FINAL REGULATION IMPACT STATEMENT for DECISION (RIS 2009-07)

Proposal to Revise the Energy Efficiency Requirements in the Building Code of Australia for Commercial Buildings — Classes 3 and 5 to 9

December 2009

The Australian Building Codes Board (ABCB) has commissioned The Centre for International Economics to prepare this Final Regulation Impact Statement (RIS) in accordance with the requirements of *Best Practice Regulation: A Guide for Ministerial Councils and National Standard Setting Bodies,* endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties regarding a proposal to amend existing regulatory requirements for energy efficiency in commercial buildings.

This RIS considers outcomes from public comment received in response to the consultation RIS 2009-04.

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Proposal to revise energy efficiency requirements of the Building Code of Australia for commercial buildings

Final Regulation Impact Statement for commercial buildings (Class 3 and 5 to 9 buildings)

Prepared for

Australian Building Codes Board

Centre for International Economics
Canberra & Sydney

December 2009

The Centre for International Economics (TheCIE) is a private economic research agency that provides professional, independent and timely analysis of international and domestic events and policies.

TheCIE's professional staff arrange, undertake and publish commissioned economic research and analysis for industry, corporations, governments, international agencies and individuals.

TheCIE is based in Canberra and has an office in Sydney.

This report has been prepared by TheCIE on behalf of the Australian Building Codes Board.

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Glossary

ABCB	Australian Building Codes Board
ABRB	Australian Building Regulation Bulletin
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
AGGA	Australian Glass and Glazing Association
AIBS	Australian Institute of Building Surveyors
AIRAH	Australian Institute of Refrigeration, Air-conditioning and Heating
BAU	business as usual
BCA	Building Code of Australia
BCC	Building Codes Committee
BMT & ASSOC	BMT & ASSOC Pty Ltd
CFC	Construction Forecasting Council
CIE	Centre for International Economics
COAG	Council of Australian Governments
CO2-e	carbon dioxide equivalent
CPD	continuing professional development
CPRS	Carbon Pollution Reduction Scheme
DEWHA	Department of the Environment, Water, Heritage and the Arts
DLC	direct load control
DTS	deemed-to-satisfy
ETS	Emissions trading scheme
FAQ	frequently asked questions
GFA	gross floor area
GHG	greenhouse gas
GWh	gigawatt hour
HVAC	heating, ventilating and air-conditioning

Glossary *(continued)*

IEA	International Energy Agency
IGU	insulated glass unit
IPCC	Intergovernmental Panel on Climate Change
kVA	kilo volt amperes
kW	kilowatts
MJ	megajoule
MoU	memorandum of understanding
MRET	mandatory renewable energy target
Mt	megatonnes or millions of tonnes
MW	megawatt
NABERS	National Australian Built Environment Rating System
NLA	net lettable area
NPV	net present value
NSEE	National Strategy on Energy Efficiency
OBPR	Office of Best Practice Regulation
O&M	operation and maintenance
OCC	opportunity cost of capital
PFC	proposal for change
PIA	preliminary impact assessment
PJ	petajoule
RET	renewable energy target
RIS	regulation impact statement
STPR	social time preference rate
USE	unserved energy
WACC	weighted average cost of capital

Summary

This report is a Final Regulation Impact Statement (RIS) that assesses the costs and benefits of proposed amendments to energy efficiency requirements in the Building Code of Australia (BCA) for commercial (non-residential) buildings (equivalent to Class 3 buildings and Classes 5 to 9 buildings in the BCA).

Policy context of this RIS

The Australian Government, and more widely, the Australian community, have identified the objective of reduction in greenhouse gas (GHG) emissions and energy efficiency as a priority. The primary instrument proposed by the Government to address this problem is through the Carbon Pollution Reduction Scheme (CPRS).

A range of technical reports have provided evidence that substantial abatement of GHG emissions could be achieved at low or possibly negative cost in the building sector - relative to reductions available in other sectors of the economy. Moreover, this abatement could be achieved through the best-practice adoption of known energy efficient technologies. Persistent market failures and policy rigidities however, are thought to impede the take-up of these technologies and hence, addressing these barriers could require additional measures to complement the CPRS.

Scope of this RIS

The Coalition of Australian Governments (COAG) has already made an assessment of these market barriers in the context of the CPRS. The National Strategy on Energy Efficiency Memorandum of Understanding (COAG 2009c) states:

> A carbon price will provide an incentive for households and businesses to use energy more efficiently. *A carbon price alone, however, will not realise all the potential cost effective opportunities to improve energy efficiency across the Australian economy.* [emphasis added] Market barriers, such as split incentives, information failures, capital constraints, early mover disadvantage and transaction costs need to be addressed to remove impediments to investment in energy efficiency by households and business.

This RIS confines itself to considering the impacts of the amendments to the BCA as the only means of dealing with these barriers. This omission recognises that: a) COAG has already acknowledged the need to adopt a range of policies and tools so as to address the diversity of market barriers that exist, and b) the BCA is already in place and these amendments are only acting to increase its stringency.

The proposed amendments have been developed in accordance with an agreement between the Australian, State and Territory Governments to pursue a National Strategy on Energy Efficiency (COAG 2009a and 2009b). The amendments include provisions to increase the stringency of energy efficiency requirements for all Classes of commercial buildings in the BCA from 2010.

It is worth noting that on this occasion, COAG has signed a National Partnership Agreement on Energy Efficiency (COAG 2009c) that supports the use of increased energy efficiency standards through the BCA by 2010, as long as they demonstrate their cost-effectiveness. Additionally, for commercial buildings, COAG has set a target benefit to cost ratio of 2. By comparison, the benefit to cost ratio for the BCA 2006 measures was 4.9.

The scope of this report is strictly limited to quantifying the benefits and costs of the proposed amendments in a way that is consistent with COAG best practice regulation guidelines.

Business as usual case

An important ingredient of the quantification of the benefits and costs of the proposed amendments is the establishment of a Business-As-Usual (BAU) scenario. The BAU represents what may happen ‘without’ the proposed amendments to the BCA. It accounts for:

- growth in the building stock and shifts in population location;
- baseline improvements in energy efficiency and changes in energy prices; and
- major policy initiatives and other factors.

Importantly, the BAU builds on the modelling undertaken by the Australian Government in its analysis of the CPRS and increases in mandatory renewable energy targets. It also necessarily excludes the implications of other policies such as financial incentives for energy efficiency investments and the national roll out of smart meters.

Consistent with the evaluation methodology recommended in CIE (2009a), the analysis only accounts for new buildings that are built within 10 years of the adoption of the new standards assumed to occur in 2010. It is assumed that compliance costs are fully passed on to the user of the asset (the owner-occupier). All new building work requiring approval from the relevant regulatory authority is assumed to comply with the amended code.

Expected net impacts in the sample from increased energy efficiency

The results demonstrate that the impact of the provisions varies widely across building types and climate zones. The amendments can be expected to impose costs on the construction of new buildings, but these costs will be offset (at least in part) by energy savings enjoyed over the building's life — of 40 years. Depending on location, occupancy and building type, it is estimated that the proposed amendments could generate a net benefit of up to $340 (per square metre of gross floor space). The analysis also recognises that the amendments could impose a net cost of up to $248 (per square metre of gross floor space) for some buildings in certain areas. Generally, the greatest beneficiaries are retail and healthcare buildings.

Expected net impacts for the economy from increased energy efficiency

A high level analysis of the national impacts of the proposed BCA changes was undertaken through the aggregation of impacts from the building sample to regional, State and national levels. The results of the analysis under a 5 and 7 per cent discount rate, economywide, are presented in table 1.

In contrast to the Consultation RIS which was calculated at a 5 per cent discount rate, the results in the Final RIS have been calculated using a 7 per cent real discount rate. This rate reflects requirements of the OBPR. The national level results from different discount rates are presented in tables 1 and 2. That is, moving from a 5 per cent discount rate as presented in the Consultation RIS, to a 7 per cent discount rate as presented in the Final RIS, results in a reduction in net benefits to the economy from $2.1 billion and a BCR of 2.05 to $1.1 billion of net benefits to the Australian economy with a BCR of 1.61.

Overall, the approximately $2.9 billion of net benefits under a 7 per cent discount rate are estimated to include $2.6 billion of energy savings, and approximately $1.8 billion of costs, the majority of which are incurred in the form of additional capital outlays.

1 Present value of net impact, economywide

Element	*5 per cent discount rate*	*7 per cent discount rate*
	$	**$**
Costs	**2.0 billion**	**1.8 billion**
Additional net capital outlays	1.9 billion	1.8 billion
Industry compliance costs	15 million	15 million
Additional administration	250,000	250,000
Benefits	**4.0 billion**	**2.9 billion**
Energy savings from improved thermal performance	3.6 billion	2.6 billion
Capital savings for electricity generators and transmission networks	389 million	280 million
Net benefits	**2.1 billion**	**1.1 billion**

Note: Net impact figures in 2009 dollars;. Figures relate to buildings belonging to Classes 5, 6 and 9 and exclude impacts on Classes 3, 7 and 8 buildings. Annualised NPV calculations over 50 years.

Source: CIE estimates based on data provided by the ABCB and BMT & ASSOC.

At a 5 per cent discount rate the estimated BCR is consistent with the target specified by COAG (a BCR of 2), and implies that the benefits generated by the proposed changes to the BCA outweigh their cost, generating $2.05 dollars of benefits to the community for every one dollar of costs. However, when evaluated at a 7 per cent discount rate, as required by OBPR, a BCR of 1.61, below 2, is achieved, indicating only $1.61 of benefits for every $1 of costs. It should be noted that a sensitivity/risk analysis which allows all variables to alter within bounds of reasonable uncertainty estimated that the average BCR was 1.91. This result indicates that there is the potential for the BCR to be increased above the estimated 1.61, accounting for up-side potential in energy prices, or conservative bias having been included in the central case.

2 Net impact assessment, Australia

Discount rate	*Present value of net impact (NPV)*	*Benefit–cost ratio*
	$ million	BCR
7 per cent	1 138.1	1.61
5 per cent	2 131.6	2.05

Note: Net impact figures in 2009 dollars; discount rates are 5 and 7 per cent real. Figures relate to buildings belonging to Classes 5, 6 and 9 and exclude impacts on Classes 3, 7 and 8 buildings. Annualised NPV calculations over 50 years.

Source: CIE estimates based on data provided by the ABCB and BMT & ASSOC.

The key underlying factor in the choice of discount rate is whether the costs and benefits are being evaluated at a social or private level. Where a private evaluation is being undertaken, the appropriate discount rate is closely associated with the private decision making process of individuals. However, if the effects of the regulation are being evaluated at a social level, where there is the potential for benefits to be accumulating for a number of years, as well as to future generations, there is scope for these future benefits to hold a greater value, and hence attract a lower discount rate.

Importantly, the net impact assessment has been conducted on only those buildings provided in a sample of buildings from the ABCB. No information was provided or assessed relating to buildings belonging to Classes 3, 7 or 8. Including these buildings in the sample would increase both costs and benefits, and consequently the impact on the amendments' net impact is ambiguous. However, if costs and benefits of those building Classes represented in the analysis are indicative of those excluded, then it is unlikely that the amendment's BCR would be altered by any significant degree.

Disaggregated results based on city and building type are presented in table 3. While there are some building types in select regions that have estimated BCRs below 1, predominantly, net benefits are estimated.

The differences across regions and across building types are driven by a number of factors one of which is summer cooling requirements. For example, cooler climate areas that do not have a significant cooling load through summer have reduced ability to generate savings from improved envelope efficiency. In contrast, commercial buildings in hotter regions, with high cooling loads through the majority of the day, have a greater ability to gain energy use savings from reduced cooling requirements and improved envelope efficiency. Buildings with a smaller area also have a reduced ability to take account of efficiencies of scale in implementation than do larger buildings.

3 Net impact assessment, by region and building type

	Form 1: Office 2000m^2	*Form 2: Office 198m^2*	*Form 1: Retail 2000m^2*	*Form H: Health 2880m^2*	*Form H: School 2880m^2*
Present value of net impact (NPV)	$ per square metre of gross floor area				
Darwin	67.6	2.1	172.1	259.3	26.8
Brisbane	34.2	-49.6	102.6	180.5	48.3
Mt Isa	-64.7	-109.7	63.5	338.7	-17.9
Kalgoorlie	-39.7	-104.1	28.4	76.0	6.0

	Form 1: Office 2000m²	**Form 2: Office 198m²**	**Form 1: Retail 2000m²**	**Form H: Health 2880m²**	**Form H: School 2880m²**
Sydney	33.0	-50.9	97.1	195.5	-23.8
Adelaide	48.7	9.9	118.4	225.8	-14.0
Perth	33.0	-50.9	97.1	195.5	-23.8
Melbourne	4.1	-34.7	53.1	23.7	7.8
Hobart	-46.0	-89.0	27.3	-47.7	-36.6
Canberra	-19.0	-73.1	82.3	-11.3	-9.6
Thredbo	na	-247.7	na	-40.2	-36.0
Benefit–cost ratio					
Darwin	1.71	1.02	2.81	2.86	1.24
Brisbane	1.28	0.70	1.87	2.28	1.44
Mt Isa	0.63	0.54	1.40	2.99	0.89
Kalgoorlie	0.70	0.45	1.23	1.49	1.05
Sydney	1.38	0.62	2.34	3.11	0.77
Adelaide	1.58	1.12	2.71	3.42	0.87
Perth	1.4	0.6	2.3	3.1	0.8
Melbourne	1.05	0.68	1.73	1.20	1.11
Hobart	0.56	0.28	1.30	0.62	0.62
Canberra	0.82	0.41	1.91	0.91	0.90
Thredbo	na	0.11	na	0.75	0.74

Note: Estimates are presented in 2009 dollars with a 7 per cent real discount rate.
Source: CIE estimates based on data provided by the ABCB and BMT & ASSOC.

Other benefits

The proposed changes are also expected to produce significant social and environmental benefits associated with designing and constructing more sustainable commercial buildings. Indeed, the analysis undertaken for this RIS shows that, taking into account the likely impact of the CPRS on the emissions intensity of electricity, the proposed changes to the BCA can be expected to reduce the sector's annual emissions by 1.2 Mt CO2-e in 2020. This represents about one per cent of the Government's abatement target for that year.

Improving the thermal performance of buildings also confers a range of ancillary benefits in addition to reductions in energy-related expenditures and GHG emissions. These benefits could include, but are not limited to improved amenity values, health improvements, productivity boosts and 'green premiums' (in the form of higher rent and occupancy rates) (Energy

Efficient Strategies 2002). These benefits, however, are difficult to measure and value and have not been quantified in the RIS.

The positive net impact of the proposed changes implies that abatement can be achieved at a *negative* cost of about $70 per tonne of carbon abatement. That is, the proposed changes can reduce greenhouse emissions while *benefiting* the economy at the same time. By comparison, the Treasury estimates that the carbon price under the CPRS will be around $35 by 2020 — that is, across a diverse range of economic sectors, abating a tonne of carbon will impose a cost rather than benefit.

Consultation responses

While there was a total of 32 submissions that responded to the commercial RIS, there were only 9 submissions that only considered the commercial RIS.

Consultation responses to the draft RIS centred on the main issues of choice of discount rate and effects of different climate change policies, measurement of specialist building energy savings, as well as the general appropriateness of the regulations to achieve GHG emission reductions. A summary of the results of the consultation sensitivity analyses are:

- 10 per cent higher fabric building costs – BCR = 1.44; and
- Garnaut-25 climate policy – BCR = 1.97.

Overall consideration

This RIS does not formally analyse alternative non-regulatory and quasi-regulatory approaches. Rather it confines itself to only considering the impacts of the proposed BCA amendments. This recognises that:

- COAG has already acknowledged the need to adopt a range of policies and tools so as to address the diversity of market barriers that exist;[1] and
- the BCA is already in place and these amendments are only acting to increase its stringency.

The results of the Final RIS estimate net national benefits of approximately $1.1 billion due to the proposed changes, and a BCR of 1.61. These are slightly lower than the initial estimates provided in the Consultation RIS which indicated net benefits of approximately $2.1 billion and a BCR of

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[1] The key point is that a suite of complementary measures to the CPRS are needed.

2.05. These differences are driven by the choice of discount rate. Following the consultation period, including advice from OBPR, the results in the Final RIS utilise a discount rate of 7 per cent, higher than the 5 per cent utilised in the Consultation RIS.

Further discussions raised through the consultation period identified a number of uncertainties in the methodology and assumptions in the Consultation RIS. While there was limited quantitative discussion presented on the scale of these uncertainties, the main topics of concern included the choice of discount rate, estimation of building costs and projections of electricity prices. Other issues that were raised included methodological questions specific to building types that have been addressed in the body of the Final RIS.

A thorough review of the evidence and arguments submitted in response to the Consultation RIS indicate that there is a balancing of both the upside and downside risks as presented in the Consultation RIS.

The results as presented in table 3 demonstrate that the impact of the provisions varies widely across building types and climate zones. Depending on location, occupancy and building type, it is estimated that the proposed amendments could impose an impact (per square metre of floor space) of between -$250 and $340. In some areas for certain buildings, the net impact is negative (that is, a net cost). For other segments of commercial buildings, the net impact is positive (that is, net benefit). Generally, the greatest beneficiaries are retail and healthcare buildings.

A BCR greater than one implies the net impact of the proposed changes for the particular building, in the particular location is positive. In other words, the associated savings in energy expenditures outweigh the direct capital costs. Depending on the building, occupancy and location, BCR ratios ranged from 0.11 to 3.42.

The BCRs for healthcare and retail buildings were on average the largest of all buildings. Form 2 offices reported a BCR less than 1 in almost all locations. Also, the BCR for Canberra and Hobart is generally lower than other cities for all building types. Therefore, if small offices (Form 2) and the changes for Canberra and Hobart were excluded from the proposal the overall BCR would improve. Excluding buildings where there is a net cost would also be consistent with the COAG Best Practice Regulation Guide, particularly Principle 3 which requires adopting the option that generates the greatest net benefit for the community. Excluding certain buildings from the proposed (more stringent) energy efficiency provisions would also be consistent with the National Strategy for Energy Efficiency (NSEE).

NSEE Measure 3.2.1 states that a key element of the measure is for a *‘package of energy efficiency measures for implementation in 2010 – for new buildings and major new work in existing buildings which meets a benefit to cost ratio of 2:1*’.

On balance, based on the evidence as it now stands, the proposal outcomes suggest that there is scope for net national benefits of approximately $1.1 billion (with a BCR of 1.61), including potential net costs applicable to small offices and to locations such as Canberra and Hobart.

The Monte Carlo based sensitivity analysis presented in the Final RIS supports this position. Indeed, the average BCR presented in the Monte Carlo analysis was 1.9, indicating that there is additional scope for upward movement in the estimated BCR as it is presented in the Final RIS.

1 Introduction

The Building Code of Australia (BCA) provides nationally consistent, minimum technical standards for the design and construction of buildings in Australia. The Australian Building Codes Board (ABCB) on behalf of the Australian Government and State and Territory Governments produces and maintains the BCA.

In addition to structural, fire protection and health and amenity provisions, Section J Volume One of the BCA addresses minimum standards regarding commercial buildings' energy efficiency.

The ABCB first introduced energy efficiency requirements for buildings in 2003. At that time, the requirements only addressed some residential buildings (Class 1 and 10 buildings). They were then expanded to apply to Class 2, 3 and 4 buildings in early 2005. In 2006, the BCA introduced energy efficiency requirements for non-residential buildings (that is Class 5 to 9 buildings). An overview of the regulatory impact analysis of the 2006 changes in energy efficiency requirements for Classes 5 to 9 buildings is provided in box 1.1.

Current energy efficiency requirements for commercial buildings (including Class 3 and Class 5 to 9 buildings) include building fabric, glazing, mechanical services and artificial lighting. The extent of the requirements and the manner in which they are applied is dependent on the BCA classification of the building and the climate zone in which the development falls.

At its meeting on 30 April 2009, the Council of Australian Governments (COAG) reaffirmed its commitment to introducing a comprehensive National Strategy on Energy Efficiency (NSEE) to help households and businesses reduce their energy costs, improve the productivity of the Australian economy and reduce the cost of greenhouse gas abatement under the Carbon Pollution Reduction Scheme (CPRS). As a first step, COAG agreed to two key measures to improve the energy efficiency of commercial buildings across Australia (COAG 2009a):

- an increase in the stringency of energy efficiency requirements for all Classes of commercial buildings in the BCA from 2010; and

1.2 Impact analysis of energy efficiency requirements for Class 5 to 9 buildings (ABCB RIS 2006b)

In 2006, a RIS was produced to analyse the likely impact of including energy efficiency requirements in the BCA for Class 5 to 9 buildings. The proposed requirements embraced lighting, glazing, building envelope insulation (wall, floor and ceiling) and air conditioning. The requirements also extended to building sealing, air movement and hot water supply services, as well as broad maintenance provisions.

The main findings of the analysis were that:

The present value of the additional construction costs from the proposed measures over 10 years was about $680 million.

- The total benefits of the measures were about $3.4 billion in present value terms.
- The net effect of the provisions was to reduce the lifetime costs of commercial buildings by about $2.7 billion.
- The effect of the measures was to reduce the emissions associated with the commercial buildings sector by about 1.2 Mt CO2e in 2010.

General features of the analysis underpinning the 2006 RIS include the following:

- The assumed life of the regulation is 10 years.
- Costs and benefits were discounted using:
  - a 5 per cent real discount rate for social costs and benefits; and
  - a 7 per cent post-tax nominal discount rate for the assessment from an owner-occupier perspective.
- A uniform figure of 12.5 per cent was applied to the estimates of additional construction costs to account for additional planning, design and compliance costs.
- Costs and benefits of refurbishment of existing floor space were not included in the analysis.
- To account for additional repairs, maintenance and running cost:
  - it was assumed that the installation of an outside air cycle increases HVAC maintenance and running costs (ex. energy) by 5 per cent; and
  - 4 per cent was added to the estimate of additional construction costs to allow for additional repair and maintenance costs.
- HVAC systems are assumed to have an economic life of 15 years.

Notably, while many features of the methodology in this RIS are similar to those used for the 2006 RIS, the analysis necessarily differs. Any significant methodological differences between the two RISs have been highlighted in the body of the report.

Source: ABCB 2006b.

- the phase-in of mandatory disclosure of the energy efficiency of commercial buildings and tenancies commencing in 2010.

Following its meeting in April 2009, COAG requested the ABCB to implement the BCA proposals. At its meeting on 2 July 2009, COAG agreed to a National Strategy on Energy Efficiency and confirmed a full suite of measures to be included in the strategy, including the above measures (COAG 2009c and 2009d).

Purpose of the report

Given the regulatory nature of the BCA and the fact that it is jointly produced by the Australian Government and the State and Territory Governments, the proposed increased energy efficiency provisions for residential and commercial buildings in the BCA are subject to a Regulation Impact Statement (RIS).

In light of this process, the ABCB commissioned the Centre for International Economics (TheCIE) to develop a Consultation RIS that assesses the costs and benefits of proposed changes to the energy efficiency provisions in the BCA with regards to commercial buildings.

Scope of the RIS

The ABCB released a draft of the proposed technical changes in June 2009 for public comment (ABCB 2009b and 2009d). This document serves as a Regulation Impact Statement (RIS) that assesses the costs and benefits of proposed changes to the energy efficiency requirements for commercial (non-residential) buildings as defined by COAG (equivalent to Class 3 and 5 to 9 in the BCA).

A general summary of classifications of buildings and structures used in the BCA is provided in table 1.2 below. The buildings defined by COAG as commercial and addressed in this report have been shaded.

Importantly, this RIS does not directly assess the costs and benefits of the phase-in of mandatory disclosure of the energy efficiency of commercial buildings and tenancies agreed by COAG at its 30 April 2009 meeting.

A separate RIS addresses a proposal to amend the energy efficiency requirements for residential buildings as defined by COAG (Class 1, 2, 4 and 10 buildings in the BCA).

1.3 Classifications of buildings and structures used in the BCA

Class	***Description***
Class 1a	A single detached house or one or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit.
Class 1b	A boarding house, guest house, hostel or the like with a total floor area not exceeding 300 m^2 and in which not more than 12 persons would ordinarily be resident, which is not located above or below another dwelling or another Class of building other than a private garage.
Class 2	A building containing 2 or more sole-occupancy units each being a separate dwelling.
Class 3	A residential building, other than a Class 1 or 2 building, which is a common place of long term or transient living for a number of unrelated persons. Example: boarding house, hostel, backpacker's accommodation or residential part of a hotel, motel, school or detention centre.
Class 4	A single dwelling in a Class 5, 6, 7, 8 or 9 building.
Class 5	An office building used for professional or commercial purposes, excluding buildings of Class 6, 7, 8 or 9.
Class 6	A shop or other building for the sale of goods by retail or the supply of services direct to the public, including: (a) an eating room, cafe, restaurant, milk or soft-drink bar; or (b) a dining room, bar, shop or kiosk part of a hotel or motel; or (c) a hairdresser's or barber's shop, public laundry, or undertaker's establishment; or (d) market or sale room, showroom, or service station.
Class 7a	A building which is a carpark.
Class 7b	A building which is for storage, or display of goods or produce for sale by wholesale.
Class 8	A laboratory, or a building in which a handicraft or process for the production, assembling, altering, repairing, packing, finishing, or cleaning of goods or produce is carried on for trade, sale, or gain.
Class 9a	A health-care building; including those parts of the building set aside as a laboratory.
Class 9b	An assembly building, including a trade workshop, laboratory or the like in a primary or secondary school, but excluding any other parts of the building that are of another Class.
Class 9c	An aged care facility.
Class 10a	A non-habitable building being a private garage, carport, shed, or the like.
Class 10b	A structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like.

Note: Highlighted classes addressed in this report.

Source: Building Code of Australia.

Compliance with COAG principles

This report and the Consultation RIS before it document the changes under consideration and detail their expected costs and benefits. The consultation report was aimed at assisting a wide range of built environment related stakeholders in providing feedback to the ABCB on the proposed changes to the BCA. This final report provides the outcomes of the process.

The RIS has been developed in accordance with the COAG regulatory principles set out in *Best Practice Regulation: a Guide for Ministerial Councils and National Standard Setting Bodies* (referred to as the 'COAG Guidelines'). It follows a seven stage process as depicted in chart 1.3.

The RIS process is aimed at ensuring that the preferred government action is 'warranted' and 'justified' (OBPR 2007). As such, a RIS should present any available evidence on benefits and costs. The process of developing a RIS is intended to enhance the transparency of the regulatory process (and thereby promote public scrutiny and debate) to provide comprehensive treatment of the anticipated (and unintended) consequences of the proposed changes.

It is worth noting that on this occasion, COAG has signed a National Partnership Agreement on Energy Efficiency (COAG 2009c and 2009d) that supports the use of increased energy efficiency standards through the BCA by 2010, as long as they demonstrate their cost-effectiveness. Additionally, for commercial buildings, COAG has set a target benefit to cost ratio of 2. By comparison, the benefit to cost ratio for the BCA 2006 measures was 4.9.

Structure of the report

This report is structured as follows:

- Chapter 2 presents evidence on the magnitude (scale and scope) of the problem being addressed by the proposed changes.
- Chapter 3 articulates the objectives of the government action and identifies a range of viable alternative policy approaches.
- Chapter 4 describes the framework for analysis.
- Chapter 5 discusses public responses to the Consultation RIS and changes made in the Final RIS to reflect these responses.
- Chapter 6 presents the costs analysis.
- Chapter 7 describes the benefits analysis.
- Chapter 8 presents the net impact analysis.

1.4 **Stages of the ABCB RIS development process**

1. OBPR COLLABORATION

Consult OBPR and seek endorsement of RIS methodology

2. CONSULTATION RIS DEVELOPMENT

Prepare consultation RIS

3. OBPR COLLABRATION

Seek OBPR endorsement of consultation RIS for public release

4. PUBLIC CONSULTATION

Release consultation RIS

5. FINAL RIS DEVELOPMENT

Develop final RIS

6. OBPR COLLABORATION

Submit final RIS for OBPR for clearance for decision-making

7. BOARD DECISION

OBPR endorsed final RIS to Board for decision

Data source: ABCB (2008).

- Chapter 9 discusses other impacts and implementation issues.
- Chapter 10 outlines the consultation process.
- Chapter 11 discusses the consultation sensitivity analysis and Monte Carlo analysis of the Final RIS results.
- Chapter 12 details the conclusion of the findings.

2 Statement of the problem

Around two-thirds of national employment and economic activity takes place in commercial buildings. Class 3 and 5 to 9 buildings include office buildings, shops, restaurants, car parks, industrial buildings and hospitals, amongst other. They effectively provide space for industry and most service sector activities, such as retail, wholesale trade, food service, finance and insurance, government administration, health and community services and education.

Since commercial buildings play such an essential role in a modern economy, improving their energy efficiency can assist in achieving both energy security and Greenhouse Gas (GHG) abatement objectives. Research shows that energy efficiency measures can be cost-effective on both a private and social level.[2] However, a range of barriers — informational and market-based — are recognised as the cause for the relatively low adoption of energy efficiency technology.

Energy demand in commercial buildings

According to ABARE estimates of Australian energy consumption, in 2006-07 the commercial sector accounted for 248 petajoules (PJ) (ABARE 2007). This demand is projected to grow to around 434 PJ by 2029-30 under the current trends (ABARE 2007 p. 80). That is, energy consumption will increase by more than 75 per cent in the period to 2030, with an average annual growth rate of around 2.3 per cent. Chart 2.5 compares the growth in forecasted energy demand for residential and commercial sectors. As shown in this chart, the commercial sector's energy demand is expected to grow faster than in the residential sector.

Chart 2.6 illustrates commercial building demand for energy relative to other sectors in 2006-07. Commercial sector energy demand in 2006-07 was around 7 per cent of Australia's total energy consumption of 3 600 PJ (ABARE 2007) (relative to the residential demand of 12 per cent). This demand is around the same as mining and more than twice that of

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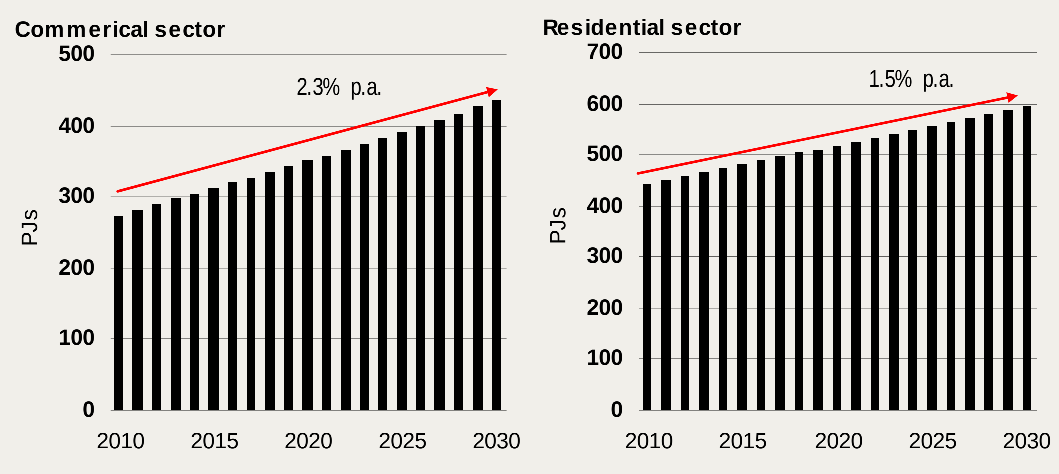
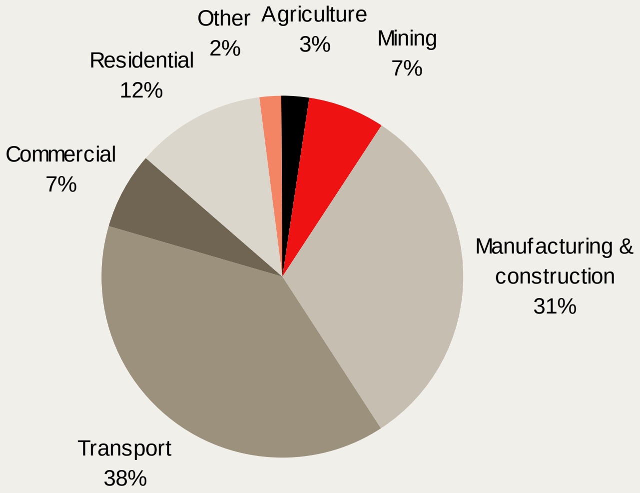
[2] See for instance Levine et al (2007), McKinsey & Company (2008), McLennan Magasanik Associates (2008a) and Productivity Commission (2005).

2.5 Energy demand projections for commercial and residential building sectors



[a] Estimates reflect the energy consumption in the absence of the CPRS.
Data source: ABARE (2007).

2.6 Energy consumption in Australia, by industry, 2006-07



Data source: ABARE (2007).

agriculture. Significantly, the chart takes into consideration energy consumed from all sources — not just electricity.

GHG emissions from commercial buildings sector

The building sector is a source of GHG emissions. Rather than being a producer of *direct* GHG emissions (from, say, burning fossil fuels) the sector mostly drives emissions through the consumption of energy (mainly electricity).[3] Emissions from this sector are often accounted for against suppliers such as electricity producers (or generators) and those that transport or transmit electricity. Clearly producers would not supply energy unless there was demand for it. Emissions from the building sector are indirect, but as shown below, they are still substantial and still have an important part to play in reducing our GHG emissions.

Buildings have other characteristics that raise issues for GHG emissions. Many have an effective lifespan that spans several decades — throughout which they house activities that consume energy. Much of the energy consumed in buildings is embedded in the systems used to support and operate that building. The design of buildings also has profound effects on the need for services such as lighting, heating and cooling. Decisions made *now* about buildings will shape energy demand for many years to *come* (CIE 2009b).

Despite the fact that the commercial buildings sector is a major source of energy demand, there are few official statistics about the amount of GHG emissions that can be attributed to the sector. As such, it is necessary to approximate the likely amount of emissions based on some official indicators and a few informed estimates. Based on data from the most recent National Greenhouse Accounts (DCC 2009), data published by ABARE (2008) and CIE estimates, energy consumption in the commercial buildings sector is estimated to be responsible for GHG emissions of around 49 Mt CO2-e in 2007.[4] This estimate reflects the carbon intensity of fuels (for example, electricity and gas) consumed by building occupants.

GHG emissions from the energy demand of the commercial buildings sector are expected to rise at a relatively fast rate under BAU. Indeed, based on official parameters, the CIE estimates that emissions from the commercial buildings sector would grow above 115 Mt CO2-e by 2050 *without the CPRS in place*. This reflects an average annual growth rate of 2 per cent (see chart 2.3).

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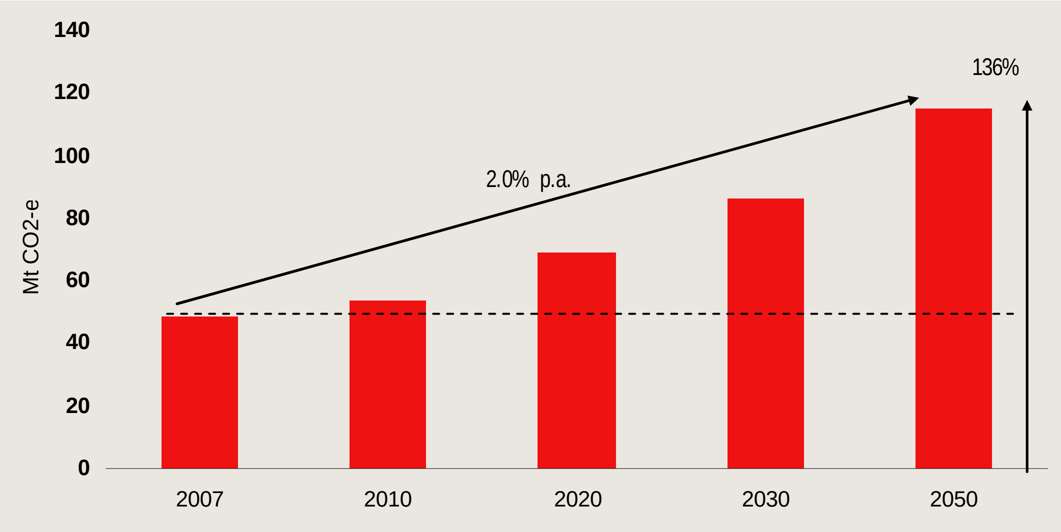
[3] Approximately 61 per cent of the energy consumed by the buildings sector in 2009 was from electricity. Nonetheless, the sector also produces direct emissions through burning of natural gas, wood and other petroleum products.

[4] Measured including scope 1 and scope 2 emissions for electricity consumption.

2.7 **Commercial building sector emissions projections**



a Estimates reflect the commercial building sector's emissions in the absence of the CPRS.
Data source: CIE (2007), ABARE (2008) and Treasury (2008)

The CPRS will impact on the commercial buildings sector emissions in two ways. First, and most significantly, the CPRS will reduce the emissions intensity of purchased electricity upon its introduction. From 2030 on — when renewable energy and carbon capture and storage technologies are expected to become available — this impact will be very dramatic. The Treasury's modelling of the CPRS[5] estimates that the intensity of electricity emissions will fall to less than one fifth of its 2006 level (Australian Government 2008).

Second, the price signal sent through the economy by the CPRS will encourage the commercial buildings sector to consume less energy. Energy demand however, is relatively unresponsive to changes in price (NIEIR 2007). As a consequence, this will mean that the effects of any price signal will be relatively mute. The CIE has estimated that on average, the commercial buildings sector will reduce energy consumption by about 16 per cent by 2050 as a result of this signal.

The two effects described above can be expected to reduce the commercial buildings sector's emissions by around 16 Mt CO2-e in 2030, and by approximately 87 Mt CO2-e in 2050 (see chart 2.4).

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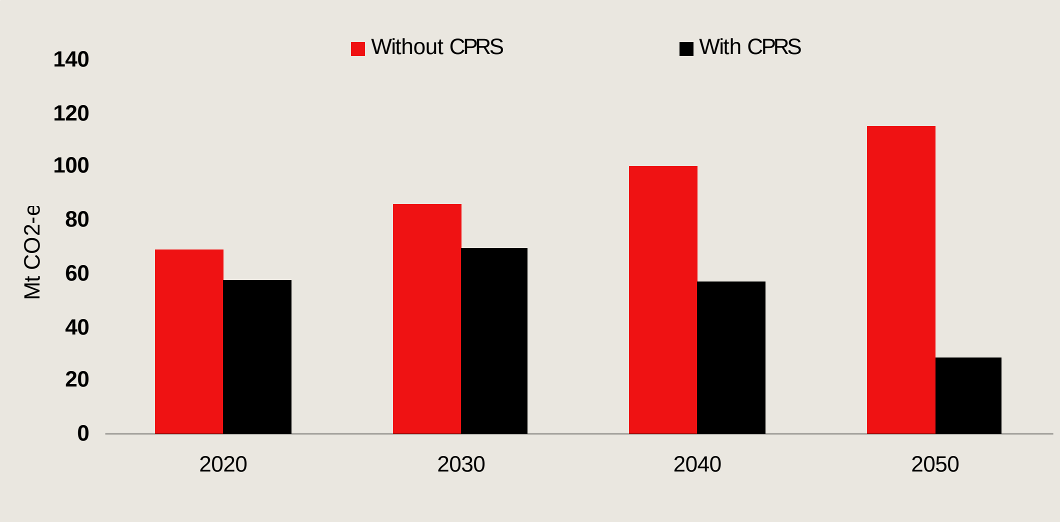
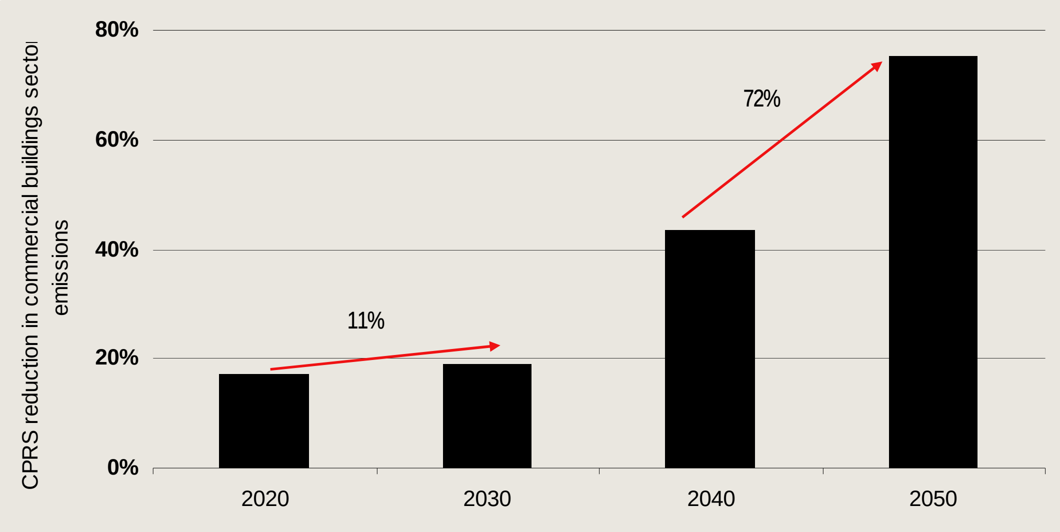
[5] Specifically, the CPRS-5 scenario.

2.8 Commercial building sector emissions with and without the CPRS



Data source: CIE (2007), ABARE (2008) and Treasury (2008)

2.9 Commercial buildings sector emissions abatement under the CPRS



Data source: CIE estimates based on various sources, including ABARE (2008) and Australian Government (2008).

Notably, as chart 2.9 illustrates, the commercial building sector's GHG abatement under CPRS rapidly accelerates after 2030. From 2020 to 2030, abatement under CPRS increases by only around 11 per cent. In contrast, abatement increases by 72 per cent in the following two decades from 2030 to 2050. Under the CPRS, the commercial buildings sector is expected to reduce its GHG emissions by nearly 75 per cent by 2050.

Policy response

While the CPRS' price signal may encourage some demand side abatement from the commercial buildings sector, a substantial amount of abatement remains untapped. Studies undertaken in Australia to assess the potential for energy efficiency gains and related GHG emissions abatement report the existence of considerable untapped cost effective energy efficiency opportunities (CIE 2008). While there are aspects of these studies that draw comment and criticism (regarding assumptions about future energy prices, discount rates, investment costs necessary to achieve energy efficiency improvements, business as usual projections, adoption rates of best practice and administration costs) consistencies in the key result results are significant. A summary of the estimated energy efficiency potential reported in selected Australian studies is provided in CIE (2008) and reproduced in table 2.6 below.

2.10 **Potential and scope for energy efficiency in Australia (selected sectors)**

	Energy efficiency potential (%)				
Sector	***SEAV-NFEE Phase 1 – low scenario***	***SEAV-NFEE Phase 1 – high scenario***	***SEAV-NFEE Phase 2***	***SEAV-NFEE general equilibrium study***	***Clean Energy Future Group***
Commercial	27	70	10.4	10.4	39
Residential	34	73	13	13	21

Note: SEAV = Sustainable Energy Authority Victoria. NFEE = National Framework for Energy Efficiency.
Source: McLennan Magasanik Associates Pty Ltd (2008) referred in CIE (2008).

International studies also highlight the significant potential to reduce energy demand in the building sector. Some examples are provided below.

- Stern (2007) notes that key reviews of global energy needs and options to combat climate change broadly agree that energy efficiency will make a very significant proportion of the GHG abatement needed and it will form the lower cost means of achieving that abatement.
- The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) examined the potential GHG abatement from the residential and commercial building sectors in considerable detail (Levine et al 2007). This study notes that a survey of 80 studies in the literature indicates that there is a global potential to cost-effectively reduce approximately 29 per cent of the projected baseline emissions in the residential and commercial sectors by 2020.

- The International Energy Agency (IEA) reviewed the experience of developed countries and concluded that there was substantial scope for GHG abatement in the building sector and that unexploited energy efficiency offers the single largest opportunity for GHG emissions reductions (IEA 2003).

There are currently a suite of policy measures at national and State and Territory levels aimed at improving energy efficiency in the commercial buildings sector. These initiatives include:

- the CPRS;
- the current energy efficiency requirements for new commercial buildings in the current BCA;
- mandatory disclosure of building energy, greenhouse and water performance;
- a variety of rating tools to measure the environmental and greenhouse performance of buildings both at the design and operational stage. While the use of these tools is not compulsory, many governments have set, or are planning to set, minimum standards for their property portfolios according either to NABERS (see box 2.7) or Green Star rating tools;
- strategies for high efficiency of heating, ventilation and air conditioning (HVAC) systems;
- the phase-out of inefficient incandescent lighting;
- Minimum Energy Performance Standards (MEPS) and labelling for appliances and equipment; and
- the Energy Efficiency Opportunities (EEO) program, which covers large energy users in the commercial sector.

Despite this range of measures focused on facilitating the adoption of energy efficient technologies, significant opportunities still exist for further improvements in the energy efficiency of commercial buildings.

Need for further government intervention

Clearly, the Australian Government and leading international agencies have highlighted opportunities for GHG abatement through energy efficient buildings for a number of reasons. In addition to complementarity with multiple policy objectives, energy efficiency measures offer economically efficient and sizeable abatement potential. Achieving the abatement potential, however, requires government action to overcome market barriers.

2.11 **NABERS and the BCA**

An issue raised by industry in the past is that the BCA contains minimum energy efficiency requirements that have to be complied with in order to receive building approval while some building owners also require the building to achieve a NABERS Energy rating (formally Australian Building Greenhouse Rating). This is seen as an unnecessary duplication.

Fundamentally, the BCA is a set of design requirements and NABERS Energy is a performance-in-use validation tool. However, NABERS Energy does have a design protocol which has aspects in common with the BCA approach.

The ABCB Office has undertaken modelling as part of an investigation into the suitability of using the NABERS Energy design protocol as a BCA Verification Method. However, the modelling found that there are a number of issues to be resolved beforehand.

Analysis of this issue is likely to be captured as part of the new national framework for energy efficiency standard setting, assessment and rating, which was announced on 2 July 2009 as part of the National Strategy on Energy Efficiency.

Source: DEWHA and the ABCB.

The Australian Government has identified energy efficiency in buildings as a ‘second plank’ to its climate change policy. The Australian Government’s white paper on the Carbon Pollution Reduction Scheme (DCC 2008) states:

> Together with the Carbon Pollution Reduction Scheme, an expanded Renewable Energy Target, investment in carbon capture and storage demonstration, and action on energy efficiency are the foundation elements of Australia’s emissions reduction strategy. These policies will ensure that Australia has the tools and incentives to reduce its emissions and to develop technologies to help reduce greenhouse gas emissions globally.

Economic studies highlight the cost-effectiveness of energy efficiency measures as a GHG abatement strategy. Improving the energy efficiency of buildings is often viewed as cost neutral or even cost negative. In other words, on a financial basis, the direct expenditures associated with improving energy efficiency are fully offset by associated savings (i.e. measures lower electricity-related expenditures). The Intergovernmental Panel on Climate Change (IPCC) in *Climate Change 2007: Mitigation* devotes a chapter to the abating GHG emissions through policies that emphasise energy efficiency in residential and commercial buildings. The authors conclude that improving energy efficiency in buildings ‘encompasses the most diverse, largest and most cost-effective mitigation opportunities in buildings.’ Stern (2007) indicates that key reviews of options to address climate change generally agree energy efficiency will make a very significant proportion of the GHG abatement needed and form some of the lower cost means of abatement.

The GHG abatement opportunities in buildings are substantial. The presence of a significant ‘energy efficiency gap’, that is the difference between potential and actual energy efficiency in buildings, is widely recognised. The gap highlights abatement opportunities reliant on known technologies. IPCC (2007) concludes that ‘substantial reductions in CO_2 emissions from energy use in buildings can be achieved over the coming years’. International Energy Agency (2007) writes, ‘energy efficiency is also widely seen as the most important near term strategy to mitigate CO_2 emissions’.

Of course, the key issue here is whether government action, that is an amendment to the BCA, is warranted here given the current suite of policy measures aimed at improving energy efficiency and the proposed implementation of the Australian Government’s CPRS. In other words, will market barriers persist?

The above sections highlight that despite a range of measures focused on facilitating the adoption of energy efficient technologies in buildings, a substantial gap continues between the potential and actual energy efficiency performance of buildings. The above sections also highlight the importance commercial buildings play in both energy demand and GHG emissions. Studies highlight that a gap exists between the current and potential level of cost-effective energy efficiency that could be achieved in buildings (see CIE 2007 and 2008, Levine et al 2007, McKinsey & Company 2008, McLennan Magasanik Associates 2008 and IEA 2008).

In the near term, the Australian Government’s modelling suggests that CPRS will not have a strong impact on projected energy demand. This effect is attributed to several factors. First, energy demand is relatively inelastic (that is, relatively unresponsive to price changes). Second, a range of market barriers exist which are not addressed by the CPRS. In proposing amendments to the BCA, COAG noted several of these market barriers. The National Partnership Agreement (COAG 2009d) states:

> A carbon price will provide an incentive for households and businesses to use energy more efficiently. *A carbon price alone, however, will not realise all the potential cost effective opportunities to improve energy efficiency across the Australian economy.* [emphasis added] Market barriers, such as split incentives, information failures, capital constraints, early mover disadvantage and transaction costs need to be addressed to remove impediments to investment in energy efficiency by households and businesses.

COAG’s view is consistent with leading international agencies. The IPCC (2007) concludes that the adoption of energy efficiency measures to abate GHG emissions faces ‘substantial’ market barriers. Among the noted market barriers is the ‘high cost of gathering reliable information on energy efficiency measures’. The authors advocate for a ‘faster pace of well-enforced policies and programs.’

The World Energy Council (2008) in a review of energy efficiency policies notes that regulatory measures are widely implemented where the market fails to give the right signals (buildings, appliances etc). It goes on to note that market measures fail because final users do not typically have to pay the heating or cooling bills and due to the lack of transparency in the market for overall energy service costs. It concludes, ‘Energy efficiency policy and measures (‘non-price measures’) are therefore necessary to complement the role of prices.’

In addition, the ABCB, in its RIS for a 5-star standard (ABCB 2006a), noted several market barriers. They include:

- negative externalities associated with electricity consumption — that is, households could not make socially optimal choices regarding electricity consumption if the price of electricity excluded the cost of climate change and if they do not receive a clear price signal about the timing and quantum of their electricity consumption (for example, peak versus off peak, seasonal fluctuations);
- information asymmetry and limitations crucially affect decisions about investing in energy efficiency. That is, calculating the pay back to investing in energy efficiency requires knowledge about how long the household will occupy the house, future energy prices and amenity preferences. Collecting and understanding the information necessary to make fully informed decisions reflecting all of these factors is difficult and time consuming; and
- split incentives where the developer, home owner and occupier may not be the same entity, resulting in one party accruing the costs (that is, up-front capital investment), while the other party receives the benefits (for example, lower energy bills).

Some studies also note an additional barrier which is capital constraint (for example, Stern 2007, PC 2005, EEWG 2004, Australian Government 2008, Garnaut 2008). Energy efficiency investments require up-front capital (or financing) while the benefits of lower energy use accrue over time and often during a period that is not aligned with the financing period.

All but the negative externality associated with GHG emissions remain relevant to current and projected conditions. The Australian Government’s proposed CPRS will address the carbon externality. It will place an economywide cap on GHG emissions. GHG abatement through the BCA's energy efficiency measures will effectively reduce the burden on other economic sectors in meeting their CPRS obligations without generating further reductions (beyond the aggregate, economywide emission cap).

3 Objectives of government action and policy options

This chapter outlines the objectives of government action, discusses the objectives of the proposed BCA amendments, provides a brief description of the regulatory proposal, and considers in brief alternative policy approaches.

Objectives of government action

All levels of government in Australia are committed to improving energy efficiency. In August 2004 the Ministerial Council on Energy (MCE), comprising the Energy Ministers of all Australian governments, agreed to support energy efficiency by agreeing to a comprehensive package of foundation measures under the National Framework for Energy Efficiency (NFEE).

The NFEE aims to ‘unlock the significant but un-tapped economic potential associated with the increased uptake of energy efficient technologies and processes across the Australian economy. It aims to achieve a major enhancement of Australia’s energy efficiency performance, reducing energy demand and lowering greenhouse gas emissions’ (DRET 2009).

The NFEE covers a range of policy measures designed to overcome the barriers and challenges that prevent the market delivering the actual economic potential of energy efficiency. In particular, the NFEE focuses on demand-side energy efficiency, primarily in the residential, commercial and industrial sectors. More details about the two stages of the NFEE are presented in box 3.12.

While the NFEE is an important step towards improving energy efficiency, Governments recognised that additional efforts were needed to improve the uptake of energy efficient opportunities. Indeed, COAG (2009c, p. 2) states that:

> While Governments agree that existing initiatives such as the National Framework for Energy Efficiency…are making important contributions to improving energy efficiency, the need to transition to a low carbon future gives renewed impetus to deliver a step change in energy

efficiency and to realise the benefits from cost-effective energy-saving initiatives.

In light of this, in October 2008 COAG agreed to develop a National Strategy on Energy Efficiency (NSEE) to accelerate energy efficiency efforts, streamline roles and responsibilities across levels of governments, and help households and businesses prepare for the introduction of the CPRS. The NSEE will complement the CPRS by addressing the barriers that are preventing the efficient uptake of energy efficient opportunities, such as split incentives and information failures.

3.12 Stage One and Two of the National Framework for Energy Efficiency (NFEE)

The NFEE Stage One ran from December 2004 through to the end of June 2008. The key measures within NFEE Stage One include (NFEE 2007):

- energy efficiency standards and mandatory disclosure for buildings;
- Minimum Energy Performance Standards (MEPS) and labelling for appliances and equipment;
- the Australian Government's Energy Efficiency Opportunities (EEO) scheme; and
- capacity building (including training, accreditation and information provision).

In December 2007, Stage Two of the NFEE was agreed by the Australian Government and State and Territory Energy Ministers. This stage comprises a package of five new energy efficiency measures:

- expanding and enhancing the MEPS program;
- Heating, ventilation and air conditioning (HVAC) high efficiency systems strategy;[6]
- phase-out of inefficient incandescent lighting;
- Government leadership though green leases;
- development of measures for a national hot water strategy.[7]

In addition to the new measures above, a number of Stage One measures are continuing including the EEO program, the Energy Efficiency Exchange (EEX), and the National House Energy Rating Scheme (NatHERS).
Source: NFEE (2007).

On April 2009, COAG reaffirmed its commitment to introducing the NSEE and agreed to the following five measures to improve the energy efficiency of residential and commercial buildings across Australia (COAG 2009a):

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[6] At the December 2008 meeting of the MCE, Australian Government and State and Territory Energy Ministers endorsed the National Hot Water Strategy and a revised HVAC high efficiency systems strategy. Both projects commenced on 1 January 2009.

[7] Ibid.

- an increase in the stringency of energy efficiency requirements for all classes of commercial buildings in the BCA from 2010;
- an increase in energy efficiency requirements for new residential buildings to six stars, or equivalent, nationally in the 2010 update of the BCA, to be implemented by May 2011;
- new efficiency requirements for hot-water systems and lighting for new residential buildings;
- the phase-in of mandatory disclosure of the energy efficiency of commercial buildings and tenancies commencing in 2010; and
- the phase-in of mandatory disclosure of residential building energy, greenhouse and water performance at the time of sale or lease, commencing with energy efficiency by May 2011.

On 2 July 2009 COAG, signed the National Partnership Agreement on Energy Efficiency and confirmed a full suite of measures to be included in the strategy, including the above measures (COAG 2009d). This partnership agreement will deliver a nationally-consistent and cooperative approach to energy efficiency, encompassing (COAG 2009e):

- assistance to households to reduce energy use by providing information and advice, financial assistance and demonstration programs;
- assistance to business and industry to obtain the knowledge, skills and capacity to pursue cost-effective energy efficiency opportunities and therefore meet the challenges of a low carbon economy;
- higher energy efficiency standards to deliver substantial growth in the number of highly energy efficient homes and buildings, and provide a clear road map to assist Australia’s residential and commercial building sector to adapt;
- nationally-consistent energy efficiency standards for appliances and equipment and a process to enable industry to adjust to increasingly stringent standards over time;
- introducing in 2010 new standards for the energy performance of air conditioners and increasing the standard by a further 10 per cent from 1 October 2011;
- addressing potential regulatory impediments to the take up of innovative demand side initiatives and smart grid technologies;
- governments working in partnership to improve the energy efficiency of their own buildings and operations; and
- a detailed assessment of possible vehicle efficiency measures, such as CO2 emission standards.

To sum up, the objectives of government action are:

- improve Australia's energy efficiency performance, reducing energy demand and lowering greenhouse gas emissions;
- overcome the barriers and challenges that prevent the market delivering the significant but un-tapped economic potential associated with the increased uptake of energy efficient technologies and processes across the Australian economy;
- accelerate energy efficiency efforts; and
- deliver a nationally-consistent and cooperative approach to energy efficiency.

Objective of the proposed amendments

The BCA sets out standards that address health, safety (structural and fire), amenity and sustainability objectives. It is intended to:

- be based upon a rigorously tested rationale for the regulation;
- generate benefits to society that are greater than the costs (that is, net benefits);
- be no more restrictive than necessary to protect the public interest; and
- be more economically efficient than other feasible regulatory or non-regulatory alternatives.

With the increased focus on combating climate change, the Australian Government, in agreement with State and Territory Governments, has committed to an approach that involves introducing mandatory minimum energy efficiency requirements through the BCA.[8] The development of these energy efficiency provisions is a collaborative effort between the ABCB, other government agencies and industry. Further, the Australian Government — in setting out its vision for the CPRS — has noted the importance of complementary measures. In particular, the Australian Government has noted the potential of the built environment to contribute through energy efficiency improvements.

To implement the energy efficiency measures, the ABCB proposes to amend Volume One of the BCA to enhance energy efficiency requirements set out in Section J.

The amendments assessed in this Final RIS address commercial buildings Class 3 and 5 to 9. Their objectives are to:

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[8] See National Partnership Agreement on Energy Efficiency signed July 2009 (COAG 2009d) and 2 July 2009 Meeting Communiqué (COAG 2009c).

- abate GHG emissions;
- reduce energy demand; and
- overcome market barriers to the adoption of energy efficiency measures.

The proposed BCA provisions are subject to a cost-effectiveness test. Additionally, they must deliver a benefit–cost ratio (BCR) of 2. This target BCR is more stringent than the BCR for the 2006 energy efficiency measures, which was 4.9.

Description of the regulatory proposal

Box 3.2 provides an overview of the BCA's structure. This overview provides context to the proposed regulatory amendments.

3.13 **BCA structure**

The BCA is organised as a hierarchy of Objectives, Functional Statements, Performance Requirements and Building Solutions.

- Each Objective is a broad societal goal, which in this case is to reduce greenhouse emissions.
- For each Objective, there are Functional Statements and Performance Requirements describing how a building meets the Objectives. For example, the building's services need to be continually capable of using energy efficiently.
- The BCA is a performance-based code, in this case requiring the implementation of Building Solutions that deliver specified minimum levels of energy efficiency. Two broad types of Building Solution may be adopted, either the deemed-to-satisfy (DTS) provisions or an Alternative Solution (or a combination of DTS and Alternative Solution). The DTS provisions are detailed building requirements that are regarded as meeting the Performance Requirements. However building practitioners can also adopt Alternative Solutions (also, in some instances, referred to as the 'software approach') where these can be shown to meet the Performance Requirements.

Source: ABCB 2006b

The proposed amendments address Section J of BCA Volume One (appendix A provides a description of these amendments). The key features of the proposal are:

- the Objective and Functional Statement in Section J will be amended to specifically reference abatement of GHG emissions through operational energy as well as energy efficiency;[9] and

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[9] Notably, both the Objective and Functional Statement in Section J are for guidance only. In contrast, the Performance Requirements in this Section are mandatory.

- amendments to various parts of Section J. Highlights of these amendments are:
  - JP3 amendments will encourage energy to be used from less greenhouse gas intensive sources, for example, affecting floor heating systems and boilers;
  - Verification Methods will also be affected by the proposed amendments;
  - Part J0 DTS provisions replace the prescriptive provisions addressing each building element in isolation;
  - Part J1 involves amendments to the building fabric provisions, such as insulation, roof and ceiling construction, floor construction, walls, etc;
  - Part J2 affects glazing requirements for commercial buildings;
  - Part J3 affects sealing provisions, such as removing exemptions for sealed louvers for commercial buildings and controls at entrances for cafes, restaurants and open front shops;
  - Part J5 involves provisions requiring automatic deactivation of air conditioning in Class 3 sole-occupancy units; variable speed motors for fan systems; lowering the fan power allowance for air-conditioning systems; reducing the pump power allowance for heating and cooling; specifying a preference for gas over oil for heating and generally prohibiting electricity for heating;
  - Part J6 addresses artificial lighting and involves changes to maximum lighting power levels for commercial buildings;
  - Part J7 extends the scope of energy efficiency requirements to include swimming pools and spa systems in addition to the currently affected reticulation systems of sanitary hot water and hot water for cooking; and
  - Part J8 is also being extended to commissioning and additional aspects of facilities to assist maintenance.

The proposed amendments address both fabric and operational aspects of Class 3 and 5 to 9 buildings. However, not all aspects of operational energy use in buildings are within the BCA’s scope. Plug-in equipment, which can account for nearly 40 per cent of power load (ABCB 2009b), cannot be included. Examples of plug-in equipment include computers, photo copiers and domestic type appliances.

Alternative policy approaches

Improved energy efficiency in new commercial buildings could be achieved through alternative approaches. These include:

- non-regulatory strategies, such as information and financial incentives;
- quasi-regulatory approaches, such as codes of conduct; and
- direct regulation, such as the proposed approach.

This RIS does not formally analyse alternative non-regulatory and quasi-regulatory approaches. Rather it confines itself to only considering the impacts of the proposed BCA amendments. This recognises that:

- COAG has already acknowledged the need to adopt a range of policies and tools so as to address the diversity of market barriers that exist;[10] and
- the BCA is already in place and these amendments are only acting to increase its stringency.

Non-regulatory approaches

Many non-regulatory approaches already exist in various forms at both the national and State level. For example, industry and government each offer a voluntary rating scheme.[11] Jurisdictions offer subsidies and rebates for energy efficient technologies. Governments have implemented ‘leading by doing’ approaches, such as Green Leases which specify minimum energy efficiency performance and maintenance.

The persistence of the ‘energy gap’ highlights that voluntary approaches have had mixed results. Participation rates appear to be low. Each of these options also tends to address a single market barrier while it may be the collective of market barriers that impede voluntary adoption of increased energy efficiency.

The COAG Intergovernmental Agreement signed on 2 July 2009 (COAG 2009d) also highlights the government’s move towards mixing regulatory strategies — among them are information and labelling approaches. For example, governments have committed to mandatory disclosure which imposes an obligation to disclose information about a building’s actual energy efficiency.

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[10] The key point is that a suite of complementary measures to the CPRS are needed.

[11] The National Australian Built Environment Rating System (NABERS) and the Green Building Council of Australia’s Green Star rating tools are two examples of national schemes that ‘score’ building energy efficiency.

Quasi-regulation

Quasi-regulation often involves industry-led approaches that are less formal than regulation, but are stronger than self-regulation. They often involve industry or a party other than government monitoring and enforcing a code of conduct.

The Australian Competition and Consumer Commission (ACCC) notes caution must be used when deciding if a code of conduct is appropriate. Ineffective (mandatory) codes may place compliance burdens on business without necessarily achieving any realisable benefits (ACCC 2005). Effective quasi-regulation codes require highly cohesive industries characterised by low rates of entry and exit.

The building supply chain is recognised as being highly fragmented and disjointed. The supply of energy efficient buildings requires cooperation up and down the supply chain. Effective codes of conduct require bridging the various suppliers — from the point of design to construction. Moreover, commercial buildings often house several economic activities and occupants — all with different preferences and electricity demand profiles. This heterogeneity adds to the complication of clear preference signals being provided to influence building supply.

The proposed changes amend existing regulation. The infrastructure to support awareness and compliance with the BCA is already in place. A code (or similar) approach would make aspects of the existing infrastructure redundant without necessarily achieving greater compliance.

DTS versus Alternative Solutions

The ABCB has advised that this RIS should specifically assess only the proposed DTS measures for commercial buildings. This was also the approach used in the 2006 RIS for commercial buildings (ABCB 2006a) (see box 3.3). As mentioned before, DTS is a prescriptive approach which provides simplicity for compliance. It involves establishing a set of minimum provisions that must be met. DTS is considered more user-friendly and easier to administer and enforce.

In contrast, an Alternative Solution provides a greater degree of flexibility. Alternative Solutions allow for creative design that takes into account the fundamental design of the building (for example, orientation, etc) and the specific conditions of the building’s location. Compliance is generally software-verified but the option of developing an alternative Building Solution is also available. In other words, the potential permutations of solutions that meet the Performance Requirements are numerous. At the same time, it is thought to better facilitate innovation (relative to DTS).

The extent to which Alternative Solutions are more cost-effective is case specific. It is generally viewed that the software approach is adopted only where it would deliver greater utility — for example, lower costs or delivery of certain amenities.

3.14 **DTS versus Alternative Solutions**

ABCB (2006b) provides a discussion of DTS versus Alternative Solutions. It states:

> The analysis of the proposals contained in this RIS follows usual practice in focusing on the impact of the DTS Provisions. This reflects the fact that the DTS Provisions are the most widely adopted means of achieving compliance with the Performance Requirements, and also that the DTS Provisions constitute the only known detailed provisions capable of *ex ante* analysis as required in a RIS. The effect of adopting this DTS focused approach may be to somewhat over-estimate the likely construction costs, since Alternative Solutions will tend to be adopted only to the extent that cost savings can be made.

Alternative DTS requirements

This RIS only assesses the DTS requirements as proposed by the ABCB (ABCB 2009b). It is of course, feasible that the proposed changes could be implemented in a variety of ways. For example, the changes could apply in only certain climate zones or jurisdictions. Further, it is plausible that an alternative implementation of the proposed amendments could produce a preferable net impact on the community.

Alternative approaches are not assessed here. Rather, this document provides a benchmark for industry and stakeholders to consider how alternative approaches could be devised, and if it would be appropriate to do so.

4 Framework for analysis

This chapter outlines both the scope of the analysis and the methodology used in the analysis. It describes a ‘bottom up’ approach that largely underpins the estimates that move from the individual building level to an economywide aggregation.

Scope of analysis

The analysis contained in this RIS has been conducted at two levels:

- at the individual building level — which assesses the impacts of the proposed amendments on a sample of commercial buildings and occupancies; and
- at an economywide level — which assesses the impacts of the proposed amendments at a national level.

The impact analysis adopts a building blocks approach. The building blocks take the form of a square metre of commercial space (in different permutations). Energy savings and capital costs are assessed per square metre and are then aggregated to provide a national estimate.

A sample of buildings provides the basis from which cost and benefits flow. As a consequence, the amendments’ impact on the economy at large is underpinned by the analysis conducted at the individual building level.

The impact analysis takes into consideration impacts on various segments of the economy, including:

- owners of commercial buildings;
- users and occupants of commercial buildings;
- entities along the supply chain of commercial buildings (for example, the construction industry);
- government agencies (tasked with the administration of the BCA amendments); and
- the broader community.

Table 4.1 summarises the types of impacts (both positive and negative) that are considered in this analysis. The range of impacts is diverse. They include both direct and indirect effects, and both financial and nonmonetary effects. For example, impacts to owners and/or occupants arise from the actual use of the building. Impacts to the broader community take the form of externalities and shared costs. Reductions in energy demand as a result of compliance with the proposed BCA amendments generate benefits for the broader economy as a result of lower electricity consumption and associated GHG abatement.

4.15 **Costs and benefits considered in the impact analysis**

Entity	***Costs***	***Benefits***
Owners/occupants	Compliance costs	Lower energy consumption
	Operation and maintenance costs	Savings in energy-related expenditure
		Health improvements
		Amenity improvements
		Productivity improvements
Broader community		Abated GHG emissions
		Deferred electricity network impacts
Construction industry	Professional development / training	
Governments	Administration	

Note: Not all impacts are able to be quantified.

Source: TheCIE.

Most of the impacts are estimated from the building sample. These impacts include the compliance costs, energy savings and abated GHG emissions. As a result, the quantum of the associated impacts is highly sensitive to the building sample. Impacts on industry and government are dependent upon the scope and scale of the proposed changes as a whole. In other words, the quantum of these costs depends upon the extent to which the amendments change resource allocation for routine compliance and enforcement activities, respectively.

Notably, the estimated impacts of the revised measures assume that the DTS provisions of the BCA will be adopted in all new floor space. In the counterfactual (or BAU case) it is assumed that the floor space would have (at a minimum) complied with the existing BCA.

Building sample

Identifying costs and benefits at the individual building level is a complicated task. Buildings are highly dependent upon the individual characteristics of the development. Key aspects of the building include scale, use and location (climate zone).

Commercial buildings span a diverse range of activities and uses. To account for this diversity, the impact analysis draws on a sample of building forms provided by the ABCB (additional details can be found in appendix B). While not exhaustive, the building sample does provide a considerable range across the key dimensions that determine the impact of efficiency measures — that is, overall size and shape of the building. Specifically, they illustrate the range of impacts (costs and benefits) across:

- building uses — retail, office, education and healthcare; and
- scales — single storey and 3-storey.

These building forms are largely consistent with the five defined in the RIS developed for the existing Section J of the BCA (ABCB 2006b).[12]

The building forms modelled by the ABCB are highlighted in table 4.2, which shows that five building form/type combinations have been modelled to test the proposed BCA 2010 requirements. Note that while the ABCB's building sample represents some of the building Classes affected by the proposed amendments, it does not cover all. The ABCB has not provided similar modelling results for buildings representing Classes 3, 7 or 8.

4.16 **Building forms and building types modelled by the ABCB**

		Building form 1	***Building form 2***	***Building form H***
	Representative of BCA Class	3 storeys — 2000m^2 GFA	Single storey — 198m^2 GFA	3 storey — 2880m^2 GFA
Office	5	✓	✓	
Retail	6	✓		
School	9b			✓
Hospital ward	9a and 9c			✓

Note: GFA = gross floor area. In ABCB (2006b), Form 1 and 2 were referred to as Building forms B and E respectively. Form H is a derivative of Form 1, but has a 'H' formation.

Source: TheCIE.

The daily occupation and operation profiles used to model the energy consumption of buildings were as documented in Specification JV of BCA 2009. It should also be noted that there has been no 'overlap' or 'double dipping' with benefits achieved through the MEPS scheme. Modelling

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[12] In ABCB (2006b), Form 1 and 2 were referred to as Building forms B and E respectively. Form H is a derivative of Form 1, but has a 'H' formation.

undertaken did not include for any benefits from equipment covered by MEPS, as has been agreed with DEWHA, the Commonwealth Department responsible for MEPS.

The detailed description of the energy simulation modelling process, as provided by the ABCB is provided in appendix C.

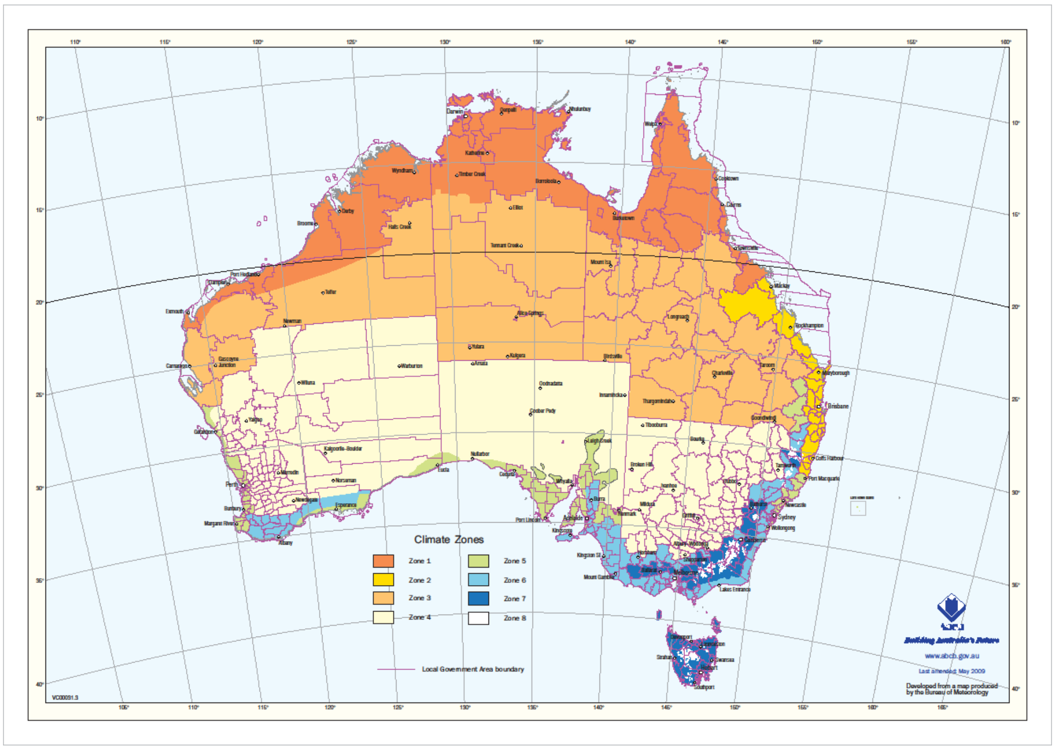
Buildings are analysed in a sample of population centres representing each of the capital cities and climate zones. The cities analysed are presented in table 4.3 and a map showing the ABCB's eight climate zones is provided in chart 4.4.

4.17 **Representative locations**

BCA Climate Zone	***Population centre***	***State***
Climate zone 1	Darwin	NT
Climate zone 2	Brisbane	Qld
Climate zone 3	Mt Isa	Qld
Climate zone 4	Kalgoorlie	WA
Climate zone 5	Adelaide	SA
	Perth	WA
	Sydney	NSW
Climate zone 6	Melbourne	Vic
Climate zone 7	Canberra	ACT
	Hobart	Tas
Climate zone 8	Thredbo	NSW

Source: ABCB.

4.18 ABCB climate zones



Source: Building Code of Australia.

Aggregation and the BAU

To estimate impacts at an economywide level, the building sample has been aggregated to regional, State and national levels. Appendices B and D describe this task in more detail.

The aggregation of the building sample accounts for:

- growth in the building stock;
- population shifts;
- changes in energy prices;
- major policy initiatives (such as the CPRS and Renewable Energy Target expansion); and
- other factors.

This aggregation provides the BAU case at the economywide level, to which the impacts of the amendments will be assessed. All estimated costs and benefits reflect the incremental difference of moving from the BAU to a scenario where the proposed amendments are implemented.

The BAU benchmark assumes no amendments will be imposed by the BCA, but this does not imply that the baseline is static. There may exist, for example, a background level of voluntary adoption and technological innovation that occurs without changes in the BCA. Major policies, such as CPRS, could be implemented that fundamentally shift key parameters, such as electricity prices and GHG intensity of energy mixes.

In essence, the baseline should portray the ‘best’ depiction of the foreseeable counterfactual (that is, what would happen in the absence of amendments to the BCA). The baseline therefore, needs to consider similar factors used for aggregating to an economywide level, such as changes in energy prices; growth of the commercial building stock; changes in the structure of the commercial building stock; population movements; changes in the GHG intensity of energy; and other relevant ‘background’ variables. All of these parameters are explicitly incorporated in the BAU for this impact analysis.

Importantly, the BAU is constructed using the Australian Government’s projections of the impacts of implementation of the CPRS. By using these inputs, the BAU incorporates several other key policies, such as increased mandatory renewable energy targets. It also excludes the implications of other policies such as financial incentives for energy efficiency investments and the national roll out of smart meters.

Cost pass through

In many cases, the costs of complying with the amended BCA will be incurred by different entities. For example, capital costs will be initially incurred by the builder. A building occupier (not necessarily the owner) may be responsible for operating costs, while the asset owner will incur maintenance and disposal costs.

Following the recommendation in CIE (2009a p. 32), this report models compliance costs as being incurred by the user of the asset (that is, the owner–occupier).

Market adaptation

Although the proposed BCA amendments are indeed likely to induce a market response — in say, the design, orientation and construction of new dwellings — the impact analysis in this report has deliberately assessed the amendments as if there is no market response whatsoever. The intent of the assessment is to reflect on the change in the cost and benefits of current choices and practices.

Refurbishments

The BCA applies to all new building work, including refurbishments of any scale. The extent to which BCA provisions are applied to refurbishments varies between each of the States and Territories. However, the BCA is generally applied where the refurbishment is sufficiently extensive to require approval from the relevant regulatory authority.

Under the proposed BCA 2010, refurbishment processes will generate some additional energy and GHG savings at some additional cost. However, at this stage, it is not feasible to *accurately* assess the impacts that the measures will have on such projects as the information required to undertake this analysis is not available.

Omitting refurbishments from the impact analysis altogether however, can understate both costs and benefits. Moreover, the directional bias — that is, to bias the net impact assessment — is unclear. To account for this then, and consistent with ABCB (2006a), the analysis here has scaled the new building stock by 10 per cent to account for refurbishments. This will have implications for both the costs and benefits of the amendments (the sensitivity analysis of the central case tests the impact of this variable explicitly).

The information gaps and the key practical difficulties for analysing the issue of refurbishment of existing buildings are summarised below.

- *Variability in the application of the BCA across jurisdictions.* The application of the BCA to existing buildings being altered, extended or undergoing a change of use or Classification is covered in the relevant building legislation in each State and Territory (ABCB 2007). As such, individual jurisdictions or approval authorities (usually the local council or private certifiers) can apply the BCA to existing buildings undergoing refurbishment as rigorously as they see fit.
- *Unknown refurbishment rates and variability in the scale and scope of the refurbishments.* Additional information that is not currently available is required to understand refurbishment rates by building Class in each State, and the extent of the work. Many refurbishments, such as tenancy and cosmetic upgrades, offer few opportunities to improve the energy efficiency of the fabric, with improvements possible only with lighting, heating, ventilation and air conditioning (HVAC), and hot water supply. In contrast, there would also be a certain proportion of major upgrades and conversions that offer significant opportunities to improve energy efficiency. However, it is difficult to derive sound quantitative estimates of these impacts since these matters tend to be project specific.

- *Not all existing buildings have the ability to comply with the BCA DTS provisions.* When carrying out new building work associated with an existing building, there are a number of factors that may compromise the ability of the new building work to fully comply with the BCA provisions. These factors are generally related to the location of the existing building on the site, the practicality of replacing major building elements and the internal configuration of existing spaces and the services being reused (ABCB 2007).
- *Uncertainty about the optimum degree of stringency for refurbishments.* Earlier work (ABCB 2006b p. 35) also highlighted an issue about the optimum degree of regulatory stringency with respect to upgrades. A particular concern is that more demanding requirements will promote the demolition and replacement of buildings, with the consequent loss of the energy embodied in existing buildings.

Interactions with State and Territory legislation

The interaction between the proposed BCA amendments and planned and existing State and Territory policies has not been addressed in the RIS. Explicitly, the analysis undertaken is in reference to the national 2009 BCA.

Analytical timeframe

The analytic timeframe used to model the costs and benefits of the proposed changes to the BCA reflects the effective life of the amendments and their associated impact. The amendments' effective lifespan affects the period of time over which asset owners incur costs of compliance and government incurs enforcement and monitoring costs (that is, the effective life of the amendments affects the start and duration of its associated impacts).

The analytic timeframe in this RIS is 10 years. The effects of the amendments are modelled to begin in 2010. All compliance and enforcement actions are modelled to extend for a decade, ending in 2020.[13] Consistent with CIE (2009a), after this period it is assumed that the policy will be either surpassed or made redundant.

Benefits and costs flow from compliance with the proposed changes. The length of these impacts depends upon the particular qualities of the assets

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[13] Note that proposed amendments to the BCA as it applies to *residential* buildings are to be adopted by 2011.

installed. For this RIS, the effective lifespan of adopted energy efficiency solutions is as follows.

- Internal loads (including lighting and power) — 7 years.
- Systems (including mechanical ventilation, sealing, insulation and glazing) — 40 years.[14]

Applying these assumptions has the following implications for the impact analysis:

- each new building incurs a once-off, lump-sum capital outlay at the start of the analytical period; and
- any benefits or costs associated with the use of the energy efficient assets (such as energy savings or operational and maintenance costs) last only for the asset's lifespan (rather than being ongoing and indefinite).

This approach assumes that once the asset is replaced, no further benefits or costs will be incurred.[15]

Discount rates

Costs and benefits in this RIS reported in present value (PV) terms are based on the application of a 7 per cent real discount rate. This rate is in line with OBPR requirements. The Consultation RIS, in contrast, was evaluated at a 5 per cent discount rate, slightly lower than the OBPR recommended central discount rate.

A lower discount rate was chosen based on two factors:

- the nature of the impacts evaluated— this factor recognises that the impacts evaluated in this RIS are long-term and concerned with environmental outcomes (climate change and global warming) that will affect future generations; and
- international best practice—this factor refers to similar studies undertaken in other developed countries.

