ACIL ALLEN CONSULTING

REPORT TO
DEPARTMENT OF INDUSTRY AND SCIENCE

MARCH 2015

COMMERCIAL BUILDING DISCLOSURE

PROGRAM REVIEW

FINAL REPORT

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Executive summary

ACIL Allen Consulting (ACIL Allen) was commissioned by the Department of Industry and Science, previously the Department of Industry (the Department), to undertake a review of the Commercial Building Disclosure (CBD) program.

CBD program

The CBD program was introduced in 2010 and fully implemented in 2011 as part of a combination of measures employed to drive energy efficiency improvements in commercial buildings. The rationale for the CBD program was to address two market failures in the commercial building sector, namely:

— a failure in the provision of information on the energy efficiency level of an office space being leased or sold, resulting in information asymmetry (with the seller/lessor having much more information about the efficiency level than the buyer/lessee)

— the different incentives facing those who take the decision of adopting energy efficient practice (e.g., building renovations) and those who might benefit from using them (known as split incentives).

The CBD program requires building owners to disclose information about the energy efficiency of large commercial office floor spaces (2,000 square metres or more) at the time of sale, lease or sublease. An estimated total of 5,000 buildings with approximately 26 million m^2 of Net Lettable Area (NLA), housing one million office workers, are expected to be covered by the scheme.

To meet the program requirements, building owners need to obtain a Building Energy Efficiency Certificate (BEEC), which consists of a National Australian Building Environment Rating System (NABERS) rating; information about the energy efficiency of the office lighting, contained in the Tenant Lighting Assessment (TLA); and generic guidance on how the energy efficiency of the office could be improved. NABERS star ratings must also be included in sale or lease advertisements for covered floor spaces.

The BEEC enables potential purchasers or lessees to include consideration of a building's energy efficiency as part of their decision-making processes. In so doing, the CBD program provides the market with information that would, over time, encourage energy efficiency improvements to be made voluntarily. By encouraging the market to appropriately value energy efficiency, rather than forcing the adoption of particular energy efficiency measures, the CBD program is a light-handed form of regulation.

Key findings

The review involved an assessment of the appropriateness of the CBD program, its effectiveness, its interaction with related programs, its benefits to date, likely benefits going forward, cost recovery options and consideration of possible changes to the scheme. The review has assembled and analysed the available evidence, developed a methodology for modelling past and future impacts and consulted with a broad range of stakeholders. To ensure that the review findings are robust and

defensible, appropriately conservative assumptions have been adopted where there is significant uncertainty.

1. **The Commercial Building Disclosure program is an appropriate program that complements a suite of related government policies and programs, including the Emissions Reduction Fund (ERF).**

ACIL Allen considers the CBD program to be an appropriate one that aligns strategically (and in practice) with related government policies and programs. It is complementary to a significant number of government programs and initiatives that target building energy efficiency. While some other programs also target split incentives, they primarily apply to newly constructed buildings, whereas this program applies to both existing and recently constructed buildings. A number of programs also target inadequate and asymmetric information; however, this information provision is primarily targeted at building owners, while CBD complements these programs by providing information to tenants and prospective buyers.

2. **The CBD program has been effective in inducing positive behaviour change in relation to commercial building energy efficiency in affected buildings, resulting in significant benefits.**

ACIL Allen's cost-benefit analysis indicates that the CBD program has been successful in inducing a change in the behaviour of building owners, operators and tenants in relation to commercial building energy efficiency.

ACIL Allen's cost-benefit analysis indicates that the CBD program has been successful in inducing a change in the behaviour of building owners, operators and tenants in relation to commercial building energy efficiency. This was particularly evident in buildings with relatively low initial levels of energy performance.

Our analysis suggests that the resultant improvements in base building energy performance, as measured by the NABERS rating, have enabled the program to achieve cumulative benefits in excess of costs to date of $44 million between 2010 and 2014[1], even though not all buildings covered by the program have triggered disclosure in that period. The benefits include a reduction in end-use energy consumption of 10,020 terajoules (TJ) and greenhouse-gas (GHG) emissions of 2,051 kilotonnes of CO_2-equivalent (ktCO_2-e) over the period 2010 to 2023.

This figure does not take into account the potential benefits associated with workforce productivity gains. Those benefits are estimated to be approximately $168 million cumulatively[2]. However, they have not been included in the net benefit numbers because of the higher level of uncertainty associated with them.

3. **The CBD program is expected to deliver further benefits in energy reduction and greenhouse gas abatement.**

Continuation of the CBD program is expected to deliver significant benefits.

ACIL Allen's forward-looking analysis of the CBD program indicates that retaining the NABERS component of the program will continue to deliver substantial net benefits. Assuming a 5-year program duration from 2015 to 2019, the cumulative net benefits (not including the value of GHG reductions) are estimated to be $53.3 million[3]. The cumulative net benefits are estimated to be $76.0 million if GHG reductions are valued at $23/tCO2-e.

[1] In 2014 dollars under a 7 per cent real discount rate. Includes ongoing benefits to 2023 from upgrades undertaken between 2010 and 2014.

[2] As above.

[3] In 2014 dollars under a 7 per cent real discount rate. Includes ongoing benefits to 2028 from upgrades projected to be undertaken between 2015 and 2019.

ACIL Allen's analysis of the TLA component of the program suggests that it has yet to deliver significant benefits. This is in part due to the newness of the TLA, which results in a lower level of awareness about the TLA (compared with the more well-established NABERS). Consequently, a relatively small proportion of tenants have taken advantage of the information generated by TLA assessments.

ACIL Allen estimated the costs and benefits for retaining the TLA under two cases. The first is based on retaining the TLA in its current form. The second is based on extending the validity period of the TLA from one year to five years. Extension of the validity period is recommended as it is estimated to reduce industry burden (by approximately $2.0 million cumulatively) with negligible impact on the scheme's effectiveness.

ACIL Allen's analysis suggests that retaining the TLA in its current form will generate a net cumulative cost of minus $3.9 million[4] excluding the value of GHG reduction, and a net cumulative benefit of $6.9 million[5] including the GHG benefits (at $23/t$CO_2$-e). ACIL Allen's analysis suggests that if the validity period of the TLA is extended to five years, these NPV estimates improve to minus $1.9 million excluding the value of GHG reduction, and $8.9 million including the GHG benefits (at $23/t$CO_2$-e) respectively. The net benefits of retaining the TLA are likely to be significantly higher if measures that accelerate awareness and understanding of the TLA by tenants are adopted.

Through both the NABERS and TLA components, continuing the program is projected to reduce end use energy consumption by 14,565 TJ and GHG emissions by 3,116 ktCO_2-e (equivalent to installing about 50,000 rooftop solar panels at an indicative cost of $350 million[6]) over the period 2015 to 2028.

4. CBD remains the principal Commonwealth Government program for driving energy efficiency improvements in the office sector.

The CBD program is expected to be complementary to the ERF rather than duplicative. This is mainly because the purpose of ERF is to provide funding for emission reduction projects, whereas the focus of the CBD is to provide information to potential tenants and buyers.

As such, CBD remains a low-cost, high-value program that drives significant energy efficiency improvements within the commercial office sector. The CBD is a light-handed form of regulation, which supports the market to value energy efficiency through greater information. This contrasts with heavy-handed regulation or non-regulatory approaches, both of which are not supported by industry.

5. There are several viable options for the future funding of the CBD program.

There are a number of options for how the costs of running the CBD program might be recovered. Each option has its own advantages and disadvantages. A two-tier BEEC pricing scheme is likely to be perceived as fairer than a single flat fee. However, it is less transparent and would be more complex to administer. Conversely, a single flat fee is more transparent and is likely to result in a more

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4 As above.

5 As above.

6 This is an indicative cost for 50,000 4.5 kW rooftop solar panels, based on the economic costs of installation (excluding GST and benefits from the government Small Scale Renewable Energy Scheme). Taxes and subsidies have been excluded as these are not economic costs but simply transfers between the government and installers/households.

predictable revenue stream. Maintaining the no fee status quo is extremely simple and transparent, but it may not be financially sustainable over the longer term.

The choice of which option to adopt is a question of striking the appropriate balance between the disadvantages and advantages of the various options, and the government's deregulation agenda. ACIL Allen therefore does not have a recommendation on the recovery of the costs incurred by the Department in administering the CBD program, or indeed if there even should be any effort to recover costs.

6. Future evaluations of energy efficiency programs would benefit from improved data relating to pay-offs of energy efficiency upgrades and workforce productivity improvements.

Key data gaps encountered by ACIL Allen included the pay-off from energy efficiency upgrades and the valuation of improved workforce productivity in more energy efficient buildings.

Pay-off estimates used in the analysis, referred to as the 'net benefits of energy efficiency', were derived from abatement cost curve analysis, cross-checked against multiple sources and tested with industry stakeholders. Extensive sensitivity analysis was also performed to ensure the review's conclusions were robust in light of the uncertainty around project pay-offs.

Nevertheless, future evaluations would benefit from a greater resolution and diversity of data related to project pay-offs. Available data was used to construct low, medium and high estimates of project pay-offs applying to buildings performing upgrades from a low, medium and high initial level of energy efficiency respectively. This captured the effect that returns from energy efficiency are relatively higher for poorer performing buildings. However, further data would allow greater differentiation of project pay-offs, if necessary, based on current star rating, building characteristics, jurisdiction, climate zone and tenants etc. It would also allow greater precision in economic benefit estimates.

Improvements in workforce productivity were found to be potentially significant. ACIL Allen estimates that this improvement could be higher than the combined benefit of project pay-offs and GHG reductions, even under conservative assumptions about productivity increases. However, there is a high level of uncertainty surrounding the valuation of productivity benefits due to the paucity of robust data on the productivity benefits of energy efficient buildings.

Recommendations

1. The CBD program should continue.

ACIL Allen finds that the CBD program has delivered benefits that significantly outweigh its costs but has yet to reach its full potential.

With expected robust growth in the number of commercial buildings in major cities around the country (commensurate with projected population and economic growth) and an increasingly urgent need to address the climate change challenge, the program is as relevant to Australia's needs today and in the future as it was at conception.

A significant proportion of the building stock is yet to be rated given that the mandatory obligations to disclose are only triggered on offer to sell or lease. The rating of as yet unrated stock is expected to occur in the coming years. Our analysis

suggests that the program will continue to deliver benefits that exceed costs if the program's life was extended for five years.

2. The focus for the CBD program should remain on office buildings.

ACIL Allen does not believe that mandatory disclosure should be extended to other types of commercial buildings at this time. At present, the NABERS rating tool for data centres is still relatively new and not yet widely embraced by industry. In addition, some data centre operators might be unwilling to allow access to energy consumption data due to the commercial sensitivity of that information.

The split incentive market failure may not be as acute for tenants of retail buildings, as they are more likely to be concerned with site size, configuration, location and rental price and conditions (rather than energy costs), as these are the key determinants of a tenant's profitability. In the hotel sector, the split incentive issue does not arise if hotel operators are also the building owners. Even if they do not own the building, they still have a natural incentive to seek out buildings that are more energy efficient and have lower energy costs

3. The CBD program should be expanded to include smaller office spaces.

Lowering the threshold for mandatory disclosure to 1,000m^2 will generate additional economic benefits.

ACIL Allen's analysis suggests there is merit in lowering the threshold for mandatory disclosure from 2,000m^2 to 1,000m^2. The projected net benefits of lowering the disclosure threshold are estimated to be $24 million cumulatively[7]. This is based on an estimated 1.5 million m^2 of additional floor space being captured by the CBD program if the threshold was reduced to 1,000 m^2. Lowering the disclosure threshold is also expected to result in a further 707 ktCO_2-e reduction between 2015 and 2028 (cumulative).

ACIL Allen recommends lowering the disclosure threshold to include the sale or lease of floor space between 1,000m^2 and 2,000m^2.

4. The CBD program should continue to harness opportunities for further process and administrative efficiency improvements.

There are well-established mechanisms for making ongoing improvements to the CBD program. These include measures for improving the administrative efficiency of the program and the NABERS assessment process. For example, the NSW Office of Environment and Heritage has implemented multiple automatic checks that have streamlined the work of assessors by preventing the most common mistakes found in audits. The Department has also adopted recommendations from a review of the program's operational efficiency conducted in 2013, strengthening requirements for conducting TLAs and improving administrative IT systems.

ACIL Allen recommends that these process improvements should continue.

5. There are clear opportunities to improve the TLA component of the CBD program.

7 In 2014 dollars under a seven per cent real discount rate. Includes ongoing benefits to 2028 from upgrades projected to be undertaken between 2015 and 2019.

ACIL Allen believes that much can be done to accelerate awareness and appreciation of TLA by tenants, and recommends the following:

1. Requiring some information on tenancy lighting performance be provided when advertising for sale or lease.
   – Where a single functional space is being leased, this could simply be the power density[8] and control system capacity for that space.
   – Where a number of functional spaces or the entire building is being sold or leased, an 'aggregate' measure will need to be devised that is meaningful and useful to the tenant. An aggregate measure is preferred over listing TLA information for all functional spaces for simplicity and because there is limited space in some media, such as billboards. This information should include an indication of the potential 'dollar difference' in lighting operating costs between the rated space(s) and an appropriate benchmark.
   – Stakeholders consulted by ACIL Allen noted potential challenges with this proposal include the ability to devise a meaningful aggregate figure, potential confusion with NABERS if star ratings are also used to represent tenancy lighting performance, and limited understanding of power density by tenants.
2. The TLA certificate should have provision to include a proposed (and binding) commitment of tenancy lighting upgrades for new tenancies. This information should be prominently displayed on the TLA certificate.

The implementation of these measures to accelerate awareness and appreciation of TLA would result in both costs and benefits. While costs have not been estimated, ACIL Allen estimates cumulative benefits of $4.2 million.

Extending the validity period of the TLA from one to five years will generate additional net benefits with no adverse impact on energy efficiency outcomes.

ACIL Allen also believes that the validity period for the TLA should be extended from one year to five years. This is because tenancy lighting performance is unlikely to change unless lighting systems are changed, which generally only occurs during a period of vacancy prior to a new tenant occupying the space. Therefore, requiring building owners who wish to maintain an up-to-date BEEC to re-assess lighting systems annually imposes an unnecessary cost on them.

ACIL Allen's analysis suggests that an extension of the validity period from one year to five years increases the net benefits of the TLA by approximately $2 million[9]. It also represents a reduction in regulatory burden for owners of disclosure-affected buildings.

Summary of results

The results from ACIL Allen's analysis of the benefits of the CBD program to date and the benefits going forward are summarised in Table ES 1.

[8] The power output per square metre (measured as Watts per m^2).

[9] In 2014 dollars under a seven per cent real discount rate.

Table ES 1 **Summary of benefits of the CBD program**

Analysis conducted	Estimated economic benefit excluding GHG reductions (NPV $m)	Estimated economic benefit including GHG reductions (NPV $m)	Reduction in end use energy consumption (cumulative TJ)	Reduction in GHG emissions (cumulative ktCO_2-e)
Backward-looking				
Net benefits to date (2010 to 2014)	$15.4	$44.0	10,020	2,051
Forward-looking				
Net benefits of continuing NABERS component of the program (2015 to 2019)	$53.3	$76.0	12,122	2,504
Net benefits of continuing TLA component of the program (2015 to 2019)	-$3.9	$6.9	2,444	612
Total net benefits of continuing program in its present form (2015 to 2019)	**$43.3** (after deducting $6.2m in program administrative costs)	**$76.8** after deducting $6.2m in program administrative costs)	**14,565**	**3,116**
Additional net benefits from reducing threshold to include office space between 1,000 – 2,000 m^2	$23.9 (additional)	$34.9 (additional)	3,684 (additional)	707 (additional)
Additional net benefits from extending validity period of TLA to 5 years	$2.0 (additional)	Change would not affect energy or GHG emissions reductions	Change would not affect energy or GHG emissions reductions	Change would not affect energy or GHG emissions reductions
Total net benefits of continuing program with reduced threshold and extension of TLA validity period	**$69.2**	**$111.7**	**18,250**	**3,824**
Indicative further net benefits through improved TLA visibility	**$4.2 minus costs of improving visibility (additional)**	**$8.5 minus costs of improving visibility (additional)**	**1,222 (additional)**	**918 (additional)**

Note: The backward-looking analysis is based on the period of CBD operation between 2010 and 2014, but includes benefits of the program to 2023 to encompass the ongoing benefits of projects undertaken during 2010-2014. Analysis of forward-looking benefits is based on continuing the program from 2015 to 2019, but includes benefits of the program to 2028 to encompass the ongoing benefits of projects undertaken during 2015-2019.

Source: ACIL Allen

1 Introduction

ACIL Allen Consulting (ACIL Allen) was commissioned by the Department of Industry and Science, previously the Department of Industry (the Department), to undertake a review of the Commercial Building Disclosure (CBD) program.

1.1 Background and context

The CBD Program, an initiative of the Council of Australian Governments (COAG), was introduced in 2010 as part of a suite of measures under the COAG National Strategy on Energy Efficiency (NSEE), that were designed to:

> accelerate energy efficiency improvements and deliver cost-effective energy efficiency gains across all sectors of the Australian economy.

The CBD Program is a national program designed to improve the energy efficiency of Australia's large office buildings. It is intended to address market barriers to the uptake of economically feasible energy efficiency improvements, such as the information asymmetry between building owners and prospective tenants or buyers, and the split incentives for energy efficiency investment between building owners and tenants. The CBD Program commenced in full on 1 November 2011 following a 12-month transition period. It is delivered by the Department.

The CBD program requires most sellers and lessors of large office spaces to provide energy efficiency information to prospective buyers and tenants. Disclosure of energy efficiency information is mandatory for commercial office spaces of 2,000 square metres or more. NABERS star ratings must also be included in advertisements for sale or lease.

Owners of disclosure-affected buildings are required to obtain a Building Energy Efficiency Certificate (BEEC) that comprises:

- a NABERS Energy star rating for the building
- an assessment of the energy efficiency of tenancy lighting in the area of the building that is being sold or leased (a Tenancy Lighting Assessment or TLA)
- general energy efficiency guidance.

BEECs are valid for up to 12 months and are disclosed publicly online.

A review of the operational efficiency of the CBD program was conducted in 2013. It identified a range of opportunities to further promote the achievement of the program aims and to improve the delivery and administration of the program.

1.2 Objectives and scope of the review

In 2014, the Minister for Industry requested that an independent review of the CBD program be conducted. ACIL Allen was engaged to undertake this review. The review was asked to assess:

1. The objectives of the CBD program, in particular, whether the objectives are clear and remain relevant.

2. Whether the CBD program is the most effective, appropriate and least-cost mechanism to achieve these objectives, including consideration of the benefits and costs imposed on industry.
3. The effectiveness of the program in promoting energy efficiency, both in its own right and in the context of the current framework of energy efficiency measures.
4. The interaction of the program with the Emissions Reduction Fund.

The review was also asked to provide recommendations on:

- the merits of continuing the program or not, both in terms of the public interest as well as the private interest of property owners and tenants
- the lessons for assessing possible extension of mandatory disclosure to other building types
- options for its funding, including cost recovery, if appropriate
- the most appropriate governance framework
- the potential for improvements to the operation of the program.

The review has assessed and analysed a broad range of available evidence, including two program related datasets, and developed suitable methodologies for modelling future impacts, in order to provide a solid evidentiary basis for recommendations.

Our analysis of the costs, benefits and program impacts considered both the separate elements of the CBD program (NABERS ratings and TLAs), as well as examined it from a whole of program perspective.

1.3 Approach to the review

1.3.1 Key project steps

ACIL Allen's initial proposed approach is illustrated in Figure 1. Following stakeholders' strong expressions of interest in the review, the consultations element of the project was extended to include two stakeholder workshops, one in Melbourne and one in Sydney.

Existing data and information reviewed included:

- NABERS dataset provided by the NSW Office of Environment and Heritage and the TLA dataset provided by the Department
- Previous reports commissioned by the Department
- Internal reports prepared by the Department's CBD team
- Documents relating to the establishment and operation of the CBD program
- Information on relevant energy efficiency programs operated by the Commonwealth Government, State/Territory governments and local governments, including the Emissions Reduction Fund
- Information on overseas commercial building mandatory disclosure programs
- Research papers and reports on the "Green Premium" associated with energy efficient office buildings.

As will be explained in Section 4.3, the NABERS data set was first segmented into buildings that were rated voluntarily prior to mandatory disclosure and buildings that entered the database after the CBD program was introduced. Within each of these broad groups, buildings were further segmented by their initial NABERS star ratings. Information on the ratings of buildings undertaken before mandatory disclosure was used to assist in constructing the counterfactual (Base Case of the cost-benefit analysis) where the CBD program is absent.

Figure 1 **Project key tasks**

Source: ACIL Allen

The methodology employed by ACIL Allen for the cost-benefit analysis of the CBD program to date is explained in Section 4.3, while the methodology for assessing the future costs and benefits of continuing the program is explained in Section 5.1. Methodological details such as specific assumptions are provided in Appendix A.

1.3.2 Stakeholder consultations

ACIL Allen, in collaboration with the Department, presented two stakeholder workshops in Sydney and Melbourne in the first half of November 2014. The purpose of the workshops was to allow invited stakeholders to provide feedback on the assumptions in ACIL Allen's analysis and on the preliminary results from ACIL Allen's cost-benefit analysis of the CBD program. It also provided stakeholders who might not otherwise have been formally consulted with the opportunity to provide any additional information they had to help inform the review.

The comments and suggestions raised by workshop participants have enhanced the robustness of ACIL Allen's analysis and helped to build acceptance of the eventual findings of the review. These factors will all help to ensure that the analysis and recommendations in this report will stand up to careful scrutiny.

The participants of the two workshops are listed in Table 1.

Table 1 **List of participants of Sydney and Melbourne workshops**

Name of workshop participant	Organisation represented
Sydney workshop (10 November 2014)	
Chris Bloomfield	Energy Action
Esther Bailey	City Switch
Frank Roberson	NSW Office of Environment and Heritage, NABERS
Carlos Flores	NSW Office of Environment and Heritage, NABERS
Sam MacLean	NSW Office of Environment and Heritage, NABERS
Tom Belsham	City of Sydney
Beck Dawson	Investa Property Group
Charlie Thomas	Property Council of Australia (PCA)
Ché Wall	Flux Consultants
Steve Hennessey	WT Sustainability
PC Thomas	Team Catalyst
Gary Whatling	Jones Lang LaSalle (JLL)
Chris Nunn	Jones Lang LaSalle (JLL)
Robert Sviderskas	ISPT Super Property
Ian Van Eerden	Normal Disney & Young
Katy Dean	Green Building Council of Australia (GBCA)
Kristin Pryce	Shopping Centre Council of Australia
Marine Calmettes	Umow Lai
Brett Johnson	Jones Lang LaSalle (JLL)
GS Rao	Team Catalyst
Paul Riordan	Paul Riordan Consulting
Emma McMahon	CBRE Australia
Michael Bosnich	CBD assessor
Melbourne workshop (6 November 2014)	
Phil Wilkinson	Australian Institute of Refrigeration, Air Conditioning and Heating (ARIAH)
Lisa Williams	CBRE Australia
Rob Murray Leach	Energy Efficiency Council
Sharn Enzinger	Department of State Development and Business Innovation, Victoria
John Casey	Facilities Management Association (FMA)
Peter Lovett	Green Pass
Sandra Qian	Property Council of Australia
Shan A	Subspace
Michelle Leembruggen	1200 Buildings Program
Chris Iape	Sustainability Victoria
Carlos Flores	NSW Office of Environment and Heritage, NABERS

Source: ACIL Allen

In addition to the stakeholder workshops, ACIL Allen undertook in-depth consultations on a range of issues with the following individuals from key organisations:

- Mark Matthews, Ester Bailey and Tom Belsham – City of Sydney
- Paul Suter – NSW Government Property
- Charlie Thomas – Property Council of Australia
- Amandine Dennis – ClimateWorks
- Chris Bloomfield – Energy Action

— Katy Dean – Green Building Council of Australia
— Kimberley Slow - IPD

1.4 Report structure

This report is structured as follows:

— This chapter provides an introduction to the report.
— Chapter 2 provides an overview of energy consumption in Australian commercial buildings, including barriers and drivers of energy efficiency.
— Chapter 3 describes the CBD scheme, complementary schemes and a review of international experiences with mandatory disclosure.
— Chapter 4 assesses the costs and benefits of the CBD program to date.
— Chapter 5 assesses the expected future costs and benefits of the program if it were to continue.
— Chapter 6 presents an assessment of potential changes to the program.
— Chapter 7 provides a summary of the key findings of the review.

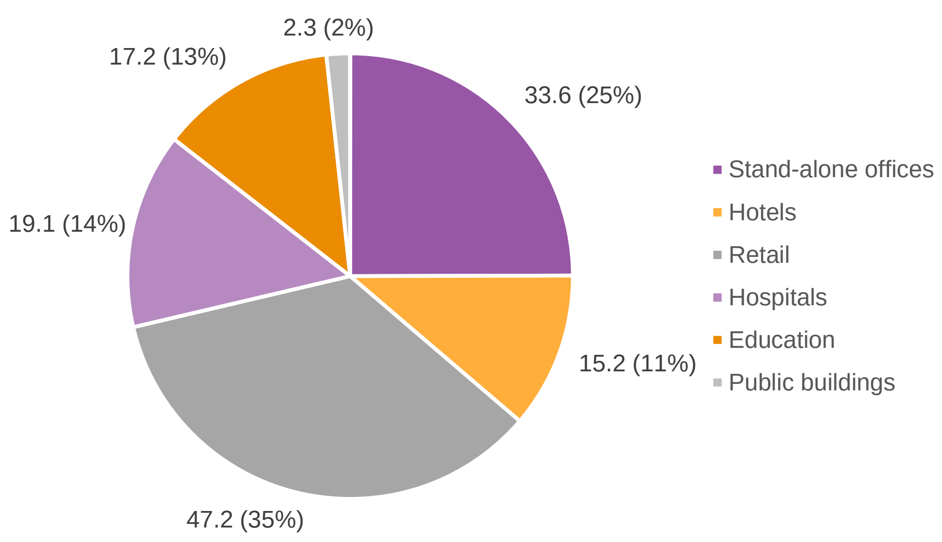
2 Why building energy efficiency matters

2.1 Impacts of buildings – energy consumption and greenhouse gas emissions

2.1.1 Energy consumption

According to pitt&sherry (2012), the total energy consumption of commercial buildings in Australia was approximately 135 petajoules (PJ) in 2009, representing around 3.5 per cent of the 3,907 PJ of gross final energy consumption in Australia in that year.[10] Stand-alone office buildings represented the second largest share of energy consumption in commercial buildings in 2009, consuming approximately 34 PJ or 25 per cent of the total (see Figure 2). Retail buildings accounted for the largest share, consuming approximately 47 PJ or 35 per cent of the total.

Figure 2 **Total energy consumption by building type, 2009 (PJ, % shares)**



Source: pitt&sherry (2012)

According to ClimateWorks (2013), the energy intensity per square metre of commercial buildings decreased by an average of only 0.3 per cent per annum between 2002-03 and 2010-11, driven by a small number of market leaders and the capture of ‘low hanging fruit’ in other buildings.[11] By 2011-12 (after the introduction of the CBD program) NABERS ratings showed average emissions reductions of 9 per cent for over 620 buildings.

10 Pitt&sherry, Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia – Part 1 – Report, 2012

11 ClimateWorks, Tracking Progress Towards a Low Carbon Economy: 1. National Progress Report, July 2013

ClimateWorks believes that increased standards for new buildings have resulted in strong improvement in the energy efficiency of new office base buildings. This comprises heating, cooling, ventilation, common area lighting and elevators, but only accounts for around 12 per cent of commercial building energy use. Lack of data prevents accurate estimates of recent changes in office tenancies and other commercial building types.

According to ClimateWorks, new office base buildings[12] are approximately 32 per cent more efficient than the average 10-year-old building. Green Star rated offices represent over 31 per cent of new office spaces built since 2003. These buildings are associated with 44 per cent less greenhouse gas emissions than offices built to meet “minimum standards”.

2.1.2 Greenhouse gas emissions

According to Climateworks, in 2010-11, buildings in Australia (including both residential and commercial buildings) were associated with 113 $MtCO_{2e}$ (20.1 per cent) of emissions out of a total of 563 $MtCO_{2e}$. Only power generation was a greater source of carbon emissions (218 $MtCO_{2e}$). In 2002-03, buildings had accounted for 18.6 per cent of total carbon emissions in Australia.

According to pitt&sherry, electricity dominates the fuel mix for all commercial buildings in Australia, with a share of almost 83 per cent in 2009 (compared with natural gas’ share of 17 per cent). Given the relatively high average greenhouse gas intensity of electricity supply in Australia, this largely explains why buildings exhibit a larger share of Australia’s greenhouse gas emissions than their share of energy use.

2.2 Profile of office building energy use

2.2.1 Overview of office building stock

According to pitt&sherry (2012), *Baseline Energy Consumption and Greenhouse Gas Emissions In Commercial Buildings in Australia*, in 2009, standalone offices were estimated to have comprised some 36.6 million square metres Net Lettable Area (NLA) across Australia as a whole. Historically, the stock grew at an average rate of 2.2 per cent per year between 1999 and 2011, and it is projected to continue to grow at approximately 2 per cent per year to 2020.

While New South Wales comprised the largest share of the office stock by state, this share is expected to fall slightly over the 2009 to 2020 period, from 38.6 per cent to 37.8 per cent. Over the same period, shares of Queensland and Western Australia are expected to increase somewhat, from 14.3 per cent to 15.2 per cent (Qld) and from 8.4 per cent to 9.2 per cent (WA).

2.2.2 Office building energy consumption

Total energy consumption in standalone offices in 2009 was estimated by pitt&sherry at some 33.6 PJ, a 14 per cent increase over the 1999 value of 29.4 PJ. This is projected to increase steadily to just over 38 PJ in 2020 according to current trends. Tenancies accounted for around 42 per cent of the energy consumption in 2009, with base buildings accounting for the balance of 58 per cent.

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[12] A building’s energy efficiency can be measured in terms of ‘base building’ (excludes energy consumption in tenanted spaces) or ‘whole building’ (includes energy consumption in tenanted spaces) performance. The CBD requires disclosure of the base building NABERS ratings but allows disclosure of whole building NABERS rating where metering is inadequate.

2.2.3 Office building greenhouse gas emissions

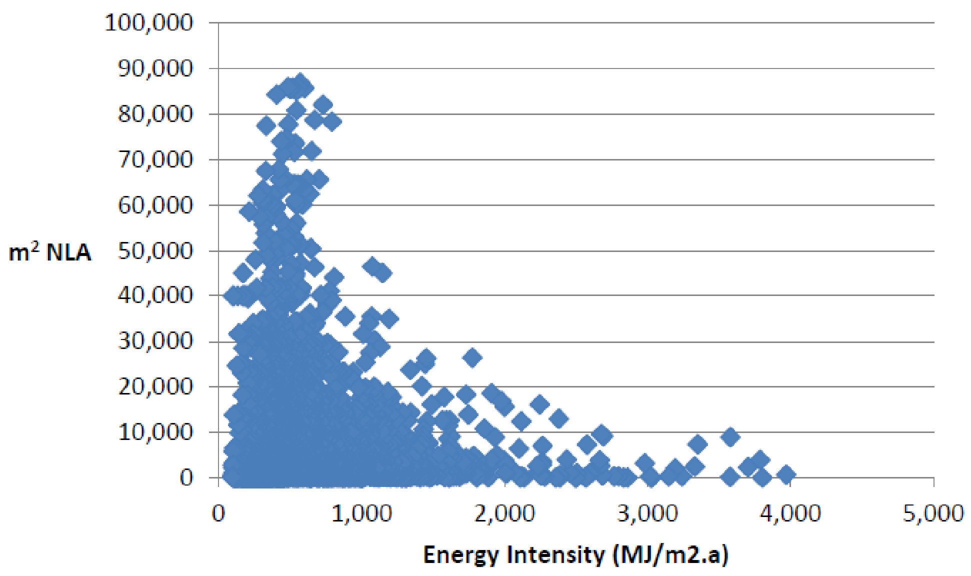
Greenhouse gas emissions associated with standalone office energy use in 2009 were estimated by pitt&sherry at 8.7 Mt CO_{2e}, and are projected to rise around 9.8 Mt CO_{2e} in 2020, assuming that the greenhouse gas intensity of electricity in each state and territory remains unchanged.

2.2.4 Office building energy intensity

In the pitt&sherry report, energy and fuel intensities were calculated for each year, office sub-type (base building, tenancies, whole buildings) and ownership type (private, government), drawing on more than 4,300 data records relating to over 1,700 actual office buildings between 1999 and 2012.

Figure 3 shows all office energy intensities (all sub-types and time periods) plotted against area. While the larger offices exhibit a reasonably symmetrical distribution of values around the mean, the overall distribution shows a skewed 'tail' of smaller and more energy intensive offices.

Figure 3 **Total energy intensity versus area, all offices**



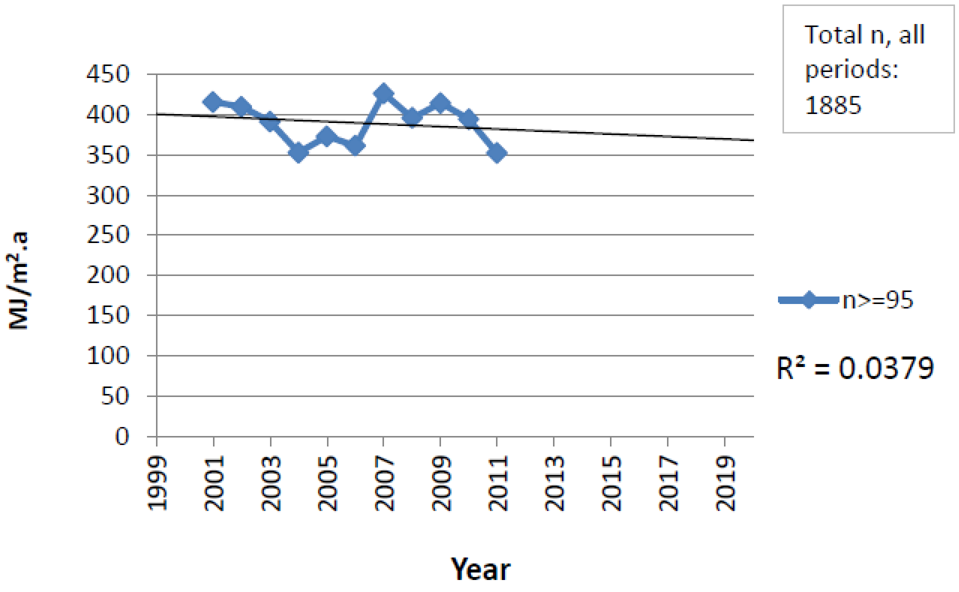
Source: Figure 5.3, p.36, pitt&sherry (2012)

Figure 4 shows the average annual energy intensity for office tenancies for the years 2001 to 2011, including linear regressions for the period back to 1999 and forward to 2020. In the base year of 2009, the average energy intensity of office tenancies in Australia was estimated to be around 385 MJ/m^2.

It can be seen in Figure 4 that the values for average annual energy intensity vary considerably around the trend, resulting in a very low R^2 value of 0.04[13]. Despite this, pitt&sherry draw a weak conclusion that, on average, the energy intensity of office tenancies in Australia appears to have fallen modestly over the decade to 2011 (which largely pre-dated the introduction and operation of the CBD program).

[13] An R^2 value indicates how well a hypothesised model fits the available data. In this case (observing energy intensities over time) it indicates how well the hypothesis that energy intensities are trending lower at a certain rate is explained by the data. R^2 values are measured between 0 and 1. A high R^2 (closer to 1) would have suggested a strong trend over time. However, the low calculated R^2 value of 0.04 suggests there is a weak trend.

Figure 4 **Average energy intensity, office tenancies, Australia**



Source: Figure 5.4, p.37, pitt&sherry (2012)

2.2.5 Energy consumption by fuel

According to the pitt&sherry report, fuel use in standalone offices is dominated by electricity, which accounts for 90 per cent of total energy consumption. Natural gas accounts for the majority of the balance, with minor use of diesel (which is likely to be primarily for standby power generation) and LPG.

The fuel mix varies by office sub-type. Office tenancies, on average, use close to 100 per cent electricity (for 'tenant light and power'), with around only 0.3 per cent natural gas and 0.1 per cent LPG. (These values represent averages over the 1999 to 2012 period, as no significant time series information was available.)

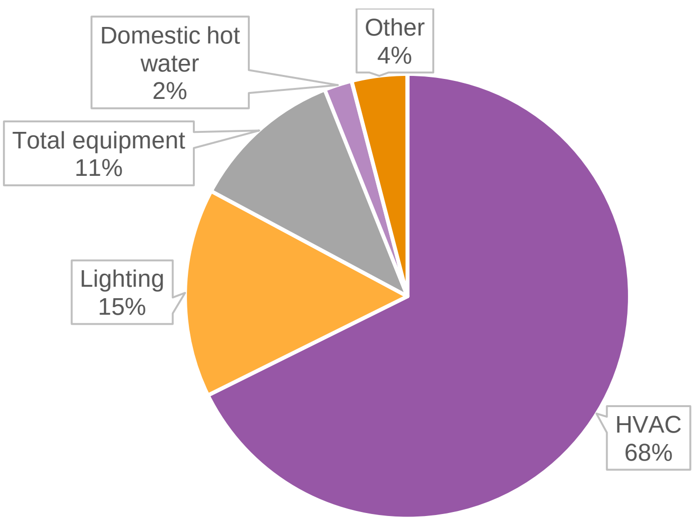
In base buildings, on the other hand, electricity's share of total energy consumption was, on average, around 83 per cent in 2009, with natural gas around 16 per cent and minor use of diesel and LPG. These fuel mix shares appear to have remained broadly constant over the 1999 to 2012 period.

2.2.6 Energy end use in office buildings

Base buildings

The average electricity end-use shares for base buildings over all periods captured in the pitt&sherry data set are shown in Figure 11. Heating, ventilation and air conditioning (HVAC) dominates total electricity use (67 per cent), followed by lighting (15 per cent) and total equipment (11 per cent).

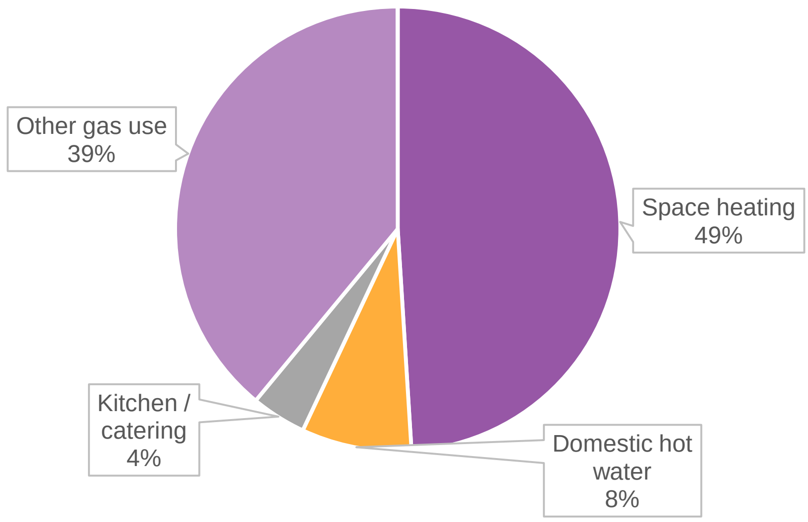
Figure 5 **Electricity end-use shares, base buildings, 1999-2012**



Source: Figure 5.9, p.44, pitt&sherry (2012)

Space heating is the dominant end use of natural gas in office base buildings, with an average end-use share of 49 per cent (see Figure 6). Domestic hot water accounts for around 8 per cent of gas use, while a significant residual of 'other gas use' is not attributed to particular end uses in the data available to pitt&sherry.

Figure 6 **Gas end-use shares, base buildings, 1999-2012**



Source: Figure 5.10, p.44, pitt&sherry (2012)

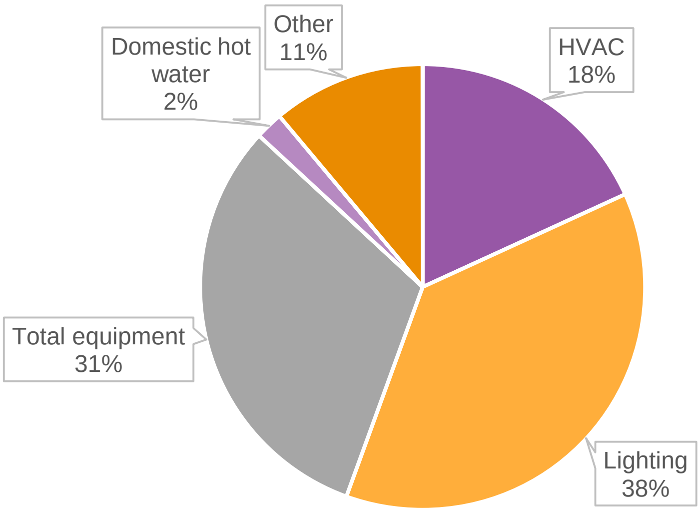
Tenancies

The average electricity end-use shares for office tenancies over all periods captured in the pitt&sherry data set is shown in Figure 7. (As noted previously, electricity accounts for nearly 100 per cent of office tenancy energy use.)

Lighting and office equipment dominate the end-use shares, accounting for 37 per cent and 31 per cent respectively on average. Supplementary HVAC accounts for a significant 18 per

cent of energy use on average, noting that this is addition to HVAC services provided by the base building plant. Domestic hot water makes up 3 per cent of the total office tenancy energy use on average.

Figure 7 **Electricity end-use shares, office tenancies, 1999-2012**



Source: Figure 5.8, p.43, pitt&sherry (2012)

2.3 Barriers and drivers of energy efficiency

2.3.1 Market failures and barriers

In general, markets will provide price signals and other information to guide private decision-making that is reasonably consistent with an efficient allocation of resources. In a market-oriented economy such as Australia's, government intervention through regulation and other means is usually predicated on the existence of market failures that prevent optimal outcomes from being achieved.

The intent of the CBD program and related government policy is therefore to address the market failures that prevented the efficient uptake of energy efficiency measures. Market failures exist when, in the absence of government regulation, the unfettered operation of markets does not lead to an efficient allocation/use of resources in the economy.

In the specific case of energy consumption in energy buildings, a number of market failures result in lower adoption of energy efficient technology than would be considered 'efficient' from an economic perspective. There are five main market failures in the commercial building sector, each of these failures is discussed in turn below.

Split incentives

In the case of the environmental sustainability of rental office properties, one potential market failure lies in the form of the 'split incentive'. While landlords are responsible for supplying and maintaining building features and management procedures which impact on the energy and water efficiency of properties, tenants are liable for the day-to-day running costs including their consumption of gas and electricity.

As landlords do not receive the direct savings benefits arising from retrofitting energy efficiency measures, they are less likely to undertake improvements to the energy efficiency of the building, such as upgrades to HVAC and control systems.

On the other hand, tenants face a different set of challenges in implementing energy saving measures. These include the length and certainty of tenure in a particular property, as well as the lack of legal rights to change fixtures and fittings to improve energy efficiency in rental properties.

Inadequate and asymmetric information

Landlords and managers of office buildings may also be reluctant to improve the potential environmental sustainability of their properties if they do not understand the indirect benefits, such as improved tenant retention. In addition, the lack of readily available information about the energy efficiency of individual properties means that it may be difficult for prospective tenants to make informed decisions that take into account energy efficiency when searching for rental space for their business.

Likewise, office building owners contemplating the sale of their properties in the near or medium term may also be reluctant to improve the potential environmental sustainability of their properties if they do not believe they can achieve a higher selling price in the market after they have incurred the cost of undertaking those improvements.

This problem is exacerbated by asymmetric information in the market for office spaces, where landlords and sellers generally have more information about the property in question (including its energy efficiency) than tenants and buyers.

Adverse selection

George Akerlof (1970) highlighted the “adverse selection” or “lemons” problem, using markets for new and used motor vehicles to illustrate the analysis.[14] His analytical approach could be applicable to the market for office space.

In the absence of action to correct the information asymmetry identified above, office accommodation would tend to sell or rent according to attributes other than energy efficiency, because buyers and renters lack any knowledge of the differential value of energy efficiency of various properties.

Consequently, builders, sellers, and investors would not be able to fully capture the benefits of constructing or acquiring properties with better energy efficiency through higher prices or rents. This means the social benefits of energy efficient buildings would exceed private benefits, and markets would undersupply office properties with superior energy efficiency.

Capital market imperfections

In addition to the split incentive problem, landlords and tenants may also face capital market imperfections in financing investments in energy saving measures. In particular, less well-resourced landlords and tenants without a strong financial track record may experience

[14] As many important mechanical parts and other elements of a vehicle are hidden from view and not easily accessible for inspection, the buyer of a used car does not know beforehand whether it is a good one or a bad one (a “lemon”). The buyer's best guess for a given car is that the car is of average quality; accordingly, he/she will be willing to pay only the price of a car of known average quality. The owner of a carefully maintained, never-abused, good used car will thus be unable to obtain a high enough price to make selling that car worthwhile. Consequently, owners of good cars will not place their cars on the used car market. The withdrawal of good cars reduces the average quality of cars on the market, causing buyers to revise downward their expectations for any given car. This, in turn, motivates the owners of moderately good cars not to sell, and so on.

difficulties in accessing loans from the financial markets to undertake energy efficiency investments that have high rates of return.

Market failures associated with climate change

Climate change has been widely cited as an example of market failure – a cause of misallocation of resources or departure from an efficient allocation/use of resources. Climate change market failure can be depicted as a result of failing to take into account the external costs of greenhouse gas emissions, and/or as the result of the pure public good nature of emissions abatement.

Individuals and firms use part of the natural environment, the atmosphere, to dispose of the greenhouse gases they emit in consumption and production activities. These emissions impose costs on others through the effects of greenhouse gases on the climate. External costs of greenhouse gas emissions are borne globally. This occurs because the effects of emissions do not vary with the location of sources of emissions. In addition, the scrapping of the carbon tax means that these external costs are no longer internalised in Australia.

An alternative depiction of climate change market failure is that it derives from the pure public good character of emissions abatement. Indeed, greenhouse gas emissions abatement is an example of a global public good. Each person’s enjoyment of the benefits of abatement would not detract from the availability of those benefits to any other person on Earth. Also, it would not be practical to exclude those who failed to pay for abatement. In such circumstances, free-riding could be pervasive.

The consequence of climate change market failure is over-exploitation of the atmosphere as a place to dispose of greenhouse gases and hence, too much emitting activity from a global social perspective. That is, the resources available to global society are *not* being used in an economically efficient way.

Addressing climate change requires a concerted reduction in greenhouse gas emissions from a variety of sources, including those from the commercial building sector.

2.3.2 Behavioural failures and the impact of uncertainty

Behavioural failures associated with energy efficiency of commercial buildings

Over time, increasing attention has been given to the role of “behavioural failures” as impediments to take-up energy efficiency opportunities that would yield private benefits in excess of private costs and achieve an economically efficient level of abatement, even in the context of a well-designed emissions pricing regime. For example, Nicholas Stern (2007, p. 429) commented that such apparently anomalous behaviour could imply the existence of “barriers to ‘rational’ behaviour and motivation”, not just market and policy failures.

More than 25 sources of “behavioural failure” have been identified in the behavioural economics literature. Key sources, some of which overlap, include[15]:

- *computational issues* (limited attention, decisional conflicts, over-optimism and over-confidence, self-serving bias, limited analytical capacity including bounded rationality and rule of thumb (heuristic) decision-making)

[15] For simple summaries of these potential sources of behavioural failure, see Thaler, Sunstein (2009), ch. 1 and Congdon et al (2011), ch.2. For discussions in the context of the environment and energy efficiency, see Shogren, Taylor (2008); Brekke, Johansson-Stenman (2008); Gillingham, Newell, Palmer (2009); Tietenberg (2009).

- *self-control issues* (time inconsistency, procrastination, temptation, channelling and framing)
- *preference issues* (reference-dependent preferences including endowment effects, status quo bias and loss aversion, outward looking or other-regarding preferences including altruism, fairness concepts and social norms).

The potential role of “behavioural failures” in impeding better energy efficiency can be illustrated by some examples related to commercial buildings. Bounded rationality has been suggested as a reason why buyers do not undertake discounted cash flow calculations, preferring to fall back on rules of thumb, before deciding on an energy efficiency investment.

It appears that very few purchasers and lessees of commercial properties undertake detailed research and analysis regarding energy efficiency features, due in part to the costs associated with searching for this information. In addition, net present value calculations may be beyond the competence of many purchasers and lessees. It is even less likely that more sophisticated analysis would be undertaken to allow for uncertainties regarding future energy prices, actual fuel efficiency and the effect of energy efficiency features on re-sale values, tenure and future refurbishments. However, it should be noted that bounded rationality suggests poor valuation of energy efficiency, not pervasive under-valuation.

Loss aversion and salience have been put forward as reasons why extra up-front costs of buildings and appliances with better fuel efficiency appear to be given more weight than energy savings over the life of the investment. Framing through advertising could help explain why buyers give less attention to energy efficiency than other features of commercial accommodation.

Impact of uncertainty on decision-making

On the other hand, the apparent under-valuation of energy efficiency in selection of commercial accommodation might also reflect the (real option) values buyers place on deferring energy efficiency investments to maintain flexibility or wait for more information in the context of:

- a significant degree of irreversibility of extra acquisition or construction costs because of uncertainty regarding capitalisation of future energy savings on resale
- uncertainty regarding future energy prices, energy savings, and realisable energy savings, investment life, and future accommodation requirements
- imprecise expectations of ongoing improvements in technologies for energy savings.

It is rational for tenants and investors considering leasing or buying office spaces to allow for these considerations when making decisions regarding transactions.

These neglected private costs are important explanatory factors for the “energy paradox”, namely the observed under-investment by office building owners in energy efficiency opportunities that seemingly yield private benefits in excess of private costs. This neglect is analytical oversight, not market, behavioural or policy failure.

2.3.3 Programs targeting building energy efficiency

In addition to the CBD program, there are a range of measures implemented by various levels of governments and other entities that seek to reduce the energy consumption and greenhouse gas emissions of buildings in Australia.

Standards

In recent years there have been strong improvements in the energy efficiency standards for both residential and commercial buildings. These changes have helped to reduce the amount of heating and cooling required, improved lighting efficiency by reducing lighting power density, and eliminated the addition of new electric hot water heaters. States and territories choose whether to adopt the changes, which are set by the Australian Building Codes Board (ABCB).

The National Construction Code (NCC) now contains a range of energy efficiency requirements, including requirements relating to the building itself – such as glazing, insulation and draught proofing – as well as major energy using equipment such as heating and cooling systems, water heating and lighting.

Minimum Energy Performance Standards (MEPS) are mandatory minimum standards that a range of appliances must meet in order to be sold in Australia. Appliances that are currently covered by MEPS include refrigerators, motors, water heaters, air-conditioners and a range of lighting products.

Commonwealth Government programs

The Energy Efficiency Opportunities (EEO) program, which was ceased on 29 June 2014, was designed to encourage large energy-using businesses to improve their energy efficiency by improving the identification, evaluation and implementation of cost effective energy savings opportunities.

Participation in the program was mandatory for corporations that, individually or as part of a corporate group, used more than 0.5 PJ of energy per year (equivalent to 139,000 megawatt hours of electricity, 9,000 tonnes of LNG, 10,000 tonnes of LPG or 13 megalitres of diesel). Medium energy users participated voluntarily.

The program applied to over 300 corporations from the manufacturing, mining, resource processing, electricity generation, transport and commercial sectors, which collectively accounted for approximately 65 per cent of Australia's total energy use.

Participants in the program were required to assess their energy use and report both publicly and to government on the results of the assessment and the corporation's business response. Decisions on the implementation of energy efficiency opportunities remained at the discretion of the business.

The Energy Efficiency Exchange (EEX) website (eex.gov.au) supports the implementation of energy efficiency practices within medium and high energy-using companies. It shares best-practice information on energy efficiency, case studies and resource materials from Australia and overseas.

The Energy Efficiency in Government Operations (EEGO) policy aims to reduce the energy consumption of Australian Government operations with particular emphasis on building energy efficiency. The program is mandatory for Australian Government agencies and incorporates energy intensity targets, annual reporting and green lease requirements into new office lease arrangements. The EEGO policy requires each agency to report its energy consumption against core performance indicators to their portfolio minister.

A key objective of the EEGO policy for Australian Government office buildings in each portfolio was to achieve the following energy intensity targets from June 2011:

- 7500 megajoules per person per annum for tenant light and power
- 400 megajoules per square metre per annum for central services.

The EEGO policy sets minimum energy performance standards for Australian Government office buildings, which vary depending upon the tenanted area and are summarised in Table 2.

Table 2 **Minimum energy performance standards for Australian Government office buildings**

Element	≥ 2,000 m^2 net lettable area			< 2,000 m^2 net lettable area
	100% of total building area	**50% to 99% of total building area**	**< 50% of total building area**	
Base building	≥ 4.5 stars NABERS Energy, or equivalent, level of energy efficiency for whole building	≥ 4.5 stars NABERS Energy, or equivalent, level of energy efficiency	No requirement	No requirement
Tenanted area	≥ 4.5 stars NABERS Energy, or equivalent, level of energy efficiency for whole building	≥ 4.5 stars NABERS Energy, or equivalent, level of energy efficiency	≥ 4.5 stars NABERS Energy, or equivalent, level of energy efficiency	Separate digital metering and max 8 W/m2 for lighting
Lease	To include a Green Lease Schedule	To include a Green Lease Schedule	To include a Green Lease Schedule	No requirement
Appliances	US EPA 'Energy Star' compliant with power management features enabled at the time of supply (where available, fit for purpose and cost-effective)			

Note: Green Lease Schedules (GLS) are intended to form part of lease documentation (or MOUs where the Government owns the building). They are designed to ensure that buildings are operated at the required level of energy efficiency and cover five essential elements: 4.5 stars NABERS Energy for Base Building (where applicable) and Tenancy; separate metering; a building management committee; an energy management plan; and disputes and remedies clauses.
Source: Department of Industry and Science

The minimum energy performance standards apply to Australian Government office buildings that are new, or have undergone major refurbishment affecting ≥ 2,000 metres squared, or are subject to a new lease (or MOU where the building is Government owned) of greater than two years duration, including options for lease extension.

State government programs

The **Energy Saver** program is a NSW Government initiative to provide support for businesses in reducing their energy consumption and costs. Operated by a dedicated team within the Office of Environment and Heritage, the program provides practical guidance on energy efficiency.

The Energy Saver program assists New South Wales businesses reduce their energy use through:

- subsidised technical investigations to identify energy efficiency opportunities
- tailored financial business cases to support energy efficiency projects
- the provision of measurement and verification for implemented projects
- assistance with accessing Energy Savings Scheme incentives (see discussion below)
- technical support for projects.

The **Energy Savings Scheme** (ESS) reduces electricity consumption in NSW by creating financial incentives for organisations to invest in energy savings projects. Energy savings are achieved by installing, improving or replacing energy savings equipment.

The ESS is governed by NSW legislation and places a mandatory obligation on liable entities to obtain and surrender energy savings certificates, which represent energy savings. When businesses invest in reducing their energy use, energy savings certificates are created by the voluntary scheme participants that have helped to implement those energy savings activities. Electricity retailers, who are mandatory scheme participants, then buy the

energy savings certificates to meet their own legislated targets, as required by law. The operation of the ESS is similar to the Victorian scheme described below.

The Victorian Energy Efficiency Target (VEET) scheme is a Victorian Government initiative promoted as the Energy Saver Incentive. The scheme is designed to make energy efficiency improvements more affordable, contribute to the reduction of greenhouse gases, and encourage investment, employment and innovation in industries that supply energy efficiency-related goods and services.

Under the scheme, accredited businesses can offer discounts and special offers on selected energy saving products and appliances installed at homes, businesses or other non-residential premises.

The scheme operates by placing a liability on large energy retailers in Victoria to surrender a specified number of energy efficiency certificates every year. These energy retailers are able to create certificates directly, or purchase certificates in a competitive market, or both.

The scheme also allows for accredited entities, known as Accredited Persons, to create VEECs when they help energy consumers make selected energy efficiency improvements to their homes, business premises or other non-residential premises. Activities specifically designed for the commercial sector include high efficiency motors, refrigerated display cabinets, refrigeration fan replacement, commercial lighting upgrades, efficient low flow trigger nozzles and water efficient pre-rinse spray valves.

The Efficient Government Buildings program, developed and managed by the Victorian Department of Treasury and Finance (DTF), involves energy service providers identifying and installing cost-effective energy and water efficiency solutions and providing a guarantee on project savings. Solutions commonly include lighting upgrades and controls, heating and cooling efficiency improvements, building automation, water conservation measures and on-site electricity generation e.g. co-generation and tri-generation.

Service providers not only design and install energy and water saving solutions, but must guarantee annual cost savings. The presence of this guarantee not only provides greater certainty that energy and water savings will be achieved, but enables the project costs to be financed, with annual cost savings used to repay the loan over the life of the investment.

Under the program's competitive tender process, contracts are awarded to the provider that identifies the greatest savings over a seven year payback period.

Local government programs

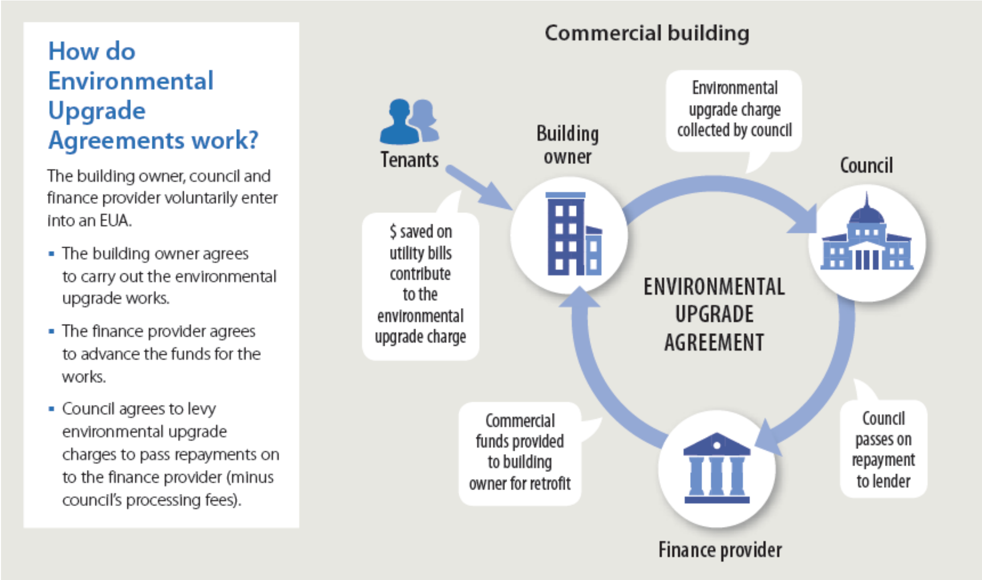
In several local government areas in New South Wales and in the City of Melbourne, Environmental Upgrade Agreements (EUAs) make it easier to access finance for environmental improvements to existing commercial, industrial, strata scheme and large multi-unit residential buildings. Under an EUA, a finance provider lends funds to a building owner for water, energy and other environmental upgrades and this low-risk loan is repaid through a local council charge on the land. Tenants of commercial buildings can be asked to contribute to the costs. However, these additional costs must be offset by their reduced energy and water bills.

EUA loans are secured, making it possible to access capital for retrofits at a competitive rate, over a longer term and for larger projects.

The loan is tied to the property and does not increase the personal debt of building owners. If the property is sold, the environmental upgrade charge may be transferred to the new owner.

The operation of an EUA is illustrated in Figure 8

Figure 8 **Operation of Environmental Upgrade Agreements**



Source: NSW Office of Environment and Heritage

CitySwitch is a no-cost service offered by selected governments in the capital cities of New South Wales, Victoria, Queensland, South Australia and Western Australia, which supports commercial office tenants to improve office energy efficiency through the provision of a range of services, with the ultimate aim of achieving a 4 star or higher NABERS Energy rating.

The program aims to:

- educate and inspire with an event series and through the provision of toolkits, workbooks, case studies and site tours
- facilitate links to other programs, information sources, industry bodies and communities of interest
- signpost to incentives and financial vehicles that are available to expedite the uptake of energy efficiency investments
- celebrate and reward leadership and achievement in energy efficiency though its annual awards and ongoing member promotions.

This structured approach to planning and implementing energy efficiency projects saves signatories time and money and helps build their internal capacity to embed sustainability within their corporate structure.

Developed and run by the City of Melbourne (which aims to be carbon neutral by 2020), the **1200 Buildings** program aims to encourage and support commercial building owners and managers to improve their energy and water efficiency and reduce the amount of waste they send to landfill in the municipality of Melbourne.

Signatories to the program have exclusive use of the 1200 Buildings logo to promote their retrofit projects to prospective tenants, shareholders and the community. They are also eligible for Environmental Upgrade Finance (EUF), a financial assistance mechanism that increases access to competitive finance. They also receive updates on industry approaches, funding initiatives and case studies. Skills building events that encourage training and

engagement are also delivered through the program in partnership with industry associations.

Private industry programs

Developed and administered by the Green Building Council of Australia (GBCA), **Green Star** is a national voluntary environmental rating system that evaluates the environmental design and construction of buildings and communities.

Green Star has built on existing systems and tools in overseas markets including the British BREEAM (Building Research Establishment Environmental Assessment Method) system and the North American LEED (Leadership in Energy and Environmental Design) system.

The Green Star rating tools assess building or community projects against a number of categories. These categories allow for a determination to be made on the environmental impact of a project's site selection, design, construction, maintenance etc. The nine categories included within the rating tools are: Management, Indoor Environment Quality, Energy, Transport, Water, Materials, Land Use & Ecology, Emissions and Innovation.

Green Star is complementary to the NABERS rating system that is an integral part of the CBD program. While Green Star assesses the design of office buildings from an environmental perspective, the NABERS measures their ongoing operational energy efficiency. NABERS is discussed in more detail in the next chapter of this report.

2.3.4 Other factors affecting building energy efficiency

There are also strong commercial drivers for improving energy efficiency in commercial buildings. These natural incentives drive 'autonomous' energy efficiency improvement. Some of the commercial drivers for energy efficiency include:

- Rising energy costs: Retail electricity and gas costs have increased significantly in real terms over the last decade. This has encouraged the adoption of more efficient building design, operation and equipment to save energy costs.
- Perceived benefits of green buildings: Our assessment of the 'green premium' and the productivity benefits from improving energy efficiency showed that although the extent of benefit is uncertain, there appears to be a willingness to pay for greener office space.
- Improved investment marketability: Energy efficiency performance provides a point of distinction during the sale of commercial buildings. Stakeholder consultations indicated that NABERS ratings are valued by Australian as well as international investors.

3 Commercial building energy efficiency disclosure

3.1 Overview of the CBD program

The CBD program was introduced in 2010 and fully implemented in 2011 as part of a combination of measures employed to drive energy efficiency improvements in commercial buildings.

The CBD program requires building owners to disclose information about the energy efficiency of large commercial office buildings (2,000 square metres or more) at the time of sale, lease or sublease. To meet the program requirements building owners need to obtain a Building Energy Efficiency Certificate (BEEC).

3.1.1 BEEC

A BEEC has three components:

- an energy efficiency star rating for the office building using the National Australian Building Environment Rating System (NABERS)
- information about the energy efficiency of the office lighting, contained in the Tenant Lighting Assessment (TLA)
- generic guidance on how the energy efficiency of the office could be improved.

The BEEC enables potential purchasers or lessees to include consideration of a building's energy efficiency as part of their decision-making processes. In so doing, the CBD program provides the market with information that raises the profile of the building's energy efficiency in the decision-making process and therefore, should over time encourage energy efficiency improvements to be made. BEECs are valid for up to 12 months.

There are nine steps involved in complying with the CBD program and associated legal obligations under the *Building Energy Efficiency Disclosure Act 2010*:

1. Confirmation that a building is likely to be affected.
2. Determination if the building, or area of the building, is disclosure affected.
3. Check if the building already has a current Building Energy Efficiency Certificate (BEEC) that covers the area available for sale, lease or sublease. Search the Building Energy Efficiency Register.
4. If the building does not have a current BEEC, a CBD accredited assessor must be engaged to undertake the necessary assessment and to apply for a BEEC.
5. The building owner or operator must provide the CBD accredited assessor with the required access to, and information about, the building or area of the building.
6. The building owner or operator must ensure the CBD assessor submits the BEEC application to the Australian Government Department of Industry and Science online via the CBD assessor portal.
7. When the Department approves the application, an electronic version of the BEEC is emailed to the CBD assessor, for printing and display. A summary and full version of the BEEC are also added to the Building Energy Efficiency Register.

8. The building owner must ensure that the building's National Australian Built Environment Rating System (NABERS) Energy star rating is included in any advertising.
9. A copy of the BEEC must be provided to prospective buyers or tenants free of charge, if requested.

In lodging a BEEC application, CBD accredited assessors can draw on the assessment results prepared by other accredited assessors (that are displayed on the Building Energy Efficiency Register) so long as the ratings are still valid and current.

For example, if a building has an existing NABERS Energy rating, the CBD assessor only needs to complete a new lighting assessment and will be able to apply for a BEEC using this and the existing NABERS Energy rating. Similarly, if the relevant area within the building has an existing lighting assessment, then the CBD assessor only needs to complete a new NABERS Energy rating assessment and will be able to apply for a BEEC using this and the existing lighting assessment.

There are exceptions to requiring a BEEC (cases where a BEEC is not required) and exemptions (cases where building owners can apply to be exempted from requiring a BEEC).

Exceptions include:

- new buildings where a certificate of occupancy (or equivalent) has either not yet been issued or was issued less than two years earlier
- buildings which have completed a major refurbishment for which a certificate of occupancy (or equivalent) was issued less than two years earlier.
- strata-titled buildings
- mixed use buildings where total office space comprises less than 75 per cent of the building by NLA (or Gross Lettable Area if NLA is unavailable)
- where the sale of a building is through the sale of shares or units or the sale of a partial interest in a building
- leases and subleases of 12 months or less (including any option to extend), in accordance with Section 11 of the Act. For example, a six-month lease with an option to extend for another six months would not trigger a disclosure requirement. However, a six-month lease with an option to extend for 12 months would trigger a disclosure requirement.

Exemptions include:

- where the building or an area of your building is used for police or security operations
- in cases where an energy efficiency rating cannot be assigned because of the current characteristics of the building or an area of the building.

3.1.2 NABERS

NABERS is a national rating system that measures the environmental performance of Australian buildings, tenancies and homes. Administered by the New South Wales Government's Office of Environment and Heritage, NABERS measures the energy efficiency, water usage, waste management and indoor environment quality of a building or tenancy and its impact on the environment. Only the energy efficiency component of NABERS is included in the BEEC.

The NABERS Energy for offices rating on a BEEC should be a *base building* rating. This covers performance of the building's central services and common areas, which are usually managed by the building owner.

However, if a base building rating cannot be calculated because utility meters are not sufficient to distinguish between base building energy use and tenancy energy use, then a *whole building* rating that includes the tenanted spaces may be used instead.

NABERS uses measured and verified performance information, such as utility bills, and converts them into an easy to understand star-rating scale from one to six stars. For example, a six star rating demonstrates market-leading performance, while a one star rating means the building or tenancy has considerable scope for improvement.

NABERS ratings enable the comparison of the environmental performance of an office building and tenancy to that of other similar premises in the same location. The NABERS rating for an office building and tenancy is based on data related to the performance of the office building or the tenancy over the previous 12 months.

To make this real-life performance data comparable with other similar office buildings and tenancies, certain adjustments are made that take into account the specific use of an office building or tenancy. This ensures the comparisons are relevant and realistic.

The adjusted data is then compared to benchmark data, and a rating score reflecting a building's performance relative to its peers is calculated. More details on how a NABERS Energy rating is calculated is provided in Box 1.

The benefits of obtaining a NABERS rating for an office building or tenancy to building owners, operators and tenants include:

- Meeting Commercial Building Disclosure requirements
- Identifying ways to lower yearly operating costs
- Identifying cost savings across a property portfolio
- Measuring the impact of sustainability initiatives
- Making the office building more desirable to tenants
- Achieving higher rents and increasing asset value
- Improving corporate reputation
- Meeting environmentally responsible reporting criteria
- Creating a better work environment for employees
- Increasing shareholder value
- Meeting tenant and community expectations.

Box 1 **NABERS Energy calculations**

NABERS Energy rates the energy efficiency of an office base building, whole building or tenancy by comparing its measured energy consumption against a set of benchmarks developed using actual building performance data.

The building or tenancy's total energy use over a 12-month period is collected from billing data and meter readings. The energy use is multiplied by a constant NABERS greenhouse gas (GHG) factor. The energy use is also adjusted to account for area, climate, hours of occupancy and equipment density. This enables buildings with different attributes to be compared against the same performance targets.

The corrected figure, called the benchmark factor, puts the building on a level playing field with other buildings in the same property market. The benchmark factor is not a $kgCO_2/m^2$ figure, but rather a value that enables a building to be located on the benchmark rating scale.

NABERS Energy also calculates the greenhouse gas emission intensity of the building in $kgCO_2/m^2$ using current National Greenhouse Accounting factors for greenhouse reporting purposes. This information is provided in the NABERS Energy rating report, which accompanies the rating.

The benchmark factor is compared against the star rating benchmarks, or performance targets, for the property market in the building's own state to determine the star rating.

A NABERS Energy rating is awarded based on the performance level the office has achieved.

Source: NSW Office of Environment & Heritage

3.1.3 TLA

The TLA measures the energy performance of the installed general lighting system of office buildings covered by the CBD program. It does this through two separate indicators:

1. The Nominal Lighting Power Density (NLPD) of the relevant functional space in the building, measured as Watts per square metre (W/m^2).
2. The capacity of installed lighting control systems, rated as good, moderate or poor.

It may also include a performance comment if appropriate. The assessment covers installed lighting and, where relevant, also proposed lighting systems. It is based on a methodical survey of the general lighting system reasonably expected to be left in place after the tenant leaves and the tenancy fit-out is removed.

The NLPD assessment methodology depends on the space being assessed. In lighting systems in which luminaires of a single type are arranged in a regular array, the grid method is applied whereby the luminaire power is divided by the area that the luminaire covers. In lighting systems in which there is an irregular layout of luminaires or where a number of different luminaire types are installed, an aggregate method sample space is used by the assessor. The total luminaire power calculated by this aggregate method is divided by the floor area. There are three alternative aggregate methods.

The NLPD assessment focuses on the general lighting system, which is the lighting system used to illuminate the workstation areas of the tenancy. For most offices, the general lighting system is best represented by the lighting in the open plan space. However, for spaces that have been extensively fitted out with small cellular offices, the lighting system in these areas can also be used.

Specialist spaces such as meeting rooms, reception areas or conference rooms are less likely to have an installed lighting system that represents the general lighting system due to the installation of architectural or feature lighting. These are not used in the assessment of the general lighting system except under Aggregate method 3, which is only used if there is no alternative. Desk-mounted task lighting and display lighting do not form part of the general lighting system.

In late 2013, the TLA rules were revised to:

- provide additional guidance to CBD Assessors on how to conduct assessments, including more examples and illustrations
- accommodate new lighting technologies such as LED lights
- improve the clarity of directions for record-keeping requirements
- make changes to the assessment methodologies to increase the consistency and reliability of assessments.

3.2 Program objectives and economic rationale

The economic rationale for the CBD program is to address market failures in the commercial building sector, namely:

- a failure in provision of information on the energy efficiency level of the office space being leased or sold, resulting in information asymmetry (with the seller/lessor having much greater information about the efficiency level than the buyer/lessee).
- the different incentives facing those who take the decision on adopting energy efficient practice (e.g. building renovations) and those who might benefit from using them (known as split incentives).

Split incentives often arise in the presence of information asymmetries. Hence the second point cannot be addressed without also addressing the information asymmetry problem.

Information asymmetry occurs when one party in a market, usually the buyer (or leaser) has insufficient information about the good they are considering purchasing, or the actions of the seller, to make a decision in their best interest. The information asymmetry can create a situation of 'adverse selection', in which a buyer is not able to differentiate between high quality and low quality goods in the market at the time of purchase.

Commercial buildings are one such good, specifically, it can be difficult to differentiate between different options at the time of purchasing (or leasing) as it is a low frequency investment where the purchaser usually cannot rely on significant previous experience. In particular, the energy efficiency attributes of a commercial building, which are relevant to its value, are hard to observe without professional advice.

In a market where there are information asymmetries, adverse selection can drive down the amount of any 'green premium' that can be obtained – essentially making it more difficult for the building owner to achieve the higher rents or higher sale prices that would more accurately reflect any investments they have made in energy efficiency improvements.

The CBD program addresses information asymmetry, and enables purchasers (or leasers) to better understand, and take into account, relevant financial and environmental information about a building's energy efficiency performance. As a consequence of this, the prices and rents of commercial buildings will, over time, begin to reflect a 'green premium', which in turn will:

  - encourage investment in energy efficiency
  - reduce energy bills for tenants
  - help reduce energy consumption and emissions, and therefore deliver benefits for society and the environment.

3.3 Interactions with other programs and policies

3.3.1 Interactions with other programs targeting energy efficiency

The energy efficiency programs discussed in Section 2.3.3 also encourage increased adoption of energy efficiency in commercial buildings. The degree to which the programs address the same market failures or have the same scope and coverage is summarised in Table 3 below.

Table 3 **Related program interactions with CBD**

Program	Status	Main market failures addressed	Scope/coverage	Government or industry initiative	Summary of Interactions with CBD
National Construction Code (NCC)	Active	Split incentives	National – new buildings and major upgrades	Commonwealth government	Partial overlap of objectives/coverage
Minimum Energy Performance Standards (MEPS)	Active	Inadequate and asymmetric information	National – new appliances	Commonwealth government	Partial overlap of objectives/coverage
Energy Efficiency Opportunities (EEO)	Ceased as of 29th June 2014	Inadequate and asymmetric information	National - large energy users	Commonwealth government	Complementary
Energy Efficiency Exchange (EEX)	Active	Inadequate and asymmetric information	National - large energy users	Commonwealth government	Complementary
Energy Efficiency in Government Operations (EEGO)	Active	Adverse selection	Australian government agencies	Commonwealth government	Complementary
Energy Saver Program	Active	Inadequate and asymmetric information	NSW – focus on data centres, manufacturing, warehousing, cold storage and heritage buildings	NSW government	Complementary
Energy Savings Scheme (ESS)	Active	Market failures associated with climate change	NSW – businesses	NSW government	Complementary
Victorian Energy Efficiency Target (VEET)	Active	Market failures associated with climate change	VIC - homes, businesses or other non-residential premises	VIC government	Complementary
Efficient Government Buildings	Active	Capital Constraints	VIC – government buildings	VIC government	Complementary
1200 Buildings program	Active	Inadequate and asymmetric information Capital constraints	Melbourne – buildings owners, managers and facility managers	City of Melbourne	Complementary
Green Star	Active	Inadequate and asymmetric information	National – building owners, tenants	Property industry	Partial overlap of objectives/coverage
Carbon Price – Clean Energy Future (CEF)/Carbon Pricing Mechanism (CPM)	Legislation repealed	Externalities associated with climate change	National – direct sources of GHG emissions	Commonwealth government	Complementary
Carbon Price – Direct Action Policy (DAP)/Emissions Reduction Fund (ERF)	First ERF auctions to be help in early 2015	Externalities associated with climate change Capital constraints	National – emissions reduction project proponents	Commonwealth government	Complementary
NABERS energy ratings	Active	Information asymmetry	National – buildings owners, tenants	Commonwealth government	Complementary (NABERS is voluntary)

Source: ACIL Allen

The CBD program is largely complementary to other programs that aim to increase energy efficiency in commercial buildings. While the NCC also targets split incentives, it applies only to newly constructed buildings, whereas the CBD applies to both existing and new buildings.

MEPS, EEO, EEX, the NSW Energy Saver Program and the 1200 Buildings program target inadequate and asymmetric information, however, the information provision is primarily targeted at building owners. The CBD complements these programs by providing information to tenants.

Therefore, the CBD addresses either the same market failures of some programs (but covers gaps in parties targeted by those programs) or targets the same parties as some programs (but addresses different market failures than addressed by those programs).

No related programs were found to detract from or conflict with the objectives of the CBD. A more detailed assessment of interactions with key programs to date interacting with the CBD are discussed in Section 4.9. Potential future interactions with the Emissions Reduction Fund (ERF) are discussed in Section 5.5.

3.3.2 Complementarity with carbon pricing

A cost on carbon alone, should it be re-instated, may be insufficient due to the interaction of climate change market failure with the other market failures (split incentives, insufficient and asymmetric information and the associated searching costs) discussed previously. These market imperfections would include market and policy failures impeding greater take-up of opportunities to improve energy efficiency.

There is strong support among economists for a multi-instrument policy framework comprising emissions pricing plus complementary measures to correct interacting market and policy failures that impede complete internalisation of greenhouse gas external costs through emissions pricing.[16]

The July 2009 COAG Agreement on the National Strategy for Energy Efficiency (NSEE) recognised the expected continued existence of market failures even if an emissions trading scheme was established, and therefore, the need for Government intervention in a number of areas.

To be economically efficient, policies intended to complement emissions pricing through an emissions permit trading regime would have to:

- address clear market, behavioural and policy failures that impede complete internalisation of external costs of emissions via traded permit prices
- comprise the most efficient available policy instruments to deal with relevant market, behavioural and policy failures
- be implemented only if deviations from efficient resource allocation caused by market, behavioural and policy failures are not trivial and social benefits of intervention would exceed the social costs
- lower the economic cost of meeting the abatement target.

Measures satisfying the first, second and third conditions would yield *negative* cost abatement. The reason is that social benefits, excluding those relating to climate change, would exceed social costs, so that net social costs of greenhouse gas emissions abatement through such measures would be below zero.

[16] For example, see Jaffe, Newell, Stavins (2005); Stern (2007); Bennear, Stavins (2007); Fischer and Newell (2008); Goulder and Parry (2008); Productivity Commission (2008).

3.4 International experiences with commercial building disclosure

A number of building energy efficiency disclosure programs have been in operation overseas. Programs in the UK (and rest of Europe), US and China are discussed below as examples.

3.4.1 UK and rest of Europe

The *Energy Performance of Buildings Directive* (EPBD) and the *Energy Efficiency Directive* (EED) are the European Union's main legislation for reducing the energy consumption of buildings.

The EPBD came into force on 4 January 2003 and had to be implemented by the EU Member States at the latest on 4 January 2006. Under the EPBD:

— energy performance certificates are to be included in all advertisements for the sale or rental of buildings
— EU countries must establish inspection schemes for heating and air conditioning systems or put in place measures with equivalent effect
— all new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018)
— EU countries must set minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.)
— EU countries have to draw up lists of national financial measures to improve the energy efficiency of buildings.

Under the EED:

— EU countries make energy efficient renovations to at least three per cent of buildings owned and occupied by central government
— EU governments should only purchase buildings which are highly energy efficient
— EU countries must draw up long-term national building renovation strategies which can be included in their National Energy Efficiency Action Plans.

It should be noted that some European countries had building energy efficiency programs that pre-dated EPBD. For example, Denmark had operated its own mandatory certification scheme since 2007.

In the United Kingdom (chosen as an example of a country that complied with the EPBD), the requirement for Energy Performance Certificates (EPC) on the sale, rent or construction of buildings other than dwellings with a floor area greater than $50m^2$ came into force in 2008.

All non-dwelling EPCs (which are valid for up to 10 years) must be carried out by, or under the direct supervision of, a trained non-domestic energy assessor, registered with an approved accreditation body. There are three levels of non-residential buildings, Level 3 (small buildings with heating systems less than 100kW and cooling systems less than 12kW), Level 4 (purpose-built buildings with heating systems greater than 100kW and cooling systems greater than 12kW) and Level 5 (larger buildings that are complex in shape).

EPCs present the energy efficiency rating of buildings on an A to G scale. This is a linear scale based on two key points defined as follows:

1. The zero point on the scale is defined as the performance of the building that has zero net annual CO_2 emissions associated with the use of the fixed building services as defined in the Building Regulations. This is equivalent to a Building Emissions Rate (BER) of zero.
2. The border between grade B and grade C is set at the Standard Emissions Rate (SER, which is based on the actual building dimensions but with standard assumptions for fabric, glazing and building services) and given an Asset Rating of 50. Because the scale is linear, the boundary between grades D and grade E corresponds to a rating of 100.

From October 2008 all buildings, including factories, offices, retail premises and public sector buildings, are required to have an EPC whenever the building is sold, built or rented. Public buildings in England and Wales (but not Scotland) also require a Display Energy Certificate showing actual energy use, and not just the theoretical energy rating.

Display Energy Certificates (DECs) show the actual energy usage of a building, the Operational Rating, and help the public see the energy efficiency of a building. This is based on the energy consumption of the building as recorded by gas, electricity and other meters. The DEC should be clearly displayed at all times and clearly visible to the public. A DEC is accompanied by an Advisory Report that lists cost effective measures to improve the energy rating of the building.

DECs are only required for buildings with a total useful floor area over 500m^2, that are occupied by a public authority and institution providing a public service to a large number of persons and therefore visited by those persons. The useful floor area limit will be reduced to 250m^2 in July 2015.

Where the building has a total useful floor area of more than 1,000m^2, the DEC is valid for 12 months. The accompanying advisory report is valid for seven years. Where the building has a total useful floor area of between 500m^2 and 1000m^2, the DEC and advisory report are valid for 10 years.

In addition, air conditioning systems first put into service on or after 1st January 2008 require an air conditioning inspection every five years from the date on which the system was first put into service.

3.4.2 North America

New York City

New York City enacted a comprehensive effort, called the *Greener, Greater Buildings Plan* (GGBP), which targets energy efficiency in large existing buildings over 50,000 square feet (4,645 m^2). These 15,000 properties (encompassing commercial, industrial, institutional, multi-family residential and mixed-use buildings) account for almost half of New York City's square footage and as much as 48 per cent of New York City's total energy use.

GGBP is designed to ensure that information about energy is provided to decision-makers and that the most cost-effective energy efficiency measures are pursued. It is composed of four pieces of legislation and two supplementary components:

- First, it establishes a New York City energy code that requires all renovations that impact energy systems to meet the standards of the New York State energy code, thus accruing the energy benefits from the natural cycle of building upgrades.
- Second, it requires annual benchmarking data to be submitted by building owners for public disclosure, which will bring transparency for energy and water usage.

- The third piece requires an energy audit and tuning, or retro-commissioning, of energy equipment in large buildings every ten years.
- The last regulatory piece mandates lighting upgrades and sub-metering of large, non-residential tenant spaces, giving tenants information about their energy usage.

The first supplementary component focuses on creating a trained workforce that can reliably deliver improved energy performance, while the second utilises New York City's federal stimulus funding to create an innovative energy efficiency financing corporation to provide funds for energy upgrades.

While much of GGBP is about energy transparency, retro-commissioning and lighting upgrades have also been broadly mandated in the policy because they are extremely cost-effective measures that will quickly start to accrue savings for building owners. When these small benefits are aggregated at the city scale, they add up to very large projected savings – GGBP is estimated to cost US$5.2 billion while saving US$12.2 billion, for a net savings of US$7 billion.

By 2030, GGBP is estimated to reduce citywide GHG emissions by at least 5.3 per cent from the 2009 baseline of 50.8 million metric tons. This equals approximately 2.72 million metric tons of emissions reduced by 2030. Assuming a business-as-usual increase of one per cent per year, GGBP will achieve approximately 10 per cent of the reductions necessary for New York City to achieve its goal toward a 30 per cent reduction in GHG emissions by 2030.

Austin, Texas

Under Austin's *Energy Conservation Audit and Disclosure* (ECAD) ordinance enacted in 2008, non-residential buildings greater than 10 years old must calculate an energy rating by a prescribed timetable depending on building size: June 1, 2012 for buildings more than 75,000 square feet (6,968 m^2), June 1, 2013 for buildings between 30,000 and 75,000 square feet (2,787 – 6,968 m^2) and June 1, 2014 for buildings between 10,000 and 30,000 square feet (929 – 2,787 m^2); while buildings less than 10 years old are required to calculate a rating within 10 years of the completion of construction. The passage of this ordinance was coordinated by the city government and the city's municipal owned electric utility, Austin Energy.

Ratings must be disclosed to prospective buyers prior to a sale transaction, however no energy audit is required. Buildings are rated using the US Environmental Protection Agency (EPA) ENERGY STAR software or a free online tool from Austin Energy (for facilities less than 5,000 square feet). Industrial properties are exempt.

Washington state

On May 8, 2009, Washington Governor Chris Gregoire signed into law SB 5854, also known as the *Efficiency First* bill. Focusing on energy efficiency in the built environment, the bill requires commercial building energy rating and disclosure, major improvements to the state energy code, and energy performance standards and retrofits (if necessary) for public buildings.

Owners of non-residential buildings larger than 10,000 square feet (929 m^2) must rate their buildings using ENERGY STAR software and disclose that information to prospective buyers, lessees and lenders prior to the closing of a transaction. Utilities were required beginning 1 January 2010, at the request of a building owner, to automatically upload energy consumption information for a building into ENERGY STAR software.

For public buildings, the requirements are more stringent. A preliminary energy audit is required for buildings with an ENERGY STAR rating less than 50. If that audit identified cost effective energy savings, an investment grade audit was required by 1 July 2013 and cost-effective measures must be implemented by 2016.

Additionally, state agencies may not sign a new lease or a lease renewal in a privately owned building with an ENERGY STAR rating of less than 75, unless certain energy efficiency measures are utilised.

3.4.3 China

In China, several local governments, such as Shanghai and Beijing, have developed building energy efficiency labelling programs. A national program, based on the Civil Building Energy Efficiency Regulation, was launched in 2008. The regulation legally requires that the energy performance of new government-owned office buildings or large public buildings should be rated and labelled.

The building labelling program is administered by the Ministry of Housing and Urban-Rural Development (MOHURD). It is only mandatory for four types of buildings:

- new government-owned office buildings or large public buildings
- existing buildings (of the type listed above) that apply for government funding to subsidise energy retrofits
- state or provincial energy efficiency demonstration buildings
- buildings that apply for National Green Building Labels.

The MOHURD rating program has five levels, from one star to five stars, and covers both residential and non-residential buildings. It also is unique in its inclusion of both asset and operational ratings.

3.4.4 Comparison with the CBD program

The NABERS tool used in the CBD program is similar to the US EPA's ENERGY STAR tool used in the New York City, Austin and Washington state programs, in that the actual energy performance of a building is assessed against its peers; whereas the European programs rely on modelled asset ratings rather than operational ratings.

The New York City program is more heavy-handed than the CBD program as it mandates lighting upgrades and requires an energy audit and tuning, or retro-commissioning, of energy equipment in large buildings every ten years. Likewise, air-conditioning systems in non-residential buildings in the UK must be inspected every five years.

In England, Wales and some European countries, the energy performance of significant public buildings (over 500m^2) must be publicly displayed. This requirement is absent in Australia.

While the CBD program required generic guidance on improving energy efficiency to be included on the BEEC (a requirement which will be scrapped), the European programs require a tailored recommendation report for each building.

The programs examined above also differ in the floor area eligibility threshold. While the CBD program has a threshold of 2,000 m^2, the programs in Austin and Washington state have a threshold of 10,000 square feet (929 m^2) while the New York City program targets buildings over 50,000 square feet (4,645 m^2). The UK's non-residential EPC program covers *all* buildings including factories, offices, retail premises and public sector buildings, regardless of size.

3.5 Assessment of the appropriateness of the CBD program

In October 2008, the Council of Australian Governments (COAG) agreed to develop a National Strategy for Energy Efficiency (the Strategy) to accelerate energy efficiency efforts, to streamline roles and responsibilities across levels of governments, and to help households and businesses prepare for the introduction of the Carbon Pollution Reduction Scheme (the Scheme). COAG agreed to the 10-year Strategy in July 2009, which was updated in July 2010.

The Strategy was designed to substantially improve minimum standards for energy efficiency and accelerate the introduction of new technologies through improving regulatory processes and addressing the barriers to uptake of new energy-efficient products and technologies. The Strategy aimed to encourage and support innovation in energy efficiency technologies and approaches. The Strategy incorporated and built on measures already agreed by COAG and the Ministerial Council on Energy through the National Framework on Energy Efficiency.

The measures in the Strategy are framed around the following four key themes:

1. Assisting households and businesses to transition to a low-carbon future
2. Reducing impediments to the uptake of energy efficiency
3. Making buildings more energy efficient
4. Government working in partnership and leading the way.

In relation to the third theme (‘Making buildings more energy efficient’), the Strategy was designed to drive significant improvement in minimum energy efficiency standards to deliver substantial growth in the number of highly energy efficient homes and commercial buildings, reflecting international best practice. The transformation was to be achieved through a combination of measures addressing both new buildings construction and the existing building stock.

New buildings would be constructed according to increasingly stringent energy efficiency standards that lead to a reduction in energy consumption, starting with the 2010 version of the *Building Code of Australia* (BCA). These standards account for climatic variation. Major renovations are subject to the same standards. There would also be new efficiency provisions for heating, ventilation and air conditioning systems, as well as artificial lighting.

The Strategy also included measures to help raise the energy efficiency of the existing building stock through voluntary action in response to better information about building energy use. In particular, people seeking to buy or lease properties would be provided with information about the energy efficiency of the buildings through proposed new mandatory disclosure provisions. Armed with this information, consumers and businesses would be able to make informed choices about the energy efficiency of the buildings they buy and lease – and builders and building owners would respond to those market signals by investing in energy efficiency.

The CBD program, which applies to existing buildings in addition to new buildings, is thus a complement to the measure of increasing the stringency of energy efficiency provisions for new commercial buildings. Collectively, these two measures relating to the energy efficiency of buildings constitute a logical part of a broader suite of measures contained in the overarching National Strategy to bring about significant gains in energy efficiency throughout Australia.

In addition, as reviewed briefly in Section 3.3.1 and will be elaborated upon in the upcoming Sections 4.9 and 5.5 of the report, the CBD program is complementary to a significant number of programs enacted by the Commonwealth, State/Territory and local governments that target building energy efficiency. While there is partial overlap between the CBD program and a small number of other programs in terms of scope and/or objectives (see Table 3 shown previously), there is no inefficient or wasteful duplication between the CBD program and other energy efficiency programs in Australia.

ACIL Allen therefore considers the CBD program to be an appropriate one that aligns strategically (and in practice) with relevant government policies and programs, such as construction codes, minimum energy performance standards, energy efficiency certificate schemes and carbon reduction programs. The design of the program is also broadly in line with international best practice, although it is more light-handed than some programs in Europe and North America (as discussed previously in Section 3.4).

With expected robust growth in the number of commercial buildings in major cities around the country (commensurate with projected population and economic growth) and an urgent need to address the climate change challenge, the program is as relevant to Australia's needs today and in the future as it was conceived more than half a decade ago.

4 Assessment of CBD costs and benefits to date

4.1 The challenge

According to the NSW Office of Environment and Heritage, which administers NABERS, an analysis of 1,207 commercial buildings across Australia, which have obtained two or more ratings since July 2010 (representing a total area of approximately 15 million m^2 of NLA), showed a 16 per cent reduction in overall energy use from 8,616TJ in 2010-11 to 7,246TJ in 2013-14, resulting in annual energy cost savings of $57.5 million. Over this period, total economic activity in Australia grew by 9.0 per cent in real terms, as measured by Gross Domestic Product (GDP).

The key challenge facing ACIL Allen is determining what proportion of this improvement in energy efficiency (and concomitant reduction in GHG emissions) is attributable to the CBD program. The next challenge is to predict what further gains in energy efficiency and GHG emission reduction could be achieved if the program were to continue

This chapter first describes the foundations of the overall framework adopted for both assessments (the assessment of benefits of the program to date and the assessment of future benefits). The remaining sections then set out:

- The methodology developed to meet the first challenge described above (determining what proportion of the historical improvement in energy efficiency is attributable to the CBD).
- The results of ACIL Allen's cost-benefit analysis of the program to date.

4.2 Framework adopted for assessment of benefits to date and assessment of future benefits

4.2.1 Application of cost-benefit analysis

A major part of the review was assessing whether the CBD program has delivered net benefits to Australia during the period of operation and whether it is expected to continue to deliver net benefits in its current or a modified form. Cost-benefit analysis (CBA) was the main tool used to perform this assessment.

A CBA involves systematically estimating all costs and benefits that have or are expected to result from a policy or program. Cost and benefit items include economic benefits, whose value can be estimated through market prices, as well as environmental and social benefits that need to be 'monetised' if market prices are not available.

A CBA measures only *incremental* costs and benefits, that is, only the costs and benefits that accrue due to the program being in place (and not the cost and benefits that would have accrued anyway).

4.2.2 Cost and benefit items estimated

Table 4 below summarises the costs and benefits that have been taken into account in the CBA. More information of the assumptions used to develop cost and benefit estimates is provided in Section A.1 of Appendix A.

Table 4 **Cost and benefit items included in CBA**

Item	Cost or Benefit	Description
Government costs	Cost	The costs to government of administering the program
Industry burden	Cost	The costs to building owners to prepare for and undertake NABERS and TLA assessments and lodgement fees associated with lodging a NABERS rating with the NSW OEH. This is referred to in this report as the 'industry burden'
Upgrade costs	Cost	The costs to building owners to upgrade base building energy efficiency performance, lighting power density and lighting control systems
Avoided energy use	Benefit	The economic costs avoided through reduced energy consumption
GHG reduction	Benefit	Avoided GHG emissions
Increased productivity	Benefit	The higher output from office workers associated with working in a more energy efficient building

Note: In this analysis, upgrade costs and avoided energy use are aggregated into a single value labelled 'net benefit of energy efficiency'.
Source: ACIL Allen

4.2.3 Backward- and forward-looking assessments

The review was required to separately assess what the cost/benefit outcomes had been to date (for industry and government), as well as the merits of continuing based on future costs and benefits.

Therefore, two separate CBAs were undertaken, including a backward-looking (or 'ex-post') CBA assessing the net benefit of the program to date and a forward-looking (or 'ex-ante') CBA assessing the estimated benefits of retaining the program in its current or a modified form.

The backward-looking CBA compares the present values[17] (PVs) of government costs, industry burden, avoided energy use net of upgrade costs ('net benefits of energy efficiency') and GHG reductions. Increased productivity benefits are also estimated, however, they are not included in the core results as data limitations prevent a precise estimation and therefore the magnitude of benefits is highly uncertain.

The forward-looking CBA compares the PVs of government costs, industry burden and net benefits of energy efficiency. GHG reductions are quantified (in tonnes of CO_2 equivalent) but not monetised. Unlike the backward-looking CBA (where a market price for GHG reductions was in place and known), the market price of GHG emissions (or value of GHG reductions) is not yet known and will be contingent on the final design and outcomes of the Australian government's Direct Action Policy (DAP). However, scenario analysis of possible economic value of GHG reductions may be applied to the projected tCO_{2e} reductions attributable to the program.

[17] A present value (PV) is a measure of the aggregate value over all years of the analysis time horizon for a cost or benefit stream. PVs take into account the 'time value of money' by discounting (attaching a lower value) to costs and benefits further into the future.

4.2.4 Common conceptual approach to estimating benefits in both backward- and forward-looking assessments

Both the backward-looking and forward-looking assessments adopt the same broad approach to estimating the benefits delivered by the program. The approach was applied separately for each component of disclosure (base building efficiency and tenancy lighting). The steps to estimate the net benefits of requiring disclosure of NABERS rating and TLA components for both the backward-looking and forward-looking assessments were:

1. Estimate the quantum of improvement already delivered (for the backward-looking analysis) or likely to be delivered (for the forward-looking analysis).
   – the quantum is measured using star improvements, energy intensity and tCO_{2e} for the assessment of the NABERS component
   – the quantum is measured in Watts (or equivalently W/m^2 combined with total m^2 of floor space) for the TLA component.
2. Estimate the value of that improvement, by applying:
   – the estimated $ per tCO_{2e} value of the estimated tCO_{2e} reduced through the NABERS component
   – the estimated $ per W value of the estimated Watts reduced through the TLA component.
3. Subtracting the government costs and industry burden from this value to arrive at a net value for the program.
4. Conducting extensive sensitivity analysis for assumptions that are uncertain but materially relevant to the analysis.

Prior to the introduction of mandatory disclosure, a growing number of buildings voluntarily participated in the NABERS scheme. Therefore, to estimate the incremental effect of disclosure requires an analysis of the improvements attained by these buildings prior to the introduction of CBD in order to develop insights into the likely improvements they would have continued to achieve in the absence of the program.

To estimate the quantum of improvement from the NABERS component of mandatory disclosure, the total commercial building floor space covered by the CBD was segregated into three broad groups, including:

— **'Voluntary' raters**: NABERS rated floor space belonging to the group of buildings that are likely to have rated without mandatory disclosure (evidenced by their voluntary participation in NABERS prior to the introduction of mandatory disclosure);
— **'Mandatory' raters**: NABERS rated floor space belonging to the group of buildings that are deemed to have only rated due to the obligations of mandatory disclosure; and
— **'Yet-to-rate'**: Floor space belonging to buildings that have not yet been NABERS rated, however, they may rate if a sales or lease event triggers disclosure in the future.

Anecdotal evidence presented to ACIL Allen suggested that these groups were not homogenous with respect to energy efficiency behaviour. Some building owners incorporate energy efficiency as a key element of their marketing, others may have had a lower emphasis on energy efficiency but still implemented highly cost effective upgrades, while still others were known to be 'laggards' and were not even participating in very generous government energy efficiency schemes. Furthermore, some building owners may have responded to mandatory disclosure by undertaking major upgrades (resulting in a step change in energy performance), while others may have responded more gradually.

To capture this diversity in underlying behaviour and likely response to mandatory disclosure, the voluntary and mandatory raters were further segmented into quartiles (refer to Section 4.3.1). The trend in average star ratings and energy intensity of floor space for each quartile was used as a basis for measuring the response to mandatory disclosure and likely behaviour if the scheme is retained or discontinued.

4.3 Overview of methodology for backward-looking assessment

4.3.1 Building segmentation

Assignment of buildings to voluntary and mandatory rater groups

The analysis distinguishes between 'voluntary raters' and 'mandatory raters' as defined above.

The voluntary uptake of NABERS has increased rapidly since 2006, with the annual rated volume growing at 38.2 per cent Compound Annual Growth Rate (CAGR) between 2006 and 2010. Motivations to voluntarily participate in the NABERS scheme include marketing advantage, corporate responsibility and energy cost reduction. Stakeholder consultations revealed that the listed property sector, in particular, have been utilising NABERS has a key element of marketing of particular buildings.

The introduction of mandatory disclosure has required those that would probably not otherwise have voluntary disclosed, to obtain a NABERS rating on a disclosure event. These buildings can be identified in the data as those registering a first NABERS rating after the policy had taken effect. However, the point in time the policy had taken effect is uncertain. On the one hand, CBD legislation commenced on 1 November 2010. However, the policy was announced by then Minister Garrett in November 2009, which may have prompted some building owners to obtain NABERS ratings in anticipation of the scheme. The act was assented on 28 June 2010.

The assumption of when the policy took effect represents a trade-off between the risk of classifying voluntary raters as mandatory (which arises from assuming a relatively early date) and the risk of classifying mandatory raters as voluntary (which arises from assuming a relatively later date).

For segmentation purposes the policy was assumed to take effect on 1 July 2010. That is, buildings with their first NABERS prior to 1 July 2010 were classified as voluntary raters, while buildings with their first NABERS ratings on or after this date were classified as mandatory raters.

Buildings which posted a first rating on or after 1 July 2011 were excluded from the mandatory raters group. There were found to be a high proportion of higher NABERS rated buildings in this group (and therefore possibly relatively new buildings), which risked 'corrupting' the analysis of mandatory group performance with new buildings of a high NABERS rating.

The effect of alternative timing assumptions was tested. The assumed timing window for mandatory raters (that is, first rating between 1 July 2010 and 1 July 2011) was found to be appropriate as alternative assumptions tended to result in energy performance trends for the segments that were counterintuitive (e.g. fluctuating year on year as opposed to monotonically improving). Alternative timing assumptions also yielded similar estimates of overall rates of improvement (despite higher year-on-year fluctuations).

Buildings with energy intensities below the 5th percentile or above the 95th percentile of all buildings of the same star rating were excluded from the analysis. This was done to remove buildings with anomalous energy intensities, likely to have been the result of error in manual recording by energy performance assessors.[18]

Assignment of buildings to quartiles

The analysis of CBD impacts was conducted by segments, with each segment representing a quartile of the voluntary and mandatory raters, respectively (therefore with 8 segments in total).

To establish quartiles, buildings within each group (voluntary and mandatory) were ranked in order of star rating. The top 25 per cent of buildings in each group were assigned to quartile 1, the next 25 per cent to quartile 2 and so on. As star ratings are discrete rather than continuous, all buildings of the same star rating are assigned to the same quartile (as opposed to dividing this group further into relatively better or worse performing buildings). This results in an unequal number of buildings for quartiles within the same group. The approach also results in an unequal quantum of floor space in each quartile (see Table 5).

Table 5 **Building segmentation**

Group	Segment	Number of buildings	Total floor space (m^2)
Voluntary	Voluntary 1st quartile	136	2,893,629
Voluntary	Voluntary 2nd quartile	208	3,404,947
Voluntary	Voluntary 3rd quartile	81	1,281,180
Voluntary	Voluntary 4th quartile	178	2,140,845
Mandatory	Mandatory 1st quartile	108	1,220,562
Mandatory	Mandatory 2nd quartile	122	1,079,105
Mandatory	Mandatory 3rd quartile	152	1,269,416
Mandatory	Mandatory 4th quartile	121	882,767

Note: Excludes buildings posting a first rating on or after 1 July 2011.
Source: ACIL Allen analysis of NABERS data

4.3.2 Estimation of Net Lettable Area

Building NLA is used as a weighting factor when calculating average star ratings and energy intensities, and for estimating the total magnitude over which benefits from performance improvement apply.

Estimating NLA from rated area

The NABERS data only provides the rated area (as opposed to NLA) for individual NABERS ratings (that is, the volume of floor space that was rated). This can be lower than the available NLA of the building, given that it is possible to rate a subset of the building only. This can also be higher than the available NLA since it can include common areas such as lifts, stairwells and lobby. The maximum rated area across all ratings was used as a proxy for the total building NLA. While it does not provide a precise estimate of the NLA, it does not introduce any known bias in the analysis.

18 Based on discussions with NSW OEH NABERS team.

Total mandatory group floor space, including yet-to-rate floor space

While this chapter describes the methodology and process for assessing the benefits of the program to date (the backward-looking CBA), some of the analysis required for this assessment also underpins the assessment of future benefits. In particular, the process of establishing a mandatory group, voluntary group and 'yet-to-rate' group (which is described below) affects both analyses. Therefore, the process is described once here and the resulting implications for both the backward and forward-looking CBAs are also discussed here. A complete discussion of the methodology for the forward-looking assessment is provided in Section 5.1).

The primary purpose of the building segmentation exercise was to understand trends in energy performance for building floor space within each segment. As described previously, it was not possible to construct segments perfectly to ensure that:

- the voluntary segments only included buildings where NABERS rating was obtained without any influence of (or in anticipation of) mandatory disclosure
- the mandatory segments only included buildings that obtained NABERS rating due to being forced by mandatory disclosure or in anticipation of it.

Instead, trade-offs were made to arrive at an appropriate group (subset) of buildings that were deemed to represent the average energy performance of the true population of buildings for each segment.

The implication of this approach is that the volume of floor space needs to be scaled prior to being used in CBA calculations (as improvements in average performance need to be applied to the total affected population as opposed to just buildings used to determine the averages).

The mandatory segments comprised a total of 4.5 million m^2 of floor space and this was scaled for each of the backward-looking and forward-looking CBAs.

For the backward-looking CBA, the mandatory population affected to date was estimated by taking the subset of 4.5 million m^2 and scaling this by 181 per cent (reflecting the estimated amount of buildings' floor space that was excluded due to having a first rating on or after 1 July 2011 but are still likely to be part of the mandatory segment population[19]). This provides an estimate of 8.1 million m^2 of floor space affected by mandatory disclosure to date.

For the forward-looking CBA, this figure was increased further to account for the fact that a certain proportion of floor space that would eventually be obligated under mandatory disclosure (part of the total 'rateable floor space') is not visible in the NABERS data as it has not triggered a disclosure event (sale or lease). This volume needs to be included in estimates when considering the forward impacts of the scheme.

Various sources (pitt&sherry, 2012; Allen Consulting Group, 2009; City of Sydney data) estimating total building stock indicated that the amount of this 'yet to rate' floor space is approximately 50 per cent of the total mandatory rateable area. However, no source provided a perfect estimate as sources did not estimate *only* the floor space where mandatory disclosure would apply (particularly as there is insufficient information on size distribution, or buildings that may be exempted or excepted from mandatory disclosure). Therefore the total mandatory rateable area was estimated as 50 per cent and this is a key factor subject to sensitivity testing.

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[19] 0.7 million m^2 of floor space which was rated after 1 July 2011 had a NABERS rating of 1 star or less. This is 81 per cent of the amount of floor space assigned to the mandatory 4th quartile (which also had NABERS ratings of 1 star or less). This percentage is applied to scale-up all quartiles of the mandatory group.

The volume of floor space of the *voluntary* segment was not scaled as it was considered that all buildings voluntarily participating in NABERS obtained ratings between 2006 and 1 June 2010.

The resulting estimates of volume and their use in the analysis is summarised in below.

Table 6 **Estimates of building floor space in the analysis**

Group of buildings	Estimated floor area (million m^2)	Used for
Voluntary segments	9.7	Understanding average energy performance improvements of buildings voluntarily participating in NABERS
Sample of mandatory population used for analysis (excludes first rating after 1 July 2011)	4.5	Understanding average energy performance improvements of buildings obtaining NABERS ratings due to mandatory disclosure
Mandatory population affected to date	8.1	Estimating the magnitude of aggregate costs and benefits of the scheme to date
Total mandatory rateable area	16.1	Estimating the magnitude of aggregate costs and benefits of retaining NABERS disclosure going forward
Total rateable area	25.8	Estimating the magnitude of costs and benefits of retaining the TLA component going forward

Note: Total rateable area includes all floor space subject to mandatory disclosure including both voluntary (9.7 million m^2) and mandatory (16.1 million m^2) raters.
Source: ACIL Allen analysis of NABERS data

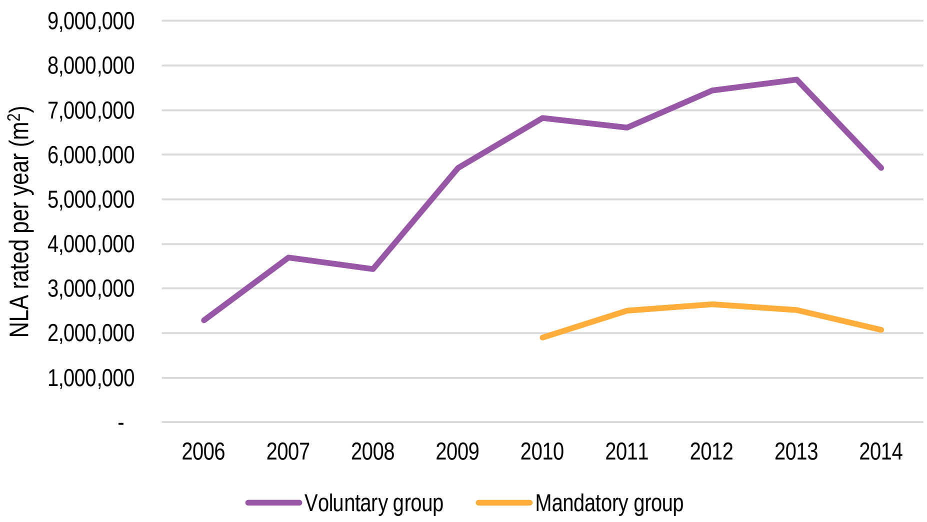
4.4 Analysis of program impact on average NABERS ratings and energy intensity

4.4.1 Impact on mandatory versus voluntary raters

Only a certain proportion of buildings within each segment rate in any given year (that is, not all buildings rate every year). Of these ratings, only base building ratings are used in the analysis, as the building owner (the party obligated under mandatory disclosure) has much greater influence over base building performance than whole building performance (which depends also on tenant practices). Therefore, trends such as average star rating and energy intensity are based only on base building ratings from the portion of buildings that rate each year.

Annual rated floor space by voluntary and mandatory raters included in the analysis is provided in Figure 9 below.

Figure 9 **Annual NLA of base building ratings from voluntary and mandatory raters**



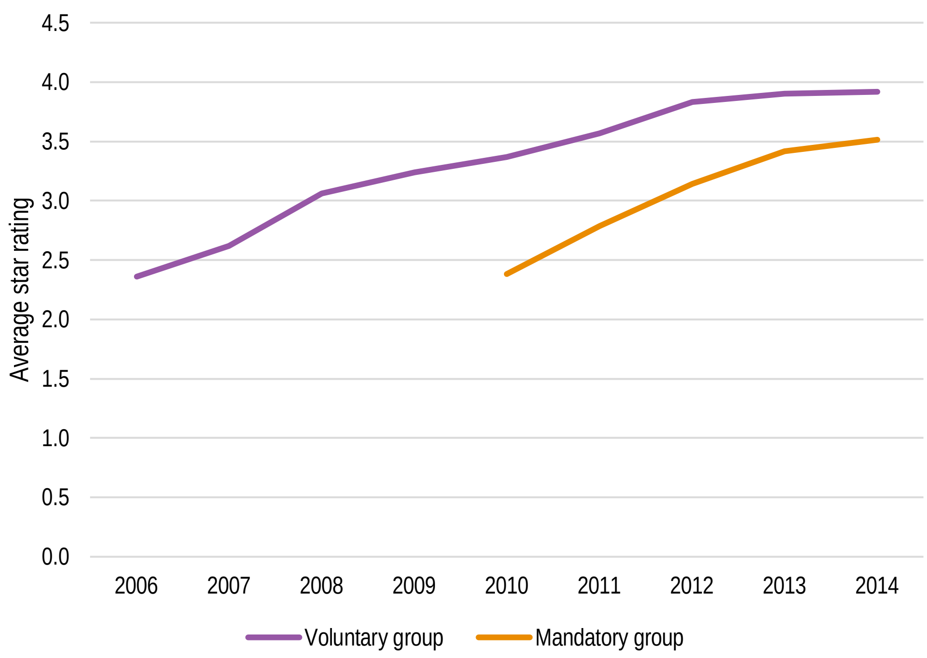
Note: Data is available to 25 October 2014, therefore, 2014 estimates are only for part of the year.
Source: ACIL Allen analysis of NABERS data

The total NLA of buildings voluntarily rating (including repeat ratings) increases rapidly between the years 2006 to 2010 (in line with known growth in awareness and popularity of NABERS). The volume of ratings for this voluntary group from 2011 are all repeat ratings.

Buildings that first rated between 1 July 2010 and 1 July 2011 are assigned to the mandatory group. The volume of ratings shown above for the mandatory group after 2011 are all repeat ratings.

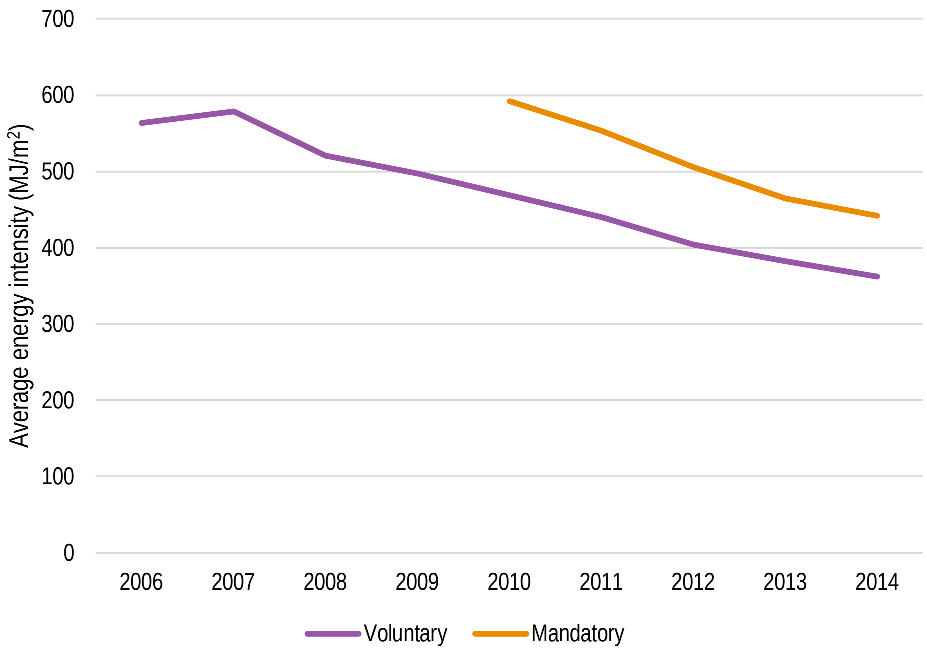
Weighted average annual star ratings and energy intensity (weighted by NLA) are presented in Figure 10 and Figure 11, respectively.

Figure 10 **Average annual star rating by voluntary and mandatory group**



Source: ACIL Allen analysis of NABERS data

Figure 11 **Average annual energy intensity by voluntary and mandatory group**



Source: ACIL Allen analysis of NABERS data

As expected, the average star rating increases over time, whereas energy intensity (inversely related to star ratings) declines over time. The gap between average star ratings and energy intensity of voluntary and mandatory raters appears to diminish over time.

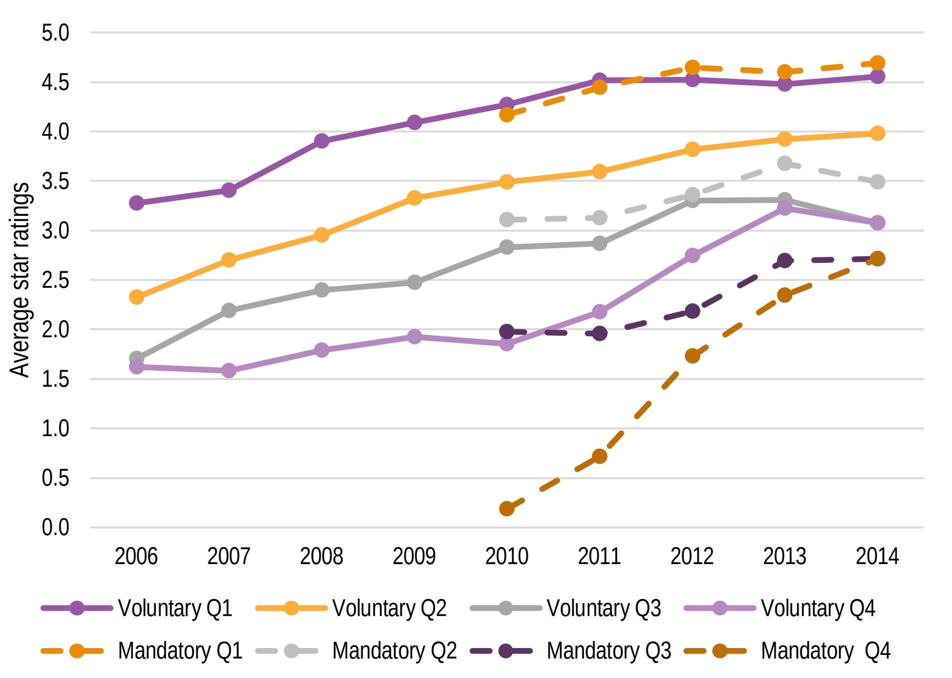
4.4.2 Impact on individual segments

The trend in energy performance of each segment over the period 2006 to 2014 provides a basis for assessing the effects of the CBD policy. The trends reveal:

- the behaviour of buildings during the period when there was no mandatory obligation to disclose energy performance (2006 to 2010), and therefore, the likely behaviour in the hypothetical scenario where no CBD policy was introduced (the 'counterfactual')
- the change in behaviour of buildings observed following introduction of the CBD policy, and therefore, the effect that this policy may have had on commercial building energy performance
- the starting point and possible future evolution of commercial building energy performance beyond 2014, either in the case where the policy is retained or where it is discontinued.

Figure 12 and Table 7 show the trend in average star rating by segment between 2006 and 2014.

Figure 12 **Average annual star rating by segment**



Source: ACIL Allen analysis of NABERS data

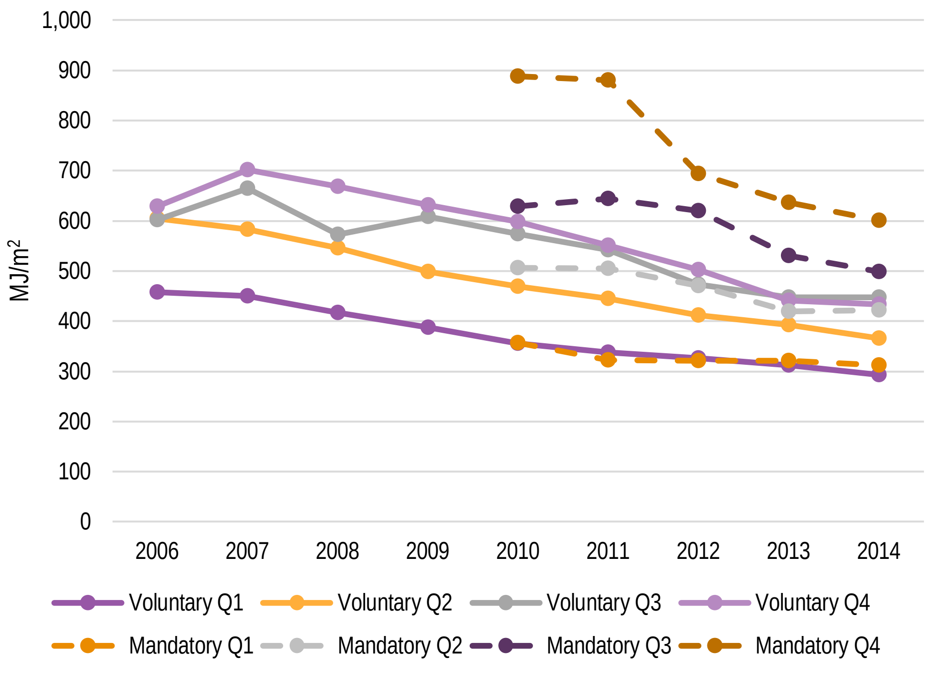
Table 7 **Growth in star rating by segment**

Segment	Pre-CBD[a]	Post-CBD[b]	Pre-CBD[a]	Post-CBD[b]
	Stars / year	Stars / year	% / year	% / year
Voluntary Q1	0.28	0.02	7.7%	0.3%
Voluntary Q2	0.33	0.13	12.7%	3.5%
Voluntary Q3	0.26	0.07	13.1%	2.4%
Voluntary Q4	0.10	0.31	5.5%	12.5%
Mandatory Q1	n.a.	0.08	n.a.	1.8%
Mandatory Q2	n.a.	0.12	n.a.	3.9%
Mandatory Q3	n.a.	0.26	n.a.	11.5%
Mandatory Q4	n.a.	0.67	n.a.	56.0%
All	**0.29**	**0.16**	**11.1%**	**4.5%**

[a] Pre-CBD growth rate defined as compound annual growth rate from 2006 to 2009.
[b] Post-CBD growth rate defined as compound annual growth rate from 2011 to 2014.
Note: No pre-CBD growth rate for mandatory segments as buildings in this group were not rating.
Source: ACIL Allen analysis of NABERS data

Figure 13 and Table 8 show the trend in average energy intensity by segment between 2006 and 2014.

Figure 13 **Average annual energy intensity by segment**



Source: ACIL Allen analysis of NABERS data

Table 8 **Reductions in energy intensity by segment**

Segment	Pre-CBD[a]	Post-CBD[b]	Pre-CBD[a]	Post-CBD[b]
	MJ/m^2 / year	MJ/m^2 / year	MJ/m^2 / year	MJ/m^2 / year
Voluntary Q1	-21.4	-15.8	-7.8%	-4.9%
Voluntary Q2	-35.1	-26.5	-8.0%	-6.3%
Voluntary Q3	2.3	-31.7	-1.6%	-6.2%
Voluntary Q4	2.7	-39.4	-1.3%	-7.7%
Mandatory Q1	n.a.	-3.2	n.a.	-1.0%
Mandatory Q2	n.a.	-26.4	n.a.	-5.6%
Mandatory Q3	n.a.	-49.0	n.a.	-8.2%
Mandatory Q4	n.a.	-94.4	n.a.	-12.1%
All	**-20.77**	**-29.87**	**-3.9%**	**-6.8%**

[a] Pre-CBD growth rate defined as compound annual growth rate from 2006 to 2009.
[b] Post-CBD growth rate defined as compound annual growth rate from 2011 to 2014.
Note: No pre-CBD growth rate for mandatory segments as buildings in this group were not rating.
Source: ACIL Allen analysis of NABERS data

Two important qualifications should be considered when interpreting the above results. First, the averages are calculated based on the sample of buildings within each segment which choose to rate that year (rather than the entire population). Second, while there is a relationship between star ratings and energy intensity, there is a range of possible energy intensities for buildings of the same star rating. This is because star ratings reflect relative performance and account for factors such as varying heating and cooling needs across climate zones. As a result, the trends contain some 'noise' (that is, movements in performance as a result of sampling rather than fundamental improvement) and this limits the types of conclusions that may be drawn from the data.

Notwithstanding the qualifications discussed, the following conclusions may be drawn:

- The broad trends in energy performance of voluntary segments appear to have been maintained[20] throughout the period, despite the introduction of CBD.
- The average star rating for buildings in the mandatory 4th quartile have rapidly increased, and energy intensities have rapidly declined, over the period covered by mandatory disclosure.
- Buildings in the mandatory 4th quartile entered the ratings database at a very low level of energy performance (average star rating of 0.19). While zero stars should not be thought of as a 'floor' for energy performance[21], both the quantitative and anecdotal evidence suggests that buildings within this segment had been stagnant[22] with respect to energy performance and they have clearly been the ones that responded most markedly following the introduction of CBD.

Furthermore, stakeholders (particularly energy performance assessors) have noted that in addition to the clearly observable impact the policy has had on buildings within the mandatory 4th quartile, two other segments are likely to have been affected by the CBD based on their experience in performing assessments. Specifically:

20 While energy intensity reductions appear to have accelerated following the introduction of mandatory disclosure for voluntary 3rd and 4th quartiles (see Table 8), this is driven by an anomalous measurement in 2007 (i.e. higher than 2006) which is likely to be the result of the previous described 'noise' in the data.

21 There is a very wide range of energy performance for 0 star buildings. Therefore a building may have improved significantly while its rating has remained at 0 stars.

22 Anecdotal evidence suggests that while a number of very generous schemes were available to building owners, these were not being taken up by a portion of the market.

- The 1st quartile of mandatory raters enters the ratings database at a high level of energy performance (average star rating of higher than 4). Anecdotal evidence from energy performance assessors suggests that many buildings that were not previously rating and have had high first ratings, have in fact undertaken informal ratings and upgrades to their energy performance prior to their first rating. Therefore, the benefits of these upgrades should be attributed to the CBD.
- A proportion of improvement for buildings in the mandatory 3rd quartile is attributable to the CBD as these buildings are also starting from a low base of performance (albeit not as low as the 4th quartile). This segment has an average star rating of approximately 2.0 in 2010 and a number of buildings are likely to have had stagnant energy performance prior to the CBD. By 2014, the segment achieves an average star rating of 2.7.

Based on this evidence, ACIL Allen believes that the CBD program is likely to have had an effect on buildings in the mandatory 1st, 3rd and 4th quartiles. The magnitude of the effect on the 4th quartile buildings may be measured through the results of the trend analysis. However, the magnitude of the effect on the 1st and 3rd quartiles is much less certain.

4.4.3 Attribution of improvements to the CBD

The effect of the CBD policy is measured as differences between the observed energy intensities and the hypothesised counterfactual energy intensities of buildings had the CBD not been in place. Energy intensities (as opposed to star ratings) are used as they may be translated into resource cost savings, which are the primary economic benefits arising from the improvements in energy performance. The uncertainty in magnitude of effect of CBD for various segments is addressed through the use of scenario analysis and construction of 'lower bound' and 'realistic' cases.

Lower bound case

The lower bound case includes only segments where the magnitude of the effect is observable and measurable through the quantitative analysis. This includes only the 4th quartile of mandatory raters. The entire estimated average improvement (from 888 MJ/m^2 in 2010 to 597 MJ/m^2 in 2014) is assumed to be attributable to the CBD program. Buildings within this segment have reportedly not participated in very generous energy efficiency schemes offered by government prior to mandatory disclosure. While the buildings may have benefited from some complementary programs following the introduction of mandatory disclosure, this improvement is fully attributed to CBD given that participation in these programs is not expected to have occurred had mandatory disclosure not been in place.

Realistic case

The realistic case also includes effects on segments where evidence suggests that improvements have been driven by CBD but the extent of these improvements cannot be as precisely estimated through the quantitative analysis. A lower level of confidence is placed on estimated improvements for these segments.

In discussions with energy performance assessors, it was suggested that the CBD program prompted a number of buildings to undertake informal ratings and improvements, delivering improvements of 1 to 2 stars, prior to their first NABERS rating. These buildings are likely to have contributed to the high average rating of the mandatory 1st quartile. However, the mandatory 1st quartile is also likely to include buildings that are relatively new (commissioned and operational in the years leading up to disclosure). These would not have experienced the same type of improvement. An assumed average improvement of one star is taken as a balanced assumption considering these two factors (that is, the observed

performance is assumed to have been on average one star higher than what it would have been without CBD over the period 2010 to 2014).

Some of the improvements to the mandatory 3rd quartile would have resulted from mandatory disclosure, as the ratings for these buildings have been improving from a low base. However, some buildings in this quartile are likely to have been undertaking improvements prior to mandatory disclosure and would likely have continued to improve had the CBD not been in place. It is assumed that 50 per cent of the observed improvements between 2010 and 2014 are attributable to the CBD.

The attribution assumptions for the lower bound and realistic cases are presented in Table 9.

Table 9 **Assumed attribution of improvements to CBD**

Segment	Assumed attribution of benefit	Confidence in assumption	Assumed attribution of benefit	Confidence in assumption
Case	**Lower bound**	**Lower bound**	**Realistic**	**Realistic**
Voluntary segments	0%	High	0%	High
Mandatory 1st quartile	0%	Intentionally not included	+ 1 star	Low
Mandatory 2nd quartile	0%	Intentionally not included	0%	Medium
Mandatory 3rd quartile	0%	Intentionally not included	50%	Low
Mandatory 4th quartile	100%	High	100%	High

Source: ACIL Allen

Attributable improvements for the 3rd and 4th quartile of mandatory raters have been estimated first in terms of reductions in average energy intensity (MJ/m^2), then translated to total tCO_{2e}, before applying the estimated net benefits of energy efficiency expressed as dollars per tCO_{2e}. However the assumed one star improvement for the 1st quartile of mandatory raters is first translated into equivalent MJ/m^2 (estimated by performing regression on NABERS data) prior to translation into tCO_{2e} and estimation of net benefits.

4.5 Analysis of program impact on tenancy lighting performance

4.5.1 The potential in tenancy lighting

Tenancy lighting has been acknowledged by stakeholders to be an area where there is significant latent potential for energy efficiency improvement. Energy performance assessors have suggested that in the past, there was on average an approximately equal proportion of energy consumption for base building energy use and tenancy energy use. Due to the rapid improvements in base building energy performance, prompted by initiatives such as NABERS, tenancy energy use now constitutes a greater proportion of total office building energy consumption.

The TLA aims to unlock this potential for improving the energy efficiency of office buildings. However, anecdotal evidence and stakeholder discussions suggest that the impact of the TLA has been limited by a number of factors including:

— The fact that tenancy lighting assessments are a new mechanism and the market has not had adequate time for the scheme to mature to the extent where there is sufficient awareness and uptake from both building owners and tenants (unlike NABERS ratings).

- There is no requirement to include TLA information in advertisements regarding the sale or lease of a building.
- Even if inclusion of TLA information was required, it is not as amenable (compared to NABERS) to produce a simple aggregate performance metric that can be easily understood by the market, as power densities and control systems will vary by functional space.
- High NABERS ratings are part of the marketing proposition of some buildings, while this is not the case for tenancy lighting.

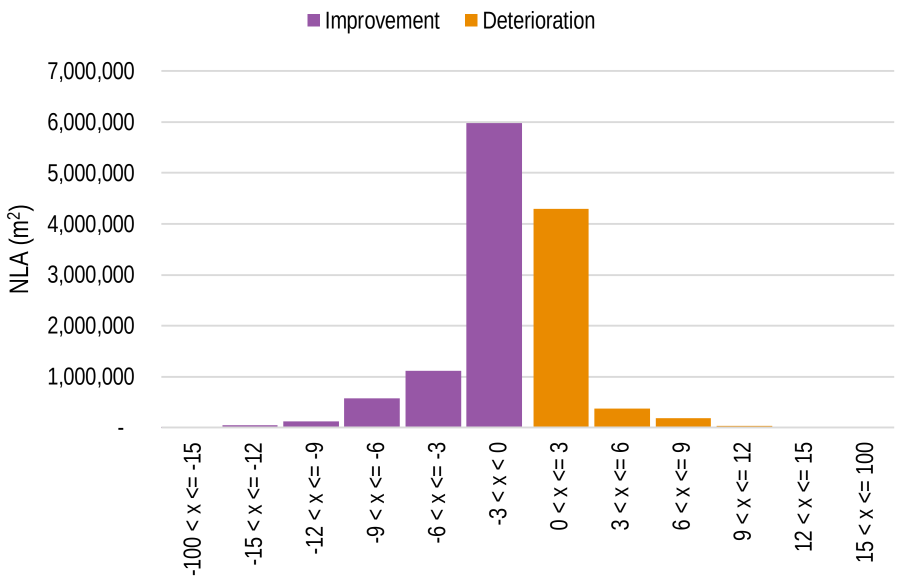
4.5.2 Analysis of tenancy lighting performance data

Analysing the effect of the TLA component of CBD on tenancy lighting is complicated by the absence of comparable data on power density and control systems prior to the introduction of TLA. There is also a lack of historical information more generally on the energy efficiency of lighting in the commercial building stock.

Therefore, the available data (2011 to 2014) within the CBD database was analysed to investigate the trend in tenancy lighting during the period of TLA operation. The analysis involved estimating average improvement in power density of all buildings that had undertaken at least two 'all building' TLA assessments. The total estimated NLA for buildings in the sample was 13.5 million m^2. For these buildings, ACIL Allen calculated the change in weighted average NLPD (weighted by area of different functional spaces within the building) between the first and last TLA assessments.

Figure 14 shows the histogram of NLPD changes for all buildings in the sample, with improvements in TLA for buildings grouped into bins of 3 W/m^2.

Figure 14 **Distribution of NLPD changes (all buildings, bins 3 W/m^2 wide)**

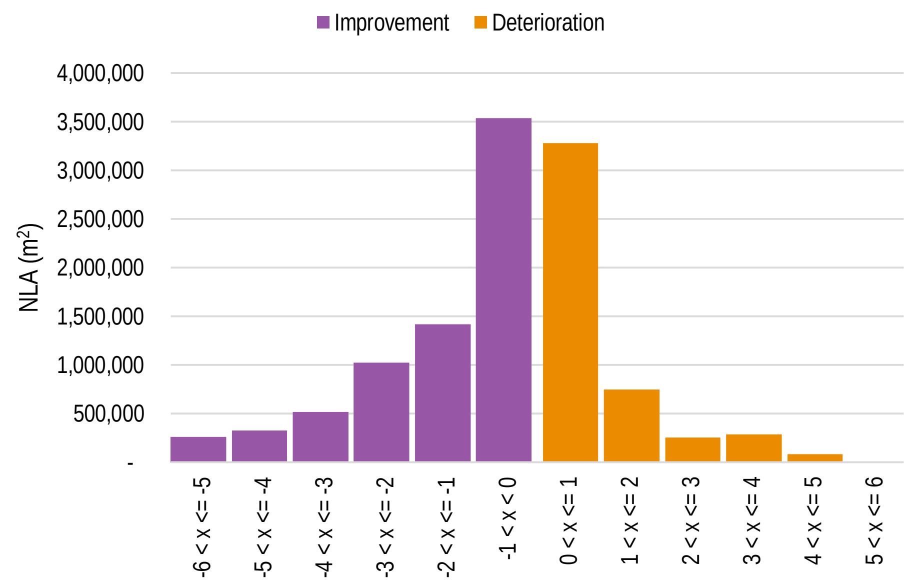


Note: Excludes buildings with no change to average NLPD (i.e. Δ NLPD = 0).
Source: ACIL Allen analysis of CBD data

A mean improvement of 0.81 W/m^2 was calculated for the sample, with 56 per cent of buildings' functional space showing improvement, 36 per cent showing deterioration and 6 per cent showing no change.

The majority of buildings had an estimated change within 3 W/m^2. According to the Department's analysis, the reported margin of error for estimates of power densities is approximately 1 W/m^2. Therefore, further analysis of changes using smaller bins of 1 W/m^2 was conducted for buildings with average NLPD change between +/- 6 W/m^2. The histogram of these changes is shown in Figure 15.

Figure 15 **Distribution of NLPD changes (all buildings, bins 1 W/m^2 wide)**



Note: Excludes buildings with no change to average NLPD (i.e. Δ NLPD = 0).
Source: ACIL Allen analysis of CBD data

The average improvement for 56 per cent of buildings' functional space was within +/- 1 W/m^2, with 32 per cent having an improvement greater than 1 W/m^2 and 10 per cent with deterioration poorer than 1 W/m^2.

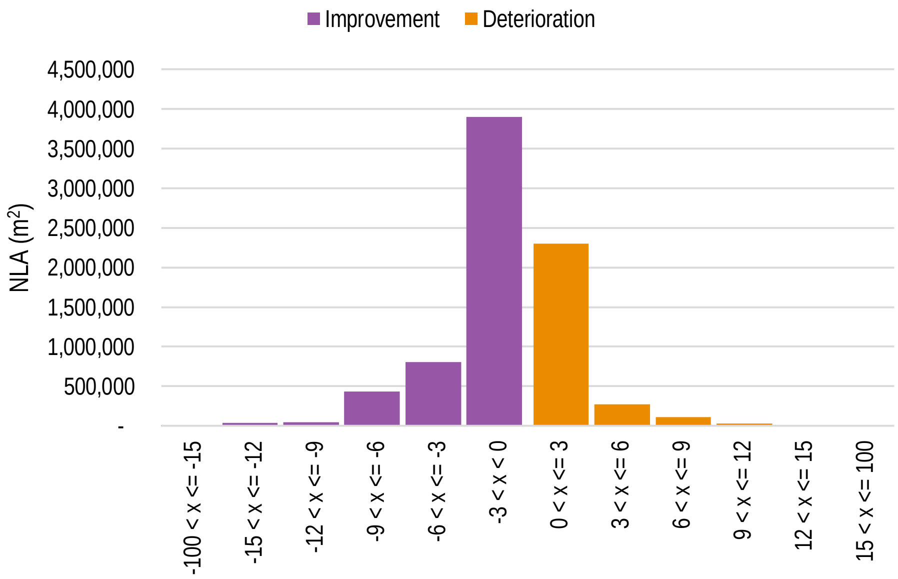
This does not suggest that 56 per cent of buildings are likely to have had no change to lighting systems. The estimated +/- 1 W/m^2 margin of error applies to individual functional spaces (rather than whole building), whereas the analysis was conducted using the average NLPD for whole buildings. A building may have had genuine improvement in at least one individual space of greater than 1 W/m^2 which still resulted in overall building improvement lower than 1 W/m^2; however, analysis by functional space was not possible due to data limitations.

Note that the sample includes all buildings contained within the CBD downloadable database[23] (including voluntary raters, mandatory raters and those that have been classified as new buildings). The analysis was undertaken for voluntary and mandatory raters separately to investigate whether there were any significant differences in improvements to NLPDs.

Figure 16 shows the histogram of NLPD changes for voluntary rater buildings in the sample, while Figure 17 shows the histogram of NLPD changes for mandatory rater buildings in the sample; both with improvements in TLA for buildings grouped into bins of 3 W/m^2.

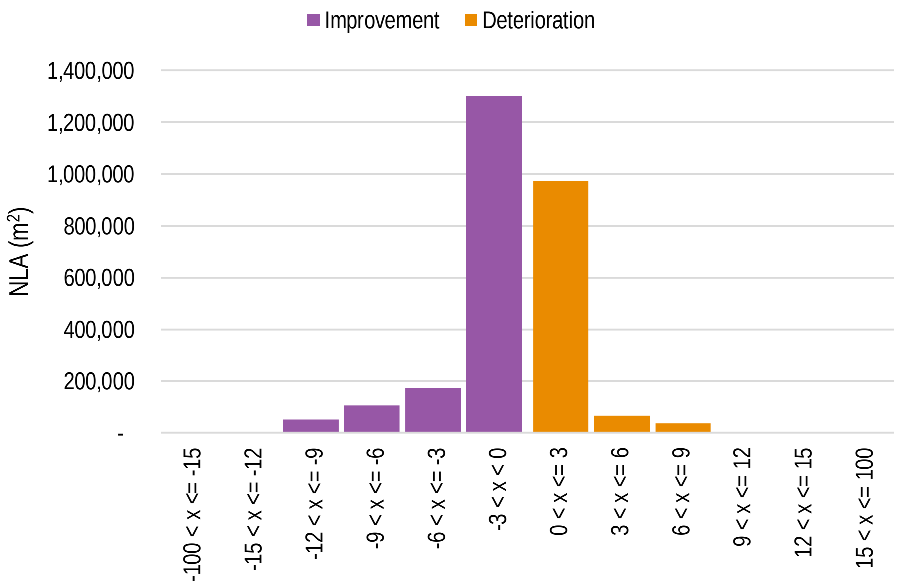
[23] The CBD database, updated weekly, is publically available (http://www.cbd.gov.au/registers/cbd-downloadable-data-set) and records data contained in BEEC and associated NABERS and TLA certificates.

Figure 16 **Distribution of NLPD changes (voluntary group, bins 3 W/m^2 wide)**



Note: Excludes buildings with no change to average NLPD (i.e. Δ NLPD = 0).
Source: ACIL Allen analysis of CBD data

Figure 17 **Distribution of NLPD changes (mandatory group, bins 3 W/m^2 wide)**



Note: Excludes buildings with no change to average NLPD (i.e. Δ NLPD = 0).
Source: ACIL Allen analysis of CBD data

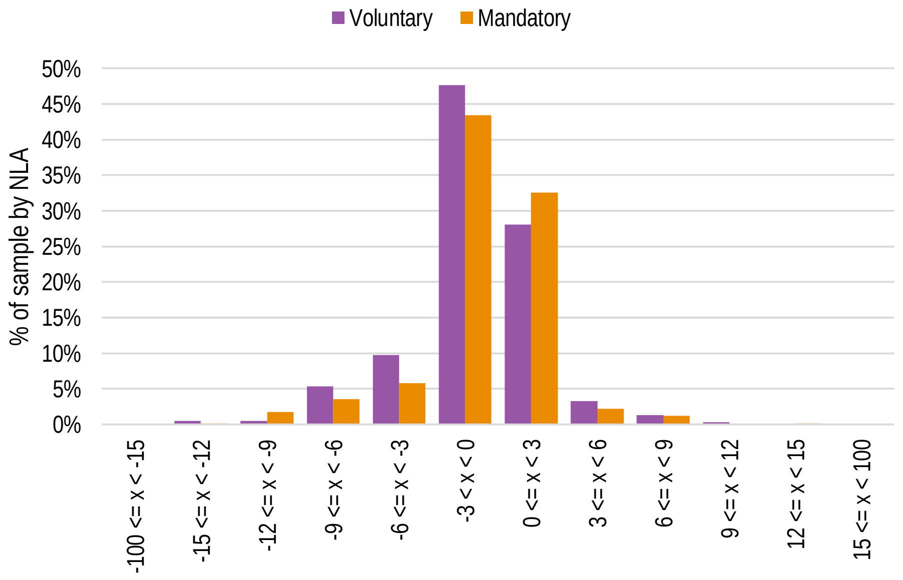
A mean improvement of 0.97 W/m^2 was calculated for voluntary raters, compared with 0.68 W/m^2 for mandatory raters.

For voluntary raters, 64 per cent of buildings had an improvement in average NLPD, 33 per cent of buildings had a deterioration and 3 per cent had no change. For mandatory raters,

55 per cent of buildings had an improvement in average NLPD, 36 per cent of buildings had a deterioration and 9 per cent had no change.

Figure 18 compares the distribution of voluntary and mandatory raters in percentage terms (for example, per cent of all voluntary raters with a change between 3 and 6 W/m² etc).

Figure 18 **Distribution of NLPD changes (voluntary and mandatory compared)**



Note: Excludes buildings with no change to average NLPD (i.e. Δ NLPD = 0).
Source: ACIL Allen analysis of CBD data

While voluntary raters demonstrate greater mean improvement than mandatory raters, the differences in tenancy lighting performance do not appear to be as marked as differences in NABERS ratings.

4.5.3 Conclusions from analysis of tenancy lighting

Data availability limits the level of analysis that may be conducted on the efficacy of TLA, particularly due to the difficulties in tracking improvements in individual functional spaces. (As noted previously, whole building improvements have been calculated as an alternative.) However, a number of observations can be made:

- There are relatively low improvements in NLPD across all groups, particularly when compared against the results of the base building NABERS performance analysis.
- Much of the change in NLPD is within the 'margin of error' (+/- 1 W/m²).
- There is, however, noticeably more improved floor space than deteriorated (excluding those within the margin of error).
- Voluntary raters showed a marginally greater improvement than mandatory raters.

The small overall improvement makes it difficult to argue that the CBD has had a significant and measurable impact on tenancy lighting performance, particularly considering that there would always likely to have been some autonomous improvement. While some evidence of upgrades can be seen, it is impossible to distinguish upgrades that were beyond business as usual.

Based on this analysis, no incremental benefits from the TLA component of the CBD have been incorporated in the cost-benefit analysis. While it is acknowledged that some upgrades are likely to have been prompted by the CBD, this is taken into consideration when interpreting the results of the CBA rather than being explicitly quantified.

4.6 Assessment of costs and benefits

4.6.1 Items included in core assessment of cost and benefits

The core CBA results are based on comparing the magnitude of the industry burden and government costs to the net benefits of greater energy efficiency and GHG reduction. Therefore, the results include benefits that can be quantified with a relatively high degree of confidence.

Our analysis of productivity benefits, although not included in the core assessment, showed that these could be significant. While we recognise their importance, productivity benefits are not included due to the relatively high degree of uncertainty surrounding their magnitude.

The economic value to assign to GHG reductions in a CBA remains a contested issue. A number of approaches are possible, including an estimate of the cost from economic damage caused by GHG emissions (the 'external cost'), the cost of reducing emissions (the 'abatement cost') or society's willingness to pay (WTP).

During the majority of the period 2010 to 2014, a Carbon Pricing Mechanism (CPM) was in place. This provided an 'economic price signal' for GHG reductions for projects undertaken during this period. The approximate price during that period ($23/t$CO_2$-e) may therefore be used as a proxy for the WTP and has been used to value GHG reductions for the backward-looking analysis.

As the backward-looking analysis time period extends beyond 2014 (to 2023) to take into account ongoing benefits of projects after their implementation, the economic value for GHG reductions has been applied to 2023 (not just the period the CPM was in operation). This is consistent with the expectation that base case financial projections for such projects would have likely considered a price signal to be in place over the project life.

The results are calculated for both the lower bound case (which excludes segments where the magnitude of the effect from the CBD is less clear) and the realistic case (which includes all segments that are expected to have been impacted as a result of the CBD).

4.6.2 Lower bound estimate of net benefits

The annual and present value of costs and benefits for the lower bound case are presented in Table 10.

Table 10 **Annual and present value of costs and benefits for lower bound case (2014 $m)**

Item	2010	2011	2012	2013	2014	…	2023	Present Value
Industry burden	-5.5	-5.4	-5.3	-5.1	-4.9			**-21.6**
Net benefits of energy efficiency	0.0	0.2	4.3	4.7	5.7	…	1.0	**33.9**
GHG reduction[24]	0.0	0.1	1.6	1.7	2.1		0.3	**12.3**
Program costs		-2.0	-2.0	-2.0	-2.0			**-6.2**

Note: Benefits accrue over a longer period than costs to reflect project lives of the improvements undertaken between 2010 and 2014.
Source: ACIL Allen

Under an assumed seven per cent real discount rate, the above cost and benefit items result in:

- Net Present Value (NPV) of $18.4 million
- Benefit-Cost Ratio (BCR) of 1.66
- Internal Rate of Return (IRR) of 22 per cent.

(NPV is the difference between the present value of benefits and the present value of costs, while BCR is the ratio of the present value of benefits to the present value of costs. IRR is the discount rate that equalises the present value of costs and benefits.)

Industry burden costs accrue between 2010 and 2014. The industry burden is incurred in 2010, despite the policy being in place for the full year, as it is expected that building owners conducted assessments in anticipation of the CBD policy. The cost reflects the incremental costs associated with the CBD policy (that is, the cost of NABERS ratings that were estimated to have occurred voluntarily is subtracted from total cost estimates derived from the Department's cost burden analysis).

Government costs reflect the employee resource costs associated with administering the scheme between 2011 and 2014.

While only the costs of the program between 2010 and 2014 are included, the benefits of the program are estimated to 2023. This is because while the program is expected to have triggered improvements between 2010 and 2014, the improvements will continue to deliver benefits over the life of the upgraded systems.[25]

4.6.3 'Realistic' estimate of net benefits

The present value of costs and benefits for the realistic case are presented in Table 11.

[24] For this analysis, the assumed economic value for GHG reductions of $23/tCO$_{2e}$ was applied over the entire time horizon (2010 to 2023). The assumed economic value is based on the approximate carbon price under the CPM (in place between 2010 and 2014), which serves as a proxy for this value throughout this period. Assuming an economic value only for the years 2010 and 2014 reduces benefits by approximately $8.2m PV.

[25] Project life of energy efficiency improvements will vary. An assumed average project life of 10 years was modelled. Some equipment may have a much longer working life. However, a 10 year average life was chosen to reflect that in some cases the effect of the policy may have simply 'brought forward' an improvement that would have otherwise occurred in the future, therefore counting benefits over a longer time horizon would not be appropriate. The shorter time horizon relative to other studies is also consistent with the conservative approach adopted for this analysis.

Table 11 **Present value of costs and benefits for realistic case (2014 $m)**

Item	Present Value (2014 $m)
Industry burden	-$21.6
Benefits for mandatory 4th quartile	$33.9
Benefits for mandatory 3rd quartile	$5.4
Benefits for mandatory 1st quartile	$3.9
GHG reduction[26]	$28.6
Program costs	-$6.2
Net Present Value	**$44.0**

Note: Benefits accrue over a longer period than costs to reflect project lives of the improvements undertaken between 2010 and 2014.

Source: ACIL Allen

The above cost and benefit items result in:

- NPV of $44.0 million
- BCR of 2.58
- IRR of 46 per cent.

4.6.4 Inclusion of worker productivity benefits

Studies in Australia and overseas have shown that more energy efficient buildings may lead to increases in the productivity of workers within these buildings (see Box 2).

Box 2 **Productivity impacts of energy efficient buildings**

In May 2009, CBRE and the University of San Diego surveyed 534 managers of tenant companies that moved from standard buildings into buildings with ENERGY STAR labels or Leadership in Energy and Environmental Design (LEED) certifications. Of these, 42.5 per cent agreed that employees were more productive, and 45 per cent agreed that workers were taking fewer sick days since moving. They perceived an average productivity increase of 4.88 per cent among those who reported increased productivity. Fifteen to 25 per cent also perceived higher employee morale, less turnover, and greater ease of recruitment.

A McGraw-Hill survey completed in 2009 showed that nearly half of all tenants who move into a green space did so in part because they anticipated productivity gains.

A 2009 Michigan State University study, “Life Cycle Cost Analysis of Occupant Well-being and Productivity in LEED Offices", found that groups moving to LEED office buildings missed less work and put in almost 39 hours more per person annually. According to the study, the total bottom-line benefits from gains included fewer allergic reactions and reduced stress. The study showed that indoor air quality, natural lighting and views to the outdoors correlated with the highest post-move increases in employee satisfaction.

A study conducted in 2007 with two tenant companies that moved into a 5 Green Star rated building in Australia found a 39 per cent reduction in average sick leave days per employee per month, a 9 per cent improvement in the average typing speed of secretaries, and a 7 per cent increase in lawyers’ billings ratios, despite a 12 per cent decline in the average monthly hours worked by the lawyers.

A 2003 report to California’s Sustainable Building Task Force, which involved 33 green building projects, recommended attributing a 1 per cent increase in productivity and health to LEED Certified and LEED Silver buildings, and a 1.5 per cent gain in LEED Gold and Platinum levels.

Source: Various

[26] For this analysis, the assumed economic value for GHG reductions of $23/tCO_{2e}$ was applied over the entire time horizon (2010 to 2023). The assumed economic value is based on the approximate carbon price under the CPM (in place between 2010 and 2014), which serves as a proxy for this value throughout this period. Assuming an economic value only for the years 2010 and 2014 reduces benefits by approximately $17.5m PV.

The assumed productivity benefits per star and square metre (described benefits in Section A.6 in Appendix A), combined with average star improvements and floor area (m^2) for each segment, were used to calculate the present value of productivity benefits for mandatory quartiles 1, 3 and 4 in the lower bound and realistic cases (affecting approximately 210,000 office staff). Total productivity benefits were estimated as $110.5m PV in the lower bound case and $167.8m PV in the realistic case.

Productivity benefits are therefore expected to be significant. However, due to the lack of sufficient and robust data estimating the productivity benefits of green buildings, there remains a high degree of uncertainty in estimates.

4.6.5 Additional unquantified benefits

The following additional benefits have been identified but were unable to be quantified due to data and resource limitations:

— Anecdotal evidence suggests that building owners who would be considered ‘mandatory raters’ are undertaking NABERS water ratings at the same time as energy ratings due to the cost savings of doing two assessments simultaneously. This is likely to have led to greater awareness of water saving opportunities and subsequent exploitation of opportunities.

— The assessment of energy efficiency benefits has been based on observed performance in energy performance (that is, of the mandatory segment with NABERS ratings). However, there are other buildings covered by mandatory disclosure but have not yet triggered a disclosure event. Some of these buildings may have undertaken improvements in anticipation of a disclosure event.

4.6.6 Sensitivity analysis

CBAs always require making assumptions about values for factors or parameters which are inherently uncertain. The results of a CBA are, therefore, also uncertain. Sensitivity analysis is a tool used to test the robustness of CBA results. The purpose of sensitivity testing is to assess how the results of a CBA would change if values of uncertain factors were different from those assumed.

The economic value of energy efficiency improvements and the star increase in performance for the 1st quartile of mandatory raters prior to first rating are two assumptions that have both a relatively high degree of uncertainty and a high degree of materiality in the analysis. While the assumptions have been developed by drawing on available evidence and further cross-validated with industry stakeholders, there remains a degree of uncertainty.

ACIL Allen therefore tested the sensitivity of the CBA results to these two assumptions. The sensitivity analysis was conducted using ‘threshold analysis’ (see Box 3)

Box 3 **Threshold analysis compared with conventional sensitivity analysis**

Threshold analysis is a type of sensitivity analysis which is used to find conditions where the results of a CBA change from being positive (that is, the policy is expected to provide a net benefit to society) to negative (the policy is expected to incur a net cost to society). It is distinguished from a conventional sensitivity analysis. In a conventional sensitivity analysis, the changes to CBA results, based on a discrete number of changes to values for uncertain factors, are calculated. For example, a conventional sensitivity analysis would test the following:

- What would the NPV be if energy prices were 20 per cent higher than that assumed and upgrade costs were 50 per cent lower (that is, the benefits of energy efficiency were higher than that assumed)?
- What would the NPV be if energy prices were 20 per cent lower and upgrade costs were 50 per cent higher?

Whereas a threshold analysis asks the question:

- What are the combinations of values for energy prices and upgrade costs where the policy is calculated as having a positive NPV?

In a threshold analysis, NPVs are calculated for a range of possible values for uncertain variables. The points at which NPVs turn from negative to positive are referred to as the 'boundary conditions'.

A stylised chart for the hypothetical results of a threshold analysis of two uncertain variables (A and B) is shown below.

The chart shows:

- The NPVs (number in each cell) for combinations of A and B.
- The NPVs for combinations of A and B are also represented as a colour shade that fills each cell. Shades of blue represent a positive NPV and shades of red, a negative NPV. The stronger the shades the more positive or negative the NPV.
- That the NPV increases as A and B increase.
- The 'threshold' or 'boundary conditions' as the white cells (the combinations of values of A and B around which the NPV switches from positive to negative).

Figure 19 **Example results of a threshold analysis**

A/B	-0.5	-0.4	-0.3	-0.2	-0.1	0	0.1	0.2	0.3	0.4	0.5
-0.5	-1.00	-0.90	-0.80	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00
-0.4	-0.90	-0.80	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10
-0.3	-0.80	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20
-0.2	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30
-0.1	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40
0.0	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50
0.1	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60
0.2	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70
0.3	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80
0.4	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
0.5	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00

Source: ACIL Allen

The threshold analysis for this CBA was conducted by fixing some of the assumptions (referred to as base settings) and varying the two selected assumptions (the economic value of energy efficiency improvements and the star increase in performance for the 1st quartile of mandatory raters prior to first rating) to examine the impact that this has on the NPV of the program.

The base settings:

- assume that 100 per cent of the improvements in the 4th quartile of mandatory raters is attributable to the CBD program (consistent with both the lower bound and realistic cases)
- assume that GHG reductions have an economic value of $23/tCO_{2e}$
- assume that none of the improvements in 2nd and 3rd quartiles of mandatory raters is attributable to the CBD program (consistent with the lower bound cases)
- exclude any consideration of potential productivity benefits.

These base settings, which are intentionally chosen to be conservative, are fixed for all sensitivities, whereas:

- the net benefit of energy efficiency is varied between one per cent and 100 per cent of the base assumption
- the average NABERS star increase for the 1st quartile of mandatory raters prior to first rating is varied from zero stars (consistent with the lower bound case) to 2.5 stars, in 0.25 star increments.

The base assumption on the net benefits of energy efficiency is that improvements in the base building energy performance of buildings in the 4th quartile of mandatory raters delivered an average economic benefit of $63.4 per tCO_2-e abated. Assuming the net benefit is 50 per cent of that under the base assumptions thus implies an assumed value of $31.7 per tCO_{2e} abated.

The results of this threshold analysis are shown in Figure 20.

The results are interpreted as follows:

- If no improvements in 1st quartile mandatory raters is assumed, the net benefits of energy efficiency improvements need to be at least 33 per cent of the base assumption for the CBD program to have delivered a positive NPV.
- The CBD program is expected to have delivered benefits even if the net benefits of energy efficiency are one per cent of the base assumption, so long as there is an assumed average performance increase of one star for the mandatory 1st quartile attributable to the CBD program.

In interpreting these results, it should be considered that (as stated above) the assumed economic value of GHG reductions is held assumed at $23/$tCO_2$-e across all sensitivities, while the value of energy efficiency benefits is varied according to each sensitivity.

While uncertain, the actual values for the sensitivity variables are expected to be much higher than the threshold values calculated above. Combined with the conservative base settings for the remaining CBA assumptions, the sensitivity test reinforces the conclusion that the CBD program has delivered substantial net economic benefits with a very high degree of certainty.

Figure 20 **Threshold analysis for benefit of CBD program to date ($m NPV)**

Net benefits of energy efficiency scaled by	Assumed Mandatory Q1 increase in star due to CBD										
	0.00	**0.25**	**0.50**	**0.75**	**1.00**	**1.25**	**1.50**	**1.75**	**2.00**	**2.25**	**2.50**
1%	-$12	-$8	-$5	-$2	$1	$4	$7	$10	$13	$17	$20
3%	-$11	-$8	-$4	-$1	$2	$5	$8	$11	$14	$18	$21
5%	-$10	-$7	-$4	-$0	$3	$6	$9	$12	$15	$19	$22
7%	-$9	-$6	-$3	$1	$4	$7	$10	$13	$16	$20	$23
9%	-$8	-$5	-$2	$2	$5	$8	$11	$14	$17	$20	$24
11%	-$8	-$4	-$1	$3	$6	$9	$12	$15	$18	$21	$25
13%	-$7	-$3	-$0	$3	$6	$10	$13	$16	$19	$22	$26
15%	-$6	-$3	$0	$4	$7	$10	$13	$17	$20	$23	$27
17%	-$5	-$2	$1	$5	$8	$11	$14	$17	$21	$24	$28
19%	-$4	-$1	$2	$6	$9	$12	$15	$18	$22	$25	$29
21%	-$4	-$0	$3	$7	$10	$13	$16	$19	$22	$26	$30
23%	-$3	$1	$4	$8	$11	$14	$17	$20	$23	$27	$31
25%	-$2	$1	$5	$8	$12	$15	$18	$21	$24	$28	$31
27%	-$1	$2	$5	$9	$12	$16	$19	$22	$25	$29	$32
29%	-$1	$3	$6	$10	$13	$17	$20	$23	$26	$30	$33
31%	$0	$4	$7	$11	$14	$17	$21	$24	$27	$31	$34
33%	$1	$5	$8	$12	$15	$18	$22	$25	$28	$32	$35
35%	$2	$5	$9	$13	$16	$19	$22	$26	$29	$33	$36
37%	$3	$6	$10	$14	$17	$20	$23	$27	$30	$34	$37
39%	$3	$7	$10	$14	$18	$21	$24	$28	$31	$35	$38
41%	$4	$8	$11	$15	$19	$22	$25	$29	$32	$36	$39
43%	$5	$9	$12	$16	$19	$23	$26	$29	$33	$37	$40
45%	$6	$9	$13	$17	$20	$24	$27	$30	$34	$38	$41
47%	$7	$10	$14	$18	$21	$25	$28	$31	$35	$39	$42
49%	$7	$11	$14	$19	$22	$25	$29	$32	$36	$40	$43
51%	$8	$12	$15	$19	$23	$26	$30	$33	$37	$41	$44
53%	$9	$13	$16	$20	$24	$27	$31	$34	$37	$42	$45
55%	$10	$13	$17	$21	$25	$28	$31	$35	$38	$43	$46
57%	$10	$14	$18	$22	$25	$29	$32	$36	$39	$44	$47
59%	$11	$15	$19	$23	$26	$30	$33	$37	$40	$44	$48
61%	$12	$16	$19	$24	$27	$31	$34	$38	$41	$45	$49
63%	$13	$17	$20	$25	$28	$32	$35	$39	$42	$46	$50
65%	$14	$18	$21	$25	$29	$32	$36	$40	$43	$47	$51
67%	$14	$18	$22	$26	$30	$33	$37	$40	$44	$48	$52
69%	$15	$19	$23	$27	$31	$34	$38	$41	$45	$49	$53
71%	$16	$20	$24	$28	$32	$35	$39	$42	$46	$50	$54
73%	$17	$21	$24	$29	$32	$36	$40	$43	$47	$51	$55
75%	$18	$22	$25	$30	$33	$37	$40	$44	$48	$52	$56
77%	$18	$22	$26	$30	$34	$38	$41	$45	$49	$53	$57
79%	$19	$23	$27	$31	$35	$39	$42	$46	$50	$54	$58
81%	$20	$24	$28	$32	$36	$40	$43	$47	$51	$55	$59
83%	$21	$25	$29	$33	$37	$40	$44	$48	$52	$56	$60
85%	$21	$26	$29	$34	$38	$41	$45	$49	$52	$57	$61
87%	$22	$26	$30	$35	$38	$42	$46	$50	$53	$58	$62
89%	$23	$27	$31	$36	$39	$43	$47	$51	$54	$59	$63
91%	$24	$28	$32	$36	$40	$44	$48	$51	$55	$60	$64
93%	$25	$29	$33	$37	$41	$45	$49	$52	$56	$61	$65
95%	$25	$30	$33	$38	$42	$46	$50	$53	$57	$62	$66
97%	$26	$30	$34	$39	$43	$47	$50	$54	$58	$63	$67
99%	$27	$31	$35	$40	$44	$47	$51	$55	$59	$64	$68
100%	$27	$32	$36	$40	$44	$48	$52	$56	$59	$64	$68

Note: Red shading with grey text indicates a negative NPV, blue shading with black text indicates a positive NPV and brighter shading indicates relatively higher magnitude of NPV. Red circle ($44m) indicates the combination of parameter values used in the central analysis.

Source: ACIL Allen

4.7 Distributional impacts of the program to date

4.7.1 Green premium

Since 2008, there has been an expanding body of research is the US investigating whether more energy efficient buildings command a “green premium” in terms of higher rental and sale prices compared with less energy efficient ones. (See, for example, Miller et al., 2008; Eichholtz et al., 2010; Pivo and Fisher, 2010; Wiley et al., 2010; Fuerst and McAllister, 2011a, b; Reichardt et al., 2012.)

This empirical research focused on US green office buildings and compared portfolios of green office properties (e.g. LEED, Energy Star) with non-green office property portfolios. Control variables were used where possible to account for differences in the office properties - this typically included age, size, building quality, number of storeys, amenities and location.

Theoretically, a green premium would arise in an informed and rational market where the cost savings from more energy efficient buildings are reflected in rents paid by tenants. An illustrative example of differences in base building energy costs for a building of 10,000 m^2 NLA in the Sydney CBD by NABERS star rating is shown in Table 12 and Figure 21.[27]

Table 12 **Illustrative energy cost difference for 10,000 m^2 NLA by star rating**

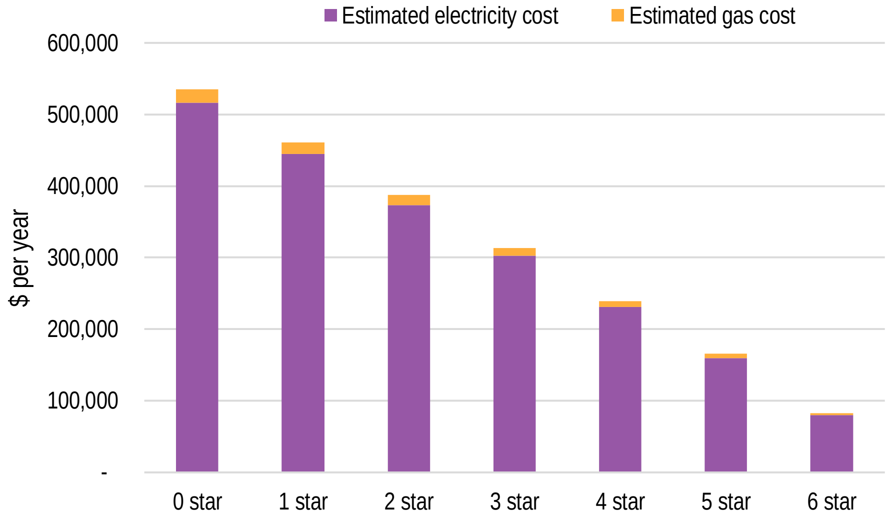
Base building energy star rating	Estimated electricity use (KWh/year)	Estimated gas use (MJ/year)	Estimated electricity cost ($/year)	Estimated gas cost ($/year)	Estimated total cost ($/year)	Incremental energy saving (MJ/year)	Incremental cost saving
0 star	2,581,069	1,032,427	$516,214	$19,028	$535,241	Not applicable	Not applicable
1 star	2,224,466	889,786	$444,893	$16,399	$461,292	1,426,412	$73,949
2 star	1,867,863	747,145	$373,573	$13,770	$387,342	1,426,412	$73,949
3 star	1,511,260	604,504	$302,252	$11,141	$313,393	1,426,412	$73,949
4 star	1,154,657	461,862	$230,931	$8,512	$239,444	1,426,413	$73,949
5 star	798,054	319,221	$159,611	$5,883	$165,494	1,426,412	$73,949
6 star	399,027	159,610	$79,805	$2,942	$82,747	1,596,108	$82,747

Note: Assuming a 10,000 m^2 NLA building, 90 per cent electricity use, 10 per cent gas use, electricity charges of 20c/kWh and gas charges of $18/GJ.

Source: NABERS reverse calculator, ACIL Allen assumptions

[27] Differences in base building (rather than whole building) energy costs have been represented in this example as these are the costs subject to market failures (the tenant incurs the costs but does not have direct control over them). The relativities between whole building energy use and costs by star rating will be similar.

Figure 21 **Illustrative energy costs for 10,000 m^2 NLA by star rating**



Note: Assuming a 10,000 m^2 NLA building, 90 per cent electricity use, 10 per cent gas use, electricity charges of 20c/kWh and gas charges of $18/GJ.
Source: NABERS reverse calculator, ACIL Allen assumptions

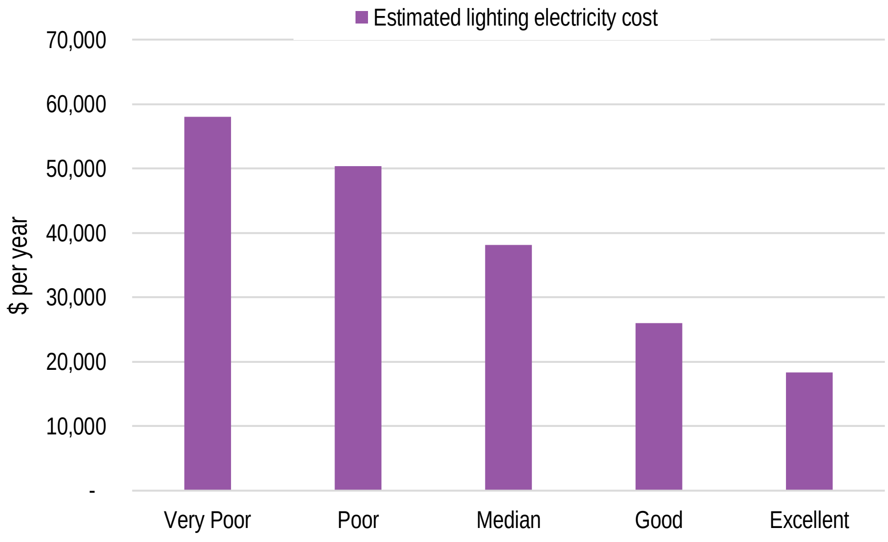
An illustrative example of differences in energy costs for a building of 10,000 m^2 NLA in the Sydney CBD by TLA grade is shown in Table 13 and Figure 22.

Table 13 **Illustrative energy cost difference for 10,000 m^2 NLA by TLA grade**

TLA Grade	Power density range for grade	Assumed power density (W/m^2)	Estimated lighting electricity use (kWh/year)	Estimated lighting electricity cost ($/year)	Incremental energy saving (kWh/year)	Incremental cost saving
Very Poor	18.1 W/m² or more	19.0	290,062	$58,012		
Poor	15.1 W/m² to 18.0 W/m²	16.5	251,896	$50,379	38,166	$7,633
Median	10.1 W/m² to 15.0 W/m²	12.5	190,830	$38,166	61,066	$12,213
Good	7.1 to 10.0 W/m²	8.5	129,765	$25,953	61,066	$12,213
Excellent	7.0 W/m² or less	6.0	91,599	$18,320	38,166	$7,633

Note: Assuming electricity charges of 20c/kWh.
Source: CBD Tenancy Lighting Assessment for Offices Rules, ACIL Allen assumptions

Figure 22 **Illustrative energy costs for 10,000 m^2 NLA by TLA grade**



Note: Assuming electricity charges of 20c/kWh.
Source: CBD Tenancy Lighting Assessment for Offices Rules, ACIL Allen assumptions

For example, each incremental improvement in star rating reduces energy costs by approximately $80,000 per year, whereas each incremental improvement in TLA grade reduces costs by approximately $10,000 per year, based on the assumptions adopted. However, the extent to which these cost savings would be reflected in rents depends on market dynamics.

There is now a number of studies on the existence of the green premium in the Australian commercial property market. According to a 2011 study commissioned by the Australian Property Institute *'Building Better Returns' A Study of the Financial Performance of Green Office Buildings in Australia*, a green premium was evident for buildings with high NABERS energy ratings. The study found:

- A 5 star NABERS rating delivered a 9 per cent green premium in value while a 3 to 4.5 star rating delivered a 2-3 per cent green premium in value.
- Green premiums differed in specific office markets, being most evident in the Sydney suburban office market (8 per cent green premium) and the Canberra office market (21 per cent green premium), compared with the Sydney CBD office market (4 per cent green premium).
- Evidence of major discounts in value in the lower NABERS energy rating categories (less than 3 stars) for the Sydney CBD (10 per cent discount in value) and Canberra (13 per cent discount in value).
- Lesser impact was seen in the green premiums in rents for the NABERS energy ratings – in the 5 star NABERS energy rating, the Sydney CBD office market showed the largest green premium in rents (3 per cent).
- Major discounts in rents were evident in the lower NABERS energy ratings for the Sydney CBD (9 per cent discount in rents) and Canberra (6 per cent discount in rents).
- Green premiums were also evident in reduced vacancy, reduced outgoings, reduced incentives and reduced yields, particularly at the higher rated NABERS energy categories.

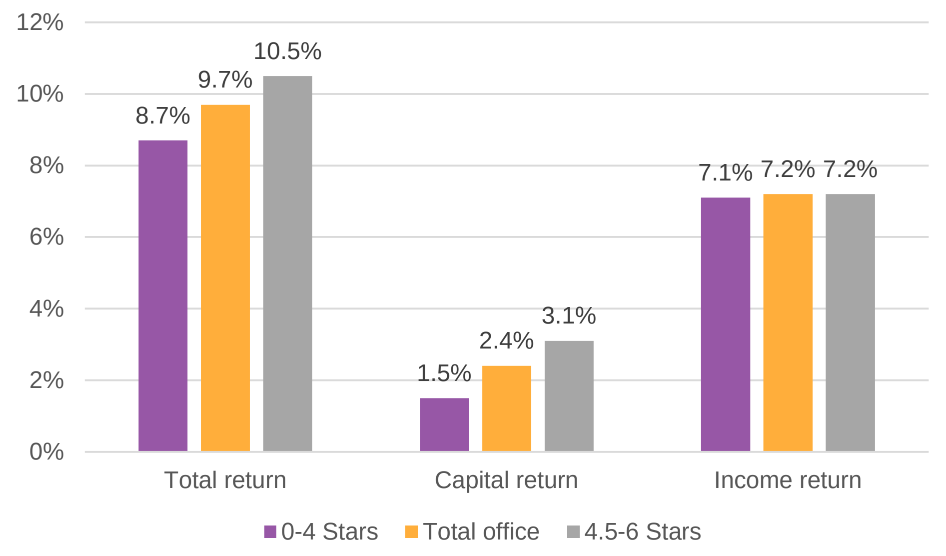
The research involved a significant portfolio of green office buildings in Sydney and Canberra benchmarked against a portfolio of non-green office buildings, and the property financial performance premiums attached to green office buildings empirically assessed, including rent, value, outgoings, yield and occupancy rate premiums.

NABERS energy office market analysis undertaken for the Department by IPD also suggests that office buildings with higher star ratings generate higher returns on average than lower rated buildings.

For the year ending December 2013, the IPD's Total Office Sample reported a total return of +9.7 per cent (see Figure 29). The best performing sample for the year was the High Rated Office Sample (+10.5 per cent), which outperformed the Total Office by +0.9 per cent and the Low Rated Office total return by +1.8 per cent. The Low Rated Office Sample produced a total return of +8.7 per cent for the year, and significantly underperformed the Total Office Sample by -0.9 per cent. The High Rated Office Sample comprises buildings with ratings of 4.5 to 6 stars, while the Low Rated Office Sample comprises buildings with zero to four stars.

(According to IPD, the return-spread between the High and Low Rated Office samples widened from +31 basis points in December 2012 to +180 basis points in December 2013.)

Figure 23 **IPD annual return comparisons, December 2013**



Source: NABERS, IPD (2014)

Figure 29 also shows that the differences in total returns to the High Rated Office Sample and the Low Rated Office Sample are primarily driven by differences in the capital return to more energy efficient buildings rather than differences in the rental return.

On the other hand, a 2014 study by Jeremy Gabe and Michael Rehm of the University of Auckland Business School, published in the *Journal of Property Investment & Finance*, failed to find Australian evidence to support the hypothesis that tenants pay increased accommodation costs for space in energy efficient office property.

The authors of the study obtained lease contracts for office space in central Sydney. Empirical data on annual gross face rent and contract terms from each lease were combined with building characteristics and measured energy performance at the time of

lease. Hedonic regression was used to isolate the effect of energy performance on gross face rent.

The study found that no significant price differentials emerged as a function of energy performance, leading to a conclusion that tenants are not willing to pay for energy efficiency. Six factors – tenancy floor level, submarket location, proximity to transit, market fixed effects, building quality specification and, surprisingly, outgoings liability – consistently explain over 85 per cent of gross face rent prices in Sydney.

Setting aside the mixed Australian evidence, the green premium is not included as a benefit in the CBA because it is a transfer from tenants to landlords, so that there are no net gains from the perspective of the broader Australian community. Nevertheless, it is an important issue to consider as the perceived green premium is a prime motivation for building owners to undertake energy efficiency upgrades.

4.7.2 Summary of distributional impacts

The distributional impacts of the CBD program are summarised in Table 14 and discussed below.

Table 14 **Impact of CBD program on stakeholders**

	Building owners	Tenants	Australian government	Energy efficiency industry (e.g. assessors, HVAC installers)	Broader Australian community	Rest of the world
Certification costs	✓ (-)	✓ (-)		✓ (+)		
Energy savings	✓ (+)	✓ (+)				
Costs of energy efficiency improvements	✓ (-)			✓ (+)		
Program costs			✓ (-)			
Productivity gains		✓ (+)			✓ (+)	
GHG reductions			✓ (+)		✓ (+)	✓ (+)

Note: Costs are denoted by (-) while benefits are denoted by (+).
Source: ACIL Allen

Building owners and operators benefit from CBD through increased rents paid by tenants (including the green premium) who have lower utility bills. They also benefit directly from reduced costs of heating and cooling the common areas of buildings. On the other hand, they incur assessment and certification costs as well as the capital costs of upgrading the energy efficiency performance of buildings.

Tenants enjoy energy savings and workforce productivity gains as a result of mandatory disclosure but bear part of the assessment and certifications costs passed onto them by landlords.

The operational costs of the CBD program are currently borne by the Australian Government. The reduction in GHG emissions made possible by the CBD program means

that the Government potentially has to spend less on other measures to meet its announced emissions reduction targets and climate change abatement goals.

The energy efficiency industry (broadly defined) benefits from the CBD program in several ways, from NABERS and TLA assessment revenues, to earnings from the manufacture, importation, distribution, retail and installation of energy efficiency upgrades (such as new HVAC, lighting and control systems).

The broader Australian community benefits from GHG reductions made possible by the CBD program as well as the economic spillovers from the higher wages resulting from productivity improvements achieved by workers in more energy efficient buildings.

The rest of the world benefits from the reduction in Australian GHG emissions enabled by the CBD program.

4.8 Assessment of the effectiveness of the CBD program

ACIL Allen's cost-benefit analysis suggests that the CBD program has been successful in inducing a change in the behaviour of building owners, operators and tenants in regards to commercial building energy efficiency. In particular, the buildings in the mandatory 4th quartile have achieved a marked improvement in NABERS star ratings and a significant reduction in energy intensity. There also appear to be improvements attained by the mandatory 1st and 3rd quartiles as a result of the program. These improvements have enabled the program to achieve benefits in excess of costs to date of $44m in present value terms, even without taking into account workforce productivity gains.

On the other hand, ACIL Allen's analysis suggests that the TLA component of the program has yet to achieve very significant gains. This is likely due to the newness of the TLA (compared with the well-established NABERS) and, consequently, the relatively small proportion of tenants who have taken advantage of the information generated by TLA assessments.

4.9 Assessment of the interactions of CBD with other programs to date

In ACIL Allen's analysis, incremental improvements for the mandatory 1st, 3rd and 4th quartiles in the realistic case have been entirely attributed to the CBD program.[28] However, these improvements may have utilised other energy efficiency programs, by taking advantage of information provision or funding.

In particular, commercial building energy efficiency projects would have obtained funding from the NSW ESS and Victorian VEET schemes. For these schemes, the CBD has resulted in a greater supply of possible projects than would have been available had the CBD not been in place.

Both schemes operate as a market mechanism, where liable entities are obligated to obtain a legislated volume of white certificates (representing a unit of abatement of CO_{2e}) in order to meet a target volume of total abatement. This creates demand for abatement which liable entities would seek to achieve through the lowest cost supply of abatement projects. The marginal cost of abatement is reflected in the white certificate price, or the price paid by

[28] Incremental improvements refers to those that have occurred beyond what was estimated to have occurred anyway without the CBD in place.

liable entities to suppliers of abatement. As the CBD scheme effectively increased the pool of available abatement projects, it lowered the certificate price (marginal cost of abatement) and the total cost of achieving the abatement target. An indicative estimate of the effect on certificate price and total cost of abatement for each scheme is discussed below.

4.9.1 Interaction with the NSW Energy Saver Scheme

The NSW ESS places a mandatory obligation on 'scheme participants' to purchase Energy Savings Certificates (ESCs) which represent energy savings (measured in terms of tCO_{2e}). The NSW ESS scheme generated 1,279 $ktCO_{2e}$ worth of annual energy savings activity in 2013 (IPART, 2014).

Based on the assessment of costs and benefits, the CBD is estimated to have contributed to 3.4 per cent of this figure from energy savings in mandatory quartiles 1, 2 and 4. The approximate average ESC spot price in 2013 was $20, and assuming a supply elasticity[29] of 1, the CBD is estimated to have reduced the spot price and annual scheme cost to participants by $0.69 per ESC and $0.9 million, respectively.

4.9.2 Interaction with the Victorian Energy Efficiency Target

The VEET requires liable entities to purchase Victorian Energy Efficiency certificates (VEECs) which also represent energy savings (measured in terms of tCO_{2e}). Approximately 5.5 million VEECs were registered in 2013 (ESCV, 2013). As VEECs are provided upfront for abatement occurring over a 'deeming' period, the annual energy savings in 2013 would be lower. Assuming a 10 year average deeming period, 5.5 million VEECs would equate to 550 $ktCO_{2e}$ worth of annual energy savings.

Based on the assessment of costs and benefits, the CBD is estimated to have contributed to five per cent of this figure from energy savings in mandatory quartiles 1, 2 and 4. Using the approximate average VEEC spot price of $18.73 during scheme operation, and assuming supply elasticity of one, the CBD is estimated to have reduced the spot price and annual scheme cost to participants by $0.94 per VEEC and $0.5 million, respectively.

4.9.3 Interaction with Carbon Pricing Mechanism

Commercial building energy efficiency projects would have also benefited from the CPM through the direct financial benefit of higher avoided energy costs. However, the level of the carbon price itself would not have been affected by the CBD as the CPM operated as a fixed price mechanism.

[29] That is, assuming that a 1 per cent increase in supply of available abatement led to a 1 per cent reduction in the marginal price

5 Assessment of CBD future costs and benefits

5.1 Methodology

5.1.1 Overview

The NABERS and TLA components of the CBD program have been assessed separately to understand whether each element of the program is projected to individually deliver benefits in excess of costs. The results for each assessment are presented in turn in the following subsection.

