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Life Cycle Cost Comparison of a High NABERS Performing Commercial Building

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Abstract

NABERS is a world leading program for rating the environmental performance of buildings. It takes real, measured impacts and communicates these in a clear and simple way. NABERS rates offices in energy, water, waste and indoor environment, shopping centres and hotels in energy and water, and energy in data centres.

NSW Office of Environment & Heritage, the National Administrator of NABERS, commissioned AECOM to conduct a comparative analysis of the upfront capital and operational and maintenance (O&M) costs for a building targeting different NABERS Star Ratings [1]. The study modelled a new build on a brownfield site with a Net Lettable Area (NLA) of 35,000 m^2 located in Sydney, NSW. This was conducted from both a building owner perspective (base building) and a tenant perspective (tenancy). The base building analysis started at 4.5 Star NABERS Energy and 4 Star NABERS Water, increasing in half star increments. The tenancy analysis started at 4.5 Star NABERS Energy, increasing in half star increments. This paper is based on the results from the AECOM study.

The study supports the industry trend of high NABERS rated buildings having a greater financial return over the long term. The trend of higher capital investment for greater long term return will be one of the key risks in the development of a business case for a new commercial building.

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1. Introduction

NABERS is a world leading program for rating the environmental performance of buildings. It takes real, measured impacts and communicates these in a clear and simple way. NABERS rates offices in energy, water, waste and indoor environment, shopping centres and hotels in energy and water, and energy in data centres.

NABERS Energy is most widely used in the office sector. High performing buildings, on average, have higher investment returns when compared with poorer performing buildings. The Investment Property Database (IPD) data shows an average of 10.6% return on buildings that achieve a 5 star Energy and above, compared to 8.5% for 4 - 4.5 star and 7.6% for 3.5 star or lower [2]. Additionally, high performing NABERS Energy buildings have a vacancy rate 0.4 ppts lower than the average lower performing building; have 17% higher net income ($/sqm), have a 21% higher capital value ($/sqm) and a longer weighted average lease expiry by 45% [2].

Anecdotally, high NABERS ratings are also a proxy for high quality and well managed buildings, as a high performing building must be well managed to obtain and maintain the rating. While there has been market wide research on the value of high ratings, little analysis has been done at the individual building level.

The NSW Office of Environment & Heritage (OEH) commissioned AECOM Australia to conduct a comparative life cycle cost analysis of a theoretical brownfield building in Sydney with a 35,000 m^2 NLA at various NABERS performance levels.

The objectives were to:

- identify building attributes and sustainability initiatives required to achieve varying performance levels
- compare capital and O&M lifecycle costs through a net present value (NPV) analysis
- identify key risks and intangible benefits associated with varying performance levels
- establish the value proposition from both the building owner and tenant perspective

The NABERS Energy tool for offices can rate a building in 3 ways. It can measure the base building; tenancy; and whole building. The base building covers the building central services, such as lifts, common area lighting, air conditioning and car park facilities. The tenancy rating covers lighting and plug loads within the tenancy, and the whole building is the base building and tenancy combined. This paper is broken into two sections, the first considers the base building analysis and the second the tenancy analysis.

Nomenclature

CapEx	Capital Expenditure
OpEx	Operational Expenditure
NABERS	National Australian Built Environment Rating System

2. Base Building

The base building analysis was undertaken from a building owner perspective with the life cycle cost analysis based on the capital and operating costs of the building. The NABERS base building energy rating covers the energy used by base building services, such as the central air conditioning plant, lighting in the common area spaces, lifts and car park facilities. The NABERS water rating covers all the water used throughout the building. The scenarios are summarised in the table below.

Table 1. Summary of the base building scenarios.

Scenario	NABERS Energy rating	NABERS Water rating
1	4 Star	4 Star

2	5.0 Star	4.5 Star
3	5 Star	5 Star
4	6.0 Star	5.5 Star

2.1. Method – Base Building

The base building was modelled on a conventional office tower, implementing the most cost effective strategies that will both service the tenancy and achieve the target NABERS rating. The capital, operational and maintenance costs were estimated based on the equipment, and the rental return estimated based on buildings of the same class (PCA A Grade) and NABERS Performance.

The façade and mechanical, electrical and hydraulic services of the building for each scenario are summarised below.

Scenario 1: 4.5 star Energy and 4 star Water:

- Mechanical services: a variable air volume system with electric chiller, gas fired hot water and cooling towers
- Electrical services: fluorescent lamp fittings
- Façade: double glazed façade
- Hydraulic services: high efficiency fittings and small rainwater tank

Scenario 2: 5 star Energy and 4.5 star Water, as Scenario 1 with the addition of:

- Mechanical services: additional air handling units (AHU) for zone control with larger duct work, higher efficiency motors and fans, low load chiller and a hybrid cooling tower
- Electrical services: LED lighting
- Façade: improved glazing and shading over north and west faces
- Hydraulic: larger rainwater collection system and fire test capture

Scenario 3: 5.5 star Energy and 5 star Water, as Scenario 2 with the addition of:

- Mechanical services: perimeter chilled beams, heat recovery, increased AHU and ducts, higher efficiency motors and fans, secondary chilled water loop and all cooling towers replaced with hybrids
- Electrical services: Dimmable fittings on occupancy sensors and car park lighting zoned
- Façade: improved glazing with thermally broken frame and shading over east face
- Hydraulic services: waterless urinals and grey water recycling

Scenario 3: 6 star Energy and 5.5 star Water, as Scenario 3 with the addition of:

- Mechanical services: cogeneration with absorption chiller
- Electrical services: photovoltaic solar array
- Façade: double skin or closed cavity
- Hydraulic services: black water recycling

2.2. Results – Base Building

The capital cost, operational and maintenance costs and the 15 and 25 year NPV are summarised in table 1 below. The NPV was based on the nominal 7% interest rate and the building was assumed to be fully tenanted for the full period at market value rental rates relative to the NABERS rating with a higher performing building attracting higher market rents. All of the values are relative to scenario 1.

Table 2. Financial analysis for the base building.

Scenario	CapEx	OpEx	15 year NPV	25 year NPV
1	-	-	-	-
2	+1.5%	-3.2%	$5,241,000	$7,240,000
3	+7.6%	-5.8%	$5,109,000	$9,037,000
4	+17.4%	-5.7%	- $115,000	$5,290,000

The operational and maintenance costs include asset renewal where appropriate. Figure 1 below shows the net present values over time.

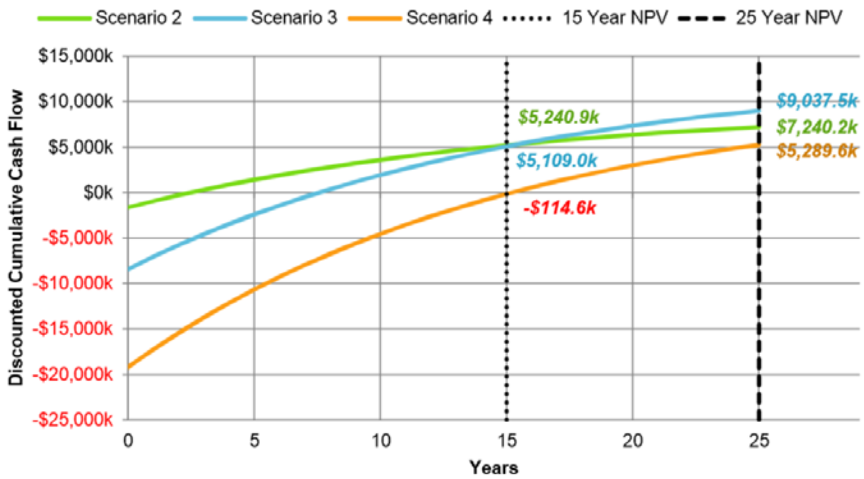

Fig. 1. Net Present Values for varying NABERS performing buildings for base buildings [1]

2.3. Discussion – Base building

The higher rental rates that higher performing NABERS rated buildings attract is based on evidence from a number of sources. Data analysis from the Investment Property Databank (IPD) show higher returns on high NABERS Energy rated buildings. This supports the AECOM study of NABERS rated buildings around the theoretical location of the building and the rental rates that these buildings are able to obtain. It is these higher rental yields that drives the NPV rather than the reduction in operational expenses from improved efficiency.

Anecdotal evidence suggests there are two primary drivers behind high performing buildings obtaining higher rental yields.

The first is the link between quality and NABERS rating. A building must achieve at least a 5 Star NABERS Energy rating (among a number of other criteria) to be classified as a Premium or A Grade office as per the Property Council of Australia (PCA) classification system [3]. This immediately creates a link between high NABERS performance and quality. Additionally, the building must be well designed and managed effectively to achieve a 5 star or above rating, reinforcing the link between high NABERS ratings and quality. This includes active energy monitoring and ensuring the mechanical systems are operating as efficiently as possible.

The second drive is for an organisation (tenant) showing leadership and corporate responsibility in occupying a high environmentally performing building. Government policy has influenced the building sector by setting minimum standards on base buildings they will lease and/or own. This is generally set at 4.5 stars, pushing buildings to achieve this as a minimum to attract a Government tenant, State or Federal [4]. Private corporations also seek office spaces in high environmentally performing buildings to meet their own sustainability objectives. This creates demand for high performing buildings, using the NABERS rating to determine a performance threshold, which the market can then respond to with higher rents in these buildings.

The other benefit is lessening the exposure of the tenant(s) to fluctuating utility costs and potential changes to the regulatory environment (such as the introduction of an emissions trading scheme) by minimising the energy and water the building uses. The energy and water costs are generally billed to the tenants as part of the outgoings. High NABERS rated buildings reduce their utility costs, which in turn reduces the outgoings on the tenant.

The general trend of improved environmental performance increasing the capital cost of the building is seen throughout all four scenarios. The fourth scenario sees a significant jump in capital costs as the target ratings (6 star energy and 5.5 star water) are individually very difficult to reach. The difficulty is compounded at this level of performance as the technologies available often require a trade off between water and energy.

For example, with regards to energy, evaporative cooling (cooling towers) is one of the most energy efficient methods of heat rejection. However, evaporative cooling consumes water as part of the heat transfer process and is a significant user of water within the building, impacting on the water rating.

Similarly, black water treatment reduces the potable water demand of the building but is an energy intensive process. This requires additional energy offsets onsite, such as the installation of a solar array and installing a larger cogeneration system to power that the black water treatment plant will use.

This general trend in the operational costs of the building is inversely follows the capital cost trend, with increasing NABERS rating resulting in lowered operational expenses. This however stops at scenario 4 where cogeneration and black water treatment is included. These systems respectively reduce electricity and water costs, however are expensive to maintain and require other utility inputs (natural gas and electricity respectively). In the case of the cogeneration unit, the overall saving on utility costs is marginal with savings on reduced electricity only slightly higher than the increased cost of gas.

These technologies introduced to operate the building at a 6 star Energy and 5.5 star Water level introduce increased risks from a technical and safety perspective. Cogeneration and black water can be more challenging to operate than originally anticipated and if the correct size and equipment is not selected and commissioned correctly, this can lead to significantly higher operational and maintenance costs to correct issues. The high capital outlay of these systems result in longer financial paybacks and decommissioning the units early due to difficulties in operation often results in not realising their full benefit.

While the building in this study makes significant use of specific technology to achieve the 6 star NABERS Energy rating, this is not necessarily required to achieve the outcome. Cogeneration was introduced to improve the increased energy use from the black water treatment plant, which was required to achieve the water result. The Sirius Building, 23 Furzer St Phillip in the ACT, achieved a 6 star NABERS Energy rating using more conventional technology such as sensor based LED lighting, chiller plant optimisation system and an 80 kW solar photovoltaic system [5], [6].

Safety risks are introduced as elements are introduced to the building to improve the environmental performance. For example, the introduction of devices such as shading devices, wastewater treatment and onsite electrical generation all pose heightened maintenance requirements and risks while maintaining and operating them. Onsite generation particularly poses its own challenges when working with the electrical distribution network within the building.

Though there are increased risks using more technology to improve the environmental footprint within a building, there are also significant risks to spending a less capital and developing a minimum performance building. The current market has 20% of buildings achieving 5 star Energy or greater [5] and minimum performance now may lead to a building falling behind if and when government policy shifts to higher performance target.

2.4. Conclusion – Base building

There is a strong business case supported by rigorous modelling that high NABERS rated buildings are more desirable to construct and operate than average or low performing buildings. From a financial standpoint, scenarios 2 (5 star energy and 4.5 star water) and 3 (5.5 star energy and 5 star water) are the most attractive for a building owner/ developer, showing a similar 15 year NPV. The 25 year NPV shows scenario 3 with a higher benefit, however it is at the expense of a greater capital outlay so selection would depend on the risk appetite of the building owner/ developer and their desired placement in the current and future rental market.