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[14] In modelling the impact, it is assumed that the benefits of the energy efficiency solutions flow over the assumed service lives. Notably, this assumption overlooks the fact that in some cases the published service life is not realised because of early replacement for reasons of capacity expansion or change of use.

[15] The cost-benefit analysis does not assume like-for-like asset replacement when the energy efficient technology expires. This assumption is consistent with the recommendations in CIE (2009a) and the current state of the literature which supports the rationale for mandating energy efficiency performance standards.

The concept behind discounting benefits and costs that occur in different timeframes lies on the assumption that, generally, consumption today is preferred over consumption tomorrow. In principle, that means that discounting discriminates against future benefits. Hence, discounting will favour regulations that confer benefits in the present or near future over regulations whose benefits society realises at a later date (Farber and Hemmersbaugh 1993). Indeed, a number of international studies and academic discussion on the appropriate discount rate for benefit–cost analysis suggest that high rates tend to favour policies that are less capital intensive and provide more immediate benefits.

However, the literature also recognises that assessing environmental policies may need use of 'special' discount rates. A lower discount rate is often applied to analyses that are more future-oriented and more concerned with environmental outcomes such as climate change and global warming. A higher discount rate would reduce the value of future environmental benefits and hence policies aiming for that outcome would be regarded as less efficient.

Outcomes in these areas occur with a substantial lag and recognise the importance of intergenerational fairness. There is a lot of ethical debate around the responsibility of present generations to ensure resources are available for future generations. Although the debate has been mainly centred in appropriateness of applying a zero discount rate (that values future equally to present), in general it is considered that lower discount rates reflect a higher valuation of those generations.

Looking at RISs on intended energy efficiency improvements in several countries[16], an average of 5 to 6 per cent real discount rate is used. Arguments for using lower discount rates are justified by the long-term objective of such policies which refers to addressing climate change. Additional information about the discount rates used for RISs in various countries is provided in appendix E.

Given the difference in timing between costs and benefits, the results in this RIS will be sensitive to the applied discount rate. A sensitivity analysis is conducted to account for the application of alternative discount rates recommended by OBPR (3, 5, 7, 9 and 11 per cent real).

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[16] Canada, Ireland, US and UK.

Net impact measures

The results of the cost–benefit analysis of the proposed changes to the BCA are presented using the three metrics below.

- *Benefit cost ratio (BCR)* — The BCR can be interpreted as: every one dollar of costs delivers ‘X’ dollars of benefits. A BCR equal to one implies that the costs exactly offset the benefits; a BCR less than one means that the costs outweigh the benefits.
- *Net present value (NPV)* — This figure is the sum of the discounted stream of costs and benefits and it reflects an aggregate term.
- *Annualised NPV* — This figure translates the NPV into an annual figure.

The BCR metric is reported to assess the impact to asset owners. That is, it focuses on assessing the economic efficiency of the amendments at the building-level, reflecting the direct private benefits and costs to the asset owner and excludes the benefits and costs for the community as a whole. Measures reflecting the economywide impacts are reported as NPV and annualised NPV figures.

5 Consultation responses

This chapter presents a summary of the stakeholder responses that were received through the consultation period for the RIS. The Consultation RIS was open for public comment until 30 October 2009, and received 32 responses from stakeholders (see appendix H). These responses were received from a wide range of stakeholders, including industry associations, State departments, local councils, academics, and professionals associated with the building industry.

The objective of the consultation process in developing the RIS is to ensure that the data, the methodology and the results are as indicative as possible of the outcomes of the regulation. This ex ante form of assessment, prior to the implementation of the regulation, is often considered to suffer from a number of forms of bias as well as contention around methodological and factual areas. Bias within the assumptions can fall either as optimism bias which would indicate that the net benefits are over estimates of the actual net benefits of the regulation, or alternatively the bias could fall as pessimism bias in which the assumptions result in a reduction in calculated net benefits compared to actual net benefits. Finally, there are generally observed contentions around factual matters that need to be resolved.

Given there has not been an ex post assessment and review of the BCA 2006 energy efficiency requirements upon which the incremental costs and benefits have been calculated, as well as the draft RIS results being quite close to break even, these issues of optimism and pessimism bias, as well as factual and methodological issues require careful consideration.

Stakeholder submissions throughout the public consultation period raised queries and supplied additional information to support claims in all of these three areas. In addition, there was also discussion raised on issues of implementation and appropriateness of the regulation in a wider GHG policy framework. The main topics of discussion under each of these headings are discussed below.

Following public stakeholder comments, OBPR also provided a directive that the results in the Final RIS were to be reported based on utilisation of a 7 per cent discount rate. As such, the results presented in Chapters 6, 7 and 8 have altered from the Consultation RIS and are reported under a 7 per cent discount rate. Further issues raised in response to the Consultation RIS have been considered in Chapter 10 where both scenario based sensitivity analyses are presented as well as a Monte Carlo simulation based sensitivity analysis of the final results.

Optimism bias

Assumptions within the analysis that suffer from optimism bias will have the effect of increasing the estimated net benefits of the proposed regulation, to varying degrees depending on the level of bias, and the relative importance of the issues. The assumptions that were discussed within the public consultation period identified as likely to be suffering from optimism bias were:

- Partial equilibrium methodology
- Building and indirect compliance costs
- Non-tangible costs

Partial equilibrium methodology

The estimated net benefits of the proposed methodology are results from a partial equilibrium model. While this methodology should capture first round effects of the proposed regulation in the construction industry, and the effects on home owners and residents, second and third round effects, as well as impacts from other policies, on associated industries are omitted. Where these second and third round effects are substantial this could have a notable impact on the final costs and benefits of the regulation.

Where the impact of associated policies have been included, they have been limited to discrete areas of the analysis. For example, the impact of the proposed CPRS policy has been drawn in through electricity prices only. In a broader, national policy framework, there is a significant possibility that the impact of the CPRS on GHG emissions, and energy efficiency more specifically will achieve the majority of the benefits that have been accrued to the proposed BCA 2010 changes. In this case, it would be the CPRS impact on carbon prices that drives the reductions in energy use and provides incentives for improved energy efficiency in buildings. In this case, the methodology in the RIS would be double counting the benefits.

Further issues with the partial equilibrium analysis and CPRS modelling is the effect that any carbon prices may, or will, have on building materials. The methodology with the RIS has not taken into account issues of embodied energy within building products, and therefore, there is no account taken of the effect of the CPRS on relative building material costs. However, this methodology may be somewhat simplistic and again may be overstating the benefits from the proposed BCA 2010 changes that should be attributed to the CPRS.

Throughout the consultation period, there have been some submissions directed towards mixed incentives potentially being presented in the proposed regulatory change for altering building materials towards those such as concrete slabs with greater energy efficiency ratings, but higher

GHG emissions values and embodied energy. This issue raises the point that embodied energy is not included in the scope of the BCA. It is in this case that the combined effects of the proposed regulatory changes and the proposed ETS are potentially able to generate incentives that cover construction and embodied energy issues, as well as operational energy usage issues to deliver a life cycle energy efficiency model. The impact of the ETS on altering the relative prices of energy intensive construction materials will likely move construction processes towards more energy efficient materials and methods, while the proposed regulatory changes are directed at ensuring that the operational energy use within the buildings are efficient.

Building and indirect compliance costs

Concern has been raised that the additional building cost estimates included in the analysis were underestimating the true and total additional capital costs that could be imposed due to the proposed BCA 2010.

While there was little quantitative evidence presented in stakeholder submissions as to the level of underestimation of these costs within the draft RIS, sensitivity scenarios have been undertaken into the influence changing these costs may have on the BCR.

Non-tangible costs

Those attributes and services within commercial buildings that are not bought and sold readily are difficult to quantify in a cost-benefit analysis, and therefore are usually treated In a qualitative manner. Where they are treated qualitatively, this should not indicate that they are of little value or influence to the overall net benefits of the RIS. Non-tangible costs imposed on consumers, through for example not being able to build the desired house due to regulation requirements, or reduced amenity value from being inside the building complying with regulations, can be quite important. Non-tangible costs that were mentioned through the public consultation period were mainly concerned with glazing ratios and indoor air quality.

Pessimism Bias

Pessimism bias is a result of conservative assumptions being utilised in the cost benefit analysis. The result of conservative assumptions and pessimism bias is to reduce the estimated net benefits of the proposed regulation. Issues that were raised within the public consultation period highlighting potential pessimism bias included:

- Building costs though time
- Projected electricity prices

- Non-market benefits
- Lifetime of buildings

Building costs through time

Through the consultation period, there was discussion around the potential conservative methodology for estimating additional capital costs over time due to the regulation. For example, “learning effects” have not been included, instead, additional capital costs are assumed to be constant over the life of the regulation. The learning effects would possibly, over time, reduce the costs of compliance as industry becomes more familiar with the regulations and adapts and innovates around building methods. International studies have suggested that the combination of economies of scale in production (over time) and the associated learning effects could result in a 20 per cent reduction in compliance costs with an associated doubling of production.

Additional benefits associated with the proposed regulations include the ability of current regulations to assist with the learning and economies of scale effects of potential future regulations, that is, that the lifetime benefits of current proposed regulations, could potentially extend beyond the current 10 years allowed for, thus the current methodology may be understating the life time benefits of the proposed regulations.

Projected electricity prices and CPRS policy

The only climate policy scenario that has been utilised within the draft RIS was CPRS-5. Currently, there is uncertainty surrounding the future stringency of climate policy both within Australia and internationally. A number of stakeholder submissions have suggested increased attention be paid to the effect of different climate policies on the net benefits of the proposed BCA changes.

Where there is a change in climate policy stringency, these effects are assumed to be predominantly felt through increased electricity prices only — due to the limitations of the partial equilibrium methodology as discussed earlier.

An increase in GHG emission targets would result in higher electricity prices and hence increased valuation of electricity savings, raising the net benefits of the proposed changes. Alternatively, a reduction in GHG emissions targets would result in lower electricity prices, and hence reduce the net benefits of the proposed BCA changes.

A further stakeholder submission has also questioned the applicability of general retail electricity prices to industrial electricity users. While the valuation of electricity savings should use the true resource cost, where this is uncertain, a sensitivity analysis has been provided on a lower industrial electricity price.

Non-market benefits

As with the optimism bias issues, there is the potential for omission of non-market benefits to result in pessimism bias in the analysis. Examples of these non-market benefits that have been discussed through the consultation period are mainly associated with additional health benefits from more energy efficient buildings. However, no quantitative data has been presented with respect to commercial buildings.

Lifetime of buildings

Where the lifetime of buildings used in the draft RIS was 40 years, stakeholder submissions have noted that this is potentially an underestimate of buildings lifetime, by approximately 30 years.

Allowing benefits to accrue for an additional 30 years, in 40 years' time will have a limited effect on the net benefits of the proposed BCA changes, due to the discount rate. The further in time benefits are being accrued, the lower is the NPV of these benefits. Where a 5 per cent discount rate is used, the benefits would be increased at most by approximately 20 per cent, and where a 7 per cent discount rate is used, the benefits would increase by a maximum of approximately 10 per cent.

It should be noted however, that there is some academic discussion that the further the point in time that benefits are being discounted from, the higher should be the discount rate to account for increased risk of changing market conditions (for example, the building may be pulled down and/or rezoned within 20 years) and the potential for these benefits not to be achieved. Truncation at 40 years could be considered to be an arbitrary method of accounting for this uncertainty.

Factual and methodological discussion

Factual and methodological issues that require consideration within the cost benefit analysis affect how and where information is drawn from into the analysis. Factual and methodological concerns that were raised in the consultation period include:

- Choice of discount rate
- Hospital methodology

Discount rate

The discount rate utilised in the Consultation RIS as part of the cost benefit analysis, to measure the net present value (NPV) of the costs and benefits of the proposed regulation, was 5 per cent. This figure is below the recommended discount rate of 7 per cent, put forward by the OBPR in evaluating regulatory impacts in general, and a justification for this divergence was included in the Consultation RIS.

A number of stakeholder submissions put forward the argument that this discount rate was too low to accurately reflect the decision making process of consumers, citing a number of international studies indicating that consumers generally make decisions over relatively short timeframes, or between 3-5 years. The implication of this shorter repayment time frame is that the implicit discount rate is quite high. In contrast, other stakeholder submissions have suggested that there is room for a further lowering of the discount rate, in line with international studies of the effects of climate change, to between 2.65 per cent and 3.5 per cent.

The key underlying factor in the choice of discount rate is whether the costs and benefits are being evaluated at a social or private level. Where a private evaluation is being undertaken, the appropriate discount rate is closely associated with the private decision making process of individuals. However, if the effects of the regulation are being evaluated at a social level, where there is the potential for benefits to be accumulating for a number of years, as well as to future generations, there is scope for these future benefits to hold a greater value, and hence attract a lower discount rate.

It should be noted that where a social discount rate is being imposed on consumers, who have a higher private discount rate, there is an additional private cost being borne by consumers because of the regulation that has not been incorporated within the estimate of net benefits.

Within the consultation and final RIS documentation, sensitivity analyses have been undertaken to closely consider the effect that altering the discount rate has on the valuation of the net benefits of the regulation, and as has been noted by stakeholders, there is a significant effect. While an argument has been put forward for the lower discount rate of 5 per cent to be applied, OBPR has required full reporting of results based on a 7 per cent discount rate.

Hospital methodology

The impact of the proposed regulatory changes on hospitals, and specialist buildings in general, attracted public submissions. The two main issues raised by the submissions are the costs associated with specialist buildings meeting the increased energy efficiency requirements, and the results of modelling utilised to measure the impact of the proposed energy efficiency regulations.

One submission presented secondary testing of the energy efficiency results proposed by the Consultation RIS in terms of the reduction in energy use per square metre for health buildings. The results of modelling, utilising 2 hospital design options across 10 different climate locations, suggested that the actual energy savings would be in the vicinity of 13-16 per cent over BCA 2009, compared to figures reported in supporting commentary to the draft BCA 2010 that reported average energy savings of 31 per cent.

Apart from Darwin, the secondary modelling results consistently reported energy savings below that presented in the Consultation RIS, across all climate zones, this included modelling for the current BCA 2009, as well as for the proposed BCA 2010.

While these results are considered to be encompassing and accurate, they are difficult to directly compare to the results of modelling undertaken within the draft RIS. The modelling of hospitals within the Consultation RIS was limited to hospital ward blocks and did not include the higher energy use areas within the hospital – such as theatres etc. Estimates of energy impacts in these areas was attempted to be covered by reviewing other building types such as offices and laboratories.

Appropriateness of regulation

A final category of concerns raised by stakeholders is the general appropriateness of the regulations to achieve their stated objective. This includes:

- the effect of targeting new buildings rather than existing building stock;
- commissioning of buildings; and
- interaction effects with associated environmental policies.

Existing building stock

Where there is a relatively large stock of existing buildings compared to newly built buildings, stakeholders have questioned whether there could be greater national improvements achieved through targeting existing buildings rather than newly constructed buildings.

This issue is outside of the scope of this RIS and is a policy direction issue for consideration by government.

Commissioning of buildings

The ineffectiveness of current building commissioning practices to validate the coordinated operation of energy regulated systems has been raised in a number of submissions. The concern centres on the likelihood of buildings delivering lower energy efficiency outcomes than they are either designed or intended to deliver. Increased requirements to assess as built energy efficiency outcomes could overcome this problem.

Again, this issue is outside of the scope of this RIS and is a policy direction issue for consideration by government. It should also be noted that the draft provisions for the commissioning of buildings which were included in the original BCA 2010 proposal were removed following public comment. Commissioning of buildings is an administrative matter which is regulated separately by State and Territory jurisdictions under their respective legislation. The removal has not affected the outcomes of this RIS.

Policy interaction effects

Where the government's stated objective is to reduce GHG emissions, there were submissions noting that energy efficiency regulations that are not able to discern for example GHG intensity of power use, have the potential to miss this GHG objective. Additional concerns were raised over the greater ability of transport, and water supply policies to achieve GHG and sustainability objectives.

Coverage of responses

The above discussion covers all of the substantive issues raised throughout the consultation period. While there was a total of 32 submissions that responded to the commercial Consultation RIS, there were only 9 submissions that only considered the commercial RIS in isolation. Therefore, where stakeholder submissions were not clear on the delineation between addressing concerns to the commercial or residential buildings RIS', the issue has been included in both.

Submissions that addressed purely technical issues and those presenting commercial proposals have not been included in this discussion.

