ENVIRONMENT DESIGN GUIDE

BUILDING ENERGY BRIEF FOR COMMERCIAL AND PUBLIC BUILDINGS

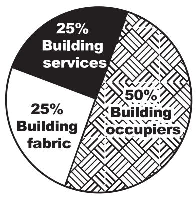
SUSTAINABLE ENERGY AUTHORITY
Taylor Oppenheim Architects, Lincolne Scott Australia, Clifton Project Management and Sustainable Solutions.

SUMMARY OF

ACTIONS TOWARDS SUSTAINABLE OUTCOMES

Environmental Issues/Principal Impacts

- Buildings consume between 40% and 50% of the world's energy.
- As a result of the 1998 Kyoto Protocol, Australia's requirement is to not increase its greenhouse gas emissions by more than 8% above their 1990 level by 2008-2012.
- Commercial buildings in Australia are responsible for around 35 million tonnes of carbon dioxide (CO_2) emissions each year. With business as usual, these greenhouse gas emissions would almost double by 2010.
- The energy consumption of a building is dictated by three main components (as shown):
  - the building fabric
  - the building services
  - the building occupants and their behaviour.



- Energy consumption of buildings can vary by a factor of up to 10 between the best and worst performing buildings of a similar type.

Basic Strategies

In many design circumstances you will have boundaries and constraints that limit the application of cutting EDGe actions. In these circumstances, you should at least consider the following:

- Establish an energy budget or target for the project prior to commencing design.
- Provide engineering services input and energy evaluation from the concept design stage.
- Evaluate the energy efficiency opportunities listed in the Building Energy Brief. The Brief is for typical commercial buildings.
- Design to minimise heat loads and artificial lighting requirements.
- Use energy efficient equipment and appliances.
- Report estimated energy consumption determined throughout various design stages against the energy budget.
- Select materials with low embodied energy.
- Provide a Management Manual and training for users/occupiers of buildings.

Cutting EDGe Strategies

- Utilise daylighting while minimising heat gains and losses.
- Use exposed interior thermal mass and natural ventilation to maintain comfortable internal space conditions.
- Apply adaptive thermal comfort models.
- Source a renewable energy supply.

Synergies and References

- *BDP Environment Design Guide*: GEN 6, GEN 7, DES 1, DES 2, DES 4, DES 6, DES 7, DES 10, DES 21, DES 22, DES 23, TEC 3, TEC 4, TEC, 6, TEC 7, PRO 2, PRO 3, NOT 1, NOT 2.
- Department of Primary Industries and Energy 1991, *Saving Energy in Commercial Buildings*, DPIE, Canberra.
- Energy Victoria 1994, *Energy Efficient Commercial Buildings – Design Guidelines and Case Studies*, Energy Victoria (now Sustainable Energy Authority).
- NSW Public Works and NSW Office of Energy 1993, *Building Energy Manual*, NSW State Projects, Sydney.

Registration

The Sustainable Energy Authority is the owner and developer of the Building Energy Brief. The Brief is freely available for use by any parties on the condition that they register its use on projects with the Sustainable Energy Authority. Registered users of the Building Energy Brief will be able to receive updated revisions of the Brief and periodic bulletins regarding its use.

To give feedback on the use of the Building Energy Brief, to receive the latest electronic copy or to register use, please contact:

Sustainable Energy Authority, Ground floor, 215 Spring Street, Melbourne, Vic, 3000, facsimile: (03) 9655 3255,
Email: Smart.Building@sea.vic.gov.au, Internet: www.sea.vic.gov.au

BUILDING ENERGY BRIEF FOR COMMERCIAL AND PUBLIC BUILDINGS

SUSTAINABLE ENERGY AUTHORITY

Taylor Oppenheim Architects, Lincolne Scott Australia, Clifton Project Management and Sustainable Solutions.

This Energy Brief is intended to form part of the brief from the client to the project team. It contains a number of clauses that will assist in the design and construction of a more energy efficient non-residential building.
It can be used in its entirety as an Appendix to an existing brief, or be inserted as clauses into an existing brief. It will however require filling in certain sections (particularly Section 1), and deletion of non-relevant clauses (particularly in Sections 2 to 10).
Most briefs are written to describe the scope of works to be undertaken, the management processes involved and the reporting mechanisms required. These can be organised either according to Project Phase, or organised according to professional discipline (Introduction, Architectural, Mechanical, Electrical, Hydraulic). To accommodate these two organisational methods, the Clauses in this brief are set out both in Project Phase sequence, as well as a further subdivision into sections of professional discipline.

Clauses that specify actions that provide accountability back to the client are contained in boxes such as this.

Commentary on the Clauses is provided in italics, such as this, in boxes at the end of each section, and need not be included in the Brief.

SECTION 1 – PROPOSAL/ PRE-DESIGN STAGE

1.1 INTRODUCTION

1.1.1 Project objectives

The building is required to be energy efficient employing current and proven cost effective technology and design techniques.

