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# Honeysuckle Central

## NABERS Computer Simulation Report

December 2008

*Revision 2*

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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# Executive Summary

GHD has been engaged as the Ecologically Sustainable Design consultant for the proposed Honeysuckle Central development at Lot 25 Honeysuckle Drive, Newcastle. Part of this process is to identify the National Australian Built Environment Rating Scheme (NABERS) Energy for Offices rating for the development. The building energy has been modelled according to the NABERS Energy Guide to Building Energy Estimation, which supersedes the previous ABGR Validation Protocol for Computer Simulations.

Prior to the Environmental Application submission, GHD has conducted preliminary energy modelling to confirm that the external façade, form and orientation of the building and its shading will enable the building to achieve the targeted energy rating. At this preliminary stage the modelling has been undertaken on one of the three buildings only, to provide a guide to the expected performance of the entire development. Future modelling will be performed on all three buildings during the design development stage.

NABERS star ratings are determined by the normalised greenhouse emissions measured in units of $kgCO_2/m^2$. These normalised emissions take into account the location of the building; the types of energy used; the number of occupants; the hours of occupancy and the floor area. The energy simulation results are entered into the NABERS Performance Rating Calculator Version 2.3 to determine the rating.

The project seeks to achieve a 4.5 star NABERS energy rating for the base building. This equates to maximum normalised greenhouse gas emissions of **87** $kgCO_2/m^2$ per annum.

Assuming all design parameters and engineering information remain as simulated, the building's normalised greenhouse gas emissions are estimated to be **55** $kgCO_2/m^2$ per annum. This is equivalent to a NABERS 5 star building (normalised greenhouse gas emissions below **71** $kgCO_2/m^2$ per annum).

At this stage the calculation of energy use does not include any safety factor and so does not allow for any changes during construction or any changes to the use or operating conditions of the building.  During the detailed design phase GHD will also create an off-axis energy model that assumes a combination of four realistic scenarios in which the buildings are operated in a sub-optimal manner. This will test the resilience of their performance when they are not operated as originally intended.

Where the operating parameters of the building are not yet known the default NABERS figures have been used.

Overall, the simulation based on the current design of the building and its services shows that the building has potential to achieve a 5 star rating if operated in an optimum fashion. Even allowing for some differences between the input data in this model and the actual services design (yet to be finalised), it should still be capable of achieving the required 4.5 star rating.

# 1. Introduction

## 1.1 General

This report presents a preliminary base building energy rating assessment for the Honeysuckle Central development at Lot 25 Honeysuckle Drive in Newcastle.  The preliminary rating is based on modelling one of the three buildings in the development, but is representative of the entire development. Future modelling during the design development stage will cover all three buildings.

The report provides details of GHD's methodology, approach and assumptions in conducting the NABERS Energy for offices star rating, and gives an estimation of the energy consumption and potential rating able to be achieved through the current design.

## 1.2 Methodology

The National Australian Built Environment Rating Scheme (NABERS) tool is used for this assessment. This uses a five star scale to allow comparative assessments of a building's energy performance and greenhouse gas emissions. A five star rating represents market leadership performance and a one star rating indicates poor energy management.

The scheme allows users to obtain three types of ratings, Base Building Rating, Tenancy Rating or Whole Building Rating. This report focuses on a Base Building Rating. This represents the energy performance of the office areas of the building excluding the tenancy fitout.

The rating is for offices and buildings containing offices. It includes all facilities provided in the building for the exclusive use of the office occupants, so areas for commercial retail use on the ground floor are excluded. Energy consumption included in this assessment is from the following categories:

- Heating, ventilation and air conditioning;
- Common area lighting and exterior lighting;
- Equipment (mainly computers);
- Lifts;
- Domestic hot water; and
- Carpark ventilation.

## 1.3 References

The preliminary NABERS Energy rating is based on the following information:

- NABERS Energy Guide to Building Energy Estimation, Version 2008-01; and
- Architectural model provided by Suters Architects on 26 November 2008.

## 1.4 Limitations

This analysis is based on the building form, building materials and building use as outlined by the design team. The findings of this report are only valid if a building is constructed and operated in a manner that is consistent with the assumptions stated within this report.

