LOW CARBON LIVING FORUM

COMMERCIAL BUILDING RETROFITS

Overview of best practice initiatives and frameworks

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University of South Australia

BACKGROUND – ENVIRONMENTAL RATINGS

There are numerous environmental rating systems/frameworks.

National

greenstar

the NatHERS Star

NABERS

An Australian Government Initiative

State Based

BASIX® Building Sustainability Index

NSW Planning & Environment

music by eWater STEPS

CITY SWITCH GREEN OFFICE

Local Government

FISHERMANS BEND STRATEGIC FRAMEWORK PLAN JULY 2014

Founding Partner CARBON NEUTRAL ADELAIDE

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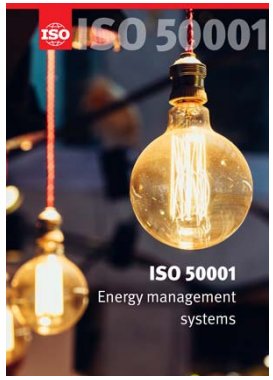
BACKGROUND – ENVIRONMENTAL RATINGS

International

ONE PLANET LIVING

LEED
LEARDERSHIP IN ENERGY & ENVIRONMENTAL DESIGN



NETZERO ENERGY BUILDING CERTIFICATION

BREEAM
CODE FOR A SUSTAINABLE BUILT ENVIRONMENT
BRE GLOBAL

LIVING BUILDING CHALLENGE

GRI Empowering Sustainable Decisions

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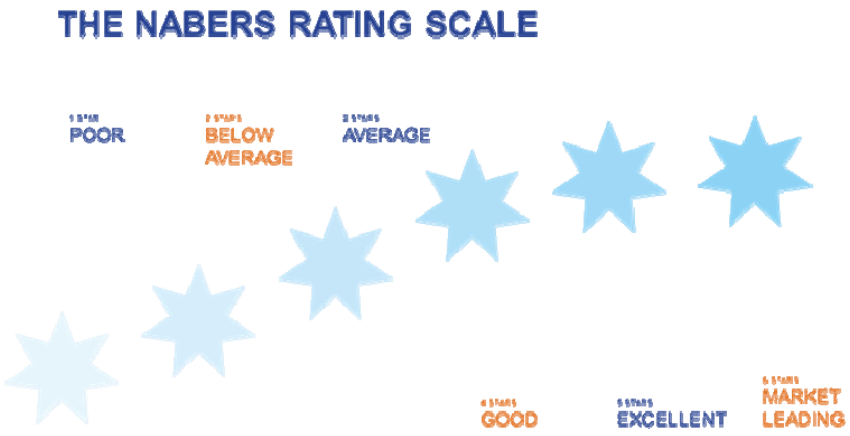
RATING CATEGORIES

Rating Framework	Rating Methodology	Driver
NatHERS	Design (theoretical) – Quantitative performance	Regulatory - NCC (min.) Voluntary - Local government (exceed min. performance)
NABERS	Operational – Quantitative performance	Regulatory – Commercial Building Disclosure (energy) Voluntary – benchmarking
Green Star	Design (prescriptive) Quantitative and Qualitative	Voluntary Property Council Office Guidelines Australian Leadership
One Planet Living	Operational – Quantitative and Qualitative	Differentiation Global Leadership

ENERGY MANAGEMENT STRATEGY – BUILDINGS / SITE-WIDE

Guiding Standards & Frameworks

- ISO 50001 Energy Management Systems
- AS/NZS 3598 Energy Audits
- Industry/organisational Benchmarking
- NABERS Energy Performance Ratings
- Minimum Energy Performance Standards (MEPS)



APPROACH & METHODOLOGY

GATE 1 - Prioritise

GATE 2 – Detailed Assessment

GATE 3 – Incumbent Contractor Coordination

GATE 4 – Business Case

GATE 5 – Stakeholder Engagement

GATE 6 – Implementation

GATE 7 – Performance Verification

GATE 1 – PRIORITISE BUILDING ORDER

- Benchmark individual building/system/end-use performance
- Establish priority criteria, including but not limited to: -
  - Worse performing buildings/systems
    (energy density; kWh/sqm)
  - Least critical operations
    (disruption impact assessment)
  - Planned capital expenditure
    (to avoid abortive works or opportunities to synchronise with CapEx projects)