To meet energy budget requirements, the building must be designed and constructed with energy conservation measures to minimise energy consumption without compromising the specified accommodation standards.

1.1.2 Project management process/QA

A design process shall be undertaken that includes the following steps:

- Hold regular project team meeting with all stakeholders to agree goals, budgets for money and energy and measurement methods for money and energy;
- review energy performance whenever cost plan is reviewed
- treat building services design and building fabric design as an integrated design exercise

This design process shall be made clear in the Pre-Design Report.

Regularly report the estimated performance of various elements to the client as they are developed by the design team. The targets established shall form the baseline case.

1.1.3 Project Budget

Consider the Project Budget. The Project Budget will be affected by inclusion of energy efficiency measures. There are three cost categories – design costs, capital costs and recurrent costs that relate to the opportunities outlined below. These costs are inter-related and need to be considered together.

Architectural – Building Envelope Opportunities

The building envelope/façade and building footprint are vital considerations

- Orientation and Shape
- Thermal efficiency of envelope (including thermal bridging)
- Shading
- High performance glazing
- Daylight possibilities
- Natural ventilation possibilities
- Level of exposed internal thermal mass
- Reflectance of internal surfaces
- Infiltration
- Lifts/stairs
- Landscaping

Mechanical – HVAC Opportunities

- Internal zoning
- HVAC controls
- HVAC system selection and design
- Thermal storage
- Co-generation
- Heat recovery /exchange/storage

- Emergency generator for lopping peak demand
- Central controls – operation/support
- Lifts

Electrical – Electric lighting possibilities

- Layout and zoning
- Low loss ballasts
- Lamps and luminaires
- Lighting controls/dimmers/sensors
- Sub–metering

Hydraulics – Water Opportunities

- Domestic hot water

Design Costs

- Identification and evaluation of energy efficiency options
- Establishment and management of energy budgets
- Energy Adviser

Inclusion of energy efficient measures may lead to increased capital costs. However these will be offset by lower running costs and are likely to be further offset by improved amenity and lower capital costs of other building elements. An integrated approach to consideration of these measures can lead to minimum capital costs and energy operating costs. In some cases, incorporation of energy efficiency opportunities reduces capital cost when plant size is reduced.

The client can either set the budget at the beginning of the project, or have the budget set by the project team at the end of the concept stage.

1.1.4 Energy adviser

An energy adviser shall be involved in projects of capital value greater than $500,000 and/or where predicted annual energy costs exceed $50,000. The adviser shall have had extensive experience in energy auditing, the implementation of energy efficient measures in existing buildings, significant computer building energy simulation capability, and a thorough understanding of the design process.

The scope of work for the energy adviser shall be:

- *Establish Energy Budget and Energy Objectives for the Project. State any prescriptive energy requirements. Establish operational variables. Set out methodology for accounting for energy efficiency during project*
- ………………………………………………….
- ………………………………………………….
- ………………………………………………….

The Project Budget includes an allowance of $……………… for the employment of the energy adviser

---

The Brief Writer is to complete.

The Brief Writer is to refer to the Project Management Flow Chart (Appendix 2) for the full scope of energy related project management activities. These may be carried out by in-house energy advice staff or an external energy adviser. It is often advantageous for the energy adviser to be independent of the building design team.

1.1.5 Investment criteria

The investment criteria for the project shall be as follows

- Inflation adjusted discount (or interest) rate applied shall be ……….
- Internal rate of return shall be ……….

or

Acceptable payback periods shall be ……….

- Cost of electricity shall be:
  - (a) ……….¢ per kWh for peak period
  - (b) ……….¢ per kWh for off-peak period
  - (c) ……….$ per kW for demand
- Cost of gas shall be ………. ¢/MJ)

The Brief Writer is to complete.

Insert nominal electricity prices by contacting electrical supplier who will provide the required figures

Insert nominal gas price by contacting gas supplier who will provide the required information.

Other criteria may have emerged and may be applicable to some projects at the discretion of the client. These criteria may be greenhouse rating, carbon tax and greenhouse emission monitoring.
In setting values, the Brief Writer is to consider the likely effects of energy price movements. The energy adviser can provide assistance.

Associated capital infrastructure costs such as electric sub-mains, gas supplies may vary with different design options.

1.1.6 External design conditions

Outside 'Winter' and 'Summer' Dry Bulb Design Temperatures are to be determined in accordance with local climatic influences and the latest or equivalent version of the AIRAH Air Conditioning Design Manual. They shall be:

For occupied areas

summer: ………………………… (ºC DB, ºC WB)

winter: ………………………… (ºC DB, ºC WB)

The Brief Writer is to complete.

1.1.7 Internal environment conditions

Internal environment conditions shall be established for the project. They shall be as follows:

Accommodation density

Accommodation shall be taken to be …… m^2/person

Internal thermal design conditions

Internal thermal design conditions to be used in the design of heating/cooling plant may be set out as below:

For occupied areas

summer: ……ºC DB, ± ..…. ºC DB, ……%RH

winter: ……ºC DB, ± ..….ºC DB, ……%RH

For process environment control

summer: ……ºC DB, ± ..….ºC DB, ……%RH

winter: ……ºC DB, ± ..….ºC DB, ……%RH

Supply air

Minimum standard supply air rates shall be:

- …… litres/sec/m² or
- …… air changes per hour for open office and
- …… air changes per hour for partitioned office

Outside air

Outside air intake and exhaust systems shall comply with AS 1668 Part 2 taking into account the energy options offered in that standard including filtration and air quality sensing.

Outside air rates should comply with the minimum rates set out in AS 1668 except where it can be shown that above minimal rates will have a positive effect on the internal environment and the occupants therein.

Lighting

Internal lighting design conditions shall be designed to Lighting AS 1680 Parts 1 and 2 and light fittings will be selected for maximum efficiency to reduce the number of fittings required and also operating cost.

The designed lighting power densities should not exceed the following:

- General Offices and Laboratories: ………W/m²
- Corridors and Storerooms:……...W/m²
- Toilets and Stairways: ………W/m²

Light loss factors shall not be less than: ……………

Hours of operation

The hours of operation for the project shall be established. They shall be as follows:

………………………. Hours, days of week and days of year

After hours/out of hours operation shall be dealt with as follows: ……………………………………………

The Brief Writer is to complete.
Accommodation density is often taken as 10m²/persons but some studies have shown actual densities are 15–20m²/person. An audit of the existing premises will establish current density. This figure should be used as the figure for new densities. Lower density figures reduce sizes of HVAC plant.
The Brief Writer is to advise internal thermal design conditions, or if not known, ask project team to state before design work is begun.
Energy savings can be achieved by having a wider band of thermal comfort. The client may wish to consult the energy adviser to determine if other internal comfort conditions are more appropriate. Note proposals including radiant heating and cooling systems will also be considered by the client if proposed by the project team.
Minimum standard supply air rates are typically recommended at 6 litres/sec/m² or 6 air changes per hour for open office and 8 air changes per hour for partitioned office.
Alternative heating and cooling systems, displacement ventilation and radiant heating and cooling may reduce air supply rates. Reduction in air supply rates reduces fan energy consumption.
As a guide, the designed lighting power densities should not exceed the following:
General Offices and Laboratories: 14W/m²
Corridors and Storerooms: 5W/m²
Toilets and Stairways: 5W/m²
Light loss factors shall not be less than 0.65
Designed lighting power densities should aim for 8W/m² of floor area or less.
Note that AS 1680 was revised as of June 1993 and some latitude is available. This should be taken into account in the lighting design. Options include task lighting.

Typically office buildings work 2,500 hours per year whilst hospitals are 8,760 hours per year. The Brief Writer should determine these in the section below 'hours of operation'.

1.1.8 Equipment and other internal heat loads

The client/project team has determined the equipment and internal heat load to be …………W/m²

OR (Brief Writer to delete one or other)

The following values are to be used in the determination of this load:

- Occupants at 15m²/person ……W/m²
- Lighting (refer above) ……W/m²
- One PC per person ……W/m²
- Other equipment ……W/m²
- Sub–total ……W/m²
- Diversity factor ……
- TOTAL ……W/m²

The Brief Writer is to complete.

Item	***Typical example***
Occupants at 15m²/person	*7 W/m²*
Lighting (refer above)	*8–14 W/m²*
One PC per person	*8 W/m²*
Other equipment	*1 W/m²*
Sub – total	*24–30 W/m²*
Diversity factor	*0.8*
TOTAL	*19–24 W/m²*

Internal heat loads have a significant impact on the sizing of HVAC plant. An audit of the existing premises will establish current internal heat loads. This figure should be used as the upper limit for this project since it is assumed that more efficient equipment will be purchased. Lower internal heat loads dramatically reduce the size of HVAC plant.

The diversity factor reflects the less than full utilisation of facilities caused by such events as annual leave, sick leave, out of office activities, etc.

1.1.9 Energy targets

Energy targets for various sections of the building shall be confirmed by return brief from the Project Design Team. These targets shall be presented in the format shown below: Note m² are for net lettable area as defined by the Property Council of Australia (PCA).

Item	Base Building	MJ/m²	Carpark	MJ/m²	Tenancy	MJ/m²
Lighting	Public lighting					
Power	Public power					
AC	Base Building (incl central plant)					
Ventilation						
Lifts						
DHW						
Other					Computer suites	
					Cafeterias	
	Sub total target		Sub total target		Sub total target	
					Overall target	

The Brief Writer is to complete.

Typical energy targets are published by the PCA in their Energy Guidelines, or advice can be sought from the energy adviser (either external or internal). Targets should note what areas of operations they include and what they exclude.

1.1.10 Energy analysis and reporting

Energy analysis shall be provided for assessment of energy efficiency of design options and assessment of design against energy budget. The weather data used shall be referenced. This analysis can be undertaken using computers or other acceptable means.

Assess and report at least ……. design options using some form of net present value (NPV) method.

The Brief Writer is to complete.

Typically, at least three design options should be assessed using some form of net present value (NPV) method

1.1.11 Proposal/Pre-Design Report

A Proposal/Pre-Design Report shall be prepared and will include all the items noted above. The energy adviser shall sign off this report to the client.

SECTION 2 – MASTER PLAN/ SITE PLAN STAGE

2.1 ARCHITECTURAL

2.1.1 Orientation and shape

Consideration shall be given to the orientation and shape of the building in such a way that minimises the operating energy consumption of the building.

Orientation that is to the cardinal axes (rather than to say NE or NW) makes shading north and west facades easier, and enhances daylight possibilities.
Ensure that the architect and HVAC engineer liaise to minimise envelope-related issues that affect peak energy demand and annual energy requirement.

Issues such as overshadowing from adjacent buildings, the grouping of areas that have the same type of conditioning requirements, should be considered at this stage.

SECTION 3 – SCHEMATIC DESIGN/CONCEPT STAGE

3.1 ARCHITECTURAL

3.1.1 Thermal efficiency of envelope

Thermal resistance (R-Values) for the building envelope shall be as follows

for walls and windows ………..…>0.4m² K/W (average value for walls and glazing)

for floors ……………………….>1.0m² K/W

for roof ………………………..>3.0m² K/W

Consideration shall be given to limiting the percentage of glazing to wall ratio in order to reduce heat gain/loss through glazing.

Consideration shall also be given to the effects of the footprint design.

3.1.2 Shading

All windows shall be shaded against summer sun penetration where practicable. Shading options may include vegetation, external louvres, external blinds, structural overhangs, low emittance glazing, spectrally-selective glazing or window films.

Peak cooling loads shall be minimised by considering north, north-west, west and south-west facades especially.

Consideration shall be given for the integration of solar shading with solar energy collection technology such as solar heat pumps for domestic hot water, and photovoltaic cells generating electricity.

The capital cost of installing shading/high performance glazing compared to single unshaded glazing shall be established. The reduction in operation costs (independent of daylight savings) and capital cost of HVAC plant and plant space shall be determined. A life cycle costing shall be undertaken using this capital cost and operation cost saving. This information shall form part of the Schematic Design Report. The use of shading/high performance glazing shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

3.1.3 High performance glazing

Consideration shall be given to the use of high performance glazing, thermal breaks and light coloured frames.

The capital cost of installing double glazing compared to single glazing shall be established. The reduction in operation costs (independent of daylight savings) and capital cost of HVAC plant and plant space shall be determined. A life cycle costing shall be undertaken using this capital cost (including reduction in HVAC capacity and peak demand charges) and operation cost saving. This information shall form part of the Schematic Design Report. The use of double glazing shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

3.1.4 Daylight possibilities

Consideration shall be given to reducing the need for electric lighting by maximising the use of daylight while limiting glare in work areas and ensuring that HVAC loads do not increase. These considerations shall include narrow floor plans, light-shelves, shaded skylights, light shafts and/or atrium with associated daylight sensing control of electric lighting.

No HVAC system shall be designed or installed until due consideration has been given to the reduction of the electric light internal heat load that has resulted from the use of daylight.

When utilising daylight, existing lighting circuit design and control systems should be arranged to realise the opportunity to minimise the operation of electric lighting. Circuitry should allow for night time use, minimum daylight availability and maximum daylight availability as a basic requirement.

Provide effective glare control, particularly in areas with screen based equipment.

Allow for convenient cleaning of glazing.

The capital cost of providing daylight opportunities that reduce the use of electric lighting shall be established. The reduction in electric light operation and capital cost of HVAC plant and plant space shall be determined. A life cycle costing shall be undertaken using this capital cost and operation cost saving. This information shall form part of the Schematic Design Report. The use of daylighting opportunities shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

An over-emphasis on the introduction of daylighting into “average” non-residential buildings may not be as energy efficient or cost effective as was previously thought. However, for “icon” buildings, daylight use should be pursued. Recent monitoring shows that the efficacy of daylighting is not being realised in built examples, so care is needed in the design and implementation of daylight strategies.

3.1.5 Natural ventilation possibilities

Consideration shall be given to reduce the need for HVAC by maximising the use of natural ventilation. These considerations shall include the following:

- night time purging to cool thermal mass
- specialised inlet ventilation openings and solar chimney/ventilation shafts for outlet ventilation
- adjustable air flow rates for high, but variable, occupancy areas (ie. office and conference areas)
- the use of winter gardens, etc. to create increased airflow.
- dust and noise control
- security
- weatherproofing
- air speed
- consideration of air flow for delivery of fresh air, and delivery of coolth
- allow for emergency ventilation of the building by having a proportion of glazing as openable (though lockable) windows (as required by AS 2982)
- car park ventilation

The capital cost of providing natural ventilation opportunities that reduce the use of HVAC systems shall be established. The reduction in HVAC operation costs and capital cost of HVAC plant and plant space shall be determined. A life cycle costing shall be undertaken using this capital cost and operation cost saving. This information shall form part of the Schematic Design Report. The use of natural ventilation opportunities shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

3.1.6 Level of internal thermal mass

Consideration shall be given to utilise the thermal mass in the structure to reduce peak loads and consequently HVAC plant size and capital cost.

The capital cost of providing higher than normal levels of thermal mass and its exposure to internal air shall be established. The reduction in HVAC operation costs and capital cost of HVAC plant and plant space shall also be determined. A life cycle costing shall be undertaken using this capital cost and operation cost saving. This information shall form part of the Schematic Design Report. The use of additional thermal mass opportunities shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

This requires sophisticated modelling tools and the outcome is sensitive to correct night purging.

3.1.7 Internal reflectance

Light coloured internal finishes shall be utilised in order to minimise lighting power densities. Ceiling/wall/floor/reflectances shall be at least 70%/50%/15% respectively, unless special circumstances such as screen based equipment require lower levels

The internal reflectance levels shall be reported in the Schematic Design Report, and all subsequent reports and sign offs.

3.1.8 Infiltration

Consideration shall be given to provide good sealing practices for external elements to minimise infiltration. The intent shall form part of the schematic design report with details checked at the Completion of Contract Documentation and during construction.

Infiltration shall be reported in the Schematic Design Report, and all subsequent reports and sign offs.

Infiltration is a much more significant energy waste problem than is generally recognised. Many buildings have above average infiltration due to lack of detailing and draughtproofing. Extreme care needs to be taken to ensure detailing is correctly done, and it is constructed as it is designed.

3.1.9 Vertical access - lifts and stairs

Consideration shall be given to maximise the use of stairs and minimise the use of lifts. The following points should be considered:

- place stairs in prominent positions to maximise their visibility and use
- design stairs with pleasant risers and treads sizes to create easy movement
- design stairs to be social spaces where conversations can occur
- design stairs to act, where appropriate, as natural ventilation shafts
- design walls, doors etc around stairs in such a way as to be able to control vertical air movement when required

Stairs and lifts shall be reported in the Schematic Design Report, and all subsequent reports and sign offs.

3.1.10 Architectural Schematic Design Report

A Report on the Architectural Aspects shall form part of the Schematic Design Report. It shall include comment on all of the above points for consideration. Capital costs and running costs of options under consideration shall be identified and a life cycle costing analysis undertaken. The use of Architectural opportunities shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

A further report shall be prepared that integrates the reports of all service consultants to ensure that all issues have been considered as a whole system, rather than separate parts of a system.

3.2 MECHANICAL

The design of the mechanical services for the building shall be integrated with the design of the building envelope and fabric and the other building services to minimise the size and cost of energy consuming systems and minimise the operational energy consumption of these systems.

3.2.1 Internal zoning

Consideration shall be given to zoning for the following circumstances:

- Delivery of conditioned air only to occupied spaces
- Low occupancy areas
- Variable occupancy areas
- Out of hours use
- Minimising reheat
- Areas exposed to high solar radiation when compared to the remainder of the building.

3.2.2 HVAC controls

Consideration shall be given to the following HVAC control system characteristics:

- Electronic controls shall be provided as a minimum, with DDC as a preferred option.
- Local timer controls linked back to a central time controller
- Run on timers to minimise out of hours use
- Time scheduling of A/C and ventilation plant operation to prevent the unnecessary use of equipment in intermittently used areas
- Variation of comfort criteria (deadband widening) and temperature set point for different space usages or when space unoccupied
- Optimisation strategies for staging on/off and operating central plant with multiple heating/ cooling modules

3.2.3 HVAC system selection and design

Consideration of HVAC systems shall include the following:

- Minimising plant capacity and plant area
- Efficiency when operating at peak capacity
- Efficiency when operating at part load.
- Consider sequenced steps or modulation of pumping capacity.
- Efficiency when operating part of the building out of hours
- Use of high efficiency condensing boilers
- Use of direct or indirect evaporative cooling
- Refrigerants with low (e.g. R123, R22) or zero (e.g. R134a) ozone depleting potential. Consider hydrocarbon refrigerants which also have a very low global warming potential. Note that ozone depleting refrigerants are subject to a phase out schedule.
- Primary fuel source to have minimised CO_2 emission taking into account end use equipment conversion efficiency
- Variable air volume systems
- Variable or multi-speed drive fans and pumps
- High efficiency motors, fans and pumps
- Insulation of pipework and ductwork to AS 4508 or better
- Distributed local HVAC units should be considered
- Using the ground as a heat source/sink for water source heat pumps
- Zone grouping based on similar loads

- CO_2 sensing control for the modulation of carparking ventilation systems
- Primary/secondary pumping systems
- A modulating economy cycle operation for all air handling units. Use of CO_2 or air quality sensing equipment to control outside air intake and the addition of high quality air filtration to reduce the outdoor air quantity and hence reduce the plant capacity (refer to AS 1668.2, Clause 2.3.4 and 2.6.2)
- Back draft dampers to be fitted to all exhaust systems to minimise air infiltration out of hours
- Capacity to vary set points of hot and chilled water on a seasonal basis
- Heat and coolth recovery
- Displacement ventilation
- Radiant heating and cooling systems

Consideration should be given to the number and size of chiller sets and staging required to minimise refrigeration energy consumption, including during periods of out of hours operation and other periods of part load operation.

Evaporative cooling may be inappropriate where close control of temperature and humidity is required, and in some climatic regions.

3.2.4 Thermal storage

Consideration of the use of chilled water storage or ice storage to reduce electricity demand charges and cooling plant size shall include the following:

- Out of hours operation and other periods of part load operation.
- Peak electrical load ‘trimming’ using storage

3.2.5 Co-generation

Consideration of the use of co-generation shall include the following:

- Assessment of capital cost and potential savings of on-site electricity generation, both in terms of consumption and demand savings. For co-generation, careful assessment of heating loads needs to be made
- Potential to export electrical/thermal energy
- The cost of a back-up power system that will rarely be required versus its use for co-generation

3.2.6 Heat recovery/exchange/storage

Consideration of the use of heat recovery/exchange/storage/pre cooling shall include the following:

- Investigate recovering thermal energy from conditioned air being spilled from the facility, especially in heavily populated areas such as courts or lecture theatres where outdoor air requirements are high.

3.2.7 Emergency generator for lopping peak demand

Consideration of the use of emergency generator shall include the following:

- Consider use of emergency generator to manage peak demand.

Ensure equipment specified gives a total installation power factor >0.90 at peak load and 0.85 at other times.

Minimise UPS capacity and standing losses and locate UPS outside conditioned space.

3.2.8 Central controls – operation/support

Consideration of the design of the central control system shall include the following:

- Consider central lighting control system and integrate with BAS system
- Optimised startup
- Optimised temperature set point
- Economy cycle/enthalpy control
- Load shedding control
- Plant scheduling and set back
- Proportioning Integral Derivative (PID) control algorithm to minimise hunting
- Dead band control to minimise simultaneous heating and cooling
- Remote monitoring and reporting
- Remote control
- The ability of the client to collect energy and environment related data pertinent to its own business operations and the facilities it occupies and/or manages and use that data to achieve best practice
- Training of the client in the use of, a building management system (or sub-system) which provides energy management facilities, including programmed time control scheduling for all areas capable of separable operation, demand management, trend logging, energy usage monitoring and reporting, exception events reporting for separable parts and systems in the building
- Car park ventilation – consider efficiency.

3.2.9 Lifts

Consideration on the use of lifts shall include the following:

- Limitation of air leakage
- Thermostatically controlled fans for lift room ventilation
- Energy efficient lift car lighting

3.2.10 Mechanical Services Schematic Design Report

A Report on the Mechanical Services shall form part of the Schematic Design Report. It shall include comment on all of the above points for consideration. Capital costs and running costs shall be identified for the options under consideration and a life cycle costing analysis undertaken. The use of Mechanical Services opportunities shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

3.3 ELECTRICAL

The design of the electrical services for the building shall be integrated with the design of the building envelope and the other building services to minimise the extent and cost of energy consuming systems and minimise the operational energy consumption of these systems.

3.3.1 Layout and zoning

Consideration shall be given to the most efficient layout and zoning for the artificial lighting system.

Internal reflectance levels shall be considered in the evaluation of the lighting system (refer to Section 3.1.7 above)

3.3.2 Low loss ballasts

Provide low loss ballasts, with power factor correction. If appropriate , consider dimmable electronic ballasts.

3.3.3 Lamps and luminaires

Consideration on the selection of lamps and luminaires shall include the following:

- Tri-phosphor lamps shall be provided.
- T5 lamps
- Luminaires with high reflectance, photometrically efficient profiles to maximise light output
- Luminaires with a light output ratio >70%
- High efficiency discharge lamps (ie metal halide or similar) for large internal spaces
- High efficiency external lighting (ie high pressure sodium or similar)

3.3.4 Lighting controls/dimmer/ sensors

Consideration on the use of lighting controls/dimmers/ sensors shall include the following:

- Lighting control to perimeter lights in the form of dimmer controls sensitive to fluctuations in outside daylight levels
- Zone light switching to minimise energy consumption. As a general rule no more then 500W per single switch for open areas. All enclosed offices should be separately switched. Switches should be in the locality of the lit area
- All light switching to be clearly labelled to indicate zoning. Coloured floor plan can be used to indicate areas for light switch controls
- Light switches to be located intuitively to relate to the zone switched and minimise likelihood of switching on non required areas by mistake
- Occupancy sensing in areas of infrequent use, i.e. offices, conference rooms, storerooms, laboratories etc
- External lighting with adjustable set-point photo-electric cell and overriding time switch control
- Computerised lighting control and dimming systems or lighting control integrated with the BAS
- Locally initiated, timed after hours override provision for each separate operating area that may be used out of hours
- Office lighting to be circuited to provide maintenance level cleaning lighting and after hours minimum security lighting levels
- Consideration of power factor optimisation shall be included