## 1.5 Simulation Package

Computer modelling is performed using the “Virtual Environment” suite of building simulation software programs supplied by Integrated Environmental Solutions (IES-VE version 5.9.0.0) to predict the annual energy requirements of the building. This program uses a dynamic simulation to provide an accurate insight into the building envelope response as well as space and surface temperatures, internal loads and energy consumption.

The simulation procedure traces the thermal state of the building, using a time step intervals of 10 minutes throughout the year. The outputs from IES-VE allow plant sizing, prediction of energy consumption, and an assessment of energy conservation options. The energy consumption outputs from the program are used as inputs to the NABERS Energy for offices rating tool.

To ensure appropriate results are derived from the software package, NABERS requires that the software conform to appropriate BESTEST validation test or be certified in accordance with ANSI/ASHRAE Standard 140-2001: “Standard Method of Test for Evaluation of Building Energy Analysis Computer Programs”. IES-VE satisfies the latter.

## 1.6 NABERS Star Rating Calculator

The NABERS Performance Rating Calculator Version 2.3 was used to determine the Star Rating. This software is available on the NABERS website (nabers.com.au) and is free to use for self-assessment.

# 2. Input Data

## 2.1 General

The data and assumptions used for the assessment of the building are presented in this section of the report.

The Whole Building energy rating of the building is calculated from the energy consumption of the following systems:

- Heating, ventilation and air conditioning;
- Common area lighting and exterior lighting;
- Equipment (mainly computers);
- Lifts;
- Domestic hot water; and
- Carpark ventilation.

Energy used for tenant lighting and equipment is excluded from the base building rating. The heat from these sources is included in the model, as it affects the energy needed to cool and heat the building.

## 2.2 Climate Data

Hourly weather data is used to model the dynamic nature of the building thermal response. This data contains records of solar radiation, temperature, humidity, sunshine duration (cloud cover), as well as wind speed and direction for a whole year. The data used for the assessment of the building is from the 1982 ACADS-BSG/CSIRO Test Reference Year for Williamtown (Newcastle Airport). The weather data for this year is representative of the average weather data for the location for the last forty years. Because of the large amount of data (8760 hourly sets of weather parameters) Test Reference Year data is only used for computerised calculations.

The Test Reference Year weather data is valid for a limited area near the weather station where the data was collected. There might be small differences in climate in areas around the reference location, but generally the deviations due to location will be small compared with the deviations from year to year.

Plant selection for the building is based on the building (peak) load analysis. This uses the ASHRAE data for Newcastle: Summer ambient conditions of 33.7$^{o}$C dry-bulb and 23.2$^{o}$C wet-bulb, and Winter conditions of 7.8$^{o}$C dry-bulb.

## 2.3 Building Envelope

### 2.3.1 Orientation and Location

The site for the proposed building is in Newcastle with latitude of 32.9 degrees south and longitude 151.8 degrees east.