GATE 1

GATE 2

GATE 3

GATE 4

GATE 5

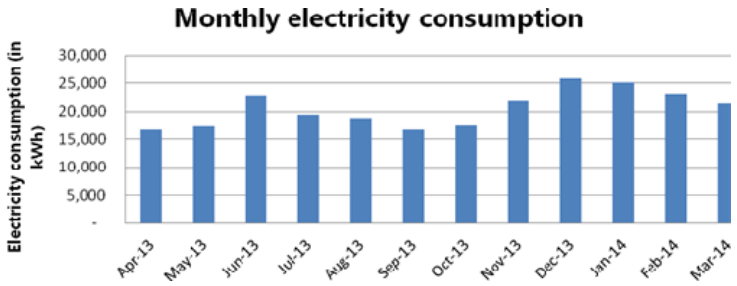
GATE 6

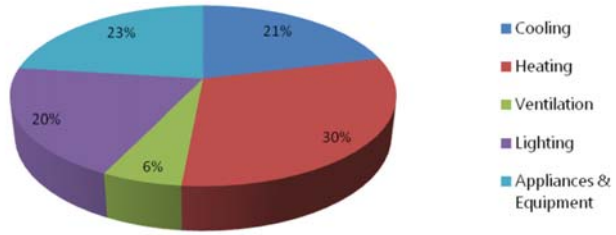
GATE 7

GATE 2 – DETAILED ASSESSMENT

- Documentation review
  (as installed drawings, O&M manuals, asset registers)
- Site survey
  (review plant, equipment, HVAC, lighting, BAS – condition and performance assessment)
- Energy analysis
  (energy balance and end use breakdown with pie charts, trends from historical data)
- Power demand analysis
  (peak vs average, off-peak, time of peak)
- Identify site measurement requirements
  (data logging, before & after)
- Identify suitable energy conservation measures (ECMs)

GATE 1
GATE 2
GATE 3
GATE 4
GATE 5
GATE 6
GATE 7





GATE 3 – INCUMBENT CONTRACTOR COORDINATION

- Review ECMs with FMs and maintenance contractors

  (discuss proposed initiatives and identify any issues)

- Risk analysis

  (conduct risk analysis for the implementation of ECMs with a focus on continuity of operations, service disruption/shut-downs, safety, cost and programme overruns)

GATE 1

GATE 2

GATE 3

GATE 4

GATE 5

GATE 6

GATE 7

	Consequences				
Likelihood	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A (Almost certain)	H	H	E	E	E
B (Likely)	M	H	H	E	E
C (Possible)	L	M	H	E	E
D (Unlikely)	L	L	M	H	E
E (rare)	L	L	M	H	H

Extreme Risk	E	immediate action required
High Risk	H	senior management attention needed
Moderate Risk	M	management responsibility to be specified
Low Risk	L	manage by routine procedures

GATE 4 – BUSINESS CASE

- Detailed description of each ECM

  (scope of works, procurement method, drawing mark-ups)

- Business case reporting

ECM	Capital Cost	Energy savings	Operational Cost Saving	Simple Payback Period	GHG Emissions Reduction
	($)	**(kWh p.a.)**	**($ p.a.)**	**(years)**	**(t CO_2-e p.a.)**
Item 1	$30,000	85,000	$14,500	2.1	110.5

- Building Analytics opportunities for integration

GATE 1

GATE 2

GATE 3

GATE 4

GATE 5

GATE 6

GATE 7

GATE 5 – STAKEHOLDER ENGAGEMENT

- Present ECMs to stakeholders
- Present programme for the proposed works including service interruptions and power outages
- Conduct risk assessment workshop
- Address any operational concerns and risks to continuity of service