3.3.5 Electrical Service Schematic Design Report

A Report on the Electrical Services shall form part of the Schematic Design Report. It shall include comment on all of the above points for consideration. Any increased capital cost and reduced running costs shall be identified and a life cycle costing analysis undertaken. The use of Electrical Services opportunities shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

3.4 HYDRAULICS

3.4.1 Domestic Hot Water

Consideration of the design of the Domestic Hot Water Systems shall include the following:

- The domestic hot water system shall be separate to the heating hot water system
- Central DHW Plant shall be gas fired where supply is available to the site, and fitted with electronic ignition
- Storage units shall be appropriately insulated to reduce standing losses
- Circulating pumps shall be controlled to operate only when required.
- The use of flow restrictors and pressure reducing valves in a water management system
- The use of low flow fixtures
- Dead legs on piping distribution systems shall be minimised
- Instantaneous water heating systems may be appropriate
- Boiling water units to be of low energy design and time controlled to limit hours of operation
- In general, localised hot water services are more energy efficient than centralised hot water systems with circulating distribution systems

Consideration shall be given to the use of solar hot water systems using either flat plate collectors or heat pump technology.

3.4.2 Domestic Hot Water Schematic Design Report

The amount of hot water (litres) used per annum shall be estimated. The capital cost of a solar hot water system to satisfy all or part of this load shall be estimated. A life cycle costing shall be undertaken using this capital cost and operation cost saving. This information shall form part of the Schematic Design Report. The use of a solar hot water system shall be adopted by the client if the internal rate of return or payback periods are acceptable to the client.

SECTION 4 – DESIGN DEVELOPMENT STAGE

4.1 Energy Compliance Report – Design Development Stage

At the end of the Design Development Stage, the Project Team shall demonstrate compliance with the energy budget and/or energy features set out in the Schematic Design Report. Any variance from this needs to be justified. This compliance report shall form part of the Design Development Report.

This compliance report in the Design Development Report shall be validated by the independent energy adviser.

SECTION 5 – DOCUMENTATION STAGE

5.1 Pre-tender energy budget

A pre-tender energy budget shall be established for the project, which estimates both annual consumption and demand.

5.2 Information transfer

The project documentation shall include detailed energy design information such as the information in Sections 1, 2 and 3 above

5.3 Energy Compliance Report – Documentation Stage

At the end of the Documentation Stage, the Project Team shall demonstrate compliance with the energy budget and/or energy features set out in the Schematic Design Report. Any variance from this needs to be justified. This Energy Compliance Report shall form part of the Documentation Report.

This Energy Compliance Report in the Documentation Report shall be validated by the independent energy adviser.

SECTION 6 – TENDER ASSESSMENT STAGE

6.1 Energy Budget – Tender Assessment Stage

An energy budget shall be nominated by the Tenderer in the tender documents that indicates the envisaged energy consumption and demand for the completed building. The energy budget shall be compared to the energy target nominated in the Tender Documents (see Section 1.1.9 above). The energy budget shall include all energy consumption and demand associated with the space. The energy budget shall report how the energy performance is to be achieved, noting building envelope and services requirements.

The energy budget shall be set in relation to the building design occupancy and operational details included in the tender documents.

6.2 Energy Compliance Report – Tender Submission

The Tenderer shall submit an “Energy Compliance Report – Tender Submission” that details the items noted in Section 6.1 above. The energy budget shall be set out in the same format as used for the energy target detailed in Section 1.1.9 of this document. The independent energy adviser shall review this report and participate in the tender assessment process.

SECTION 7 – CONSTRUCTION STAGE

7.1 Construction matters

Consideration shall be given to the following matters:

- the site manager shall be thoroughly briefed on the energy aspects of the project by the energy adviser
- the Building Project Team shall confirm on an on-going basis that the energy features detailed in the Schematic Design Report are being incorporated
- the progressive installation of the energy features may be audited by the energy adviser at any stage

SECTION 8 – COMMISSIONING/ HANDOVER/PRACTICAL COMPLETION STAGE

8.1 Builder’s responsibilities

The Builder shall certify that all of the energy features noted in the documentation have been installed and commissioned correctly.

8.2 Documentation and training

The Project Team shall hand to the client all relevant drawings, manuals and operational plans, and undertake any appropriate training/instruction.

8.3 Energy Compliance Report – Practical Completion Stage

For Practical Completion to be granted, the Builder shall prepare an "Energy Compliance Report – Practical Completion Stage" that shows that the agreed Energy Budget and/or energy features have been achieved/included. This report must be validated by the independent energy adviser. The adviser must be independent of the Project Team

SECTION 9 – DEFECTS STAGE/ BUILDING TUNING STAGE

Information regarding energy performance shall be collected during this period and shall be made up of two parts as noted below:

- energy bills
- an indication of occupancy levels, equipment loads, and hours of operation

This information shall be used as input for the Energy Performance Report – Final Hand Over Stage required for the next stage of the project.

