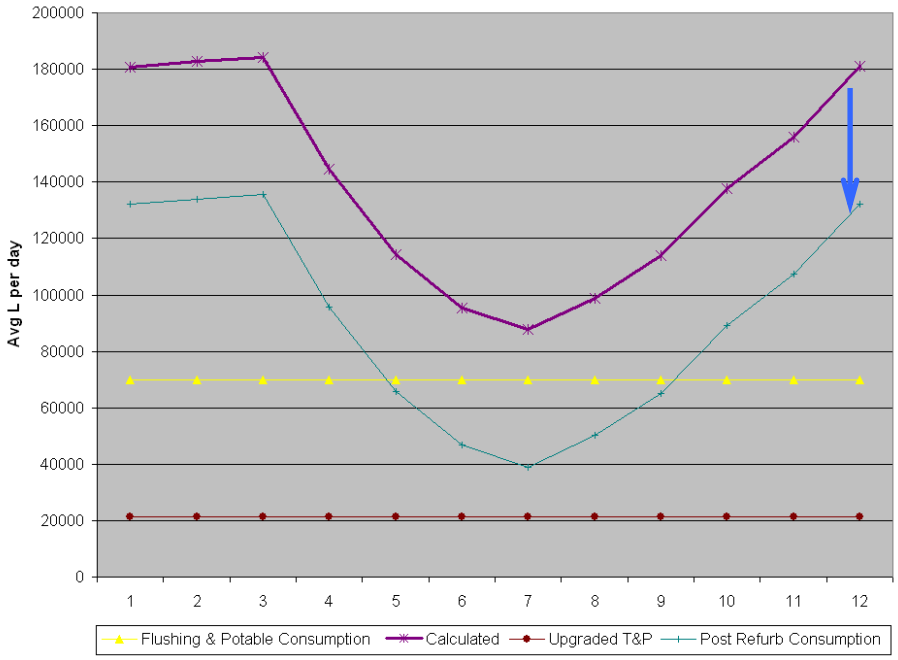
7. ENVIRONMENTAL PERFORMANCE

- GREENHOUSE GAS EMISSIONS

Per Annum	Pre-Upgrade	Post Upgrade	Saving
Estimated Tenant Costs	$299k	$153k	$146k
Base Building CO_2	4,900 tonnes	2,500 tonnes	2,400 tonnes
Tenancy CO_2	4,700 tonnes	2,400 tonnes	2,300 tonnes

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

Saving at least 12.6 Million litres p.a



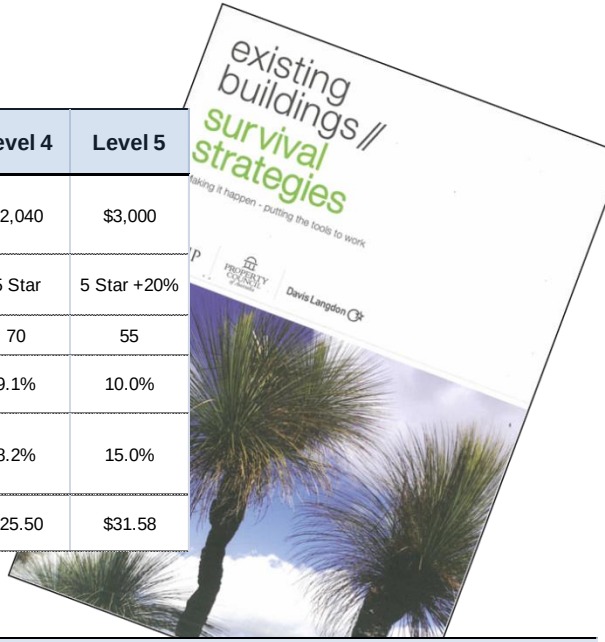
48.7 kL per day

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

	Do Nothing	Level 1	Level 2	Level 3	Level 4	Level 5
Capital Upgrade Cost (per m^2) (RHS)	$0	$35	$226	$980	$2,040	$3,000
NABERS Star Rating (LHS)	2.5 Star	3 Star	4 Star	4.5 Star	5 Star	5 Star +20%
$kgCO_2/m^2$	150	130	100	85	70	55
IRR (10 year DCF) (LHS)	3.9%	4.2%	5.1%	10.0%	9.1%	10.0%
Increase in Building Value (LHS)	0.0%	1.5%	6.5%	10.3%	8.2%	15.0%
Cost per kgCO2	$0.00	$1.75	$4.52	$15.08	$25.50	$31.58



PCA Study	Do Nothing	Level 1	Level 2	Level 3	Level 4	Level 5
Capital Cost per kgCO2	$0.00	$1.75	$4.52	$15.08	$25.50	$31.58
Reduction $kgCO_2/m^2$	-	20	50	65	80	95

AECOM Case Studies	Project A	Project B	Project C
Capital Cost per kgCO2	$12.08	$16.98	$12.72
Reduction $kgCO_2/m^2$	27.8	18.9	19.2

Trigeneration	4.8 W/m^2	9.6 W/m^2	12 W/m^2
Capital Cost per kgCO2	$3.93	$5.06	$5.50
Reduction $kgCO_2/m^2$	5.5	8.5	9.8

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SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY