Tamworth Hospital Redevelopment

Energy and Sustainability Report

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1 Executive Summary

This report addresses the requirements of the Consultant Scope of Services, Part F, including:

- Clause 3.4 Schematic Development Planning Phase 1
- Clause 4.4 Engineering and Technical Consultants
- Clause 4.5 mechanical Consultants
- Clause 4.6 Electrical Consultants
- Appendix 1 Clause 5.4 Part 3 Schematic Development

This schematic design report has been prepared by Steensen Varming for Health Infrastructure and outlines the design decisions which have been made during the schematic design stage.

In order to compile this report we have met with the hospital engineers and facilities management to identify and discuss energy initiatives and opportunities to suit the requirements of the Stage 2 development.

The project brief requires the proposed Tamworth facility's energy and water conservation measures to meet the requirements of NSW Health Technical Guidelines (TS-11 – Version 2: Engineering services & sustainable development guidelines).

This report focuses on opportunities and strategies that have been considered suitable to the proposed development, in order to result in:

- Reduced carbon emissions and environmental impact
- Improved Indoor Environmental Quality
- Reduced operating costs
- Reduced consumption of potable water
- Cost effectiveness over life cycles
- Efficient material usage.

A key objective for the proposed project has been to design towards an aspirational 4 star Green Star rating, as per the Green Star Healthcare Version-1 tool prepared by the Green Building Council of Australia (GBCA).

A preliminary Green Star pre-assessment has been undertaken to review the proposed design, and identify the ESD initiatives that are required to achieve an aspirational 4 Star rating. During the next design phase, these initiatives will need to reviewed and confirmed by the respective design disciplines.

2 Energy and Environmental Objectives

As identified within the Tamworth Rural Referral Hospital redevelopment briefing information, the project has the following energy and environmental objectives:

- Mechanical and electrical services design to comply with the requirements of BCA Section J
- Design to be based on an aspirational 4 Star Green Star Design rating under the most recent version of the Green Star Healthcare rating tool.

3 Energy & Environmental Targets & Benchmarks

The following table presents the environmental targets and benchmarks that are applicable to the Tamworth Referral Hospital. The proposed design needs to achieve compliance with all the below mentioned targets.

4 Star Green Star Rating	• For all projects greater than $10m the project shall undergo the Green star rating process, using the Green star Healthcare Tool, such as to achieve a minimum aspirational 4 star rating.
10% Improvement over BCA Section-J requirements.	• The development shall be designed to improve upon the minimum requirement of Section J of the Building Code of Australia. It is a requirement of NSW Health that energy modelling be undertaken for all projects larger than $10m. The energy modelling shall be undertaken in accordance with either verification method JV2 or JV3 from the BCA. The facility shall be designed such that the designed energy performance achieves a minimum of 10% improvement when compared with either the “stated value” or the deemed to satisfy reference building.
Alternative Energy Sources	The design shall target that 20% of the facility's power shall be sourced from alternative energy sources including solar and photovoltaic.
Independent Commissioning Agent	• For all projects greater than $10m "an independent commissioning agent" shall be engaged such as to ensure that all mechanical services and automated control systems are commissioned to meet the required function and for minimum energy use. The process shall follow the proforma identified in Green star, with appropriate adjustment to suit healthcare.

4 Energy & Environmental opportunities

The following energy saving initiatives have been identified at this Schematic Design stage. During the next design phase, each of these strategies would be analysed in greater detail.

4.1 KEY ESD INITIATIVES

Mixed Mode Ventilation

A mixed-mode ventilation approach will be considered for areas of low sensitivity where suitable (such as main entrance, circulation areas, offices, staff areas, etc).

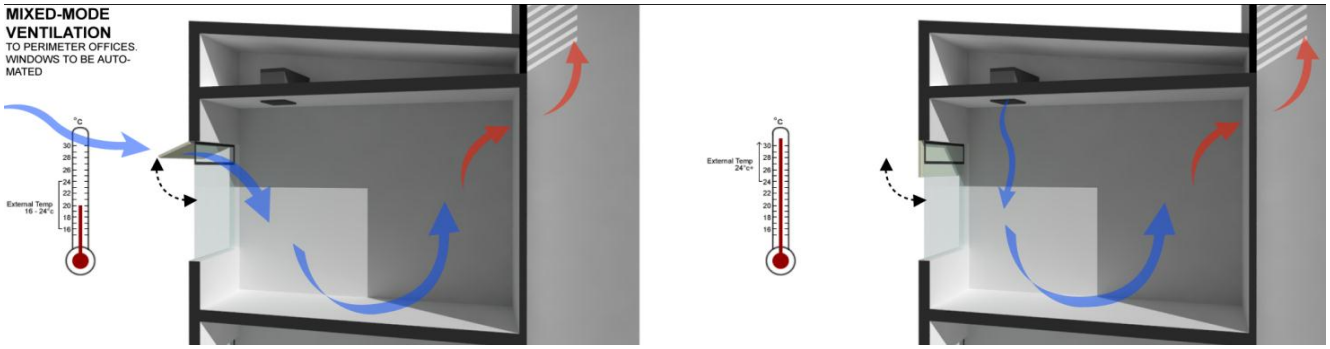
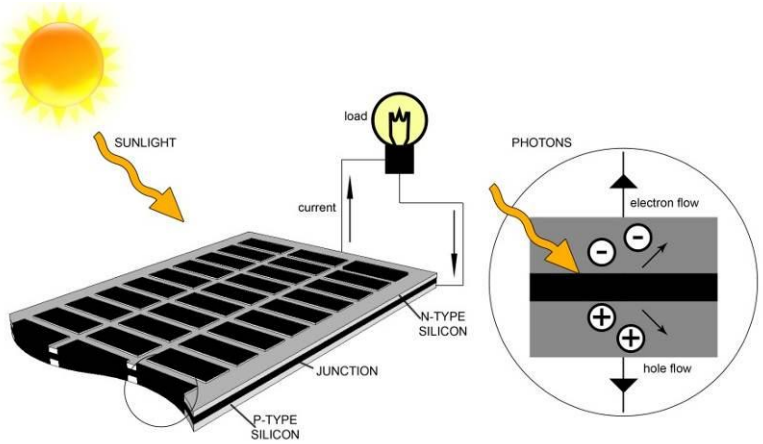


Fig: Schematic illustration of mixed mode ventilation.

Photovoltaics

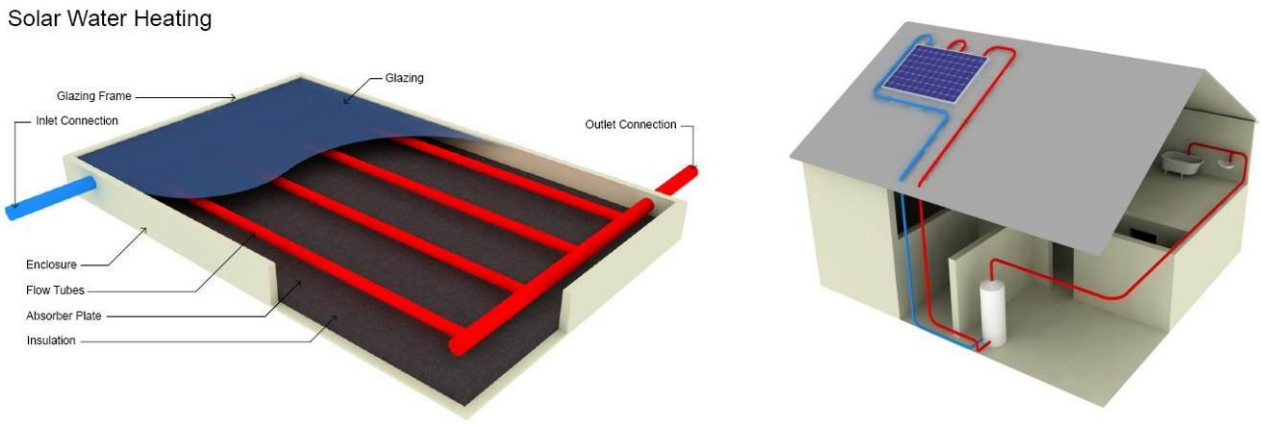
Solar power contributes to reducing the building energy demand, and also makes a visible statement of involvement in renewable energy harvesting.



Onsite solar power systems include the reduction in energy losses through power lines and power is generated at the point of uses to eliminate the distribution losses.

Solar Hot water

Domestic Solar hot water should be incorporated into the new Acute building by using the energy from the sun to heat water.



Thermal panels (heat collectors) can be mounted on the roof in which fluid will be heated by the sun.

Daylighting

Daylighting should be considered for areas that do not have specific task lighting requirements (such as the main entrance, circulation areas, offices, staff areas, maternity ward, Inpatient etc).

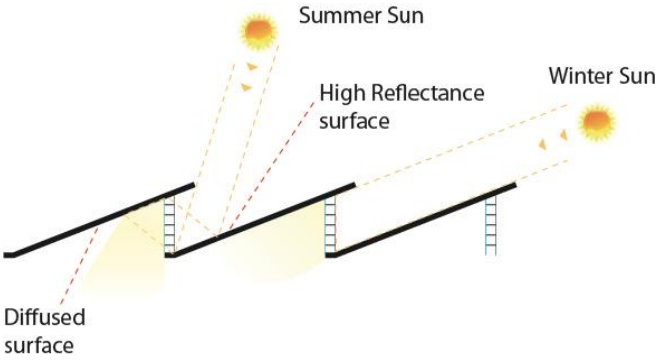


Fig 1: Skylights can be incorporated to diffuse and redirect natural light to internal spaces.

Fig 2: Voids and atriums can be incorporated to allow daylight harvesting to core spaces.

4.2 ELECTRICAL SERVICES:

- All sub-mains servicing distribution boards, mechanical boards and other major control cabinets shall be metered and be linked to the building management system (BMS) for energy auditing, energy monitoring and troubleshooting.
- Cross-Linked Polyethylene (XLPE) and Low Smoke Zero Halogen (LSZH) cables shall be used in the electrical distribution systems in place of traditional PVC type cabling.
- Motion sensors, timers and daylight sensors shall be used where appropriate to control the internal artificial lighting in the development to reduce energy usage. Lighting circuits shall be designed to provide high flexibility and not control large/multiple areas with one switch.
- The building management system will have the ability to control lighting circuits within the major corridors of the extension building to allow the hospital to switch off lighting that is not specifically required at any point in time.

- Efficient external lighting to meet or exceed the minimum requirements of AS 1158 for illuminance levels.
- The use of luminaries with high efficiency lamps and electronic control gear and high frequency ballasts
- The lighting system shall incorporate energy efficient lamps, use of luminaires with high light output ratios, and be coupled with lighting controls in selected common spaces to reduce energy consumption.
- External artificial lighting shall be designed to minimise light spillage and shall incorporate day light sensors.
- Emergency lighting within the hospital will make use of long life LED fittings.
- The lighting design would comply with AS 4282 'Control of the Obtrusive Effects of Outdoor Lighting', to minimise light pollution into the night sky.
- PVC minimisation
- Commissioning clauses in specification to ensure correct procedures are undertaken.

4.3 Contributions to Energy Reduction Targets

Based on the energy and environmental opportunities listed above, the following energy reduction targets have been identified compared to that of an equivalent installation without any energy initiatives.

Energy & Environmental Opportunities	**Anticipated Energy Reduction Target**
Electrical Commissioning	2%
Lighting System	8%
Energy metering	2%

4.4 MECHANICAL SERVICES

Following mechanical services initiatives are being considered for this project:

- Energy efficiency will be an integral part of all mechanical services design.
- Provide advice to improve thermal performance of building envelope through effective sun shading, high performance glass and innovative construction details. BCA section J checks will be performed on the glazing and facade insulation.
- High efficiency, low loss water-cooled chillers, selected to give the optimum coefficient of performance.
- The proposed air handling system which will incorporate a Central Air Handling unit plant with Multizone, VAV and CAV systems for zone control.
- Heat recovery between exhaust/relief and outside air will be included whenever these duct routes permit to recapture heat from the exhaust air for pre-treatment of the outside air.
- The use of variable speed drives on all appropriate fan and pump systems, coupled with high efficiency motors.
- Fan coil units shall be used to serve large intermittently occupied rooms such as meeting rooms such that they can be switched off when not in use.
- The use of high efficiency equipment such as chillers with environmentally friendly refrigerants such as R134a and R407c and high coefficients of performance.
- Outside air economy cycles on all appropriate air handling systems.
- Multi zone air handling units designed to provide the minimum amount of heating or cooling to zones, thus minimising the possibility of reheating.
- A fully automated Building Monitoring and Control system to schedule and optimise plant to maximise efficiency.
- UVC emitter would be installed in AHUs and FCUs to maintain the cleanliness of coils without washing or chemical cleaning.
- The use of thermal and energy simulation to minimise oversizing of plant.
- PVC minimisation
- Sub metering
- Commissioning clauses in specification to ensure correct procedures are undertaken.

4.5 HYDRAULIC SERVICES

- Solar Hot Water - The proposed development will incorporate solar hot water plant with gas boost. Current design philosophies aim for a 50% contribution to hot water generation from the solar system.
- Water Efficient Fixtures and Tapware - All fixtures and tapware installed in the proposed building will confirm to the Water Efficiency Labelling Scheme (WELS), and will be within 1 star of the best available WELS rating.
- Metering – Meters will be provided for all major water uses. This includes: whole building, LINACS, Mechanical plant, hot water plant and other zones required to be sub-metered by the client.
- PVC minimisation – All drainage pipework would be installed in HDPE.

4.6 ARCHITECTURAL

- Efficient facade treatments which will provide shading and improve thermal performance

- Provision of energy efficient glazing to improve thermal transmittance as required
- Daylight glare control treatments such as integral venetian blinds
- The internal planning locates primary patient and open work spaces to the perimeter to maximise opportunities for natural light. Enclosed spaces have been located in the centre of the plan.
- opportunity for patient and office areas to have access to external views
- There will be minimal removal of top soil
- Landscape planting will be appropriate to site and climatic conditions

4.7 STRUCTURAL

The main ESD initiatives relevant to structural design, include the following:

Concrete

- Replacement of Ordinary Portland Cement (OPC) with supplementary cementitious materials & use of at least 20% slag aggregates has been reviewed by the structural consultant.
- Use of recycled aggregates should be considered.

Steel

- Maximise use of high strength steel grades.
- 60% or greater of the fabricated steelwork to be supplied by a steel fabricator accredited to the Environmental Sustainability Charter of the Australian Steel Institute (Currently there are very few accredited fabricators in NSW. So this may not be practical to achieve).
- 60% of reinforcing steel to be produced using energy reducing processes in its manufacturer such as Polymer Injection Technology (Currently reinforcing steel is produced only by OneSteel. Once again this may not be practical to achieve).

The above steel initiatives are based on the current GBCA requirements. But it should be noted that to achieve any Green Starpoints with this system, at least 95% of the steel for a project must be sourced from a steel maker with a valid ISO 14001 Environmental Management system and be a member of the World Steel Association Climate Action Program (WSA CAP). Currently in Australia, only OneSteel and BlueScope comply with these requirements.

5 ENERGY EFFICIENCY

Energy efficiency will be an integral part of all services design. It is appropriate to note that efforts shall be spent on firstly minimising the inherent energy requirement and then to cater for the requirement efficiently. The following key elements will be included or pursued:

The design team should set appropriate energy performance targets and verify the building performance against these targets prior to finalisation of design and documentation. The setting of targets is an important step at the early stage of the design process. This shall take into account relevant Government targets and initiatives and comparable health care installations at similar climate regions. The target should be agreed by all stakeholders.

Whilst ESD has been a subject of importance and discussion over recent years, its implementation has been restricted on a large number of occasions by the lack of funding. The building budget should seek to make appropriate allocations in the cost plan to ensure the implementation of ESD initiatives.

The Green Stars rating will be adopted and used to inform the basis of the design for this building. An aspirational minimum equivalent of 4 Star rating would be set.