Many of the methodological elements used in the assessment of costs and benefits to date (described in Section 4.1) have been retained in the assessment of future costs and benefits. In particular:

- Cost Benefit Analysis (CBA) was the main tool used to perform this assessment.
- The distinction between voluntary and mandatory raters is retained, with future benefits of NABERS disclosure projected to accrue to mandatory raters only.
- The assessment of *incremental* benefits has been projected by considering outcomes of retaining components of the CBD program, compared with counterfactual outcomes (expected outcomes if program components are discontinued).
- The main measure of improvement in base building energy performance is energy intensity (MJ/m^2).
- Analysis of NLPD of a sample of buildings that had undertaken at least two ‘all building’ TLA assessments have been used as the basis for analysing tenancy lighting improvements.

The forward-looking analysis of benefits from continuing the program has been conducted by assuming a program duration of five years and projecting costs and benefits over this time horizon. Possible costs and benefits assuming a 10-year time horizon have been estimated as part of the sensitivity analysis in Section 5.3.2.

5.1.2 Assessment of NABERS component

The likely future benefits of retaining the NABERS component of the CBD program are estimated by considering expected outcomes with the program in place compared to what may occur if the program is discontinued.

The projected outcome if the scheme is retained was modelled by considering the ‘evolution’ of building energy performance during the period the scheme was in operation. This provides an evidentiary basis for the projections as it is based on observed outcomes.

There is less evidence available to project likely outcomes if the scheme is discontinued. The outcomes will depend on the extent to which positive changes triggered by the scheme are retained by the market even if it is discontinued (for example, if the market demands and places a sufficient value on NABERS ratings), and the extent to which the behaviour of building owners and operators will revert to pre-CBD behaviour.

The approaches used to model the projected outcome with the scheme retained, and possible outcomes if the scheme is discontinued, are discussed in turn.

Projected outcome if NABERS component is retained

The benefits of retaining NABERS disclosure are calculated by considering likely differences in the future performance of mandatory raters only, as it is assumed that the behaviour of voluntary raters would be the same irrespective of legislation requiring mandatory disclosure.

Overall, the star rating of mandatory raters improved during the time the CBD was in effect. However, this improvement differed by building. Buildings improved to a greater or lesser extent, while a smaller proportion of buildings were also found to have reported a decrease in star rating.

The transition in the star ratings of mandatory rater floor space (including only buildings with at least two ratings) observed during the operation of the CBD program is shown in Figure 24.

Figure 24 **Transition in star ratings of mandatory rater floor space during CBD**

From/To	0	1	1.5	2	2.5	3	3.5	4	4.5	5.0 - 6.0
0.0	30%	4%	8%	2%	11%	14%	8%	13%	7%	4%
1.0	17%	3%	7%	16%	11%	7%	13%	4%	22%	0%
1.5	11%	5%	10%	9%	11%	11%	35%	0%	2%	5%
2.0	4%	0%	8%	9%	30%	31%	13%	2%	3%	1%
2.5	11%	2%	2%	12%	9%	22%	9%	23%	4%	5%
3.0	0%	4%	9%	4%	4%	18%	13%	25%	20%	3%
3.5	2%	1%	0%	0%	4%	16%	20%	30%	13%	13%
4.0	0%	0%	0%	0%	1%	6%	4%	18%	55%	16%
4.5	0%	0%	0%	0%	0%	0%	1%	14%	44%	41%
5.0 - 6.0	0%	0%	0%	0%	2%	0%	1%	0%	0%	97%

Note: Includes only buildings with at least two star ratings.
Source: ACIL Allen analysis of NABERS data

For example, of all buildings that had a first star rating of 1.5 stars, 35 per cent of these buildings had a final star rating of 3.5.

The observed transition, which occurred over a period of approximately four years, is used to project the future evolution of building star ratings by assuming the same transition occurs every four years. A number of qualifications accompany this approach, including:

- The two key factors that drive a star transition are the cost effective energy efficiency opportunities for a building and the propensity of building owners to capitalise on these opportunities. It is implicitly assumed these continue to drive future improvement.
- The cost effectiveness of energy efficiency improvements will in turn depend on government incentives. In particular, it is assumed that state-based white certificate schemes will remain in place.
- Buildings of the same star rating are not a homogenous group. They vary by size, potential for improvement, climate zone, market demand etc. The above transition attempts to capture this heterogeneity through a distribution of the final states for each starting state.

Possible outcomes if NABERS component is discontinued

Estimating the net benefit of retaining NABERS disclosure requires determining the benefits that would be delivered in the absence of mandatory NABERS disclosure (the counterfactual). However, there is significant uncertainty in projecting the likely outcome if the NABERS component of CBD is discontinued.

The likely outcome will depend on how mandatory raters respond to the ending of NABERS disclosure. The behaviour of mandatory raters in the absence of disclosure cannot be inferred through the NABERS data (as mandatory raters did not obtain NABERS ratings during the period preceding the introduction of CBD). Furthermore, expected behaviour following cessation of the NABERS component may differ from past behaviour before the scheme was introduced, since at least some behaviour change may be ingrained.

Therefore, the assumed behaviour of mandatory raters (the extent to which the rate of improvement during the period of mandatory disclosure is maintained compared with no improvement or stagnation) is a key sensitivity for the estimation of benefits of retaining NABERS disclosure.

ACIL Allen developed assumptions relating to the extent of behaviour retention (shown in Table 15 below). These were tested with stakeholders and it was generally agreed that they were plausible.

Table 15 **Assumed rate of improvement in the absence of NABERS disclosure**

Segment	Rate of improvement in energy intensity during CBD operation[a]	Assumed retention of trend in improvement
Mandatory 1st quartile	1.0%	80%
Mandatory 2nd quartile	5.6%	40%
Mandatory 3rd quartile	8.2%	40%
Mandatory 4th quartile	12.1%	40%

[a] Compound annual rate of improvement (reduction in energy intensity) between 2011 and 2014.
Source: ACIL Allen analysis of NABERS data and ACIL Allen assumptions

Furthermore an overall 'attribution rate' (the percentage of monetised benefits of base building energy performance improvement delivered over the forward projections that may be attributed to retaining NABERS disclosure) is estimated for the above scenario. This is then compared with a 'break-even' attribution rate (the attribution rate required for the policy to be expected to deliver net economic benefits).

5.1.3 Assessment of TLA component

Future improvements in tenancy lighting performance will depend on pay-offs from lighting upgrades and the extent to which the TLA component succeeds in addressing the underlying market failures.

During the period of CBD operation, much of the upgrades in luminaires consisted of switching from T8 fluorescent lighting technology to T5. However, the financial returns from lighting upgrades continue to improve, with LED lighting technology now proving economic for many commercial building applications.[30]

Reduced energy consumption and environmental benefits achievable by the TLA component will depend on the uptake of energy efficiency opportunities made possible by

30 Based on discussions with Paul Suter, NSW Government Property

technological improvements. In turn, uptake will depend on awareness of the benefits of lighting upgrades and the ability of tenants to negotiate upgrades with building owners. Tenancy lighting upgrades are typically only practical to undertake during a change of tenant.

Projected outcome if TLA component is retained

The TLA component aims to address market failures preventing the uptake of cost effective lighting upgrades. In a hypothetical market with no such failures, all cost effective upgrades would be undertaken with new occupancies. For example, where tenants are fully informed of the cost implications of lighting systems, they would be able to negotiate upgrades with building owners and the more efficient lighting would be valued through market rents. Such an outcome can be interpreted as an upper bound on the potential of the TLA.

Our analysis shows that the TLA has yet to fully address the existing market failures and therefore, on current projections, as awareness of TLA grows, an outcome between the observed business-as-usual and the upper bound is expected.

The theoretical upper bound has been estimated by simulating the behaviour of a 'model tenant' (that is, one who is able to utilise TLA information to overcome market failures and negotiate cost effective upgrades). For example, the NSW government aims to achieve and maintain a minimum 4.5 star rating for large owned and leased buildings by June 2017 (NSW OEH, 2014). This goal is pursued by implementing a range of measures, including negotiating improvements to lighting systems on occupying new office space. Discussions with NSW Government Property about this policy were used to develop rules of thumb simulating the behaviour of a 'model tenant':

— areas with an NLPD of less than 12 W/m^2 are generally considered not cost effective to upgrade
— areas with an NLPD of 12 W/m^2 or higher are considered cost effective to upgrade
— upgrades of areas with NLPD of 12 W/m^2 or higher aim to achieve NLPD of less than 6 W/m^2 and are sometimes also accompanied by improvements to control systems.

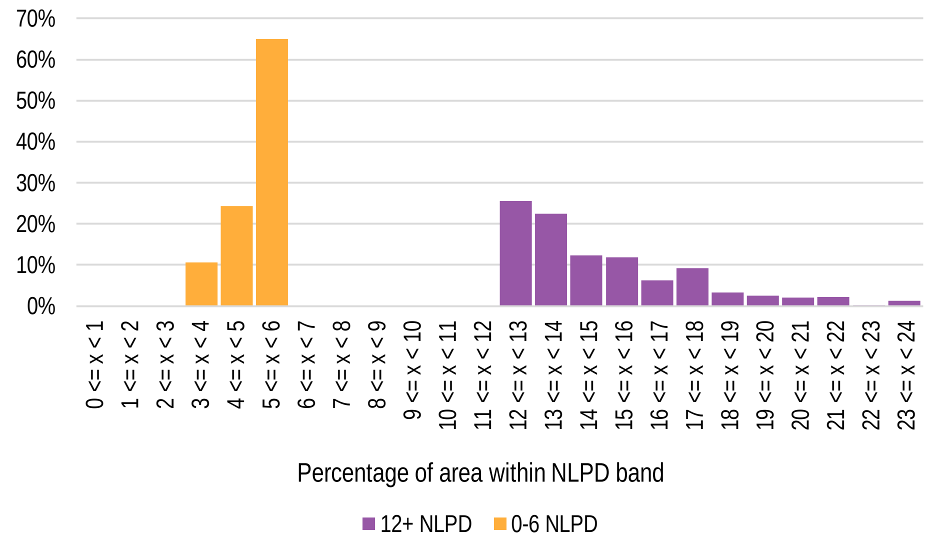
Therefore areas with NLPD of higher than 6 W/m^2 and lower than 12 W/m^2 have a higher power density than what upgrades would aim to achieve, but are not considered cost effective to upgrade.

The distribution[31] of NLPD of sample[32] floor space less than 6 W/m^2 and greater than 12 W/m^2 is shown in Figure 25.

[31] Calculated as the percentage of building floor space where the average NLPD for that building (weighted by TLA rated floor space) in NLPD band.

[32] Using the same sample as used in the assessment of tenancy lighting outcomes to date.

Figure 25 **Distribution of area within NLPD bands**



Source: ACIL Allen analysis of CBD data

The simulation assumes that each time a model tenant occupies a new functional space, the NLPD improves from greater than 12 W/m^2 to 6 W/m^2 or less. Furthermore, the upgraded power density is set within the 3 – 6 W/m^2 range such that if two separate floor spaces are assumed to be upgraded, the floor space which started with the higher NLPD will still have a higher NLPD following the upgrade (that is, preserving the relative ranking of floor space by mapping the distribution of floor space greater than 12 W/m^2 to the distribution of floor space 6 W/m^2 or less).

It is assumed that this transition occurs over 10 years (by 2024),[33] reflecting the approximate average length of commercial building leases, with a constant annual average improvement rate every year.[34]

The economic pay-off achieved through upgrades, taking into account both power density and control system improvements is described in Section A.4.

This upper bound is then adjusted to take into account that there is likely to be a sub-optimal outcome as awareness of TLA, which is likely to increase gradually over time. We assumed that the awareness of TLA increases steadily, with 10 per cent of tenants acting as model tenants in 2015 and 100 per cent by 2024.

Possible outcomes if TLA component is discontinued

The projected improvements to NLPD if the TLA component is discontinued is assumed to be the compound annual rate of the observed improvement in the sample of buildings that had undertaken at least two 'all building' TLA assessments by the third quarter of 2014. This rate is calculated to be 2.6 per cent per year (equivalent to a mean improvement of 0.81 W/m^2 from a base of 10.43 W/m^2 over a period of three years).

33 IPD (2014) notes a weighted average lease expiry (WALE) of 5.0 for their 'Total Office' sample as at December 2013. This suggests an average commercial lease length of 10 years, assuming that the distribution of lease expiries is symmetrical.

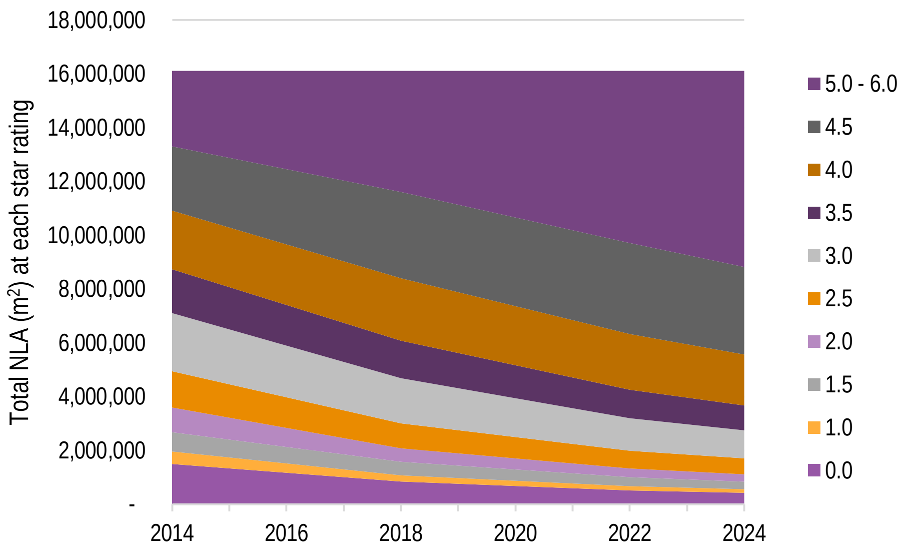
34 Implicitly this assumes that only a portion of the floor space in each NLPD band is upgraded every year, gradually increasing to the point where all floor space within the NLPD band is upgraded by 2024.

5.2 Assessment of future costs and benefits of retaining NABERS component

5.2.1 Projection of total base building energy efficiency benefits

Using the approach described in Section 5.1.2, the projected evolution of star ratings for the approximately 16 million m^2 of estimated mandatory rateable area if the scheme is retained is shown in Figure 26.

Figure 26 **Projected evolution of star ratings**



Source: ACIL Allen analysis of NABERS data

In particular, a substantial proportion (almost half) of building floor space is projected to have an energy performance rating of 5 to 6 stars by 2024.[35]

The projected star improvements are first translated into equivalent MJ/m^2 (estimated by performing regression on NABERS data), then to equivalent tCO_{2e} abated, and finally into the net benefits of energy efficiency expressed in monetary terms.

These projections result in the stream of cost and benefits for the NABERS component of the CBD program shown in Table 16 below.

Table 16 **Projection of total base building energy efficiency benefits (2014 $m)**

Item	2015	2016	2017	2018	2019	Terminal Value	Present Value
Industry burden	-2.8	-2.8	-2.9	-3.0	-3.0	Not applicable	**-12.9**
Net benefits of energy efficiency	2.6	6.7	12.1	18.8	25.2	164.2	**159.9**

Notes: The economic value of GHG reduction is excluded. Benefits accrue over a longer period than costs to reflect project lives of the improvements undertaken between 2015 and 2019. The terminal value is calculated as the present value of 2019 benefits repeated over 9 further years.
Source: ACIL Allen

35 It is expected the star ratings will be extended as the market approaches this point (e.g. introduction of a 7 star rating etc).

The above cost and benefit items result in a Present Value of energy efficiency benefits of $159.9m and a NPV of $147.0m.

Note that this should not be considered as the projected benefit attributed to retaining the NABERS component, as some benefits are expected to occur even if the scheme is discontinued, and these must be subtracted from this 'total benefits estimate'.

The benefits that will accrue even if the CBD program is ended (the counterfactual) are highly uncertain as it will depend on the extent to which behaviour is ingrained and the value of energy efficiency retained in the market through rents.

The following analysis tests whether retaining the program delivers sufficient benefits over and above the counterfactual to justify the program costs:

1. A break-even point was calculated that suggests that at least 11.9 per cent of the total benefits would need to be attributable to the NABERS component of the CBD program for there to be a positive NPV.
2. A possible counterfactual has been constructed and the percentage of benefits attributable to CBD based on this counterfactual has been calculated.
3. This percentage was compared with the required 11.9 per cent of total benefits, to indicate whether the NABERS component is expected to deliver net benefits.
4. Sensitivity/threshold analysis was conducted to test the robustness of results.

5.2.2 Projection of benefits attributable to mandatory disclosure of NABERS

Using the assumptions described in Section 5.1.2, namely an 80 per cent retention of trend observed rate of improvement by the mandatory 1st quartile while CBD was in operation, and a corresponding 40 per cent retention of trend improvement for the remaining quartiles, this would result in net benefits of energy efficiency of $93.7m PV (or 41 per cent of the total $159.9m PV energy efficiency benefits in the total potential benefits estimate).

This 41 per cent exceeds the breakeven point of 11.9 per cent by a large margin. Furthermore, the assumption of an 80 per cent behaviour retention by mandatory 1st quartile and 40 per cent for remaining quartiles is conservative,[36] considering that there is a high degree of risk that more building owners could have lower retention as they revert to pre-CBD behaviour. The resulting present values of costs and benefits are shown in Table 17.

Table 17 **Potential present value of costs and benefits from retaining NABERS component (2014 $m)**

Item	Present Value (2014 $m)
Industry burden	-$12.9
Net benefit of energy efficiency	$66.2
Net Present Value	**$53.3**

Note: The economic value of GHG reduction is excluded. Present value estimates are based on an assumed five-year program duration and estimated between 2015 and 2028.
Source: ACIL Allen

Based on the above analysis, it is expected that the NABERS component of the CBD program will deliver substantial benefits well in excess of costs. This is further tested through sensitivity analysis as described in Section 5.2.4.

[36] In the context of this analysis, an assumed high retention of behaviour in the counterfactual is considered conservative, since it reduces the benefits attributable to the NABERS component. If benefits exceed costs in the conservative case, there will be greater net benefits in the case where lower counterfactual retention is assumed.

5.2.3 Associated GHG reduction and productivity benefits

The above estimates do not include benefits of the value of GHG reduction and increased productivity. Table 18 compares the total benefit estimate with the proportion attributable to retaining NABERS disclosure with respect to economic benefits (excluding GHG reduction and productivity improvements), the quantity of GHG reduced and the estimated value of productivity improvements.

Table 18 **Benefits of retaining NABERS component including GHG reductions and productivity improvements, 2015-2028 (2014 $m)**

Item	Costs and benefits (negative = cost)	Attributable to CBD (negative = cost)
Incremental Industry burden	-$12.9m PV	-$12.9m PV
Net benefit of energy efficiency	$159m PV	$66.2m PV
Net Present Value (excluding GHG benefits and productivity improvements)		**$53.3m PV**
Estimated productivity benefits [a]	$376.7m PV	$155.9m PV
Avoided GHG emissions	4,267 ktCO_2-e	2,504 ktCO_2-e

[a] Approximately 0.7 million office staff are estimated to occupy buildings where the CBD will improve energy efficiency and therefore, productivity.
Source: ACIL Allen

5.2.4 Sensitivity analysis for assessment of NABERS benefits

Sensitivity to assumed retention of post-CBD behaviour

Under base assumptions for the forward-looking counterfactual (with an assumed 80 per cent retention of trend improvement by the mandatory 1st quartile and a corresponding 40 per cent retention of trend improvement for the remaining quartiles), the estimated net benefit from NABERS disclosure is $53.3 million.

There is significant uncertainty relating to the likely continuation of efficiency improvements if the scheme is discontinued. The projected net benefit assuming a range of values for behaviour retention is shown in Table 19.

Table 19 **Sensitivity to assumed retention of post-CBD behaviour**

Mandatory Q1 retention of behaviour	Mandatory Q2 – Q4 retention of behaviour	Break-even attribution point	Estimated attribution	NABERS NPV ($m)
0%	0%	11.9%	100%	$147
10%	5%	11.9%	92%	$135
20%	10%	11.9%	85%	$122
30%	15%	11.9%	77%	$110
40%	20%	11.9%	70%	$99
50%	25%	11.9%	62%	$87
60%	30%	11.9%	55%	$76
70%	35%	11.9%	48%	$64
80%	**40%**	**11.9%**	**41%**	**$53**
90%	45%	11.9%	35%	$42
100%	50%	11.9%	28%	$32

Note: Base assumptions highlighted in **grey**.
Source: ACIL Allen

If it is assumed that base building energy performance of the total mandatory rateable area would completely stagnate if the scheme is discontinued, the NPV of retaining the NABERS component is estimated to be $147m (the 'total benefit' estimate described above).

It is likely that some retention of improvements would occur in the case where the scheme is discontinued, although it is highly unlikely to be more than indicated by the upper end of above range (that is, 100 per cent retention for mandatory 1st quartile and 50 per cent for the remaining mandatory quartiles).

Sensitivity to benefits of energy efficiency and total floor space

As with the backward-looking analysis, the economic pay-off from energy efficiency upgrades and the assumed volume of yet-to-rate floor space are uncertain variables and materially affect the estimate of net benefits.

Therefore sensitivity analysis was again carried out using threshold analysis (see Box 3) to find the boundary conditions for the set of two assumptions for which the policy is expected to be economic.

The base settings for the threshold analysis:

- assume a counterfactual where 80 per cent of trend improvement is retained by the 1st quartile of mandatory raters and a corresponding 40 per cent is retained by 2nd to 4th quartile of mandatory raters
- exclude any economic value for GHG reductions
- exclude any consideration of potential productivity benefits.

These base settings are fixed for all sensitivities, whereas:

- the net benefit of energy efficiency is varied between one per cent and 100 per cent of the base assumption[37]
- the assumed proportion of total rateable mandatory floor space that is floor space yet to have triggered disclosure is varied from 0 per cent (that is, including only the mandatory segment already rated) to 90 per cent (that is, the total rateable mandatory floor space is 1 ÷ [100% – 90%] or 10 times the already rated mandatory segment).

The results of this threshold analysis are shown in Figure 27. The results are interpreted as follows:

- The NABERS component of the CBD program is projected to deliver benefits even if the net benefits of energy efficiency are 41 per cent of the base assumption and the outstanding floor space yet to rate is excluded.
- If the assumed proportion of total rateable mandatory floor space that is floor space yet to have triggered disclosure is 50 per cent, the NABERS component of the CBD program is projected to deliver benefits so long as net benefits of energy efficiency are at least 21 per cent of the base assumption.

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[37] The base assumption is that improvements deliver an average economic benefit of $35 per tCO_{2e} abated in 2010 increasing to $117 per tCO_{2e} in 2024. Assuming the net benefit is 50 per cent of the base assumptions results in assumption that of $18 per tCO_{2e} in 2010 increasing to $59 per tCO_{2e} in 2020.

Figure 27 **Threshold analysis for benefit of continuing NABERS component ($m NPV)**

Net benefits of energy efficiency scaled by	Yet to rate floor space as proportion of total									
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
1%	-$13	-$13	-$12	-$12	-$12	-$12	-$12	-$12	-$11	-$10
3%	-$12	-$12	-$12	-$11	-$11	-$11	-$10	-$10	-$8	-$3
5%	-$11	-$11	-$11	-$11	-$10	-$10	-$9	-$7	-$5	$4
7%	-$11	-$10	-$10	-$10	-$9	-$8	-$7	-$5	-$1	$10
9%	-$10	-$10	-$9	-$9	-$8	-$7	-$5	-$3	$2	$17
11%	-$9	-$9	-$8	-$8	-$7	-$6	-$4	-$1	$5	$24
13%	-$9	-$8	-$8	-$7	-$6	-$4	-$2	$1	$9	$30
15%	-$8	-$7	-$7	-$6	-$5	-$3	-$0	$4	$12	$37
17%	-$7	-$7	-$6	-$5	-$4	-$2	$1	$6	$15	$43
19%	-$7	-$6	-$5	-$4	-$2	-$0	$3	$8	$19	$50
21%	-$6	-$5	-$4	-$3	-$1	$1	$4	$10	$22	$57
23%	-$5	-$4	-$3	-$2	-$0	$2	$6	$12	$25	$63
25%	-$5	-$4	-$3	-$1	$1	$4	$8	$15	$28	$70
27%	-$4	-$3	-$2	-$0	$2	$5	$9	$17	$32	$76
29%	-$3	-$2	-$1	$1	$3	$6	$11	$19	$35	$83
31%	-$3	-$1	-$0	$2	$4	$7	$13	$21	$38	$90
33%	-$2	-$1	$1	$3	$5	$9	$14	$24	$42	$96
35%	-$1	-$0	$2	$4	$6	$10	$16	$26	$45	$103
37%	-$1	$1	$2	$5	$8	$11	$18	$28	$48	$110
39%	$0	$1	$3	$6	$9	$13	$19	$30	$52	$116
41%	$1	$2	$4	$7	$10	$14	$21	$32	$55	$123
43%	$1	$3	$5	$7	$11	$15	$23	$35	$58	$129
45%	$2	$4	$6	$8	$12	$17	$24	$37	$62	$136
47%	$3	$4	$7	$9	$13	$18	$26	$39	$65	$143
49%	$3	$5	$7	$10	$14	$19	$28	$41	$68	$149
51%	$4	$6	$8	$11	$15	$21	$29	$43	$71	$156
53%	$5	$7	$9	$12	$16	$22	$31	$46	$75	$162
55%	$5	$7	$10	$13	$17	$23	$33	$48	$78	$169
57%	$6	$8	$11	$14	$19	$25	$34	$50	$81	$176
59%	$7	$9	$12	$15	$20	$26	$36	$52	$85	$182
61%	$7	$10	$12	$16	$21	$27	$38	$54	$88	$189
63%	$8	$10	$13	$17	$22	$28	$39	$57	$91	$196
65%	$9	$11	$14	$18	$23	$30	$41	$59	$95	$202
67%	$9	$12	$15	$19	$24	$31	$43	$61	$98	$209
69%	$10	$12	$16	$20	$25	$32	$44	$63	$101	$215
71%	$11	$13	$16	$21	$26	$34	$46	$65	$105	$222
73%	$11	$14	$17	$22	$27	$35	$48	$68	$108	$229
75%	$12	$15	$18	$23	$28	$36	$49	$70	$111	$235
77%	$13	$15	$19	$24	$30	$38	$51	$72	$114	$242
79%	$13	$16	$20	$24	$31	$39	$52	$74	$118	$248
81%	$14	$17	$21	$25	$32	$40	$54	$76	$121	$255
83%	$15	$18	$21	$26	$33	$42	$56	$79	$124	$262
85%	$15	$18	$22	$27	$34	$43	$57	$81	$128	$268
87%	$16	$19	$23	$28	$35	$44	$59	$83	$131	$275
89%	$17	$20	$24	$29	$36	$46	$61	$85	$134	$282
91%	$17	$21	$25	$30	$37	$47	$62	$87	$138	$288
93%	$18	$21	$26	$31	$38	$48	$64	$90	$141	$295
95%	$19	$22	$26	$32	$40	$49	$66	$92	$144	$301
97%	$19	$23	$27	$33	$41	$51	$67	$94	$148	$308
99%	$20	$24	$28	$34	$42	$52	$69	$96	$151	$315
100%	$20	$24	$28	$34	$42	$53	$70	$97	$153	$318

Note: Red shading with grey text indicates a negative NPV, blue shading with black text indicates a positive NPV and brighter shading indicates relatively higher magnitude of NPV. Red circle ($53m) indicates the combination of parameter values used in the central analysis.

Source: ACIL Allen

5.3 Assessment of future costs and benefits of retaining TLA component

5.3.1 Projection of benefits from TLA component

The benefits of the TLA program have been estimated by using the approach outlined in Section 5.1.3. The projected improvements to average power density (and the pay-off through associated upgrades delivering improvements in both power density and control systems) was first estimated under a hypothetical scenario where all tenants were 'model tenants'. The projected pay-off from assuming a gradual increase in awareness is then calculated as a growing proportion of those benefits delivered over time, as shown in Table 20.

Table 20 **Costs and benefits of retaining TLA, 2015-2028 (2014 $m)**

Item	All model tenants (Hypothetical scenario)	Gradual increase in awareness
TLA industry burden	-$8.4m PV	-$8.4m PV
TLA benefits of energy efficiency	$16.6m PV	$4.5m PV
Net Present Value (excluding GHG benefits)	**$8.2m NPV**	**-$3.9m NPV**
Reduced end use energy consumption	1,472 GWh	679 GWh
Avoided GHG emissions	1,327 ktCO_2-e	612 ktCO_2-e
NPV including GHG benefits at $23/t$CO_2$-e	**$28.5m NPV**	**$6.9m NPV**

Note: Present value estimates are based on an assumed 5 year program duration and estimated between 2015 and 2028.
Source: ACIL Allen

In the absence of changes to the TLA (that is, with a 'gradual increase in awareness') and excluding an assumed economic value for reduction in GHGs, the TLA component of the scheme is projected to incur a net cost of $3.9 million. This is equivalent to a $9.25 / t$CO_2$-e abatement cost. There is significant uncertainty surrounding the economic price signal on carbon going forward (which will depend on outcomes from the government's Direct Action Policy). However, assuming a value consistent with the backwards looking analysis of $23 / t$CO_2$-e, the projected NPV of the TLA component of the scheme increases to $6.9 million.

Therefore, with no changes, whether the scheme's NPV is positive is projected to depend on the assumed value of GHG reductions. However, changes to the TLA scheme to reduce costs and increase awareness are likely to improve its projected performance. These recommendations are discussed in Section 6.4.

5.3.2 Sensitivity analysis for assessment of TLA benefits

Similar to the analysis of NABERS, the projected benefit of TLA depends primarily on assumed values for the economic benefit from upgrades and the potential volume of upgraders (in turn dependent on floor space yet to trigger disclosure). These two assumptions are varied in the same way using a sensitivity/threshold analysis.

This sensitivity analysis is conducted by first simulating upgrades assuming all 'model tenants' and then assuming a more plausible, gradual increase in awareness.

Sensitivity to rateable area and upgrade benefits assuming all model tenants

This base settings for the threshold analysis:

- Assume that tenants exploit the full potential of lighting upgrades when occupying a new space over a period of 10 years to 2024 (that is, assuming they are all model tenants)
- Assume a counterfactual NLPD improvement at 2.6 per cent per year
- exclude any economic value for GHG reductions.

These base settings remain fixed throughout this sensitivity test. The following assumptions are varied to determine the sensitivity of the outcomes to that variable:

- The net benefit of lighting upgrades is varied between one per cent and 100 per cent of the base assumption (refer to Section A.4), for the approach used to estimate pay-off from lighting upgrades).
- The assumed proportion of total rateable mandatory floor space that is floor space yet to have triggered disclosure is varied from zero per cent (that is, assuming inclusion of only the mandatory segment already rated) to 90 per cent (that is, the total rateable mandatory floor space is 1 ÷ [100% – 90%] or 10 times the already rated mandatory segment).

The results of this threshold analysis are shown in Figure 28. The results show that if awareness could be improved to the extent where all tenants are able to fully capitalise on and negotiate lighting upgrades, the TLA component would deliver projected net benefits even if:

- economic benefits from upgrades are assumed to be 79 per cent of the base assumption and any outstanding floor space yet to rate is excluded
- the assumed proportion of total rateable mandatory floor space that is floor space yet to have triggered disclosure is 50 per cent and economic benefits from upgrades are at least 55 per cent of the base assumption.

Figure 28 **Threshold analysis for benefit of continuing TLA component assuming all model tenants ($m NPV)**

Yet to rate floor space as proportion of total (columns); Net benefits of lighting upgrades scaled by (rows)

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
1%	-$8	-$8	-$8	-$8	-$8	-$8	-$8	-$8	-$8	-$8
3%	-$8	-$8	-$8	-$8	-$8	-$8	-$8	-$8	-$7	-$7
5%	-$8	-$8	-$8	-$8	-$8	-$8	-$7	-$7	-$7	-$6
7%	-$8	-$8	-$8	-$7	-$7	-$7	-$7	-$7	-$6	-$4
9%	-$7	-$7	-$7	-$7	-$7	-$7	-$7	-$6	-$6	-$3
11%	-$7	-$7	-$7	-$7	-$7	-$7	-$6	-$6	-$5	-$2
13%	-$7	-$7	-$7	-$7	-$7	-$6	-$6	-$5	-$4	-$1
15%	-$7	-$7	-$7	-$6	-$6	-$6	-$6	-$5	-$4	$0
17%	-$6	-$6	-$6	-$6	-$6	-$6	-$5	-$4	-$3	$1
19%	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$2	$3
21%	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$4	-$2	$4
23%	-$6	-$6	-$6	-$5	-$5	-$5	-$4	-$3	-$1	$5
25%	-$6	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$0	$6
27%	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$2	$0	$7
29%	-$5	-$5	-$5	-$4	-$4	-$4	-$3	-$2	$1	$8
31%	-$5	-$5	-$4	-$4	-$4	-$3	-$2	-$1	$2	$10
33%	-$5	-$4	-$4	-$4	-$4	-$3	-$2	-$1	$2	$11
35%	-$4	-$4	-$4	-$4	-$3	-$3	-$2	-$0	$3	$12
37%	-$4	-$4	-$4	-$3	-$3	-$2	-$1	$0	$3	$13
39%	-$4	-$4	-$3	-$3	-$3	-$2	-$1	$1	$4	$14
41%	-$4	-$4	-$3	-$3	-$2	-$2	-$1	$1	$5	$15
43%	-$4	-$3	-$3	-$3	-$2	-$1	-$0	$2	$5	$16
45%	-$3	-$3	-$3	-$2	-$2	-$1	$0	$2	$6	$18
47%	-$3	-$3	-$2	-$2	-$1	-$1	$1	$3	$7	$19
49%	-$3	-$3	-$2	-$2	-$1	-$0	$1	$3	$7	$20
51%	-$3	-$2	-$2	-$1	-$1	-$0	$1	$4	$8	$21
53%	-$2	-$2	-$2	-$1	-$1	$0	$2	$4	$9	$22
55%	-$2	-$2	-$1	-$1	-$0	$1	$2	$4	$9	$23
57%	-$2	-$2	-$1	-$1	$0	$1	$2	$5	$10	$25
59%	-$2	-$1	-$1	-$0	$0	$1	$3	$5	$10	$26
61%	-$1	-$1	-$1	-$0	$1	$2	$3	$6	$11	$27
63%	-$1	-$1	-$0	$0	$1	$2	$4	$6	$12	$28
65%	-$1	-$1	-$0	$0	$1	$2	$4	$7	$12	$29
67%	-$1	-$0	$0	$1	$2	$3	$4	$7	$13	$30
69%	-$1	-$0	$0	$1	$2	$3	$5	$8	$14	$32
71%	-$0	$0	$1	$1	$2	$3	$5	$8	$14	$33
73%	-$0	$0	$1	$2	$2	$4	$6	$9	$15	$34
75%	$0	$1	$1	$2	$3	$4	$6	$9	$16	$35
77%	$0	$1	$1	$2	$3	$4	$6	$10	$16	$36
79%	$1	$1	$2	$2	$3	$5	$7	$10	$17	$37
81%	$1	$1	$2	$3	$4	$5	$7	$11	$18	$38
83%	$1	$2	$2	$3	$4	$5	$7	$11	$18	$40
85%	$1	$2	$2	$3	$4	$6	$8	$12	$19	$41
87%	$1	$2	$3	$3	$4	$6	$8	$12	$19	$42
89%	$2	$2	$3	$4	$5	$6	$9	$12	$20	$43
91%	$2	$2	$3	$4	$5	$7	$9	$13	$21	$44
93%	$2	$3	$3	$4	$5	$7	$9	$13	$21	$45
95%	$2	$3	$4	$5	$6	$7	$10	$14	$22	$47
97%	$3	$3	$4	$5	$6	$8	$10	$14	$23	$48
99%	$3	$3	$4	$5	$6	$8	$11	$15	$23	$49
100%	$3	$4	$4	$5	$6	$8	$11	$15	$24	$49

Note: Red shading with grey text indicates a negative NPV, blue shading with black text indicates a positive NPV and brighter shading indicates relatively higher magnitude of NPV. Red circle ($8m) indicates the combination of parameter values used in the central analysis.