6 Cost analysis

The cost analysis considers the impacts of the proposed BCA provisions on owner/occupiers of buildings, industry and government. In total, the amendments' costs are expected to sum to nearly $2.0 billion, comprising of (in present value terms):

- $1.8 billion in additional net capital outlays;
- $15 million in industry compliance costs; and
- $250 000 in additional administration.

This chapter discusses the approach to estimating costs and then presents the results of the cost analysis.

The proposed changes to the BCA are likely to involve a range of costs. Some costs will be private (such as the increase in capital outlays required for compliance), while others will be public (such as administration costs). The relevance of particular costs to the analysis however, is largely dependent on the degree of aggregation. For example the costs associated with industry up-skilling may be relevant at the economywide level, but less relevant when analysing the impact on individual buildings. On the other hand, increased capital outlays required for BCA compliance are relevant at both aggregations. As such, costs for building and economywide aggregations are discussed separately. Table 6.1 below, summarises the costs discussed at different levels.

6.19 **Analysis of costs**

	Building analysis	***Economy-wide analysis***
Additional capital outlays	✓	✓
Additional maintenance costs	✓	✓
Additional commissioning costs	✓	✓
Administration costs		✓
Industry up-skilling		✓

Source: TheCIE.

The sections below detail how these costs were estimated and treated in the analysis.

Direct costs to owner/occupiers

The lion's share of costs at the owner/occupier level is associated with increased capital outlays necessary for compliance. These are described and quantified below. Also discussed is the treatment of additional maintenance costs and costs involved with commissioning requirements.

Additional capital outlays

BMT & ASSOC Pty Ltd (BMT & ASSOC) estimated the costs associated with upgrading the BCA energy efficiency measures for commercial buildings. Specifically, BMT & ASSOC estimated the *incremental* costs of a general increase in the stringency of compliance provisions.

Capital costs have been estimated net of the impact on HVAC plant capacity. The improved thermal performance of new commercial buildings may have implications for the choice of HVAC capacity and building optimisation during the design phase. A building's HVAC plant needs to be of sufficient capacity to ensure that comfortable temperatures can be maintained within buildings under most climatic conditions (ABCB 2006b). As thermal performance improves, the dependence on HVAC plant to provide this comfort decreases. And it follows then, that building designers — acting rationally and informed — will seek to alter HVAC specifications to take account of these expected changes.

To account for the change in optimal HVAC plant capacity, the cost estimates provided by BMT & ASSOC have been adjusted accordingly. The analysis below reports the *net* change[17] in the required capital expenditure for BCA compliance. Estimates of the cost savings associated with the change in HVAC capacity are provided in appendix F.[18]

To estimate the incremental costs, BMT & ASSOC first estimated the costs of compliance under the current BCA provisions then estimated the costs of compliance associated with the proposed BCA amendments and then calculated the cost differential between the two compliance methods.

BMT & ASSOC estimated the additional construction costs associated with the proposed BCA amendments based on a building modelling summary of energy efficiency requirements and types of buildings provided by the ABCB. In light of this, BMT & ASSOC and CIE are not in a position to exclude the possibility that the energy efficiency requirements could be achieved using alternative methods.

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[17] That is, capital outlays net of the change in HVAC capacity.

[18] The changes in required HVAC plant capacity were estimated by the ABCB.

BMT & ASSOC's methodology was based largely upon their interpretation of the proposed modification to the BCA, assumptions as to likely construction requirements, cost information contained within the Australian Institute of Quantity Surveyors Building Economist (June 2009), price index information contained within Rawlinsons Australian Construction Handbook Edition 27 2009, and with a minor amount of pricing estimated by using BMT & ASSOC's internal construction rate library.

The cost assessment of the impact associated with increased energy efficiency requirements was modelled based on an assessment of quantities and construction materials likely to be used for the different building types and assumptions as to the extent of sealing to openings and windows and the extent of changes to insulation.

Estimates of the incremental compliance costs for commercial buildings are provided in table 6.1.[19] The table shows that the proposed amendments are likely to impose costs of between $70 and $280 per square metre of gross floor space, depending on the building form. On average, Form 2 offices incur the greatest additional costs, while Form 1 offices and retail buildings incur the least. Largely, the differences in cost estimates across locations are due to a combination of climatic requirements and differences in trade costs (note that all costs reported in table 6.2 are net of the anticipated savings from changes to HVAC plant capacity).

Additional maintenance costs

No allowance has been made for additional repair and maintenance costs in this study. This is because it is foreshadowed that the additional energy efficiency measures do not require additional *extra* maintenance activities.

Commissioning costs

Commissioning is a systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent, and the building's operational needs.

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[19] Estimates were calculated on a 'per building' basis, but are reported here as the average cost per square metre of gross floor area.

6.20 **Net additional capital cost by building form** $/m^2 of gross floor area

	Form 1: Office	*Form 2: Office*	*Form 1: Retail*	*Form H: Health*	*Form H: School*
Darwin	96	138	96	140	145
Brisbane	121	164	118	142	106
Mt Isa	176	238	160	170	118
Kalgoorlie	133	190	123	155	140
Sydney	86	134	72	93	152
Adelaide	83	82	69	93	106
Perth	86	134	72	93	152
Melbourne	82	109	73	116	71
Hobart	105	124	91	126	82
Canberra	88	122	71	109	127
Thredbo	na	278	na	159	102

na = Not available.

Note: Costs are presented in 2009 dollars and represent incremental costs. Brief descriptions of building forms can be found in table 4.2. Compliance costs are net of changes to required HVAC plant capacity.

Source: BMT&ASSOC based on data provided by the ABCB.

Building commissioning can play a major and strategically important role in attaining broader national energy savings goals. As technologies and applications change and/or become more complex in the effort to capture greater energy savings, the risk of under-performance rises and the value of building commissioning increases (Mills et al, 2005).

Commissioning can also bring about economic benefits to building owners and occupiers from the resultant energy cost savings, operating cost savings, and the improvements in building comfort and indoor air quality. Despite these benefits, not all buildings are receiving an adequate level of commissioning.

In past submissions to the ABCB, practitioners have advocated the importance of correct commissioning of building services systems. For example, poorly commissioned outside air dampers will introduce more hot or cold outside air than BCA Section F requires and so require more energy to cool or heat the air. Even worse, a heating system and a cooling system may be operating at the same time if the controls are not properly set.

There has been some reluctance in the past to include in the BCA something that could be considered a matter of workmanship. However, with the Government’s desire to further improve the energy efficiency of buildings, the ABCB has revisited the proposal to include commissioning in the BCA.[20]

In light of this, Part J8 (‘access for maintenance’) is proposed to be extended to include other aspects such as commissioning and aspects that facilitate the ongoing operation of plants including maintenance manuals and monitoring means.

Specifically, the proposed 2010 BCA states that the following energy efficiency systems and equipment must be commissioned to meet the design intent of the systems and to validate their required performance (ABCB 2009b):

- the energy efficiency systems of Parts J5 to J7, including the balance of air and water systems, damper settings, thermostat settings and the like; and
- adjustable or motorised shading devices.

Commissioning costs vary considerably with project size and building type, equipment type and commissioning scope. However, some studies have found that, as a general rule, commissioning costs for new buildings amount to approximately 0.6 to 1.5 per cent of total construction costs (Mills et al 2005 and PECI 2002).

While it is recognised that commissioning has the potential to increase the compliance costs associated with the proposed amendments, anecdotal evidence suggests that commissioning activities are *already* being carried out in most buildings to maximise the performance of the energy efficiency systems and equipment and minimise energy costs to owner–occupiers.[21] For instance, a number of certifiers consulted during the development of this RIS advised that, in order for them to signoff on construction completion and issue their certification, they need to be supplied with the mechanical services contractor’s signoff that works are in accordance with specifications, Australian Standards and have been tested, by them.

In light of this, no allowance has been made for additional commissioning costs in this study as it is foreshadowed that no *additional* commissioning and testing of mechanical services is required under the proposed changes to the BCA.

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[20] Note that the BCA already includes commissioning through reference standards such as AS 1670.1, AS/NZS 1668.1, AS 1668.2, AS 2118 and AS/NZS 3666.1.

[21] However, it should also be noted that commissioning may not be as common at the bottom end of the market.

Economywide costs

At the economywide level, increased capital outlays again account for the majority of costs. As maintenance costs and commissioning requirements were not deemed significant or quantified at the building level, they do not feature here. Other costs included at the economywide level include government costs and other industry costs.

Additional capital outlays

Estimates of economywide compliance costs are provided in table 6.3. These estimates use the estimates provided in table 6.2 in combination with data about the size of the commercial building stock (see appendix B). Note that each year, it is assumed that an amount of the commercial building stock equal to 10 per cent of new buildings is refurbished (ABCB 2006a). Estimates of newly constructed commercial floor space have been scaled by this factor to account for the costs of refurbishments.

6.21 **Present value of additional capital outlays**

	Total cost (present value)	*Annualised present value*
	$m	$m
Australia	1769.9	128.2

Note: All figures in 2009 dollars; discount rate is 7 per cent real. Annualised NPV calculated over a 50 year period. Cost figures relate to buildings belonging to Classes 5, 6 and 9 and exclude impacts on Classes 3, 7 and 8 buildings. Compliance costs are estimated net of the anticipated change in HVAC plant capacity.

Source: CIE estimates based on BMT&ASSOC and data provided by the ABCB.

The proposed amendments have an assumed a policy life of 10 years. Compliance costs, consequently, are borne by new commercial building stock each year for the period 2010–20. Estimates reported in table 6.3 are of the present value of the total compliance cost (estimated with a 7 per cent real discount rate) for those buildings contained in the sample.[22] In total, the amendments will add just under $1.8 billion to the cost of commercial building construction (an annualised NPV of $128 million).

Government costs

Government costs reflect resources required to support the administration of the amended BCA, including the costs incurred to:

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[22] The ABCB building sample does not reference Class 3, 7 or 8 buildings. As such it was not possible to analyse the impact on these buildings. These buildings represent approximately two-fifths of the total commercial building stock.

- increase awareness of the changes to the BCA; and
- provide assistance on how to comply.

The ABCB estimates that the additional cost of administering the changes to the BCA (compared to the costs of administering the current BCA) would be around $250 000 for commercial buildings. This is a once off cost and no additional annual costs are foreshadowed as any ongoing government costs would most likely be included in general BCA ongoing development. It is not anticipated that the role of any public agency involved with the BCA will change as a result of the amendments.

Other industry costs

In addition to the capital costs of complying with the amended BCA (for example, materials and installation), the construction industry could incur costs beyond those directly associated with the energy efficient materials and designs. For example, complying with the general increase in stringency of the energy efficiency provisions in the BCA may require additional up-skilling for builders and certifiers. Additionally, the new provisions may mean that the industry will require capital investment to increase production or redesign some products to meet the new thermal performance requirements under the BCA.

The Australian Institute of Building Surveyors (AIBS) acknowledges the possibility of the need for additional up-skilling, but suggests that most of the costs associated with changes in the regulation would be absorbed within the Continuing Professional Development (CPD) costs. The AIBS also notes that some other costs would vary from company to company and State to State, but these costs are considered to be minor. Major changes that require additional assessment work by the surveyor/certifier, such as assessing energy requirements over and above a building assessment would be charged to the consumer and not borne by industry. While there is no specific information about the magnitude of these costs, they are likely to be small. Therefore, they are excluded from the cost–benefit analysis.[23]

In terms of additional capital investment to increase production or redesign some products, the biggest concern has been the capacity and capability of the windows and glass industries to respond to the BCA 2010 thermal performance requirements (to meet demand). A report produced by the

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[23] Energy efficiency compliance costs were initiated when the measures were first introduced in 2006. Additional compliance costs as a result of these changes should be minimal.

Australian Window Association (AWA) in response to these concerns shows that high performance products are available and accessible, and that the industry has the capacity and capability to meet a significantly increased demand for these products. However, doing so will impose extra costs on fabricators and system suppliers which in turn will impact the cost of the products.

The AWA report indicates that some of their members would be investing up to $20 million to increase production of double glazed windows and doors; this could mean investment for the whole industry (affecting both commercial and residential buildings) of around $50 million. The ABCB estimates that approximately 30 per cent, or some $15 million, would be attributable to BCA amendments impacting on commercial buildings. These $15 million have been included in the modelling of the impacts of the BCA changes. Additional details about the AWA report and the windows industry capacity and capability to respond to the BCA changes are provided later in this report.

Total economywide cost impact

Table 6.4 summarises the economywide costs associated with the proposed changes. In total, it is estimated that the amendments will impose costs on the economy with a present value of nearly $1.8 billion.

6.22 **Present value of total economywide costs**

	Total cost (present value)	*Annualised present value*
	$m	$m
Additional capital outlays	1769.9	128.2
Government costs	0.3	0.0
Other industry costs	15.0	1.1
Total	**1785.2**	**129.4**

Note: All figures in 2009 dollars; discount rate is 7 per cent real. Annualised NPV calculated over a 50 year period. Cost figures relate to buildings belonging to Classes 5, 6 and 9 and exclude impacts on Classes 3, 7 and 8 buildings. Compliance costs are estimated net of the anticipated change in HVAC plant capacity.

Source: CIE estimates based on BMT&ASSOC and data provided by the ABCB

7 Benefits analysis

The energy efficiency improvements proposed through the BCA amendments are expected to deliver a range of private and public benefits. Economywide, the amendments to the BCA are expected to provide nearly $2.9 billion in positive impacts. This includes:

- energy savings with a present value of $2.6 billion; and
- capital savings for electricity generators and transmission with a present value of $280 million.

This chapter discusses the range of benefits that have been considered and presents figures where benefits have been quantified and/or monetised. It begins with discussing direct, private benefits that emerge as a result of greater energy efficiency in commercial buildings. These focus on the quantity of avoided energy consumption. It then provides a qualitative discussion of ancillary amenity and welfare enhancements. The chapter concludes with a presentation of the estimated total benefits across the categories.

Approach to estimating benefits

The key metric used to quantify and monetise the benefits of the proposed amendments is the quantity of reduced energy consumption as a result of the proposed enhanced energy efficiency requirements.

Team Catalyst, a group of experts in thermal performance modelling and energy efficiency in the commercial building sector estimated the changes in energy consumption associated with the proposed amendments to the BCA. In particular, Team Catalyst collated the *incremental* energy savings stemming from a general increase in the stringency of the DTS provisions. These energy savings were collated from energy simulation output data provided by the ABCB.[24]

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[24] Daily occupation and operation profiles used were as documented in Specification JV of BCA 2009. The detailed description of the energy simulation modelling process, as provided by the ABCB is provided in appendix C.

Energy savings were estimated by comparing the annual energy use predictions for buildings modelled to be *just* compliant with the BCA 2009 DTS requirements (also referred to as the 'baseline') against buildings modelled to be *just* compliant with the proposed BCA 2010 DTS requirements.[25]

Reduced energy consumption

The estimated impact of the amendments on energy consumption is reported in tables 7.1 (expressed in MJs per m^2) and 7.2 (expressed in percentage terms). The tables report the average annual change per square metre of gross floor area, for gas and electricity. These estimates take account of the fact that each of the proposed measures is likely to have different effective life spans.[26]

To estimate energy savings, the ABCB provided TheCIE with results of thermal performance modelling which illustrated the likely impacts of the proposed amendments on building energy consumption. The ABCB assumes that the amendments will only affect a building's consumption of electricity — with the exception of changes in energy required for heating. Any changes to building heating are assumed to be gas. (Note that table 7.1 indicates that for some buildings, gas consumption actually increases — this reflects a switch in the fuel mix.)

The reported per cent changes to gas consumption should be interpreted with caution. In proportional terms, the amendments might induce a large reduction in gas consumption — but buildings use relatively little gas compared to electricity. It is not uncommon for the amendments to reduce total energy consumption by 20 per cent or more. This type of effect is consistent with the amendments' objectives. From an abatement perspective, the demand for gas is preferred to electricity because it is less GHG intensive. From an energy efficiency perspective, the total change in energy use is the leading indicator.

The predicted savings in total energy consumption are seen to be positive in all cases; varying from 5.6 per cent in Thredbo (climate zone 8) for the 2-form office building (single storey, light-weight building) to 39.7 per cent

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[25] That is, it is not assumed that buildings *exceed* the required energy efficiency performance as specified in the 2009 and proposed 2010 BCA, for the BAU and change scenario respectively.