We see the following initiatives as key elements in achieving a sustainable outcome for the building and would score well against the Green Star criteria:

- Heat recovery will be provided to the operating theatre full outside air systems, these systems will transfer energy that would normally be discharged to outside back into the outside air supply serving the theatre.
- Outside air cycles on air conditioning plant serving ward and support areas
- Low friction high efficient chillers will be specified.
- Photovoltaic cells will be evaluated for possible employment to provide some direct green energy.

- Energy efficient luminaries and lamps will be specified.
- Variable speed drives will be provided to chilled water and heating hot water pumps to save energy during low demand periods.
- Multiple medical gases vacuum suction pumps will be provided to allow capacity matching of load demand.
- Daylight wells to harvest daylight deep in the buildings core will be investigated
- Metering of electrical sub-mains to allow evaluation of energy usage.
- Adjustable external shade element to control solar heat and glare
- Enhanced commissioning of systems to ensure that controls are optimised.
- Winter gardens external balconies as places of respite for patients and staff
- Fire stairs used for public access to reduce demanded on lifts
- Material selection to improve indoor air quality

5.1 Overview of primary energy System arrangement

Introduction
During the schematic design stage a number of options for providing energy for the building where assessed. These included a central energy plant that could be accommodated in the new acute building to servecampus. A second option was to locate central plant in a purpose built central energy plantroom on the hospital campus separate to the new acute building.

Central Energy Systems
Centralised systems are one of the most effective means of meeting the cooling/ heating demands within a large hospital campus. The central plant allows for overall system diversities to be accounted for in plant sizing and allow for central redundancies to be accommodated. It also provides a central point for the maintenance and servicing of some of the most complex plant installed into a hospital site. The opportunity exists for the plantroom to be sized to serve future stages, but with plant for initial stages only installed at the offset.

The benefits of decoupling the central energy plant are:-

- Elimination of plant space in the building
- More freedom for space planning in buildings/ reduced costs and architectural impacts
- Noise and vibration is removed from the buildings
- Future expansion of the plantroom is easier and cheaper
- Maintenance access is remote from the clinical buildings
- Systems can be designed to provide low pumping and thermal losses between building and remote plantroom

Findings
While the benefits of central energy plant are evident central energy plant has not been further assessed due to the following reasons;

The most suitable area for plant space in the new acute building is at lower ground level. Floor area needs to be excavated at this level and so has a high build cost. Hence it was deemed too costly to provide additional plant space at this level.
The option of putting central energy plant on the roof of the new acute building could also be an option but due to the weight of the large central energy plant and the implications on structural requirements this was discounted. There are also significant issues with getting large plant on the roof and off the roof in the future.

Recommendations
Taking these findings into consideration it is proposed to provide an individual plantrooms in the new acute.

Should Health Infrastructure wish to include a central energy system a system schematic, costs and plant spatials are provided within this report and could be incorporated into the detailed design stage if instructed.

5.2 Overview Of Energy Source

Introduction
The following options where reviewed with regard to central energy plant strategy;

Option 01: High Efficiency Electrical Chillers to meet cooling demand
High efficiency Gas Hot Water boilers to provide Heating demand

Option 02: Coal fired Hot Water boilers to provide Heating and Cooling demand
Absorption Chillers to meet cooling demand via waste heat from Coal Fired Boilers

Option 03: Gas Chillers to meet cooling demand
High efficiency Gas Hot Water boilers to provide Heating demand

Option 04: Tri-generation system utilizing gas generators to generate on-site power. Base cooling demand will be met via absorption chillers and hot water demand via heat exchangers both served from waste heat from the Gas Generators. High Efficiency Electrical Chillers to meet peak cooling demand

Findings

Option 01 uses the least amount of energy and has the lowest annual energy costs.

Option 2 uses the least amount of energy to produce heating but due to the use of an absorption chiller for cooling has a higher annual energy usage for cooling in comparison to option 01. The carbon emissions from this system is also the highest of all options and so the impact of the carbon tax will be significant and also the impact on the aspirational four star green star would need to be assessed.

Option 03 has a low carbon emission as it uses gas as a fuel source but due to the relatively high cost of gas the running costs are significantly higher in comparison to options 01 and 02. This option uses a considerable amount of more energy in comparison to option 01 due to the poor COP of gas chillers.

Option 04 has the highest energy usage of all options, this is due to the usage of gas to generate power. This option also has the highest cost usage of all options, this is due to the relatively high cost of gas. This option does have a significant reduction in carbon emissions, indeed the emissions could be seen as negative when compared to the carbon emissions that would be generated if grid coal fired substation was used. If the hospital was aspiring to be carbon neutral then Tri-generation would be a suitable option.

5.2.1 Conclusion and Recommendations

From the findings above it would be our recommendation that electric chillers and gas boilers be provided in the new acute building.

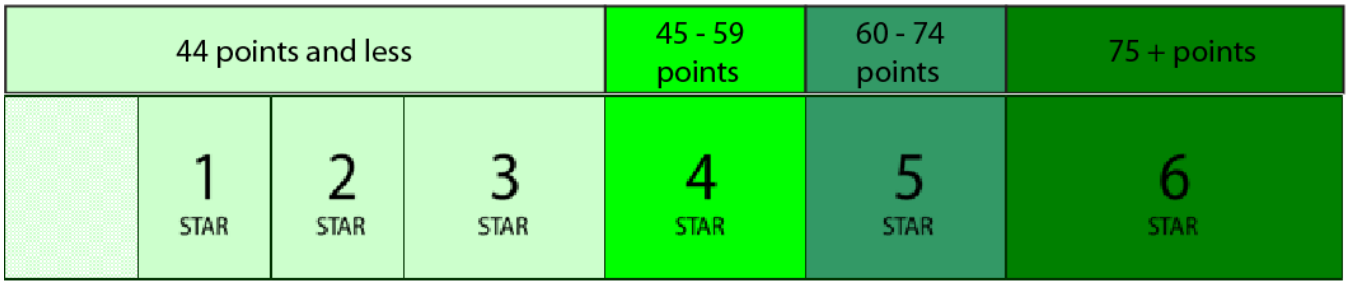
The current design is based on this proposal and will be developed further during detailed design stage.

However, should Health Infrastructure wish to proceed with a central energy plant and/or with a Tri-generation system than the majority of the information for these systems has been assessed and could be developed during detailed design stage.

Green Star

As per NSW Health Technical Guidelines TS-11, all projects with a budget of greater than $10 M, shall undergo the Green Star rating process, using the Green Star Healthcare Pilot Tool and achieve a minimum aspirational 4 star rating. The Green Building Council of Australia (GBCA) has released the Healthcare tool Version-1, in June 2009, which will be utilised to assess the new Acute building.

In the current design proposals, Green Star initiatives are being incorporated, in order to notionally achieve a 4 star Green Star rating.



We have identified the credits that should be targeted to attain a minimum of 45 points. The project would attain a 4 star Green Star rating, provided most of the identified initiatives are incorporated in the proposed design.

In addition to the minimum 45 points required to achieve a 4 Star rating, an additional 10% (5 points) should be targeted as buffer points. Changes in the future design may cause some credits to be unachievable, and the buffer points should be targeted to allow for the future changes.