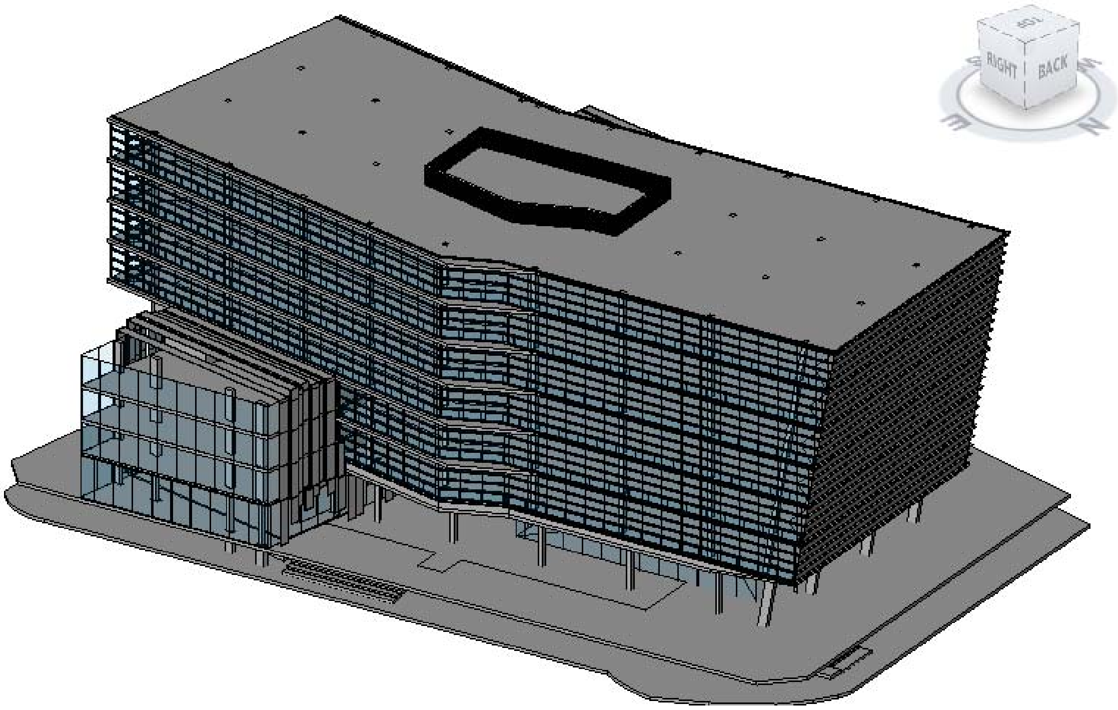



**Figure 2-1 Revit Model of the Eastern Building**

### 2.3.2 Building Form and Layout

The building and shading surfaces have been imported to Revit MEP 2009 and the space definition has been created using these surfaces. The Revit model was then imported into IES to perform the load calculations and the energy simulation.