The manner in which this information is collected will depend on the contractual arrangements in place.

SECTION 10 – FINAL HAND OVER STAGE

10.1 Documentation

The Project Team shall hand to the client all relevant drawings, manuals and operational plans.

10.2 Energy Performance Report – Final Hand Over Stage

The appropriate person (Builder/ M + E contractor/ Developer) shall prepare an Energy Performance Report to show compliance of the operation of the building during the Defects Stage/Building Tuning Stage with the Energy Budget that was established in the Schematic Design Stage. Final hand over shall be dependent of acceptance of this report by the independent energy adviser.

APPENDIX 1 SCHEDULE OF OPPORTUNITIES

SECTIONS OF THE BRIEF (TO THE RIGHT)	CLAUSES THAT DEFINE ENERGY EFFICIENT OPPORTUNITIES UNDER CONSIDERATION (TO THE RIGHT) / STAGES WHEN OPPORTUNITIES NEED TO BE CONSIDERED (BELOW)	Proposal/Pre-design	Budget established	Appoint project team	Master Plan/Site Plan	Cost Plan A	Schematic/Concept	Cost Plan B	Design development	Cost Plan C	Documentation	Cost Plan D	Tender stage	Tender cost analysis	Construction	Commissioning/Initial handover/Prac'lCompletion	Hand over cost account	Defects	Final hand over	Final cost account	Continuing occupation
INTRODUCTION PRE DESIGN OPPORTUNITIES	Project Objectives	●																			
	Project management process/QA	●																			
	Project Budget	●																			
	Energy adviser	●																			
	Investment criteria	●																			
	External design conditions	●																			
	Internal environment conditions	●																			
	Equipment and other internal heat loads	●																			
	Energy targets	●																			
	Energy analysis and reporting	●																			
ARCHITECTURAL and MASTERPLANNING SITE and BUILDING ENVELOPE OPPORTUNITIES	Orientation and shape				●																
	Thermal efficiency of envelope						●														
	Shading						●		●		●										
	High performance glazing						●		●		●		●		●						
	Daylight possibilities						●		●		●		●		●	●		●	●		●
	Natural ventilation possibilities						●		●		●		●		●	●		●	●		●
	Level of internal thermal mass						●		●		●		●								
	Internal reflectance						●		●		●				●						
	Infiltration						●		●		●		●		●						
	Vertical access – lifts and stairs						●		●		●		●		●						
MECHANICAL HVAC OPPORTUNITIES	Internal zoning						●		●		●		●		●	●			●		●
	HVAC controls						●		●		●		●		●	●		●	●		●
	HVAC system selection and design						●		●		●		●		●	●		●	●		●
	Thermal storage						●		●		●		●		●	●			●		●
	Co-Generation						●		●		●		●		●	●		●	●		●
	Heat recovery/exchange/storage						●		●		●		●		●	●		●	●		●
	Emergency generator for lopping peak						●		●		●		●		●	●		●	●		●
	Central controls – operation/support						●		●		●		●		●	●		●	●		●
	Lifts						●		●		●		●		●	●		●	●		●
ELECTRICAL OPPORTUNITIES	Layout and zoning						●		●		●		●		●			●	●		
	Low loss ballasts						●		●		●		●		●			●	●		●
	Lamps and luminaires						●		●		●		●		●			●	●		●
	Lighting controls/dimmer/sensors						●		●		●		●		●	●		●	●		●
HYD'CS DHW	Domestic hot water						●		●		●		●		●	●		●	●		●

APPENDIX 2 PROJECT MANGEMENT FLOW CHART

Project Stage	Energy Efficiency Actions
Proposal/ Pre Design	Establish Energy Budget and Energy Objectives for the Project. State any prescriptive energy requirements. Establish operational variables
⇩	
Consultants Brief	Define Consultant types and their respective roles and responsibilities regarding energy efficiency during the Project
⇩	
Schematic/ Concept Design	Determine concept design to comply with Energy Budget based on prescriptive requirements and stated operational variables. Demonstrate consideration of various options against a life cycle assessment process.
⇩	
Design Development	Detailed design checked against Energy Budget
⇩	
Documentation	Contract (tender) documentation checked against Energy Budget and Energy Objectives prior to pricing. Pre tender energy budget established. Detailed design information passed onto the Constructors
⇩	
Construction	Construction design checked for compliance with Energy budget and Energy Objectives including any prescriptive requirements. Detail of energy efficiency accounting procedure agreed and applied.
⇩	
Commissioning/ Initial Handover	Initial compliance (indicative) with Energy Budget and other Energy Objectives/ requirements demonstrated post commissioning. Detailed operational and maintenance information supplied together with appropriate training/instruction. Detailed design information provided.
⇩	
Defects Liability Period/ Final Handover	Active and demonstrable program of building tuning and adjustment to suit occupancy and actual operation. Final demonstration of compliance with Energy Budget, Energy Objectives and any prescriptive requirements.