Green Star - Healthcare v1

Credit Summary: Green Star Pre-assessment

New Acute Building

Category	Title	Credit No.	Points Available	Points Achieved	Points to be Confirmed
Management					
	Green Star Accredited Professional	Man-1	2	2	0
	Commissioning Clauses	Man-2	2	2	0
	Building Tuning	Man-3	1	1	0
	Independent Commissioning Agent	Man-4	1	1	0
	Building Guides	Man-5	1	1	0
	Environmental Management	Man-6	2	2	0
	Waste Management	Man-7	2	2	0
	Building Management Systems	Man-9	1	1	0
	Maintainability	Man-11	1	1	0
	Construction Indoor Air Quality Plan	Man-12	3	3	0
	Sustainable Procurement Guide	Man-13	1	1	0
		TOTAL	17	17	0
Indoor Environment Quality					
	Ventilation Rates	IEQ-1	4	0	1
	Air Change Effectiveness	IEQ-2	2	0	1
	CO2 Monitoring & Control and VOC Monitoring	IEQ-3	1	1	0
	Daylight	IEQ-4	3	0	1
	Thermal Comfort	IEQ-5	2	0	1
	Hazardous Materials	IEQ-6	1	1	0
	Internal Noise Levels	IEQ-7	1	1	0
	Volatile Organic Compounds	IEQ-8	5	5	0
	Formaldehyde Minimisation	IEQ-9	1	1	0
	Mould Prevention	IEQ-10	1	1	0
	Daylight Glare Control	IEQ-11	1	1	0
	High Frequency Ballasts	IEQ-12	1	1	0
	Electric Lighting Levels	IEQ-13	1	1	0
	External Views	IEQ-14	2	2	0
	Individual Thermal Comfort Control	IEQ-15	2	0	0
	Exhaust Riser	IEQ-16	1	1	0
	Air Distribution System	IEQ-17	1	1	0
	Outdoor Pollutant Control	IEQ-18	1	1	0
	Places of Respite	IEQ-19	1	0	1
		TOTAL	32	18	5
Energy					
	Conditional Requirement	Ene-Con	Conditional Requirement	Yes	/
	Greenhouse Gas Emissions	Ene-1	20	0	3
	Energy Sub-metering	Ene-2	1	1	0
	Peak Energy Demand Reduction	Ene-3	2	0	1
	Lighting Zoning	Ene-4	2	2	0
	Car Park Ventilation	Ene-6	0	NA	0
	Efficient External Lighting	Ene-9	1	1	0
		TOTAL	26	4	4
Transport					
	Provision of Car Parking	Tra-1	0	NA	0
	Fuel-Efficient Transport	Tra-2	1	0	1
	Cyclist Facilities	Tra-3	3	0	2
	Commuting Mass-Transport	Tra-4	5	0	1
	Transport Design and Planning	Tra-6	1	1	0
		TOTAL	10	1	4

Water					
	Occupant Amenity Water	Wat-1	5	0	5
	Water Meters	Wat-2	1	1	0
	Landscape Irrigation	Wat-3	2	0	2
	Heat Rejection Water	Wat-4	4	0	0
	Fire System Water	Wat-5	1	0	0
	Potable Water Use for Equipment	Wat-6	1	0	0
		TOTAL	14	1	7

Materials					
	Recycling Waste Storage	Mat-1	1	1	0
	Building Re-use	Mat-2	6	0	0
	Recycled Content & Re-used Products & Materials	Mat-3	2	1	0
	Concrete	Mat-4	3	1	0
	Steel	Mat-5	2	1	0
	PVC	Mat-6	2	2	0
	Timber	Mat-7	1	1	0
	Design for Disassembly	Mat-8	1	0	0
	Dematerialisation	Mat-9	1	1	0
	Flooring	Mat-11	3	2	0
	Joinery	Mat-12	1	1	0
	Loose Furniture	Mat-13	4	4	0
	Ceilings, Walls and Partitions	Mat-14	2	2	0
		TOTAL	29	17	0

Land Use & Ecology					
	Conditional Requirement	Eco-Con	Conditional Requirement	Yes	/
	Topsoil	Eco-1	1	0	1
	Re-use of Land	Eco-2	1	0	0
	Reclaimed Contaminated Land	Eco-3	2	0	0
	Change of Ecological Value	Eco-4	4	0	0
		TOTAL	8	0	1

Emissions					
	Refrigerant ODP	Emi-1	1	1	0
	Refrigerant GWP	Emi-2	2	0	0
	Refrigerant Leaks	Emi-3	2	2	0
	Insulant ODP	Emi-4	1	1	0
	Stormwater	Emi-5	3	0	1
	Watercourse Pollution	Emi-5	3	0	0
	Discharge to Sewer	Emi-6	5	0	1
	Light Pollution	Emi-7	1	1	0
	Legionella	Emi-8	1	0	0
	Trade Waste Pollution	Emi-9	1	0	1
		TOTAL	17	5	3

Sub-total weighted points:	**36**	**17**

Innovation					
	Innovative Strategies and Technologies	Inn-1	2	0	0
	Exceeding Green Star Benchmarks	Inn-2	2	0	0
	Environmental Design Initiatives	Inn-3	1	0	0
		TOTAL	5	0	0

Total weighted points:	**36**	**17**
Total points Targeted:	**53**	