3. Tenancy

The tenancy analysis was undertaken from a tenant perspective with the life cycle cost analysis based on the capital and operating costs of the fit out for a tenancy space within a building. The NABERS tenancy Energy rating covers the energy used by the office tenancy, such as tenancy lighting, plug loads from computers and equipment, and any supplementary air conditioning to meet their specific needs. The scenarios are summarised in the table below.

Table 3. Summary of the tenancy scenarios.

Scenario	NABERS Energy rating
1	4.5 Star
2	5.0 Star
3	5.5 Star
4	6.0 Star

The AECOM study also conducted a comparative analysis of the tenancy scenarios including rental costs within a base building with varying NABERS Energy performance. The analysis showed that the costs are overwhelmingly driven by the rental costs, contributing over 80% of the life cycle costs [1]. As such, this paper has focused on the efficiency of the tenancy in a stand alone analysis for comparison between varying NABERS performances.

3.1. Method – Tenancy

The base building was modelled on a conventional office tenancy, implementing the most cost effective strategies to meet the operational requirements of an office and achieve the target NABERS rating. The capital, operational and maintenance costs were estimated based on the equipment selected for each scenario using a standard office occupancy profile as defined by the NABERS Commitment Agreement protocols.

Scenario 1: 4.5 star Energy:

- Computers: 50/50 split in desktop and laptops with 2 large screens per system
- Whitegoods and appliances: High star rated fridges, dishwashers, microwave etc.
- Server capacity: Switch panels and routers only – data contained in the cloud
- Lighting: Fluorescent (T5) lighting, zoned with motion sensors in core areas

Scenario 2: 5 star Energy, as Scenario 1 with the addition of:

- Computers: 100% laptops with ecoswitch power board
- Whitegoods and appliances: No change
- Server capacity: No change
- Lighting: Smaller zones

Scenario 3: 5.5 star Energy, as Scenario 2 with the addition of:

- Computers: automated control with average of 1.5 monitors per workstation
- Whitegoods and appliances: No change
- Server capacity: No change
- Lighting: Reduced fittings with dimming capacity and motion sensors in all zones

Scenario 4: 6 star Energy, as Scenario 3 with the addition of:

- Computers: 1 slightly smaller monitor per workstation
- Whitegoods and appliances: No change
- Server capacity: No change
- Lighting: CBUS control and PE sensors in perimeter zones

3.2. Results – Tenancy

The capital cost, operational and maintenance costs and the 15 year NPV are summarised in table 1 below. The NPV was based on the nominal 7% interest rate. All of the values are relative to scenario 1.

Table 4. Financial analysis for tenancies.

Scenario	CapEx	OpEx	15 year NPV
1	-	-	-
2	+1.5%	+6.3%	- $2,099,000
3	+0.5%	-3.0%	$582,000
4	-0.6%	-9.4%	$3,238,000

The operational and maintenance costs include asset renewal, such as fit out refresh and replacing IT equipment at end of life, where appropriate. Figure 2 below shows the net present values over time.

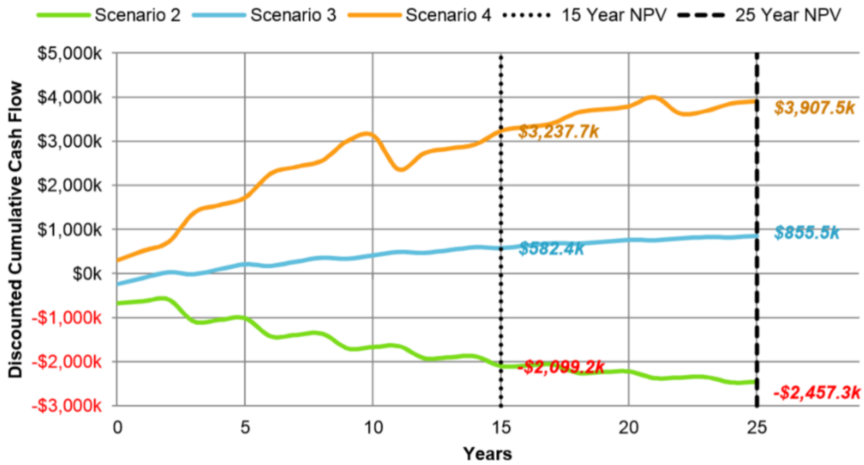

Fig. 2. Net Present Values for varying NABERS performing tenancies [1]

3.3. Discussion – Tenancy

The results for the tenancy analysis were not as anticipated, showing a decreasing capital cost with improvement to the NABERS rating. The operational cost peaked in scenario 2 before decreasing again. The expectation was a similar trend to the base building analysis, with increasing capital cost and lower operational costs as the target performance increased.