GATE 1
GATE 2
GATE 3
GATE 4
GATE 5
GATE 6
GATE 7

Item	Scope of Works	Comments / Actions
11	Internal Zone Air Handling Unit Supply Air Temperature Shall be calculated based on 'average' space temperatures within respective zones. Any temperature sensors that are adversely affected by tenancy equipment or dumping air from ceiling registers shall be removed from the calculation sample.	Completed.
12	VAV Dead Band Incorporate a dead band control philosophy whereby each VAV damper is at minimum air flow position and the heating hot water reheat valve is closed (0%) when the space temperature is within the range of 21.0 and 23.0ºC DB via the BMS. Proportionally modulate the damper open when the space temperature exceeds 23.0ºC. Proportionally modulate the heating hot water valve open when the space temperature drops below 21.0ºC.	Completed. Ongoing maintenance works are associated with the following VAV's: i.e. NW L1, NW L2, NE L2, NE L3, NE L6,

GATE 6 – IMPLEMENTATION

- Develop technical scope of works, specification
- Develop engineering drawings and schematics
- Market tender | quotations with incumbent contractors
- Contractor engagement
- Oversee installation works

GATE 1

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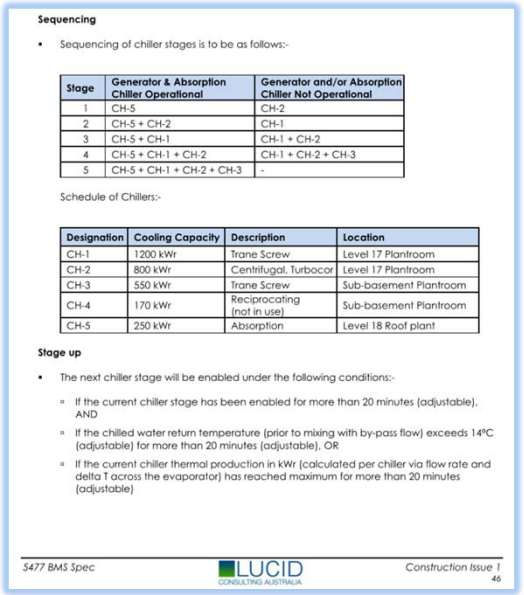
GATE 3

GATE 4

GATE 5

GATE 6

GATE 7



Sequencing

- Sequencing of chiller stages is to be as follows:-

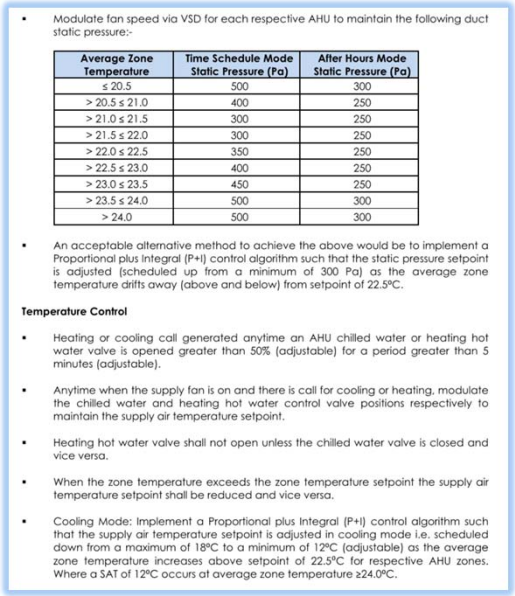
Stage	Generator & Absorption Chiller Operational	Generator and/or Absorption Chiller Not Operational
1	CH-5	CH-2
2	CH-5 + CH-2	CH-1
3	CH-5 + CH-1	CH-1 + CH-2
4	CH-5 + CH-1 + CH-2	CH-1 + CH-2 + CH-3
5	CH-5 + CH-1 + CH-2 + CH-3	-