Source: ACIL Allen

Sensitivity to rateable area and upgrade benefits assuming gradual increase in awareness

Repeating the threshold analysis based on:

- the awareness of TLA increasing gradually, with 10 per cent of tenants acting as model tenants in 2015 and that proportion increasing steadily to 100 per cent by 2024
- a counterfactual NLPD improvement at 2.6 per cent per year
- excluding any economic value for GHG reductions.

These base settings remain fixed throughout this sensitivity test. The following assumptions are varied to determine the sensitivity of the outcomes to that variable:

- The net benefit of lighting upgrades is varied between one per cent and 100 per cent of the base assumption (refer to Section A.4 for the approach used to estimate pay-off from lighting upgrades).
- The assumed proportion of total rateable mandatory floor space that is floor space yet to have triggered disclosure is varied from zero per cent (that is, assuming including only the mandatory segment already rated) to 90 per cent (that is, the total rateable mandatory floor space is 1 ÷ [100% – 90%] or 10 times the already rated mandatory segment).

The results of this threshold analysis are shown in Figure 29. The results show that:

- Under the base assumption for economic benefits from upgrades, the volume of total floor space would need to be such that an assumed 90 per cent of total rateable mandatory floor space is floor space yet to have triggered disclosure.
- If the assumed proportion of total rateable mandatory floor space that is floor space yet to have triggered disclosure is 50 per cent, then the TLA component does not deliver economic benefits, despite scaling assumed benefits to 156 per cent of the base assumption.

While the amount of total rateable building stock is unknown, evidence reviews suggest that the outstanding rateable floor space is likely to be around 50 per cent of the total mandatory rateable floor space and highly unlikely to be as high as 90 per cent. Based on the estimates of costs and pay-offs from lighting upgrades, the net benefit of upgrades is unlikely to be higher than 50 per cent of what is assumed.

This reinforces the conclusion that in the absence of improvements to scheme awareness, scheme cost or an assumed economic value for GHG reductions, the TLA component of the scheme is not expected to deliver net benefits.

Figure 29 **Threshold analysis for benefit of continuing TLA component assuming gradual increase in awareness ($m NPV)**

Net benefits of lighting upgrades scaled by	Yet to rate floor space as proportion of total									
	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%
57%	-$7	-$7	-$6	-$6	-$6	-$6	-$5	-$5	-$3	$1
59%	-$7	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$3	$1
61%	-$7	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$3	$1
63%	-$6	-$6	-$6	-$6	-$6	-$6	-$5	-$4	-$3	$2
65%	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$3	$2
67%	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$3	$2
69%	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$2	$3
71%	-$6	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$2	$3
73%	-$6	-$6	-$6	-$6	-$5	-$5	-$5	-$4	-$2	$3
75%	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$4	-$2	$3
77%	-$6	-$6	-$6	-$6	-$5	-$5	-$4	-$3	-$2	$4
79%	-$6	-$6	-$6	-$5	-$5	-$5	-$4	-$3	-$1	$4
81%	-$6	-$6	-$6	-$5	-$5	-$5	-$4	-$3	-$1	$4
83%	-$6	-$6	-$6	-$5	-$5	-$5	-$4	-$3	-$1	$5
85%	-$6	-$6	-$5	-$5	-$5	-$5	-$4	-$3	-$1	$5
87%	-$6	-$6	-$5	-$5	-$5	-$4	-$4	-$3	-$1	$5
89%	-$6	-$6	-$5	-$5	-$5	-$4	-$4	-$3	-$1	$6
91%	-$6	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$0	$6
93%	-$6	-$5	-$5	-$5	-$5	-$4	-$4	-$2	-$0	$6
95%	-$5	-$5	-$5	-$5	-$5	-$4	-$3	-$2	-$0	$7
97%	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$2	$0	$7
99%	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$2	$0	$7
100%	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$2	$0	$7
102%	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$2	$1	$8
104%	-$5	-$5	-$5	-$5	-$4	-$4	-$3	-$2	$1	$8
106%	-$5	-$5	-$5	-$4	-$4	-$4	-$3	-$2	$1	$8
108%	-$5	-$5	-$5	-$4	-$4	-$4	-$3	-$1	$1	$9
110%	-$5	-$5	-$5	-$4	-$4	-$3	-$3	-$1	$1	$9
112%	-$5	-$5	-$5	-$4	-$4	-$3	-$3	-$1	$1	$9
114%	-$5	-$5	-$4	-$4	-$4	-$3	-$2	-$1	$2	$10
116%	-$5	-$5	-$4	-$4	-$4	-$3	-$2	-$1	$2	$10
118%	-$5	-$5	-$4	-$4	-$4	-$3	-$2	-$1	$2	$10
120%	-$5	-$4	-$4	-$4	-$4	-$3	-$2	-$1	$2	$11
122%	-$5	-$4	-$4	-$4	-$3	-$3	-$2	-$1	$2	$11
124%	-$5	-$4	-$4	-$4	-$3	-$3	-$2	-$0	$2	$11
126%	-$4	-$4	-$4	-$4	-$3	-$3	-$2	-$0	$3	$12
128%	-$4	-$4	-$4	-$4	-$3	-$3	-$2	-$0	$3	$12
130%	-$4	-$4	-$4	-$4	-$3	-$3	-$2	-$0	$3	$12
132%	-$4	-$4	-$4	-$4	-$3	-$2	-$1	$0	$3	$13
134%	-$4	-$4	-$4	-$3	-$3	-$2	-$1	$0	$3	$13
136%	-$4	-$4	-$4	-$3	-$3	-$2	-$1	$0	$4	$13
138%	-$4	-$4	-$4	-$3	-$3	-$2	-$1	$0	$4	$13
140%	-$4	-$4	-$4	-$3	-$3	-$2	-$1	$1	$4	$14
142%	-$4	-$4	-$3	-$3	-$3	-$2	-$1	$1	$4	$14
144%	-$4	-$4	-$3	-$3	-$3	-$2	-$1	$1	$4	$14
146%	-$4	-$4	-$3	-$3	-$2	-$2	-$1	$1	$4	$15
148%	-$4	-$4	-$3	-$3	-$2	-$2	-$1	$1	$5	$15
150%	-$4	-$4	-$3	-$3	-$2	-$2	-$1	$1	$5	$15
152%	-$4	-$3	-$3	-$3	-$2	-$2	-$0	$1	$5	$16
154%	-$4	-$3	-$3	-$3	-$2	-$1	-$0	$1	$5	$16
156%	-$4	-$3	-$3	-$3	-$2	-$1	-$0	$2	$5	$16

Note: Red shading with grey text indicates a negative NPV, blue shading with black text indicates a positive NPV and brighter shading indicates relatively higher magnitude of NPV. Red circle (-$4m) indicates the combination of parameter values used in the central analysis.

Source: ACIL Allen

5.4 Combined assessment of NABERS and TLA

The above analysis of benefits from continuing the program assumed that the program continues for a further five years and projects the costs and benefits over this time horizon.

Table 21 below provides the combined projected benefits of both the NABERS and TLA components. The results assuming a 10 year extension of the CD program are also shown.

Table 21 **Costs and benefits of continuing the CBD program over 5 and 10 years (2014 $m)**

Item	5 years ($m PV)	10 years
NABERS industry burden	-$12.9	-$23.1
Net benefits of energy reduction	$66.2	$143.3
NABERS NPV	**$53.3**	**$120.1**
TLA industry burden	-$8.4	-$15.1
TLA benefits from upgrades	$4.5	$47.9
TLA NPV	**-$3.9**	**$32.8**
Program costs	-$6.2	-$10.5
Combined NPV	**$43.3**	**$142.3**

Note: NPVs exclude productivity benefits and GHG benefits. Present value estimates based on a 5-year program duration are estimated between 2015 and 2024 and present value estimates based on a 10-year program duration are estimated between 2015 and 2028.
Source: ACIL Allen

The uncertainty in estimates of costs and benefits increases significantly for years further into the future; thus, there is a lower level of confidence for estimates of benefits over a 10-year program duration.

The distributional impacts of continuing the CBD are expected to be similar to the estimated distributional impacts of the program to date (refer to Section 4.7).

5.5 Assessment of potential interactions with Emissions Reduction Fund

The ERF will purchase emissions reduction credits through a $2.5 billion fund and a pay-as-bid ‘reverse auction’ process, with some design elements yet to be confirmed. The reverse auction will function under a ‘benchmark price’ (the maximum price that will be paid to auction bidders to undertake abatement). The Clean Energy Regulator (CER) will not publish the benchmark price, except for the first auction, where the CER may at its discretion publish the benchmark price to increase participation in the absence of any other price information. The CER will publish the weighted average price paid across successful bids following each auction. The CER will also publish annual reports on the total amount of abatement in successful bids, total funding allocated, the number of units purchased and expenditure on those units.

A ‘safeguard mechanism’ to penalise emissions increasing from business as usual is being considered. The safeguard mechanism will commence on 1 July 2016 following consultation with business. Consultation will focus on the treatment of new investments and flexible compliance arrangements.

The commercial buildings sector will be able to participate in the ERF using a number of different methods, including a commercial buildings method that employs NABERS tools to calculate abatement. The likely level of participation by the sector is uncertain, with auction prices and the feasibility of aggregating smaller projects into single bids identified by stakeholders as key factors that could influence uptake.

The Commercial Building methodology requires a minimum abatement per building equivalent to a one star NABERS rating improvement. Other methodologies are being developed (such as the Commercial and public lighting methodology) that could also apply to specific types of commercial building energy efficiency projects. A minimum bid size for participation in the auction is 2,000 tCO_2-e[38] and this may only be achievable through projects aggregated over 4 – 5 larger buildings.

Projects are only eligible to receive ERF funding so long as they are not utilising other sources of government funding judged to provide sufficient incentive for emissions reduction activities in the absence of the ERF. This would disqualify projects already benefitting from the NSW and Victorian white certificate schemes.

Regardless of the level of participation in the ERF, the CBD program is expected to be complementary to the ERF, rather than duplicative. This is mainly because the purpose of ERF is to provide funding for emissions reduction projects, whereas the focus of the CBD is to provide information to potential tenants and buyers.

[38] This minimum of 2,000 tCO_2-e applies to bids rather than individual projects. That is, projects that deliver less than 2,000 tCO_2-e would need to be aggregated with other projects (which could include projects under different methods) for a combined bid of greater than 2,000 tCO_2-e.

6 Assessment of potential changes to the CBD program

6.1 Extension of the program to smaller office spaces

6.1.1 Rationale for extending program to smaller office spaces

Analysis conducted by the City of Sydney shows that there is likely to be significant potential for energy efficiency improvement in small buildings. Relative to larger buildings, small buildings have a greater percentage of private ownership. Anecdotal evidence suggests that private owners are less active managers of property and have less sophistication and knowledge with regard to energy efficiency. Therefore, the market failures of information adequacy and split incentives are more acute in this sector.

Mandatory disclosure could be extended to cover small buildings by reducing the NLA threshold for disclosure from 2,000 m^2 to 1,000 m^2. Such a change would result in both benefits and costs. The requirement to disclose is likely to increase information and awareness of energy efficiency opportunities for both building owners and tenants. However, the costs associated with disclosure may be relatively higher (e.g. on a per m^2 basis) for smaller buildings.

The following sub-sections discuss the likely effects of lowering the threshold for disclosure and provide an indicative assessment of the costs and benefits.

6.1.2 Effect of lowering disclosure threshold

Lowering the threshold for disclosure (currently 2,000 m^2) would result in a greater number of buildings covered by CBD and also bring forward disclosure for other buildings. The reason for these two effects is explained below.

Increase in number of buildings and total floor space covered by the scheme

Buildings with an NLA between 1,000 m^2 and 2,000 m^2 are not currently required to disclose energy performance upon a sale or lease event. Lowering the threshold for disclosure to 1,000 m^2 will mean that these buildings will trigger disclosure obligations in the event that the building is sold or floor space in the building of more than 1,000 m^2 is leased.

Bringing forward of disclosure for some buildings

Under the current disclosure threshold, buildings greater than 2,000 m^2 will only need to disclose once the building is sold or once floor space in the building of more than 2,000 m^2 is leased (and not before). If a floor space of less than 2,000 m^2 is leased, disclosure is not yet required.

If the threshold for disclosure is lowered to 1,000 m^2 then it is more likely that a lease event will trigger mandatory disclosure. Therefore, all else equal, if the threshold is lowered, some buildings are likely to disclose earlier than they would otherwise.

6.1.3 Estimate of costs and benefits of lowering disclosure threshold

An indicative estimate of the net benefit of lowering the disclosure threshold was calculated by first estimating the unit benefits ($ per m^2 of additional floor space covered by mandatory disclosure) and unit costs (also $ per m^2), and then applying the unit net benefits to the additional volume (m^2) of floor space covered by lowering the threshold.

Estimated unit benefits were derived from estimated net energy efficiency benefits for the mandatory 4th quartile. This segment was used as a proxy for small buildings given the reportedly large potential for improving energy efficiency of small buildings. The unit benefits (calculated as the total Present Value of benefits divided by total floor space) was estimated to be $24.01 per m^2 (excluding productivity benefits or an economic value for GHG benefits).

Unit costs were calculated, based on estimated assessment costs and assessment frequency (refer to Section A.2.2), to be $5.14 per m^2 in present value terms.

Conservative estimates of small building floor space[39] suggest that approximately 1.5 million m^2 of additional floor space would be captured by the CBD program if the threshold was lowered to 1,000 m^2. The volume of floor space between 1,000 and 2,000 m^2 that was found to be voluntarily rating as at 25 October 2014 was 0.23 million m^2 (estimated based on analysis of NABERS data). This was subtracted to arrive at an estimate of the additional 'mandatory' floor space that would be covered by the CBD scheme of 1.27 million m^2.

Lowering the disclosure threshold is projected to reduce energy consumption by a cumulative 3,684 TJ and GHG emissions by 707 ktCO_2-e. The indicative projected net benefits of lowering the disclosure threshold is therefore estimated at $24 million in present value terms under a seven per cent real discount rate[40], excluding the value of GHG emissions reduction, or $35 million in present value terms under a seven per cent real discount rate if GHG emissions reductions are valued at $23 per t$CO_2$-e. Lowering the threshold is therefore expected to deliver substantial net economic benefits.

6.1.4 Stakeholder support for lowering the disclosure threshold

In submissions to the CBD Review, the City of Sydney and the Facility Management Association of Australia (FMA Australia) expressed support for lowering the threshold for mandatory disclosure from 2,000 m^2 to 1,000 m^2 as they believe that there is significant scope for energy efficiency improvements in buildings of this size.

(FMA Australia represents professionals involved in the strategic and operational management of facilities for both public and private sector organisations throughout Australia, as well as professionals who support the industry through the provision of products and services.)

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39 Based on analysis of Property Council of Australia and RP Data stock estimates.

40 The estimated net benefits exclude productivity benefits or an assumed economic value of GHG reductions. There may be some incremental administrative costs to government but these have not been estimated.

6.2 Extension of the program to other building types

6.2.1 Extension to data centres

NABERS has developed three metrics or tools for NABERS Data Centres, which cover centre infrastructure, the IT equipment and the whole data centre (and are termed 'infrastructure rating', 'IT equipment rating' and 'whole facility rating', respectively).

Mandatory disclosure, if extended to data centres, would apply only to the NABERS infrastructure rating (over a threshold in size) because it involves equipment with similar functions to other buildings, such as cooling systems.

The NABERS infrastructure rating for data centres is an operational metric that takes into account how well a data centre is run in comparison with benchmarks. It has an established process for developing rules and alternative measurement methods, which is important because every data centre tends to be unique and they often have unexpected measurement issues. The rating uses the mature and well-established Power Usage Effectiveness (PUE) metric[41] with detailed guidance on measurement.

A consideration is that the PUE is most relevant for co-located data centres and clients, which represent only 21 per cent of the data centre market. Another issue identified in the 2014 report *Energy Efficiency Policy Options for Australian and New Zealand Data Centres* prepared by Consumer Research Associates for the Department, is the potential preference in some areas for more in-depth advisory audits, such as CEEDA[42]. In addition, LEED,[43] and to a lesser extent BREEAM,[44] are international certification schemes that might appeal to global organisations due to their international marketing and reputational value.

According to the Consumer Research Associates report, experience with the EU Code of Conduct shows electricity consumption can be very commercially sensitive, particularly for cloud providers, since it provides in-depth information about business profitability and competitiveness. Total processing and storage capacity is likely to be even more commercially sensitive. Some data centres might thus be unwilling to allow third parties to access energy consumption data and could result in resistance to any mandatory measures.

Because of the relative newness of the NABERS data centre rating tool (which means that it has not yet been widely embraced by industry) and the issues raised above, ACIL Allen advises caution against the immediate extension of the CBD program to data centres in Australia. Instead, a more detailed study should be undertaken to better understand how the concerns highlighted above can be successfully addressed and to determine the optimal timing of extending mandatory disclosure to the data centre sector.

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41 PUE is a measure of how efficiently a data centre uses energy; specifically, how much energy is used by the computing equipment in contrast to cooling and other overheads. It is calculated by dividing total facility energy consumption by IT equipment energy consumption, with a lower PUE indicating higher energy efficiency.

42 Certified Energy Efficient Datacenter Award (CEEDA) is certification scheme delivered worldwide by Datacentre Dynamics Ltd that focuses heavily on the operational energy efficiency of data centres.

43 Leadership in Energy & Environmental Design (LEED) is an internationally recognised green building certification system used mainly in the United States and Canada. Third-party certification is possible against the standard, which is aimed at addressing energy use, water use, greenhouse gas emissions, indoor environmental quality and resource stewardship. LEED can be used through the building life-cycle, during design, operation and retrofit. The US Green Building Council runs the program, which covers both residential and commercial buildings.

44 BRE Environmental Assessment Method (BREEAM) is a similar system that was established by BRE, a building research organisation funded mainly by the UK government.

6.2.2 Extension to retail buildings

The retail sector in Australia is highly diverse in terms of its activities, energy intensity and scale of different facility types. Comparable types of retail facilities that lend themselves more easily to energy efficiency ratings tend to be large shopping centres, supermarkets, department stores and other "big box" retail sites. However, these facilities are likely to consume less than half of the total retail sector energy, with some fraction of this capable of being rated using benchmarking tools such as NABERS Retail or other NABERS tools under development.

An internal analysis by the Department using Property Council of Australia (PCA) data indicated that there were just under 300 NABERS rateable shopping centres at the time of analysis, with a total of 10.9 million square metres of Gross Lettable Area Retail (GLAR). This constituted 18.7 per cent of all shopping centres and 57.5 per cent of total shopping centre area (and 16.4 per cent of all retail area encompassing shopping centres, supermarkets and retail strips).

The Department's internal analysis indicated that just under 50 shopping centres had a current NABERS rating, constituting approximately 15 per cent of the total rateable market. It noted that some industry players (such as GPT) have moved strongly towards sustainability, while others had not.

According to CBBS, shopping centre base building energy use was 7.9PJ per annum, while tenancy energy use was 23.6PJ per annum. The average energy intensity of shopping centres was 400MJ/m^2 and energy use was expected to grow by 26.5 per cent between 2012 and 2020.

Approximately 40 per cent of shopping centres were covered by the now defunct EEO program through their operators (AMP, Centro, Dexus, GPT, Mirvac, Stockland and Westfield), while state site-based EEO programs covered a few of the largest shopping centres in each state.

According to ClimateWorks, there are substantial cost-effective abatement opportunities available in the retail sector. Data analysis undertaken for the *Tax Breaks for Green Buildings* (TBGB) initiative indicated that a one-star jump above three stars is likely to cost \$79/m^2 in centrally serviced areas.

ACIL Allen does not recommend that mandatory disclosure be extended to shopping centres or other retail buildings for the following reasons:

— The information asymmetry problem is not judged to be acute, as shopping centres are already currently required by state legislation to disclose (base building) energy costs to prospective tenants.

— While the split incentive problem exists (with building owners controlling capital expenditure and tenants generally paying for base building energy, and the law prohibiting the recovery of capital costs from tenants), information on the energy efficiency performance of a shopping centre, made available through mandatory disclosure, is unlikely to exert much influence on the decision-making of prospective tenants.

— In addition to the imbalance in the bargaining power of shopping centre owners/operators and prospective tenants, other factors, such as site size and configuration, location (of the shopping centre and the site under consideration within the shopping centre) as well as rental price and conditions, are likely to matter far more to them as these are the key determinants of a tenant's profitability.

- The total amount of energy use covered by rating tools is unlikely to cover more than 50 per cent of the retail market. The remainder of the retail sector is characterised by a very high level of diversity between sites and low energy savings per site. Hence, it is unlikely that a benchmarking tool such as NABERS will be useful at this level. Other measures, such as green leases, may be a better way of advancing energy efficiency at this level.

6.2.3 Extension to hotel buildings

Hotels are a relatively small part, in energy use terms, of the accommodation/tourism sector. According to CBBS, the average energy intensity of hotels was 1,462MJ/m^2 in 2011. It was expected to increase by 26.7 per cent between 2012 and 2020.

Ownership and management of hotels tend to be separate and is increasingly so. It is estimated that 50 per cent of hotels in Australia are foreign-owned.

A NABERS Hotel tool exists, but no similar tool exists for motels, serviced apartments, holiday parks, visitor hostels, bed and breakfasts (B&Bs) or resorts. In its 2010 report for the then Department of Climate Change and Energy Efficiency *Commercial Buildings Disclosure Phase 2 – non-office buildings Scoping Study*, Energetics estimated that under 20 per cent of energy in the accommodation/tourism sector may be suited to rating by NABERS Hotel.

Davis Langdon estimated that there were approximately 530 NABERS rateable hotels in 2012, covering around 2.3 million square metres of Gross Internal Floor Area (GIFA), and representing 9.7 per cent of hotel sector establishments and 14.2 per cent of the ABS estimate of total hotel sector area (and 21 per cent of CBBS' estimate of total hotel sector area).

Turnover in the hotel sector is low, with an estimated 20 to 30 rateable hotels sold per year. An internal analysis by the Department undertaken in late 2012 indicated a low take-up of NABERS by the hotel sector, with just 21 current ratings (corresponding to a 4 per cent uptake rate) in September 2012.

Industry insiders suggest that utilities (including energy) make up less than five per cent of industry costs, compared with approximately 40 per cent for wages. Energy costs do not appear to be a key concern for hotel owners and managers. The main determinants of profits are vacancy rates and room rates, which in turn depend on location as well as customer and official ratings.

TBGB analysis of Green Building Fund (GBF) applications identified an average cost of $3,505/room for a project to achieve a one-star improvement that increased a hotel's NABERS rating to three stars or higher.

Coverage of the hotel sector by other energy efficiency programs is minimal. Holiday Inn and Mirvac were covered by the now defunct EEO program, while some large Sydney hotels (such as Shangri-La and Four Seasons) are covered by the NSW *Energy Savings Action Plan* (ESAP).

ACIL Allen does not recommend that mandatory disclosure be extended to hotel buildings for the following reasons:

- There is no split incentive problem if hotel operators are also owners of the hotel buildings. Even if they do not own the buildings, they have a natural incentive to seek out buildings that are more energy efficient and have lower energy costs, holding all other building characteristics constant.
- If energy efficiency is an important attribute in the selection of buildings by hotel operators, they could demand information on a prospective property's energy efficiency performance (which would likely be acceded to by building owners because assessment

costs are very small in comparison to the value of a typical transaction). However, it is not clear that energy efficiency matters greatly to buyers or lessees of hotel buildings, in comparison with other factors, such as geographic location. In either case, mandatory disclosure is superfluous for overcoming the information asymmetry problem.

6.3 Cost recovery options

6.3.1 Background

The total costs associated with administering the CBD program (including issuing approximately 1,100 BEECs and 1,000 TLAs in 2012-13) are currently approximately $2 million per year. This is funded by the Commonwealth Government from the general budget, with no input from States and Territories.

The Department estimates that, in accordance with the *Government Cost Recovery Guidelines* administered by the Department of Finance, up to $1.5 million of the total annual cost could be recovered.

The Department is exploring cost recovery options as the Explanatory Memorandum to the *Building Energy Disclosure Act 2010* states:

> Administration of the scheme will be undertaken with the objective of moving to full cost recovery at the cessation of this funding.

The current cost of compliance (the cost to obtain a BEEC) for a building owner is comprised of the cost of engaging an accredited assessor to carry out the NABERS rating and the TLA, plus the lodgement fee charged by NABERS. The fees charged by assessors for a NABERS rating and TLA vary, with the typical cost ranging from $4,000 to $14,000. The variation is based on factors such as the size of the individual building in question and the individual accredited assessor chosen to undertake the work. The lodgement fee currently payable to the NABERS administrator is $980 for all buildings over 2,000m^2. The cost of obtaining a BEEC is thus a relatively small proportion of the total value of a building's sale or lease transaction.

6.3.2 Options considered

ACIL Allen considered the following cost recovery options for the Department in relation to the future operation of the CBD program:

- Option 1: Single flat fee for BEEC
- Option 2: Two-tier BEEC by building size
- Option 3: Status quo (no BEEC fee)

Under Option 1, with the maximum amount that could be recovered equal to $1.5 million distributed equally to all 1,100 BEECs, the application lodgement fee charged would be approximately $1,400.

Under Option 2, the cost of obtaining a BEEC is related to the size of the building, on the grounds that the capital value and rental returns of a building are also related to the size of the building. On this basis, it could be argued that the BEEC application fee should be tiered to more evenly align the cost of compliance with the overall transaction amount.

According to the Department's internal analysis, the 1,100 buildings issued with a BEEC in the 2012-13 period ranged from 2,000 m^2 to 80,000 m^2, with the median being at 9,500 m^2. A two-tier BEEC fee based on the median building size of 9,500 m^2 would be as follows:

- Small building (less than or equal to 9,500 m^2): approximately $900

— Large building (greater than 9,500 m[2]): approximately $1,800.

Option 3 would not preclude the introduction of a BEEC application fee at some stage in the future, but no fee will be prescribed at present. The costs of administering the CBD program would continue to be sourced from budget funding.

It should be noted that, going forward, the Department's expenditure on the CBD program is expected to be reduced to approximately $1.5m per annum. This would reduce fees by around 35 per cent, compared with the numbers cited above.

6.3.3 Assessment of options

The three options were assessed against the following criteria:

1. *Efficiency* – the fee structure should minimise any economic distortions
2. *Equity (fairness)* – the fee structure should be seen to be fair in terms of taking into consideration the ability of parties applying for BEECs to pay and the benefits they receive from CBD
3. *Transparency* – the fee structure should be very clear and indisputable to parties applying for BEECs
4. *Simplicity* – the fee structure should be administratively simple for the Department
5. *Financial sustainability and predictability* – the fees recovered should cover the Department's administrative costs of processing and issuing BEECs and should not fluctuate unduly from year to year.

The results of the assessment are summarised in Table 22.

Table 22 **Assessment of cost recovery options**

	Option 1 Single flat fee	Option 2 Two-tier fee	Option 3 No fee
Efficiency	?	?	
Equity (fairness)		✓	
Transparency	✓✓	✓	✓✓
Simplicity	✓		✓✓
Financial sustainability and predictability	✓✓	✓	

Note: The number of ticks indicates the extent to which each option fulfils a particular criterion.
Source: ACIL Allen

Options 1 and 2 are likely to perform equally well in the efficiency criteria, as it is not obvious that either fee structure would result in significant economic distortions or perverse behaviour on the part of building owners, operators or tenants.

Option 2 is likely to be perceived to be fairer than Options 1 and 3, in that larger buildings are likely to generate greater benefits from higher rents or sale prices as a result of mandatory disclosure. The owners of larger buildings also tend to be in stronger financial positions than owners of smaller buildings.

The single fee structure of Option 1 and the absence of fees in Option 3 mean that these two options are extremely transparent. A clearly specified tiered fee structure in Option 2 can also be transparent, albeit not to the same degree.

Option 1 is administratively simpler than Option 2, although Option 3 (which entails no fees at all) is simpler still. However, with no fee recovery, Option 3 is the least financially sustainable option, while Option 1 will generate a more certain and predictable income stream for the Government than Option 2. The fees collected under Option 2 may vary from year to year due to changes in the composition of the office building stock in terms of leased area.

6.4 Changes to the scheme design

6.4.1 Raising the visibility of Tenancy Lighting Assessments

The information provided on TLA certificates (the power density, the corresponding performance rating and control capacity) is currently not a key factor taken into consideration by tenants. This is despite tenancy lighting having a large bearing on ongoing electricity charges, comprising 38 per cent of tenancy end-use (pitt&sherry, 2012). This lack of awareness is due to a number of factors.

- The fact that tenancy lighting assessments are a new mechanism and the market has not had adequate time for the scheme to mature to the extent where there is sufficient awareness and uptake from both building owners and tenants (unlike NABERS ratings).
- There is no requirement to include TLA information in advertisements regarding the sale or lease of a building.
- Even if inclusion of TLA information was required, it is not as amenable (compared to NABERS) to produce a simple aggregate performance metric that can be easily understood by the market, as power densities and control systems will vary by functional space.
- High NABERS ratings are part of the marketing proposition of some buildings, while this is not the case for tenancy lighting.

The LEASA[45] app is designed to assist tenants understand how energy performance affects occupancy costs. Using the LEASA app calculator, tenants can estimate the monetary savings achieved by more energy efficient tenancy lighting. However, in stakeholder consultations, CitySwitch noted that their engagement with tenants revealed that tenants were almost universally unaware of TLA information and that the LEASA app is not being used.

One concern with TLA noted by stakeholders was that the TLA does not necessarily provide an accurate reflection of the likely tenancy lighting performance for new tenants moving in. This is because tenancy lighting is generally only upgraded during a period of vacancy (that is, prior to a new tenant moving in). The TLA therefore does not show the targeted post upgrade tenancy lighting performance.

ACIL Allen makes two specific recommendations to accelerate awareness and appreciation of TLA by tenants:

1. Some information on tenancy lighting performance should be provided when advertising for sale or lease.
   - Where a single functional space is being leased, this could simply be the power density and control system capacity for that space.

[45] http://www.cbd.gov.au/leasa-app-for-tenants-released-based-on-cbd-data

  - Where a number of functional spaces or the entire building is being sold or leased, an 'aggregate' measure will need to be devised that is meaningful and useful to the tenant. An aggregate measure is preferred over listing TLA information for all functional spaces for simplicity and because there is limited space in some media, such as billboards. This information should include an indication of the potential 'dollar difference' in operating costs compared with the benchmark performance of similar buildings.
  - Stakeholders noted that the ability to devise a meaningful aggregate figure, potential confusion with NABERS if star ratings are also used to represent tenancy lighting performance, and limited understanding of power density by tenants, are potential challenges faced by this proposal.
2. The TLA certificate should have provision to include a proposed (and binding) commitment of tenancy lighting performance for new tenancies. This information should be prominent on the TLA certificate.

Implementing these recommendations would result in both costs and benefits, and these should be considered prior to adoption. Government costs would include the cost of designing changes to TLA regulations, the cost of updating regulations and additional costs relating to auditing and monitoring. Industry costs would include incremental industry burden associated with incorporating the additional information in advertisements and TLA certificates. The benefits would include greater uptake of lighting upgrades due to improved awareness, leading to lower energy consumption and GHG emissions.

ACIL Allen has not conducted extensive modelling on the likely increase in the effectiveness of TLA due to these changes. However, we consider that an acceleration of growth in market awareness[46] (from 10 per cent per year to 15 per cent year) is possible. This would increase the PV of energy efficiency benefits of TLA from $4.5 million to $8.7 million (that is, an improvement of $4.2 million), excluding the value of GHG reductions. GHG emissions would be further reduced by 226 ktCO_2-e cumulatively, which would be worth $5.3 million if GHG emissions reduction is valued at $23 per t$CO_2$-e.

6.4.2 Extending validity period of Tenancy Lighting Assessments

NABERS and TLA assessments are currently valid for a period of one year, after which the assessment is considered to be expired. Therefore, building owners who choose to maintain valid BEECs on an ongoing basis, irrespective of whether there is a sale of lease event requiring disclosure, must undertake NABERS and TLA assessments annually.

Base building energy performance is partly dependent on building operation (and not just efficiency of equipment) and therefore may degrade without any change to building equipment. As a result, obtaining annual NABERS ratings provides an up-to-date estimate of base building performance, taking into account recent changes in operational processes.

On the other hand, tenancy lighting performance is unlikely to change unless lighting systems are changed, which generally only occurs during a period of vacancy prior to a new tenant occupying the space. Therefore, requiring those building owners wishing to maintain ongoing BEECs to re-assess lighting systems annually leads to unnecessary costs.

These unnecessary costs may be reduced by extending the validity period of the TLA certificate. For example, if a TLA certificate was valid for five years, an updated assessment

46 The growth in market awareness refers to growth in the proportion of the market that act as 'model tenants'

would not be required until five years after the last assessment was undertaken, in order to maintain a valid ongoing BEEC.

The extent of possible cost reduction was estimated by considering the proportion of current TLAs that are obtained annually and in turn, a proportion of those may not be needed in the scenario where TLAs certificates are valid for five years.

The proportion of annual TLAs was estimated as 30 per cent (based on the Department's analysis). Of this 30 per cent, four out of five may be unnecessary. Therefore, extending the TLA validity period to five years was estimated to result in a potential 24 per cent reduction (30% * 4/5) in TLA costs. Increasing the validity period is not expected to result in any reduction in projected benefits.

The effect on the projected NPV of the TLA component from increasing validity period of TLA certificates to 5 years, as well as the combined effect of increasing validity *and* improving visibility (refer to Section 6.4.1) is shown in Table 23.

Table 23 **Costs and benefits of retaining TLA, 2015-2028 (2014 $m)**

Item	TLA certificate valid for 1 year	TLA certificate valid for 5 years	TLA certificate valid for 5 years and implementation of recommendations to improve TLA visibility
TLA industry burden	-$8.4m PV	-$6.4m PV	-$6.4m PV
TLA benefits of energy efficiency	$4.5m PV	$4.5 m PV	$8.7 m PV
Net Present Value (excluding GHG benefits)	**-$3.9m NPV**	**-$1.9m NPV**	**$2.3m NPV minus cost of improving visibility**
Avoided GHG emissions	692 ktCO_2-e	692 ktCO_2-e	918 ktCO_2-e
NPV including GHG benefits at $23 per tonne	**$6.9m NPV**	**$8.9m NPV**	**$18.4m NPV minus cost of improving visibility**

Source: ACIL Allen

6.5 Other potential improvements

6.5.1 Ongoing process improvements

There are well-established mechanisms for making ongoing improvements to the CBD program. These include measures for improving the administrative efficiency of the program and the NABERS assessment process. For example, the NSW Office of Environment and Heritage has implemented multiple automatic checks that have streamlined the work of assessors by preventing the most common mistakes found in audits and by informing assessors when an explanation is required. This has significantly reduced the waiting time for certification.

In addition, until recently, a NABERS rating was valid for 12 months from the day the certificate was issued. To minimise the risk of not having a rating when leasing or selling occurs, many office buildings were obtaining a certified rating after 11 months. NABERS implemented major changes to its website to allow buildings with existing ratings to mitigate the risk of not having a rating without sacrificing certification length or incurring extra costs. If there is an existing rating for the property, assessors can now choose the start date of their new rating to coincide with expiry of the previous rating.

The Department of Industry and Science conducts ongoing process and system improvements based on CBD program data and stakeholder feedback. Examples of these include:

- Enhancements to the TLA rules based on advice from CBD accredited assessors. The revised TLA rules provide a simplified process, including additional assessment methods with associated guidance material for assessors
- Improvements to the CBD IT system that were implemented in 2012 following consultation with stakeholders. Enhancements included the development of an online TLA form (replacing the old Excel-based form) and the creation of a one-step BEEC and TLA application process.
  - The online TLA assessment form has a number of automatic checks that have resulted in fewer applications being sent back to assessors for corrections or additional information.
  - The one-step BEEC and TLA application process means that assessors no longer have to wait for a TLA to be certified before submitting a BEEC application, thereby saving them time. This process also allows the TLA, BEEC and NABERS expiry dates to be aligned, enabling a full 12 months of validity of the BEEC.