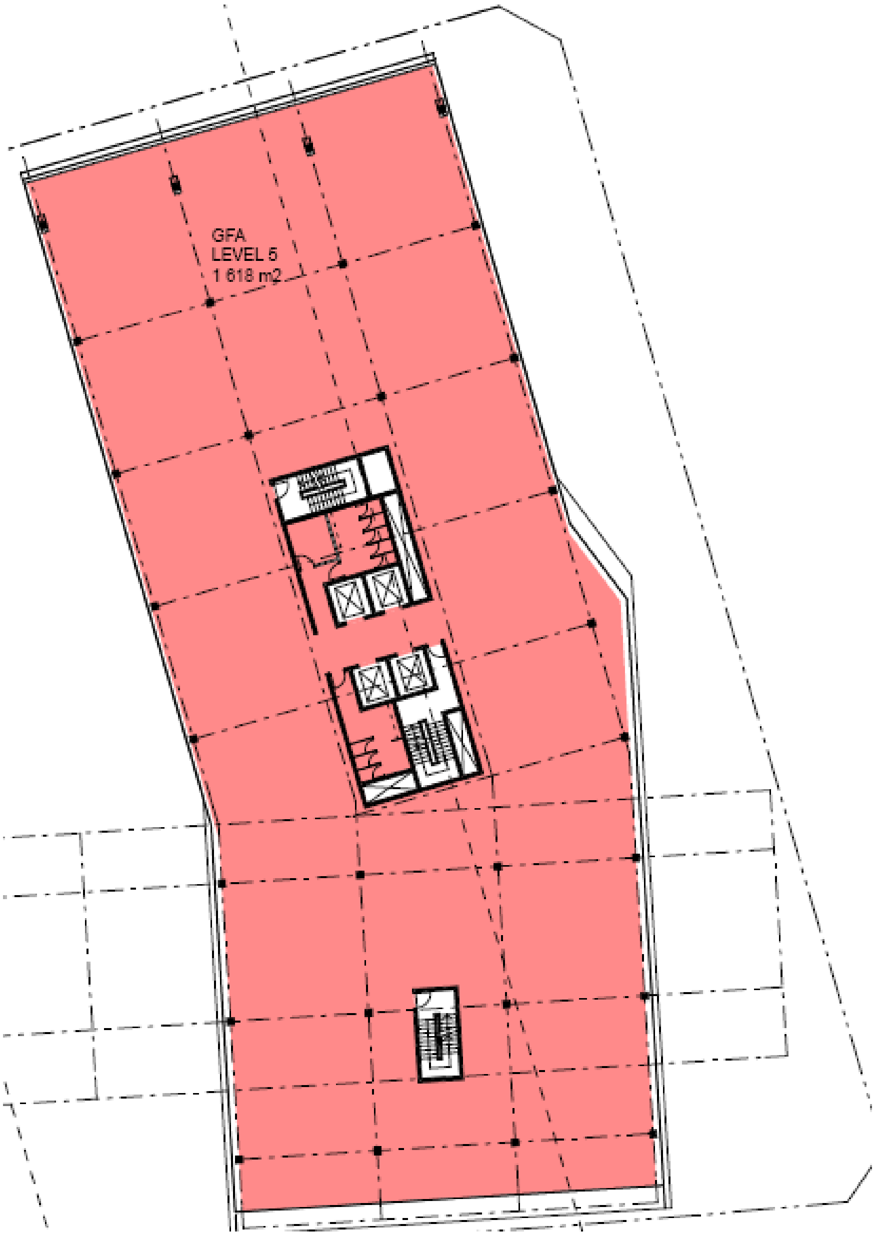



**Figure 2-2 Typical Floor Plan of Office Levels**

### 2.3.3 Building Surfaces

#### External Walls / Glazing

External walls of the building are glazed curtain walls, the properties of which are based on Viridian Comfortplus Neutral 59 glazing:

- Thickness: 6 mm;
- Transmittance: 0.43;
- Reflectance: 0.07;
- Outside emissivity: 0.84; and
- Inside emissivity: 0.28.

The R-values used for air films are 0.06 $m^2K/W$ for the outside surface and 0.21 $m^2K/W$ for the inside surface.

The overall U value of the window is 3.6 $W/m^2K$.

This represents a medium level performance single glazing option.

### Roof

The Roof construction is (from outside to inside):

- 200mm concrete slab;
- R3.0 insulation batts;
- 500mm reflective airspace; and
- 15mm acoustic ceiling tiles.

The R-values used for air films are 0.04 $m^2K/W$ for the outside surface and 0.12 $m^2K/W$ for the inside surface. The solar absorbance of 0.70 is used for the outside surface and 0.55 for the inside surface. The emissivity is 0.9 for both outside and inside surfaces. The overall roof R value is 4.90 $m^2K/W$.

### Internal Ceiling/Floors

The internal ceilings and floors are modelled as:

- 10mm carpet;
- 200mm concrete slab;
- 500mm ceiling cavity; and
- 15mm acoustic tiles.

The total R value is 2.80 $m^2K/W$.

The R-values used for air films are 0.12 $m^2K/W$. A solar absorbance of 0.55 and emissivity of 0.9 is used for the surfaces.

### Internal Partitions

Internal partitions are modelled as follows:

- 10 mm plaster;
- 90 mm airspace (90mm studs were omitted from the model); and
- 10 mm plaster.

The R-values used for air films are 0.12 $m^2K/W$. A solar absorbance of 0.55 and emissivity of 0.9 is used for the surfaces. The overall partition R value is 0.57 $m^2K/W$.

### Basement Floor

The basement floor is modelled as:

- 250 mm concrete slab; and
- 750 mm sand.

The overall R value is 1.21 $m^2.K/W$.

The R-value used for the air film is 0.12 $m^2K/W$ on the inside surface. A value of 0.55 is used for the solar absorbance and 0.9 for the emissivity.

## 2.4 External Shading

The external shading for the building can be seen in Figure 2-1. The building facades are heavily glazed, but there are 200mm wide horizontal shading elements around the perimeter of the building, at vertical intervals of 900mm. For this preliminary model, no allowance has been taken for shade from neighbouring buildings to allow a conservative result, which is representative of either of the three buildings in the development.

## 2.5 Car Parks

The above ground car parks are naturally ventilated. The basement car park will require mechanical exhaust ventilation in accordance with the requirements of AS1668.2, the energy consumption of which has been included in the rating for the development.

## 2.6 Rated Floor Area

The Rated Floor Area is the office area covered by the central services being rated.

This is calculated using the Net Lettable Area (NLA) based on the Property Council of Australia publication “Method of measurement for lettable area”, March 1997. The floor areas of the non-office spaces are subtracted from the NLA to give the Rated Floor Area.

A Rated Floor Area of **8530 $m^2$** has been used in the analysis, based on areas calculated in the Revit model. Note that the Rated Floor Area is not the same as the NLA as it excludes areas such as toilets.