Schedule of Chillers:-

Designation	Cooling Capacity	Description	Location
CH-1	1200 kWr	Trane Screw	Level 17 Plantroom
CH-2	800 kWr	Centrifugal, Turbocor	Level 17 Plantroom
CH-3	550 kWr	Trane Screw	Sub-basement Plantroom
CH-4	170 kWr	Reciprocating (not in use)	Sub-basement Plantroom
CH-5	250 kWr	Absorption	Level 18 Roof plant

Stage up

- The next chiller stage will be enabled under the following conditions:-
  - If the current chiller stage has been enabled for more than 20 minutes (adjustable), AND
  - If the chilled water return temperature (prior to mixing with by-pass flow) exceeds 14ºC (adjustable) for more than 20 minutes (adjustable), OR
  - If the current chiller thermal production in kWr (calculated per chiller via flow rate and delta T across the evaporator) has reached maximum for more than 20 minutes (adjustable)



- Modulate fan speed via VSD for each respective AHU to maintain the following duct static pressure:-

Average Zone Temperature	Time Schedule Mode Static Pressure (Pa)	After Hours Mode Static Pressure (Pa)
≤ 20.5	500	300
> 20.5 ≤ 21.0	400	250
> 21.0 ≤ 21.5	300	250
> 21.5 ≤ 22.0	300	250
> 22.0 ≤ 22.5	350	250
> 22.5 ≤ 23.0	400	250
> 23.0 ≤ 23.5	450	250
> 23.5 ≤ 24.0	500	300
> 24.0	500	300

- An acceptable alternative method to achieve the above would be to implement a Proportional plus Integral (P+I) control algorithm such that the static pressure setpoint is adjusted (scheduled up from a minimum of 300 Pa) as the average zone temperature drifts away (above and below) from setpoint of 22.5ºC.

Temperature Control

- Heating or cooling call generated anytime an AHU chilled water or heating hot water valve is opened greater than 50% (adjustable) for a period greater than 5 minutes (adjustable).
- Anytime when the supply fan is on and there is call for cooling or heating, modulate the chilled water and heating hot water control valve positions respectively to maintain the supply air temperature setpoint.
- Heating hot water valve shall not open unless the chilled water valve is closed and vice versa.
- When the zone temperature exceeds the zone temperature setpoint the supply air temperature setpoint shall be reduced and vice versa.
- Cooling Mode: Implement a Proportional plus Integral (P+I) control algorithm such that the supply air temperature setpoint is adjusted in cooling mode i.e. scheduled down from a maximum of 18ºC to a minimum of 12ºC (adjustable) as the average zone temperature increases above setpoint of 22.5ºC for respective AHU zones. Where a SAT of 12ºC occurs at average zone temperature ≥24.0ºC.

GATE 7 – PERFORMANCE VERIFICATION

- ‘Before’ and ‘After’
- Compare results against established energy performance indicators (EnPI)
- Utilise existing and new energy metering devices including variable speed drives
- Report on outcomes at 1, 3 and 6 months.

GATE 1

GATE 2

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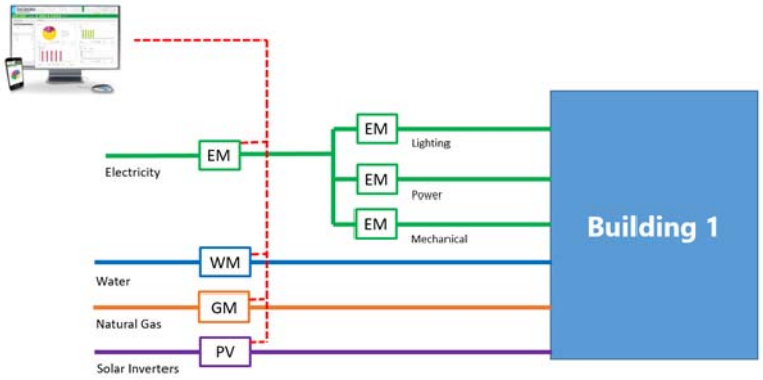
GATE 4