ACIL Allen recommends that these process improvements should continue.

6.5.2 Closing data gaps

Future evaluations of energy efficiency programs, such as the CBD program, would benefit from improved data relating to pay-offs of energy efficiency upgrades and potential benefits from improved productivity.

Key data gaps encountered by ACIL Allen in the review of the CBD program included the pay-off from energy efficiency upgrades and potential benefits from improved productivity.

Pay-off estimates used in the analysis, referred to as the 'net benefits of energy efficiency', were derived from abatement cost curve analysis, cross-checked against multiple sources and tested with industry stakeholders. Extensive sensitivity analysis was also performed to ensure the review's conclusions were robust in light of the uncertainty around project pay-offs.

Nevertheless, future evaluations would benefit from a greater resolution and diversity of data related to project pay-offs. Available data was used to construct low, medium and high estimates of project pay-offs applying to buildings performing upgrades from a low, medium and high base of energy efficiency, respectively. This captured the effect that returns from energy efficiency are relatively higher for poorer performing buildings. However, further data would allow greater differentiation of project pay-offs, if necessary, based on current star rating, building characteristics, jurisdiction, climate zone and tenants etc. It would also allow greater precision in economic benefit estimates.

Improvements in workforce productivity were found to be potentially significant. ACIL Allen estimates that this improvement could be higher than the combined benefit of project pay-offs and GHG reductions, even under conservative assumptions about productivity increases. However, there is a high level of uncertainty surrounding productivity benefits due to paucity of robust data on productivity benefits of energy efficient buildings.

There are multiple approaches to addressing these data gaps. Additional data collection through the application process for NABERS, TLA or BEEC certificates is not recommended as this would increase regulatory burden to building owners. Rather, independent research engaging targeted stakeholders from the industry could be considered.

7 Summary of key findings from the review

7.1 Impacts of the program to date

7.1.1 Appropriateness of the CBD program

ACIL Allen finds the CBD program to be an appropriate one that aligns strategically (and in practice) with relevant government policies and programs. Rather than directly requiring building owners to improve energy efficiency, it provides information to the market to encourage improvements. It is therefore a light-handed form of regulation.

It complements the other measures designed to increase the energy efficiency of new commercial buildings as set out in the National Strategy for Energy Efficiency. It is also complementary to a significant number of programs enacted by the Commonwealth, State/Territory and local governments that target building energy efficiency. While there is partial overlap between the CBD program and a small number of other programs in terms of scope and/or objectives, there is no inefficient or wasteful duplication.

With expected robust growth in the number of commercial buildings in major cities around the country (commensurate with projected population and economic growth) and an increasingly urgent need to address the climate change challenge, the program is as relevant to Australia's needs today and in the future as it was at conception.

7.1.2 Effectiveness of the CBD program

ACIL Allen's cost-benefit analysis suggests that the CBD program has been successful in inducing a change in the behaviour of building owners, operators and tenants in regards to commercial building energy efficiency. In particular, the buildings in the mandatory 4th quartile have achieved a marked improvement in NABERS star ratings and a significant reduction in energy intensity. There also appear to be improvements attained by the mandatory 1st and 3rd quartiles as a result of the program. These improvements have enabled the program to achieve benefits in excess of costs to date of $44 million in present value terms, under a seven per cent real discount rate. If workforce productivity gains were taken into account then the benefits would be even greater.

The Benefit-Cost Ratio of the program in the 'realistic scenario' is calculated to be 2.58 with a corresponding Internal Rate of Return of 46 per cent. Worker productivity benefits are estimated to be approximately $168m in present value terms, but these have not been included in the net benefit numbers cited above because of the higher level of uncertainty in the estimate of their magnitude.

ACIL Allen's analysis of the TLA component of the program suggests that it has yet to deliver significant benefits. We believe that is in part due to the newness of the TLA (compared with the more well-established NABERS) and, consequently, the relatively small proportion of tenants who have taken advantage of the information generated by TLA assessments.

7.1.3 Interactions with other energy efficiency programs

ACIL Allen's quantitative analysis of the CBD program's interactions with the NSW Energy Saver Scheme (ESS) and Victorian Energy Efficiency Target (VEET) suggests that these programs are complementary. The CBD program is estimated to have reduced the cost of the ESS by approximately $0.9 million per annum and the cost of the VEET scheme by approximately $0.5 million per annum.

7.2 Likely impacts of continuing the program

7.2.1 NABERS

ACIL Allen's forward-looking analysis of the CBD program indicates that it is likely that the NABERS component of the program will continue to deliver substantial net benefits. Those net benefits (not including the value of GHG reductions) are estimated to be $53.3 million in present value terms over the next five years, under a seven per cent real discount rate. In addition, retaining the scheme will likely result in avoided GHG emissions of nearly 1,500 $ktCO_{2e}$.

7.2.2 TLA

ACIL Allen estimated the Net Present Values for retaining the TLA under two cases. The first is based on retaining the TLA in its current form. The second is based on extending the validity period of the TLA from one year to five years. Extension of validity period is recommended as it is estimated to reduce industry burden (by approximately $2.0 million in PV terms), with negligible impact to the scheme's effectiveness.

ACIL Allen's analysis suggests that retaining the TLA in its current form will generate a Net Present Value of minus $3.9 million over the next five years (under a seven per cent real discount rate) excluding the value of GHG reduction and a NPV of $6.9 million including the GHG benefits (at $23/$tCO_2$-e).

ACIL Allen's analysis suggests that if the validity period of the TLA is extended to five years, these NPV estimates improve to minus $1.9 million excluding the value of GHG reduction, and $8.9 million including the GHG benefits (at $23/$tCO_2$-e).

However, the net benefits of retaining the TLA are likely to be significantly higher if measures that accelerate awareness and understanding of the TLA by tenants and reduce compliance costs are adopted (see the recommendations in Section 7.3.4).

7.2.3 Energy and GHG reductions

The benefits of retaining the CBD program accrue from reductions in energy consumption and GHG emissions. Table 24 below compares energy and GHG reductions from continuing the program, based on retaining the current 2,000 m^2 disclosure threshold and from lowering the threshold to 1,000 m^2.

Table 24 **Energy and GHG reduction from continuing the program**

Item	Retaining 2,000 m^2 disclosure threshold	Lowering disclosure threshold to 1,000 m^2
Energy reduction[a] from NABERS component	12,122 TJ	15,806 TJ
Energy reduction[a] from TLA component	679 GWh	679 GWh
Total energy reduction [a]	**14,565 TJ TJ**	**18,250 TJ**
GHG reduction from NABERS component	2,504 tCO_2-e	3,212 tCO_2-e
GHG reduction from TLA component	612 tCO_2-e	612 tCO_2-e
Total GHG reduction	**3,116 tCO2-e**	**3,824 tCO_2-e**

[a] Energy reductions refers to the amount of reduced end use energy consumption by buildings (in the former of lower electricity and gas drawn from distribution grids and reduced combustion of diesel). It does not represent reduced primary fuel use (e.g. reduced coal and gas used in generators etc.).

Note: The projections of GHG and energy reduction above assume a 5-year program duration (2015 to 2019) and are estimated over the period 2015 to 2028. The estimates corresponding to the TLA component do not take into account measures to increase awareness and adoption of TLA by tenants. Such measures would further improve energy and GHG reduction from the TLA component.

Source: ACIL Allen

7.2.4 Interaction with the ERF

The CBD program is expected to be complementary to the ERF rather than duplicative. This is mainly because the purpose of ERF is to provide funding for emissions reduction projects, whereas the focus of the CBD is to provide information to potential tenants and buyers.

As such, CBD remains a low-cost, high-value program that drives significant energy efficiency improvements within the commercial office sector.

7.3 Potential program changes and improvements

7.3.1 Extension to smaller buildings

ACIL Allen's analysis suggests there is merit in lowering the threshold for mandatory disclosure from 2,000 m^2 to 1,000 m^2. The projected net benefits of lowering the disclosure threshold is estimated to be $24 million in present value terms under a seven per cent real discount rate. This is based on an estimated 1.5 million m^2 of additional floor space would be captured by the CBD program if the threshold was reduced to 1,000m^2.

7.3.2 Extension to other building types

ACIL Allen does not recommend that mandatory disclosure be extended to other types of commercial buildings at this time.

At present, the NABERS rating tool for data centres is still relatively new and not yet widely embraced by industry. In addition, some data centre operators might be unwilling allow access to energy consumption data due to the commercial sensitivity of that information.

ACIL Allen believes that information on energy efficiency revealed to tenants of retail buildings will not be acted on as site size, configuration, location, and rental price and conditions are likely to matter far more to tenants than energy costs, as the latter are the key determinants of a tenant's profitability.

In regards to hotel buildings, there is no split incentive problem if hotel operators are also owners of the hotel buildings. Even if they do not own the buildings, they have a natural incentive to seek out buildings that are more energy efficient and have lower energy costs, assuming all other building characteristics are similar. Potential tenants' demands for an energy rating are likely to accepted by building owners because assessment costs are very small in comparison to the value of a typical transaction.

7.3.3 Cost recovery

ACIL Allen does not have a recommendation on the recovery of the costs incurred by the Department in administering the CBD program. A two-tier BEEC pricing scheme is likely to be perceived as fairer than a single flat fee. However, it is less transparent and would be more complex to administer. A single flat fee is more transparent and is likely to result in a more predictable revenue stream. Maintaining the status quo is extremely simple and transparent but it may not be financially sustainable over the longer term.

7.3.4 Changes to the TLA

ACIL Allen believes that much can be done to accelerate awareness and appreciation of the TLA by tenants. We recommend the following:

1. Some information on tenancy lighting performance should be provided when advertising for sale or lease.
   - Where a single functional space is being leased, this could simply be the power density and control system capacity for that space. Where a number of functional spaces or the entire building is being sold or leased, an 'aggregate' measure will need to be devised that is meaningful and useful to the tenant. An aggregate measure is preferred over listing TLA information for all functional spaces for simplicity and because there is limited space in some media, such as billboards. This information should include an indication of the potential 'dollar difference' in operating costs compared with the benchmark performance of similar buildings.
   - Stakeholders noted that the ability to devise a meaningful aggregate figure, potential confusion with NABERS if star ratings are also used to represent tenancy lighting performance, and limited understanding of power density by tenants, as potential challenges with this proposal.
2. The TLA certificate should have provision to include a proposed (and binding) commitment of tenancy lighting performance for new tenancies. This information should be prominent on the TLA certificate.

ACIL Allen also believes that the validity period for the TLA should be extended from one year to five years. This is because tenancy lighting performance is unlikely to change unless lighting systems are changed, which generally only occurs during a period of vacancy prior to a new tenant occupying the space. Therefore, requiring building owners who wish to maintain an up to date BEEC to re-assess lighting systems annually imposes an unnecessary cost on them.

ACIL Allen's analysis suggests that an extension of the validity period from one year to five years increases the net benefits of the TLA by approximately $2 million in present value terms. While the cost of raising awareness and appreciation of the TLA has not been quantified, the benefits are estimated to be $4.2 million in present value terms.

7.3.5 Ongoing process improvements

There are well-established mechanisms for making ongoing improvements to the CBD program. These include measures for improving the administrative efficiency of the program and the NABERS assessment process. For example, the NSW Office of Environment and Heritage has implemented multiple automatic checks that have streamlined the work of assessors and has allowed property assessors to choose the start date of the new NABERS rating (so that building owners are able to fully utilise the 12-month validity period of the rating).

The Department of Industry and Science also conducts ongoing process and system improvements based on CBD program data and stakeholder feedback, including enhancing the TLA rules based on advice from CBD accredited assessors and implementing improvements to the CBD IT system.

ACIL Allen recommends that these process improvements should continue.

7.3.6 Closing data gaps

Future evaluations of energy efficiency programs, such as the CBD program, would benefit from improved data relating to pay-offs of energy efficiency upgrades and potential benefits from improved productivity.

There are multiple approaches to addressing these data gaps. Additional data collection through the application process for NABERS, TLA or BEEC certificates is not recommended as this would increase regulatory burden to building owners. Rather, independent research engaging targeted stakeholders from the industry could be considered.

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Appendix A Cost benefit analysis assumptions

A.1 Program costs (costs to government)

A.1.1 Program costs to date

The costs to government have been derived from estimates provided by the Department. The Department estimates include an estimate of the number of Full Time Equivalent (FTE) employees and non-staff costs involved in operating the program.

An estimated 14 FTEs were required to administer the program in 2012-13. The assumed average annual cost per FTE is $100,000 (including on-costs) for a total employee cost of $1.4 million. Non-staff costs were estimated to be $0.6 million. Non-staff costs include:

- information and communication technology (ICT) maintenance
- monitoring & evaluation
- specialist legal advice
- auditing
- training
- data purchase
- communications.

This results in a total annual program cost estimate of $2.0 million.

A.1.2 Program costs from continuing the program

The forward-looking costs of continuing the program have been estimated at $1.5 million per year. This is based on the Department's revised estimates and reflect expected efficiency savings going forward.

A.2 Industry burden

The industry burden refers to the incremental costs incurred by industry stakeholders affected by the program. These comprise:

- the costs to prepare for and obtain incremental NABERS rating (only those ratings which would not have otherwise occurred in the absence of mandatory disclosure)
- the costs of lodging incremental NABERS ratings with the NABERS scheme administrator, the NSW Office of Environment and Heritage (OEH)
- the costs to prepare for and obtain a TLA assessment.

Estimates of the industry burden have been derived from analysis prepared by the Department and discussions with CBD accredited energy performance assessors.

A.2.1 Industry burden to date

The Department's analysis estimates the total (gross) cost for all businesses to comply with the BEED legislation at $6.6 million per year (including both NABERS and TLA costs, but excluding NSW OEH lodgement fees). To arrive at a net figure, the analysis estimates and subtracts the business as usual costs (those that would have occurred without BEED legislation). In the analysis, the counterfactual burden is estimated based on an assumed

average NABERS assessment cost of $3,800 per rating[47] and an assumed counterfactual 342 ratings (the number of unique ratings in 2009 with a rated area for more than 2,000 m²).

A similar approach has been used in this study to estimate the industry burden of the program to date, however the assumed counterfactual ratings are grown at the trend rate of growth between 2006 and 2009 (inclusive) over the period 2010 to 2014.

A NSW OEH lodgement fee of $980 per rating[48] is applied to the incremental ratings and are assumed to reflect the incremental resource costs of administering the NABERS scheme. The resulting total annual industry burden estimates are provided in Table A1.

Table A1 **Industry burden of CBD program to date**

Item	2010	2011	2012	2013	2014
Industry burden ($m)	5.5	5.4	5.3	5.1	4.9

Source: ACIL Allen

A.2.2 Industry burden of continuing the program

The industry burden from continuing the program has been separated into the costs of complying with mandatory disclosure of NABERS ratings and the cost of complying with the TLA component.

Costs of complying with mandatory disclosure of NABERS ratings

The incremental industry burden from continuing NABERS disclosure has been calculated by first estimating a figure for 2014 of $2.7 million arrived at by:

- Taking the 2014 estimate of combined (NABERS and TLA) industry burden of $4.9 million; and
- Subtracting from this the portion that is estimated to relate to TLA assessments of $1.9m (assumed to be an average $1,700 per TLA assessment[49] multiplied by an estimated 1,133[50] assessments).

This figure is increased by 2.3 per cent per year, based on projections of NLA growth by Pitt&Sherry (2012), and assuming that both voluntary and mandatory ratings, and therefore incremental ratings, will grow in line with long term NLA growth. The projected annual industry burden associated with NABERS disclosure is provided in Table A2.

Table A2 **Industry burden from continuing NABERS disclosure**

Item	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Industry burden ($m)	3.0	3.1	3.1	3.2	3.3	3.4	3.4	3.5	3.6	3.7

Source: ACIL Allen

47 Based on responses to the Department from assessors.

48 NABERS website: (http://www.nabers.gov.au/public/WebPages/ContentStandard.aspx?module=30&template=3&include=Processingfees.htm&side=RatingTertiary.htm)

49 Based on the Department's 'industry burden' analysis, using the estimated combined NABERS/TLA average cost of $5,500 minus the estimated average NABERS only cost of $3,800.

50 Assuming that a TLA assessment accompanied each projected NABERS ratings for 2014 (in turn estimated by taking the observed number of ratings of greater than 2,000 m² for 2014 up to 25 October 2014 and scaling up by the proportion of the 2014 year remaining).

Costs of complying with TLA component

The TLA component of the industry burden is projected by increasing the estimated portion of 2014 total industry burden associated with TLA (that is, $1.9 million[51]) by 2.3 per cent per year. The projected annual industry burden associated with TLA assessments is provided in Table A3.

Table A3 **Industry burden from continuing TLA disclosure**

Item	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Industry burden ($m)	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.4	2.4

Source: ACIL Allen

Uncertainty in industry burden from continuing the program

The key uncertainty related to projecting the *incremental* industry burden is the level of counterfactual uptake in disclosure if the scheme is discontinued, referred to as 'behaviour retention' in the analysis. While sensitivity analysis is performed on the level of behaviour retention, the assumed industry burden is held constant across each sensitivity test. In actuality, the level of incremental industry burden is expected to inversely scale with assumed retention of behaviour. However, for simplicity, such precision was not incorporated into the model and this simplification does not have any material bearing on results or conclusions.

Assumed industry burden for floor spaces between 1,000 m^2 and 2,000 m^2

The potential industry burden for floor spaces between 1,000 m^2 and 2,000 m^2 (used to estimate the additional industry burden associated with lowering the NLA threshold for disclosure) was estimated based on discussions with energy performance assessors. The estimate took into account:

- a 'mobilisation' fixed cost component of $2,000 per assessment
- a variable cost component of 20 cents per m^2
- a NABERS lodgement fee of $490[52]
- an assumed average assessment floor area of 1,500 m^2.

An average cost expressed in dollars per square metre per year of $0.64/$m^2$/year was calculated based on an assumed rating frequency of requiring disclosure approximately 1 in 3 years.

A.3 Energy efficiency improvement costs and associated energy savings benefits

Energy efficiency improvements in the CBAs are expressed as improvements in the energy intensity (MJ/m^2) of building floor space (or alternatively, improvements in star rating translated into assumed equivalent improvements in energy intensity).

Building energy efficiency improvements can be achieved through a variety of measures, ranging from simple and negligible cost process improvements to major retrofits of building equipment involving large capital costs.

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51 This is estimated to be $1.9 million based on number of ratings multiplied by the average cost of a TLA.

52 NABERS website: (http://www.nabers.gov.au/public/WebPages/ContentStandard.aspx?module=30&template=3&include=Processingfees.htm&side=RatingTertiary.htm)

In most cases, energy efficiency improvements will result in a net financial benefit to the project proponent, except in some cases where a net cost may be justified on marketing or corporate social responsibility grounds.

This net benefit is comprised of a combination of one or more of the following items:

- electricity supply cost savings
- gas supply cost savings
- diesel cost savings
- value of carbon abatement
- less costs (capital and operating) associated with the improvements.

There is a large variance in project net benefits which depend on many factors. These include pre-existing energy performance of the building, climate zone, building operation, pattern of energy use, building envelope and emissions intensity of fuel used. Pre-existing energy performance, in particular, has a significant bearing on project benefits as improvements from a lower base of performance tend to have a much higher pay-off.[53]

Due to this large degree of variance and the lack of sufficient publicly available data on energy efficiency project costs and benefits, it was not feasible to precisely model project costs and benefits. Instead, an approach using average benefit across the building sector was developed, incorporating some variance of costs based on pre-existing energy performance.

The potential benefits were estimated based on ClimateWorks (2013) and energy efficiency audit data supplied by the City of Sydney. The estimates have also been cross-validated against other publicly available and non-publicly available sources, including studies by Allen Consulting Group (2008), CIE (2009) and the Victorian Department of Treasury and Finance (2013).

The approach used to derive an average net benefit and to vary this benefit based on pre-existing energy performance is discussed below.

A.3.1 Estimated average net benefit from energy efficiency upgrades

The average estimated benefit from energy improvements was derived from cost curve data published by ClimateWorks (2013). Of the sources reviewed, the ClimateWorks analysis is relatively current and provides estimates of abatement potential and cost from a range of commercial building measures as averages across the sector. Exhibit 4.6 of ClimateWorks (2013) (shown in Figure A1 below) illustrates the commercial building sector ‘investor abatement cost curve’.

Using net benefit estimates expressed as tonnes of abatement ($ per tCO_{2e}) provides the advantage of having already combined all cost and benefit streams (including capital costs, operating costs and energy savings) into a single aggregated unit value which can be applied to the estimated tCO_{2e} of energy improvements (refer to Section A.5) to provide an estimate of monetised economic benefit.

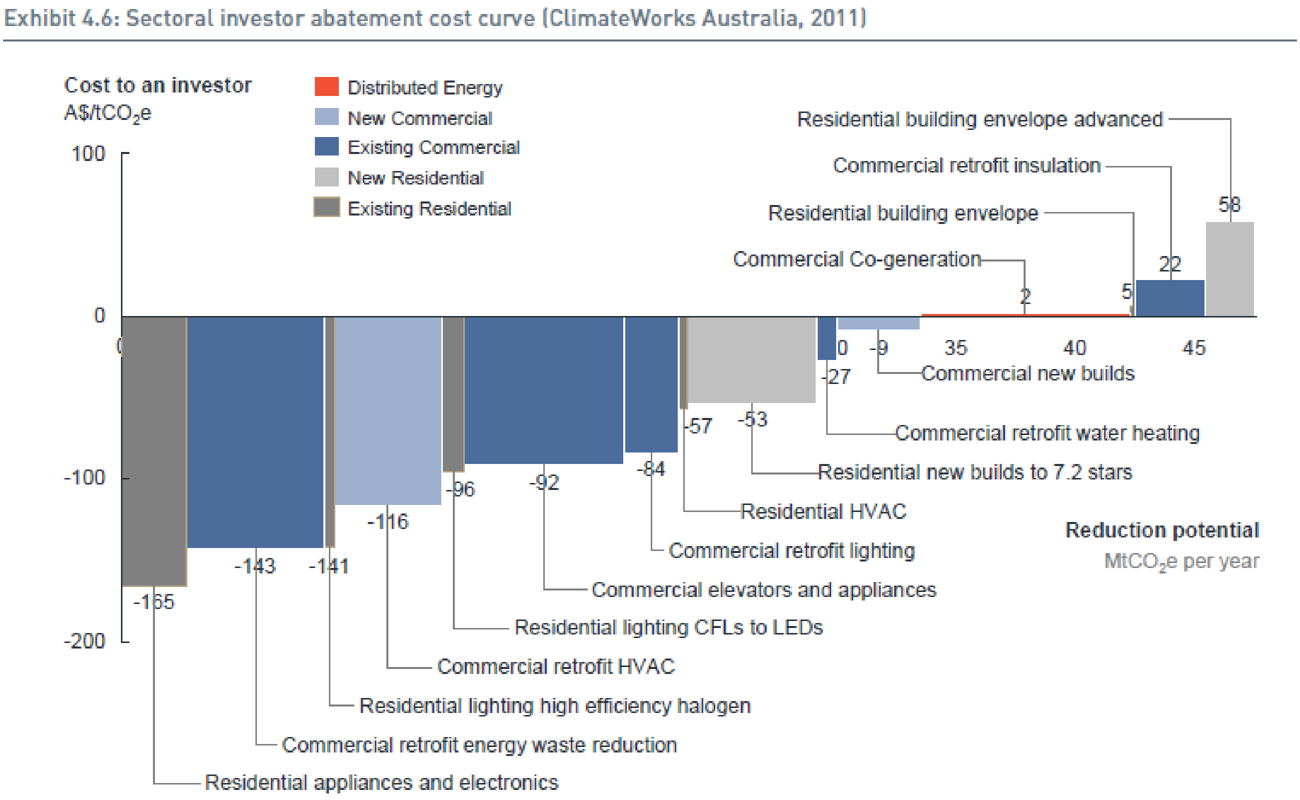
Two steps were required to derive a value suitable for used in the CBAs:

1. The weighted average of a range of representative measures was calculated to arrive at an average value; and

53 Based on discussions and indicative upgrade cost data provided by energy performance assessors and the Energy Efficiency Council (EEC)

2. This value was adjusted due to differences in study contexts.

Figure A1 **Commercial building investor abatement cost curve**



Source: Exhibit 4.6, p.14, (ClimateWorks, 2013)

Calculation of weighted average net benefit

A study by pitt&sherry (2012) provides a breakdown of base building electricity use by type of end use. These end use shares were combined with corresponding estimates of net benefit from abatement projects from ClimateWorks (2013) to calculate weighted average abatement benefit as shown in Table A4 below.

Table A4 **Calculation of weighted average investor benefit**

End use type	End use share of total base building electricity use	Corresponding abatement activity	Investor benefit from abatement activity in 2020 (2010 prices)
HVAC	67%	Commercial retrofit HVAC	$116/tCO_{2e}$
Lighting	15%	Commercial retrofit lighting	$84/tCO_{2e}$
Total equipment	11%	Commercial elevators and appliances	$92/tCO_{2e}$
Hot water	2%	Commercial retrofit water heating	$27/tCO_{2e}$
Other electrical processes[a]	4%		
Calculation of weighted average based on HVAC, lighting, total equipment and hot water			**$106/tCO_{2e}$**

[a] Not used in the calculation of weighted average.
Source: Figure 5.9, p. 44, pitt&sherry (2012); Exhibit 4.6, p.14 ClimateWorks (2011)

The estimated average $117/tCO$_{2e}$ ($106/tCO$_{2e}$ inflated to 2014 prices) of benefit was then adjusted to account for differences in study contexts as described below.

Adjustments for differences in study contexts

The backward-looking CBA assesses the net benefits from energy efficiency to *society* between 2010 and 2014. However, the $117/tCO$_{2e}$ figure represents the estimated average benefit to an *investor* in 2020. To estimate the average economic benefit to *society* in 2010 (for the backward-looking estimate), the figure was reduced by 70 per cent (to $35/tCO$_{2e}$) to reflect that:

- The net benefit is assumed to comprise of approximately $200/tCO$_{2e}$ of energy saving benefit (assuming commercial building electricity tariffs of approximately $200/MWh and a grid emissions intensity of approximately 1 tCO$_{2e}$ per MWh).
- Therefore total costs can be inferred as comprising approximately $83/tCO$_{2e}$ (200 – 117).
- The ClimateWorks analysis includes 10 per cent GST on energy saving benefits, which must be excluded from the CBA as they represent a transfer (not an economic benefit).
- Approximately 5 per cent of the investor energy saving benefit can be attributed to Renewable Energy Target (RET) charges, which must be excluded in the CBA as they represent a transfer[54] (not an economic benefit).
- Approximately 10 per cent of the investor energy saving benefit can be attributed to retail margins, which must be excluded in the CBA (as retail overheads are largely fixed and will remain unchanged).
- The ClimateWorks analysis assumes an approximate 10 per cent difference in retail tariffs between 2010 and 2020 on energy saving benefits, which must be excluded in the CBA as it is a transfer (not an economic benefit).
- Costs are assumed to be 10 per cent higher in 2010 relative to 2020, as 2020 costs are likely to include cost reductions over time.

[54] This is based on the assumption that as at the time of the report, the costs of meeting the Renewable Energy Target (RET), which comprises the Large Scale Renewable Energy Target (LRET) and Small Scale Renewable Energy Scheme (SRES), would not be affected by building energy efficiency projects, as the LRET is a fixed target (in gigawatt-hour terms) and the uptake of SRES is driven primarily by small scale photovoltaic solar in the residential sector.

The net effect of the above factors (an approximate 35 per cent reduction in benefits and 10 per cent increase in costs) results in an approximate 70 per cent reduction in overall net benefit.

A.3.2 Variance of benefit based on pre-existing energy performance

Although there was insufficient data to construct a full profile of likely net benefits from energy efficiency based on various states of pre-existing energy performance, there are known ‘bounds’ on this profile that may be estimated. For example, the most attractive opportunities (such as process changes) will deliver the full energy reduction at minimal cost, and therefore net benefits approaching approximately \$200/tCO_{2e}. The least attractive opportunities are likely to break even (\$0/tCO_{2e}) or have a marginal pay-off.

Based on these known bounds, low, medium and high estimates of net benefits were constructed based on 0.2 times, 1 times and 1.8 times multiples of the average net benefit, respectively. This results in the following profile of net benefit assumptions shown in Table A5 below.

Table A5 **Low, medium and high estimates for net benefits of energy efficiency**

Estimate	Multiple of average benefit	Estimated benefit
Low estimate	0.2x	\$64/tCO_{2e}
Medium estimate	1x	\$35/tCO_{2e}
High estimate	1.8x	\$7/tCO_{2e}

Source: ACIL Allen

These estimates were cross-checked against, and found to be consistent with, net benefit estimates derived from pay-off data from selected audits of commercial buildings provided to the project team by the City of Sydney.

The net benefits from energy efficiency upgrades is one of the key variables used in sensitivity analysis due to the number of assumptions required in deriving estimates and the lack of widely available estimates in the public domain that may be used to cross validate the results.

A.4 Benefit of lighting upgrades

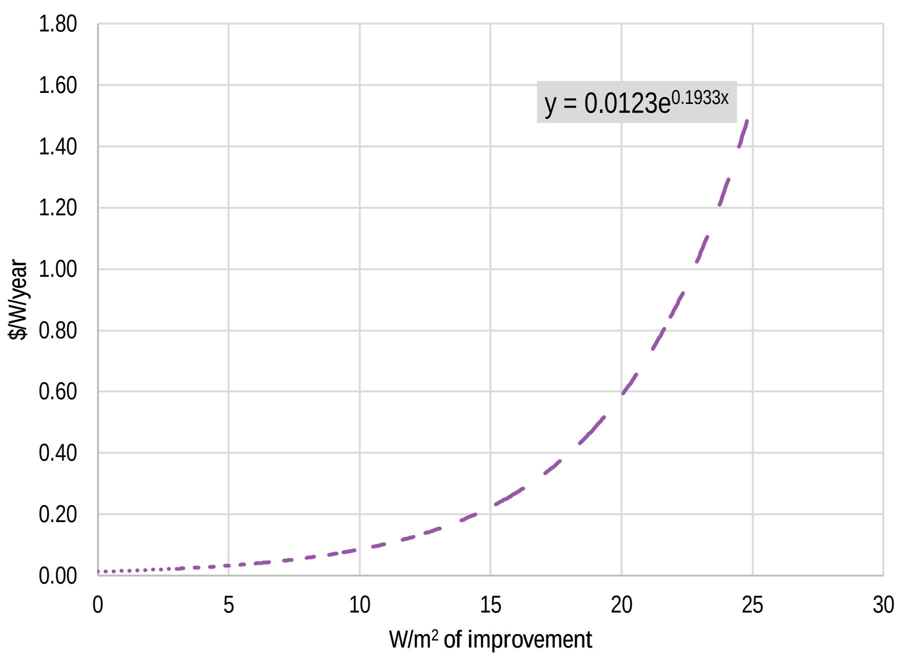
Estimates of the benefits of lighting upgrades were derived from case study data provided by NSW Government Property. The case study data included:

- Financial pay-offs (including benefits from improvements to power density and control systems) from upgrades to four types of new systems (T5 technology, LED technology with timer control, LED technology with timer control and dimmer, and LED technology with sensors).
- For each type of upgrade, pay-offs were differentiated based on prior power densities of 12, 18 and 24 W/m^2.

A change in power density (Δ W/m^2/year) and average benefit per Watt of improvement (\$/W/year) for each combination of prior power density and upgrade technology was estimated.

An exponential regression[55] was then fitted to the 12 data points as shown in Figure A2 below. The analysis suggests that pay-offs from lighting upgrades increase very rapidly with the extent of change being undertaken. This finding is consistent with anecdotal data provided by energy performance assessors, who note that pay-offs are much more marginal (or not beneficial) for small improvements to power density.

Figure A2 **Pay-off from lighting upgrades**



Source: ACIL Allen analysis of CBD data

While this analysis provides an evidentiary basis for estimating the economic benefit of lighting upgrades, it is based on a relatively small sample of pay-off data; publicly available estimates, which could be used to validate the results, were not found. Therefore, the net benefits from lighting upgrade is one of the key variables used in sensitivity analysis.

A.5 GHG reductions

The estimated improvements in energy efficiency (from both base building energy efficiency improvements and tenancy lighting upgrades) have been translated into estimated GHG reductions (tCO_{2e}) based on assumed electricity, fuel and diesel savings and associated fuel emissions intensities.

A.5.1 Estimates of electricity, fuel and diesel savings

Fuel savings from base building energy efficiency upgrades

Fuel savings from base building energy efficiency upgrades were estimated based on differences in assumed breakdown of fuel consumption (per cent of total MJ) of buildings between the counterfactual with CBD scenarios. This was done by calculating:

[55] Found to fit the data better than a linear model.

- The average proportion (per cent of total MJ) of electricity use, gas use and diesel use (or the 'fuel mix') for buildings in various star bands (0-1.5, 2-3.5 and 4-6) for the years 2010, 2011, 2012 and 2013 (derived based on NABERS data on energy use).
- Total electricity, gas and diesel fuel consumption for both the counterfactual and with CBD scenarios based on this fuel mix.
- Fuel savings as the difference in fuel use between the with CBD and counterfactual scenarios.

Electricity savings from tenancy lighting upgrades

Estimates of electricity savings from tenancy lighting upgrades have been derived from changes to total power capacity (MW) of tenancy lighting in commercial buildings attributable to CBD, and an assumed average capacity factor of 35 per cent (e.g. a 1 MW total reduction due to improvements in power density is estimated to result in approximately 300 MWh of electricity savings).

A.5.2 Estimated fuel emissions intensities

Emissions intensities for electricity, gas and diesel were derived from the Australian Government Department of Environment (2014). An average electricity emissions intensity for Australia was estimated as the weighted average state grid emissions intensities (weighted by the state's proportion of total building NLA for buildings in the NABERS database). The resulting estimates of Australian average emissions intensities are shown in Table A6 below.

Table A6 **Assumed emissions intensities for CBA**

Fuel	Assumed emissions intensity
Electricity	0.90139 kg/kWh
Gas	0.05133 kg/MJ
Diesel	2.68270 kg/L

Source: NGA (2014), NABERS Database

The same emissions intensities have been applied for all years of analysis. Although average electricity grid intensity is expected to decline over time, future emissions reduction from energy efficiency will depend primarily on the intensity of displaced electricity generation, rather than the average intensity itself. This displaced generation may have a lower or higher energy intensity than the grid average. Therefore, the assumed emissions intensity factor applying to energy efficiency improvements is not reduced over time.

A.6 Increase in productivity

In May 2009, CBRE and the University of San Diego surveyed 534 managers of tenant companies that moved from standard buildings into buildings with ENERGY STAR labels or Leadership in Energy and Environmental Design (LEED) certifications (Norm et al. 2009).

Forty-two-and-a-half (42.5) per cent agreed that employees were more productive, with a perceived average productivity increase of 4.88 per cent.

Making further assumptions (and adjustments for uncertainty) results in a potential productivity benefit of $3.07 per star and square metre as shown in Table A7 below.

Table A7 **Assumed value of productivity improvements due to improvements in star rating**

Assumption/adjustment	Value	Source/note
Star improvement equivalent to ENERGY STAR or LEED certification	3 stars	ACIL Allen assumption
Productivity gain per star improvement (unadjusted)	0.7%	$\frac{42.5\% \times 4.88\%}{3}$
Productivity gain per star improvement (adjusted)	0.1%	Uncertainty in study (e.g. control of other factors, bias etc.)
Average annual earnings per office worker	$72,800	ABS Labour Force Survey
Density (m^2 per worker)	24	Australian Government Office Occupancy Report, 2009
Estimated productivity benefit per star and m^2	**$3.07 per star.$m^2$**	**Applied to total improvements in star rating (see note below)**

Note: The total annual productivity benefit for any given segment in the analysis is calculated as $3.07 × (Δ in average star rating) × (total estimated NLA of segment in m^2).

Source: Miller et al. (2009), ABS Labour Force Survey, Australian Government Department of Finance and Deregulation (2009)

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