## 2.7 Lighting

### 2.7.1 Lighting Power Density

A uniform minimum lighting level of 320 Lux is assumed for all the office areas. This value is taken from AS1680.2.2-1994 “Interior lighting – Part 2.2: Office and screen based tasks”.

A lighting power density of 12 $W/m^2$ is modelled for the Rated Floor Area of the building, this is the NABERS simulation guidelines standard value and is a conservative estimate, actual lighting power density when designed is likely to be around 60-75% of this.

### 2.7.2 Lighting Hours

In the absence of information on office use by future tenants, the model assumes a 50-hour per week schedule. The lighting power distribution has been taken from the NABERS Energy Guide to Building Energy Estimation. This accounts for a different lighting pattern on weekdays to that on weekends and holidays.

**Table 2-1 Lighting Load Schedule**

| Time Period | Weekdays | Weekends and Holidays |
|---|---|---|
| 0000-0700 | 15% | 15% |
| 0700-0800 | 40% | 15% |
| 0800-0900 | 90% | 25% |
| 0900-1700 | 100% | 25% |
| 1700-1800 | 80% | 15% |
| 1800-1900 | 60% | 15% |
| 1900-2100 | 50% | 15% |
| 2100-2400 | 15% | 15% |

### 2.7.3 Lighting Controls

The operation of lighting controls is imperative to the project and needs to be carefully managed.

Lighting control for office spaces should be automated with after-hours operation segregated by operational areas and limited to a maximum of 1 hour per after hours call.

External lighting should operate only during darkness and be controlled by a Photo Electric cell. It is assumed to operate for an average of 12 hours a day, 7 days a week.

## 2.8 Equipment

### 2.8.1 Equipment Density

The model assumes that the equipment load is the default provided by the NABERS Energy Guide to Building Energy Estimation for Computer Simulations of $11W/m^2$.

### 2.8.2 Equipment Hours

The distribution of equipment load has been taken from the NABERS Energy Guide to Building Energy Estimation. This accounts for a different load pattern on weekdays to that on weekends and holidays.

**Table 2-2 Equipment Load Schedule**

| Time Period | Weekdays | Weekends and Holidays |
|---|---|---|
| 0000-0700 | 50% | 50% |
| 0700-0800 | 65% | 50% |
| 0800-0900 | 80% | 55% |
| 0900-1700 | 100% | 55% |

| Time Period | Weekdays | Weekends and Holidays |
|---|---|---|
| 1700-1800 | 80% | 50% |
| 1800-1900 | 65% | 50% |
| 1900-2100 | 55% | 50% |
| 2100-2400 | 50% | 50% |

## 2.9 Occupancy

Heat gain from occupants is estimated as 75 W per person sensible gain and 55 W per person latent gain.

### 2.9.1 Occupant Density

In the absence of information on office use by future tenants, the model assumes that the occupancy density is 1 person per 15 $m^2$. This is the default figure provided by the NABERS Energy Guide to Building Energy Estimation.

### 2.9.2 Occupancy Hours

The occupancy distribution has been taken from the NABERS Energy Guide to Building Energy Estimation. This accounts for a different occupancy pattern on weekdays to that on weekends and holidays.

**Table 2-3 Occupancy Load Schedule**

| Time Period | Weekdays | Weekends and Holidays |
|---|---|---|
| 0000-0700 | 0% | 0% |
| 0700-0800 | 15% | 0% |
| 0800-0900 | 60% | 5% |
| 0900-1700 | 100% | 5% |
| 1700-1800 | 50% | 0% |
| 1800-1900 | 15% | 0% |
| 1900-2100 | 5% | 0% |
| 2100-2400 | 0% | 0% |

## 2.10 HVAC Services

### 2.10.1 HVAC System Type

Heating and cooling will be delivered to the indoor spaces by means of in-ceiling mounted ducted Fan Coil Units (FCUs) connected to the VRV system serving each building. These units will be separately zoned with one FCU per thermal zone, allowing for flexibility in operation and efficient after hours operation. High thermal comfort will be achieved by limiting the size of the thermal zones to $100m^2$ and the use of perimeter zones extending no more than 3m from the façade.

The fresh air/exhaust air throughout the building will comprise of one pre-conditioning unit, air to air heat exchanger and inline axial flow fans located within the roof mounted plant room including associated duct systems.