The driving component in both the capital and operational costs is the selection of IT equipment (computers and monitors) in the scenarios. Scenario 2 moved from a 50% desktop to laptop split, which increased the capital cost of the fit out as laptops are more expensive than desktop computers. Laptops use less energy and were required to replace the cheaper desktops to achieve the required performance. The operational costs include the assumption that the computers are replaced every three years (expected asset life of a computer), with replacement costs of the units and screens more than the electricity savings over the three years. This explains the negative NPV. This may be somewhat offset by delaying replacement of IT equipment so they are not replaced as often, however this may impact productivity. It is outside the scope of this paper to consider the cost benefit of this option.

There may be other drivers to move to laptop computers beyond the improved energy performance. One factor may be staff are required to be mobile, for example sales, which require work from a laptop so they have a virtual office everywhere they travel. Another is moving into an activity based work environment (or agile working), where the savings may be offset by reduced rental area and associated costs from increasing staff density and workstation utilisation.

Scenario 3 shows a slight increase in capital cost from the base scenario, which is expected. However it is lower than scenario 2, which was not expected. This is attributed to lower IT cost of moving from an average of 2 monitors per workstation within the tenancy to an average of 1.5 monitors per workstation across the tenancy. This is also reflected in the lower replacement costs as part of the assumed asset renewal program.

From an operational point of view, 1.5 screens per workstation should suit most normal office operations. The screens selected in the original scenario were large (22”) and most office operations would be able to retain efficiency with the single screen. The dual screen is still available in the tenancy at half the workstations, allowing for teams and individuals where the work requires a dual screen for maximum productivity.

Scenario 4 shows a very unusual result, with a lower capital cost than the base case scenario 1. The operational cost is also lower and in line with expectations. Similar to scenario 3, the reduced capital cost is explained by the reduced IT equipment (monitors) to meet the target NABERS rating. Moving to 1 screen per workstation significantly reduces the initial capital outlay and the asset renewal costs.

From an operational point of view, this may have an impact on productivity if there are staff members that require the dual screen for maximum productivity.

3.4. Conclusion – Tenancy

There are two issues competing with one another; productivity and financial. Evaluating a tenancy fit out on the financial analysis alone shows the NABERS 6 star Energy tenancy is the most desirable, with both the lowest capital and operating costs. However, this could adversely impact the productivity of the workplace depending on the level of IT equipment employees require to complete their work effectively.

The third scenario (5.5 star energy) seems to tread the line between environmental performance, cost effectiveness and productivity. Within the scenario, there are many IT equipment variables and combinations that can be altered to achieve a balanced outcome for a particular tenancy.

Due to the impact on IT equipment for improving the environmental performance of a tenancy, determining a NABERS target is dependent on the needs of the occupants within the tenancy. A 5.5 star Energy target is achievable, however it needs to be considered against the operational needs of the occupants.

4. Conclusion

When developing a new building, there is a strong financial incentive to target a high NABERS rating. Market data demonstrates buildings achieving 5 star Energy and see greater financial benefits in comparison to poorer performing buildings. These benefits include greater return on investment, higher capital value and net income, lower vacancy rates and longer leases. The AECOM study verifies this trend with analysis at a building level, showing the greatest net present values on 5 and 5.5 star Energy rated buildings.

With regards to a tenancy fit out, there may be IT operational requirements that limit the NABERS performance. The financial paybacks are very strongly driven by the IT equipment selection, which makes sense given the NABERS Energy rating evaluates lighting and plug loads. Using less IT equipment will decrease energy demand from the tenancy, improving the rating and decreasing operational costs. The simple message in improving tenancy performance and reduce costs is minimise IT equipment without sacrificing operational efficacy.

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