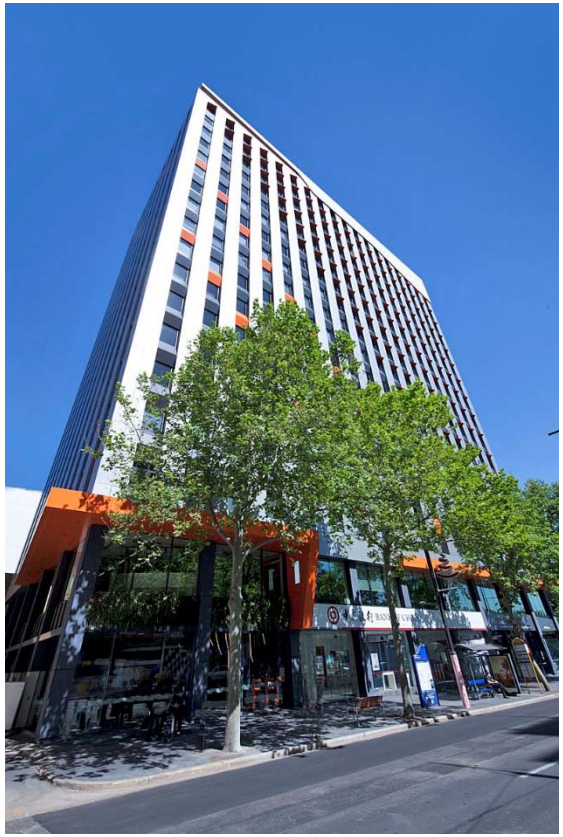
GATE 5

GATE 6

GATE 7



CASE STUDY – 1 KING WILLIAM STREET



CARBON NEUTRAL ADELAIDE AWARDS 2017

Finalist

Leadership & Influence Award

Awarded to:

Anvil Capital &
Lucid Consulting Australia

The Hon. Ian Hunter MLC
Minister for Climate Change

The Right Honourable Lord Mayor
Martin Haese

17 November 2017

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CARBON NEUTRAL ADELAIDE AWARDS 2017

Partner of the Year 2017

Awarded to:

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17 November 2017

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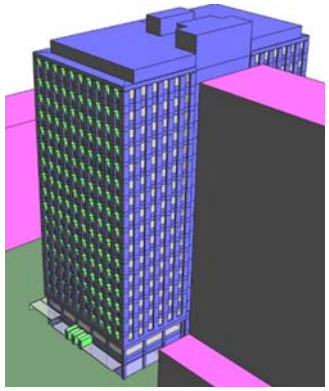
CASE STUDY – 1 KING WILLIAM STREET

Project Scope

Sustainable Energy System (SES) incorporating the following systems and technologies: -

- Tri-generation plant including a natural gas generator and absorption chiller
- Roof mounted solar photovoltaic (PV) array
- Replacement of existing chiller with a high efficiency, magnetic bearing 'frictionless' type chiller
- Upgraded building management system (BMS) complete with intelligent, efficient control strategies
- Outside air pre-conditioning cooling coils



CASE STUDY – 1 KING WILLIAM STREET

Project Scope (Cont.)

- Facade cladding incorporating insulated panels and ‘sun hood’ shading devices
- Roof mounted weather station to influence building heating and cooling strategies
- Utility energy metering and monitoring system (EMS) with a web-enabled ‘dashboard’ graphical interface
- Internal blinds with automated operation that follows the sun with solar radiation tracking technology
- End of Trip (EOT) cyclist facilities
- Electrical main switchboard replacement

CASE STUDY – 1 KING WILLIAM STREET

Project Objective

from 2 Star to +5 Star energy performance

Building Details

- 20,000 sqm,19 storey, Grade A commercial office, occupied, Adelaide CBD

Stage 1 Quick Wins Project

1. Energy audit & real-time BMS monitoring
2. Coordinate with incumbent contractors
3. Developed control philosophy modifications
4. Active commissioning witnessing and tuning

Stage 1 Outcomes

1. +1,000 GJ gas reduction in 3-months
2. +120,000 kWh electricity reduction
3. 1.5 Star NABERS improvement
4. $100k energy savings p.a.
5. Capital costs $45k
6. Financial payback < 6 months