The operation of this ventilation system is to supply conditioned fresh air into the building, de-humidified and filtered and delivered to each area of the building. A similar quantity of exhaust air shall be exhausted from the building though the proposed toilet exhaust systems.

Both the fresh air intake to pre-conditioning unit and the exhaust air shall pass through an “air to air” heat exchanger, this will enable the exhaust air from within the building, which will be at a temperature of approximately $26^0$C, to naturally cool the fresh being supplied from outside the building, which could be on average $32^0$C, down to approximately $29^0$C.

To further reduce heating and cooling loads associated with preconditioning fresh air entering the building, $CO_2$ sensors will be fitted to the return ducts of each Fan Coil Unit, allowing the BMS to actively monitor and control the flow rate of fresh air to each zone according to the level of airborne contaminants present. Motorised fresh and return air dampers will be included on each FCU as well as variable speed supply and relief air fans for the fresh air system. This system will be designed in accordance with the Green Star credit criteria for $CO_2$ controlled ventilation systems.

### 2.10.2 HVAC Plant

Detailed HVAC plant design is not yet complete, but will be described in the final NABERS Energy report.

### 2.10.3 HVAC Zoning

HVAC zoning has not yet been designed, but will be described in the final NABERS Energy report.

### 2.10.4 HVAC Normal Hours

The distribution of HVAC operation has been taken from the NABERS Energy Guide to Building Energy Estimation and is shown in Table 2-7. This accounts for a different HVAC equipment usage pattern on weekdays to that on weekends and holidays.

## Table 2-4 HVAC Load Schedule

| Time Period | Weekdays | Weekends and Holidays |
|---|---|---|
| 0000-0700 | Off | Off |
| 0700-1800 | On | Off |
| 1800-2400 | Off | Off |

### 2.10.5 HVAC After Hours Operation

Some office areas will be assigned as HVAC after hours zones to consider the effect of some after hours operation. This will be considered in the final energy model.

### 2.10.6 HVAC Control

IES includes a component where the HVAC control system can be modelled and overlayed on the plant arrangement to more accurately model and calculate the energy used by the fans and pumps, as well as the loads on the heating coils and chillers. This will be used in the final energy model.

#### Temperature Control

Proportional control is used for the conditioned spaces.

The room temperature setpoint is 22.5$^{o}$C with a 1$^{o}$C deadband.

For cooling, the temperature at minimum signal is 23$^{o}$C and at maximum signal is 24 $^{o}$C.

For heating, the temperature at minimum signal is 22$^{o}$C and at maximum signal is 21 $^{o}$C.

#### Outside Air

The $CO_2$ based demand controlled outside air ventilation system described above will be included in the final energy model, for this preliminary model a constant flow rate of 11.25 7.5 l/s per person has been assumed which is a 50% increase over the AS1668.2 standard inline with Green Star Outside Air Ventilation credit criteria.

## 2.11 Energy Coverage

Energy consumption included in this assessment is from the following categories:

- Heating, ventilation and air conditioning;
- Common area lighting and exterior lighting;
- Equipment (mainly computers);
- Lifts;
- Domestic hot water; and
- Carpark ventilation.

# 3. Metering Requirements Description

The actual NABERS energy performance of the building will be based on meter readings of actual energy use when the building has been constructed and is occupied. It is crucial to the success of this project that non-rated areas are metered separately, otherwise the energy use from these areas would need to be included in the NABERS energy rating.  A detailed table of metering requirements will be provided in the final NABERS energy report, based on the final services design.

# 4. Simulation Results

## 4.1 Off Axis Simulation Scenarios

The following scenarios will be used in the off-axis simulation:

- An increase in occupancy to one person to every 10 square meters and a corresponding increase in equipment load to 20W/$m^2$ for all office areas of the building;
- A change in HVAC set points to 21$^o$C for cooling and 24$^o$C for heating;
- An extension of the HVAC schedule by 5 hours per week; and
- An increase in fan pressures by 50Pa to as a result of dirty or clogged air filters.

GHD consider these to be realistic scenarios, which may cause the energy performance of the building to degrade if the building is not used in the way that was originally intended. All other parameters in the off-axis model will be the same as those in the base model.

The results of the off-axis simulation will be subject to the same caveats as for the base model: that the building is constructed and operated in a way that is consistent with the assumptions described in this report.

## 4.2 Energy End-Use Summary

**Table 4-1 Energy Summary**

| Energy End Use | Electricity Included in Rating (MWh) | |
|---|---|---|
| | Base Model | Off-axis Model |
| Space heating | 3.6 | TBC |
| Space cooling | 286.2 | TBC |
| Fans, pumps and controls | 65.3 | TBC |
| Common area and exterior lighting | 121.8 | TBC |
| Lifts | 42.6 | TBC |
| Domestic Hot Water | 17.1 | TBC |
| Carpark ventilation (basement) | 33.9 | TBC |
| Total Energy Use | 570.5 | TBC |

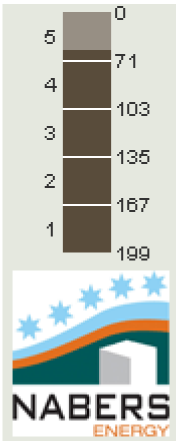
## 4.3 Figures for Use in NABERS Energy Rating

### Table 4-2 Figures for use in NABERS Energy Rating

| Item | Figure for use in Rating | Notes |
|---|---|---|
| Post Code | 2300 | Newcastle |
| Rated Floor Area (as modelled) | 8530 $m^2$ | Not the same as NLA (see section 2.7) |
| Hours of Use | 50 hours – based on people schedule above | Based on VP where occupancy is 20% or greater |
| Electricity Use – Base Model | 570.5 MWh annually | Base building electricity use |
| Electricity Use – Off-axis Model | TBC | Base building electricity use |
| Fuel Use | 0 MJ annually | No fuel used in building |

## 4.4 Estimated ABGR Performance Based on the Simulations

The NABERS Performance Rating Calculator Version 2.3 has been used to calculate the star rating based on the data shown in Table 4-2.




The calculator gives a NABERS Energy rating for the building of 5 stars for the base model (based on normalised emissions of 55 $kgCO_2/m^2$ per annum).

## 4.5 Risk Assessment

Table 4-3 shows the potential risks that may impact on the estimated energy performance of the building and suggestions as to how these risks might be abated.

Table 4-3 Summary of Risk Factors included in Off-axis Model

| Risk | Potential Impact | Abatement Approach |
|---|---|---|
| Increased building occupancy. | Increased cooling loads from people and equipment. | Design office fit-out to limit the number of people and computers. |
| Tampering with HVAC controls such as set points | Increased energy needed to heat and cool the building. | Restrict access to HVAC controls to trained and authorised personnel. |
| Extension of HVAC hours of use. | Increased energy needed to heat and cool the building. | Restrict access to HVAC controls to trained and authorised personnel. |
| An increased fan pressure due to dirty or clogged filters. | Increased power needed to run the fans. | Regular filter maintenance procedures and well trained maintenance personnel. |

### Other Risk Factors

An important risk factor that is not included in the off-axis model is higher than average temperatures for the year. This would clearly result in increased energy use for cooling, as the weather data used in the model is representative of average conditions. There is little the owner of the building can do to control this risk. This risk may increase over time due to changes in the local climate.

There is a risk that tenants may leave more lights and equipment on overnight than has been allowed for in the model. This may cause a small increase in energy needed to cool the building. This risk could be reduced if the occupants are encouraged to turn off lights and equipment at the end of the day. This risk has been incorporated to some degree in both the modelling scenarios by assuming a certain proportion of lights and equipment are always left on overnight as per the above operational schedules. Good energy management techniques and disciplined tenants could actually improve these assumed operational trends, however they are assumed to be realistic.

## 4.6 Disclaimer

Computer building simulation provides an estimate of building performance. This estimate is based on a necessarily simplified and idealised version of the building that does not and cannot fully represent all of the intricacies of the building once built. As a result, simulation results only represent an interpretation of the potential performance of the building. No guarantee or warrantee of building performance in practice can be based on simulation results alone.

**GHD**

352 King St Newcastle NSW 2300
PO Box 5403 Hunter Region Mail Centre NSW 2310
T: (02) 4979 9999 F: (02) 4979 9988 E: ntlmail@ghd.com.au



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