[26] For example, mechanical ventilation assets will have an effect that last the entire life of the building. In contrast, lighting will require replacement every 7 years, resulting in a much shorter effective lifespan.

for the H-form hospital ward form (3-storey, heavy weight building) located at Mt. Isa (climate zone 3). More than half of the form/type combinations modelled are predicted to have energy savings between 20 and 30 per cent.

Reductions in energy consumption generate benefits to building occupants in the form of reduced expenditure on energy bills. The energy savings are valued using estimates of electricity and gas prices (charts 7.3 and 7.26). Given the potentially significant impact the Australian Government's proposed CPRS will have on electricity prices, this analysis draws on its modelling (Australian Government 2008). In estimating retail electricity prices, it has been assumed that increases in wholesale electricity prices (caused by the CPRS and modelled by the Treasury) are passed-on in full to consumers. Importantly, the prices estimated here are *average* prices as recommended by CIE (2009a). Peak and off-peak prices have not been separately identified. Appendix D details how these prices have been estimated.

7.23 **Change in energy consumption** MJ/m^2 of gross floor area

	Form 1: Office	*Form 2: Office*	*Form 1: Retail*	*Form H: Health*	*Form H: School*
Gas					
Darwin	na	na	na	na	na
Brisbane	na	-0.9	na	na	0.1
Mt Isa	na	-0.3	na	na	0.4
Kalgoorlie	-4.5	-2.5	-1.1	7.1	12.2
Sydney	-2.3	-2.9	-5.9	18.0	3.5
Adelaide	-2.3	-2.9	-5.9	18.0	3.5
Perth	-2.3	-2.9	-5.9	18.0	3.5
Melbourne	-1.7	-4.8	5.2	58.9	1.7
Hobart	-13.4	-13.9	14.5	30.3	-7.3
Canberra	-13.4	-13.9	14.5	30.3	-7.3
Thredbo	na	-5.1	na	34.4	-74.2
Electricity					
Darwin	-256.2	-221.5	-457.5	-636.1	-222.5
Brisbane	-195.1	-143.6	-315.5	-415.1	-197.9
Mt Isa	-141.5	-162.3	-319.1	-641.2	-186.3
Kalgoorlie	-149.4	-141.0	-285.9	-395.7	-213.8
Sydney	-174.9	-122.7	-284.4	-455.1	-127.5

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7.1 **Change in energy consumption** MJ/m^2 of gross floor area (continued)

	Form 1: Office	*Form 2: Office*	*Form 1: Retail*	*Form H: Health*	*Form H: School*
Adelaide	-174.9	-122.7	-284.4	-455.1	-127.5
Perth	-174.9	-122.7	-284.4	-455.1	-127.5
Melbourne	-168.7	-142.5	-293.2	-351.0	-158.7
Hobart	-116.2	-65.4	-309.9	-220.2	-122.5
Canberra	-116.2	-65.4	-309.9	-220.2	-122.5
Thredbo	na	-45.1	na	-231.2	-81.4
Total energy					
Darwin	-256.2	-221.5	-457.5	-636.1	-222.5
Brisbane	-195.1	-144.5	-315.5	-415.1	-198.0
Mt Isa	-141.5	-162.6	-319.1	-641.2	-186.7
Kalgoorlie	-153.9	-143.5	-287.0	-388.6	-201.6
Sydney	-177.2	-125.6	-290.3	-437.1	-124.0
Adelaide	-177.2	-125.6	-290.3	-437.1	-124.0
Perth	-177.2	-125.6	-290.3	-437.1	-124.0
Melbourne	-170.4	-147.3	-288.0	-292.1	-157.0
Hobart	-129.6	79.3	-295.4	-189.9	-129.8
Canberra	-129.6	79.3	-295.4	-189.9	-129.8
Thredbo	na	-50.2	na	-196.8	-155.6

Source: CIE estimates based on data provided by the ABCB.

7.24 **Change in energy consumption** Percentage change per square metre of gross floor area

	Form 1: Office	*Form 2: Office*	*Form 1: Retail*	*Form H: Health*	*Form H: School*
Gas					
Darwin	na	na	na	na	na
Brisbane	na	-33.3	na	na	-3.2
Mt Isa	na	-60.0	na	na	-100.0
Kalgoorlie	-41.7	-43.1	-3.9	25.3	239.2
Sydney	-19.5	-33.7	-19.9	94.2	12.7
Adelaide	-19.5	-33.7	-19.9	94.2	12.7
Perth	-19.5	-33.7	-19.9	94.2	12.7
Melbourne	-3.6	-6.8	4.2	58.8	1.2
Hobart	-15.0	-12.0	7.0	13.6	-3.1
Canberra	-15.0	-12.0	7.0	13.6	-3.1

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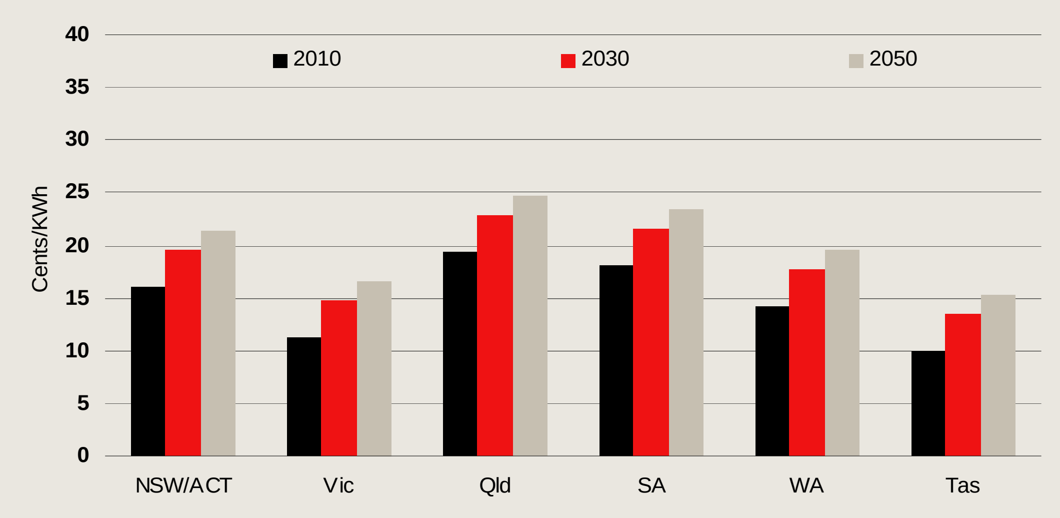
7.2 **Change in energy consumption** Percentage change per square metre of gross floor area (continued)

	Form 1: Office	*Form 2: Office*	*Form 1: Retail*	*Form H: Health*	*Form H: School*
Thredbo	na	-1.4	na	5.7	-13.9
Electricity					
Darwin	-20.7	-16.6	-24.4	-33.4	-25.6
Brisbane	-21.2	-16.6	-24.5	-35.5	-30.6
Mt Isa	-13.5	-14.4	-21.7	-39.7	na
Kalgoorlie	-16.1	-16.5	-23.7	-31.1	-26.3
Sydney	-20.8	-17.0	-25.1	-37.0	-19.9
Adelaide	-20.8	-17.0	-25.1	-33.3	-19.9
Perth	-20.8	-17.0	-25.1	-33.3	-19.9
Melbourne	-21.7	-20.5	-25.7	-20.0	-24.4
Hobart	-19.1	-12.2	-26.0	-15.9	-21.4
Canberra	-19.1	-12.2	-26.0	-15.9	-21.4
Thredbo	na	-6.0	na	-11.8	-21.6
Total energy					
Darwin	-20.7	-16.6	-24.4	-33.4	-25.6
Brisbane	-21.2	-16.7	-24.5	-35.5	-30.6
Mt Isa	-13.5	-14.5	-21.7	-39.7	-27.1
Kalgoorlie	-17.2	-17.2	-23.7	-31.6	-29.7
Sydney	-20.8	-17.4	-25.0	-38.7	-20.5
Adelaide	-20.8	-17.4	-25.0	-38.7	-20.5
Perth	-20.8	-17.4	-25.0	-38.7	-20.5
Melbourne	-21.5	-20.1	-26.1	-27.2	-24.6
Hobart	-18.7	-12.2	-27.1	-19.2	-20.6
Canberra	-18.7	-12.2	-27.1	-19.2	-20.6
Thredbo	na	-5.6	na	-14.3	-18.1

Source: CIE estimates based on data provided by the ABCB.

7.25 **Average retail electricity prices** Cents per KWh



Note: Data limitations prevent making a robust estimate for the Northern Territory. Data for the NT will be evaluated using Australia-wide average.

Data source: Based on CIE (2009a) using ABS (2006), Australian Government (2008) and ABARE (2008).

Gas price forecasts are reported in chart 7.4. The impact on gas prices are less well understood. In a report commissioned by the Treasury, MMA (2008b) estimated the implications that introducing the CPRS would have for different fuel sources — gas included. MMA estimated that the CPRS would increase gas prices by about 40 per cent by 2020 and that prices would remain relatively constant thereafter. These estimates underpin the forecasts of gas prices used in this analysis [27] (only forecasts of the national averages are provided — see appendix D).

Table 7.5 provides estimates of the annual savings on energy expenditure due to the proposed amendments. Estimates are expressed in ‘per building’ terms. For example, the estimated value of energy savings for a typical Form 1 retail building in Sydney is about $26 500. In comparison, a typical Form 1 office building in Sydney saves about $16 000 per annum.

In table 6.6 the energy savings created by the amendments have been aggregated to a national level. Estimates here are based on projections of the building stock used in the cost analysis and are specific to those buildings classes provided in the ABCB sample. To account for commercial building refurbishments, the stock of new commercial buildings has been scaled by an additional 10 per cent.

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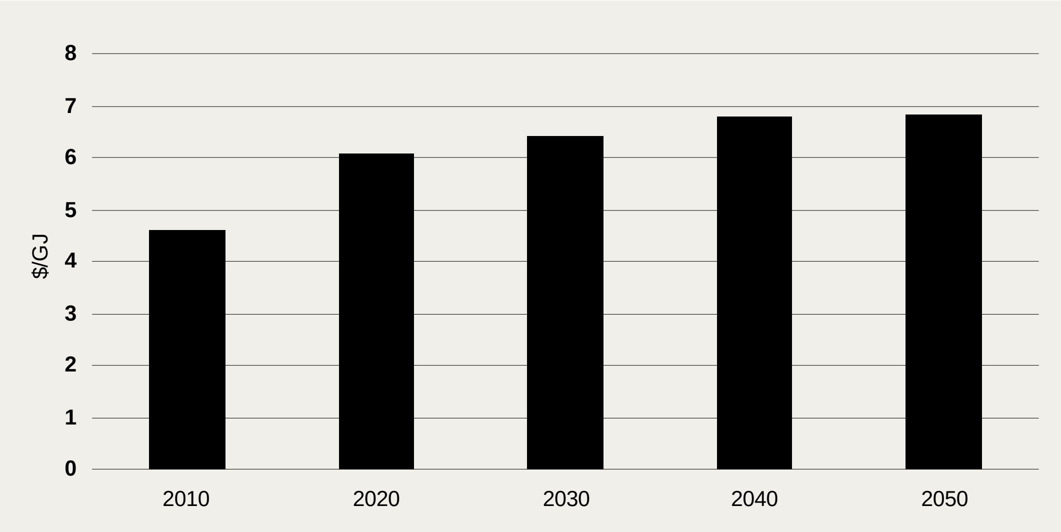
[27] MMA (2008b) uses city node gas prices in NSW as an indicator of Australian gas prices. Note that this data source differs from that used to estimate gas prices in CIE (2009a), which was based on forecast wholesale prices of Integrated Gasification Combined Cycle and did not include the effects of the CPRS.

7.26 **Average retail gas prices** $ per GJ



Data source: Based on CIE (2009a) using ABS (2006) and ABARE (2008).

7.27 **Value of annual energy savings, 2010** Dollars saved per annum per building

	Form 1: Office 2000m^2	***Form 2: Office 198m^2***	***Form 1: Retail 2000m^2***	***Form H: Health 2880m^2***	***Form H: School 2880m^2***
Gas					
Darwin	na	na	na	na	na
Brisbane	na	3	na	na	5
Mt Isa	na	1	na	na	21
Kalgoorlie	161	9	39	-366	-629
Sydney	82	10	211	-928	-180
Adelaide	82	10	211	-3 036	-180
Perth	82	10	211	-3 036	-180
Melbourne	61	17	-186	-3 036	-88
Hobart	480	49	-519	-1 562	376
Canberra	480	49	-519	-1562	376
Thredbo	na	18	na	-1 773	3 825
Electricity					
Darwin	21450	1836	38303	76688	26825
Brisbane	21774	1587	35211	66710	31804
Mt Isa	15792	1793	35613	103047	29940
Kalgoorlie	12387	1157	23704	47244	25526
Sydney	16193	1125	26331	60674	16998

(Continued on next page)

7.5 **Value of annual energy savings, 2010** Dollars saved per annum per building (continued)

	Form 1: Office	***Form 2: Office***	***Form 1: Retail***	***Form H: Health***	***Form H: School***
	2000m^2	***198m^2***	***2000m^2***	***2880m^2***	***2880m^2***
Adelaide	18182	1263	29566	74252	19087
Perth	16193	1125	26331	60674	16998
Melbourne	11186	935	19442	33515	15153
Hobart	6899	384	18399	18826	10473
Canberra	3873	216	10329	10569	5879
Thredbo	na	413	na	30824	10852
Energy					
Darwin	21450	1836	38303	76688	26825
Brisbane	21774	1590	35211	66710	31809
Mt Isa	15792	1794	35613	103047	29961
Kalgoorlie	12548	1166	23744	46878	24897
Sydney	16275	1135	26542	59746	16818
Adelaide	18265	1273	29777	71215	18906
Perth	16275	1135	26542	59746	16818
Melbourne	11247	952	19255	30478	15066
Hobart	7379	434	17880	17264	10849
Canberra	4353	265	9810	9007	6256
Thredbo	na	431	na	29050	14677

Note: Estimates are presented in 2009 dollars. They reflect average annual savings of a new commercial building built in 2010, using 2010 energy prices. Negative savings reflect an increase in expenditure.

Source: CIE estimates based on data provided by the ABCB.

7.28 **Total energy savings**

	Total benefits (present value)	***Annualised present value***
	$m	$m
Australia	2592.7	187.9

Note: All figures in 2009 dollars, discounted 7 per cent real over a 50 year time horizon. Figures relate to buildings belonging to classes 5, 6 and 9 and exclude impacts on classes 3,7 and 8 buildings. 7 per cent discount rate.

Source: CIE estimates based on data provided by the ABCB.

Again, the ‘life’ of the policy is ten years (from 2010 to 2020). Each commercial building constructed over this period is assumed to enjoy energy savings as described in table 7.1. Energy savings are asset specific and are accrued over the life of the asset.[28] When an asset expires, it no longer produces energy savings for that building. In total, the proposed amendments produce some $2.6 billion in energy savings (an annualised present value of about $188 million).

GHG abatement

As well as reducing energy consumption, the proposed changes also have the potential to reduce greenhouse gas emissions. In short, as the sector consumes less energy, less energy will need to be produced, and fewer greenhouse gasses will be emitted.

The GHG abatement achieved through the proposed amendments generate benefits for society by easing the impact of the CPRS on other sectors. Under the CPRS, the cost of carbon emissions will be internalised within the cost of ordinary economic activity. Under the CPRS the price of electricity will *already account for the value of greenhouse gasses avoided*. The carbon price impost on electricity is already reflected in earlier estimates of energy savings. Valuing avoided emissions separately would double count this benefit.

Similarly, while the amendments may be expected to impact on the electricity sector's response to the CPRS (by, for example, delaying augmentation of generators, or investing in Carbon Capture and Storage technologies), this has also not been estimated. The extent to which this impact is embodied in electricity generation and network impacts is unclear. In any case, it is anticipated that the impact will be marginal.

That said, the relative cost effectiveness of GHG abatement via the proposed amendments, and the total quantum of abated GHG emissions are nonetheless important measures when assessing the appropriateness of the amendments.

Accounting for the CPRS's likely impact on the emissions intensity of electricity, it is estimated that the amendments could reduce the sector's emissions by some 1.2 MtCO2-e by the year 2020. Cumulatively to 2020, the amendments could reduce GHG emissions by 7.5 Mt CO2-e.

Notably, these estimates have been calculated assuming a building life of only 40 years. And as indicated previously, there may be a case to suggest that this estimate is rather conservative. If a building's 'life'

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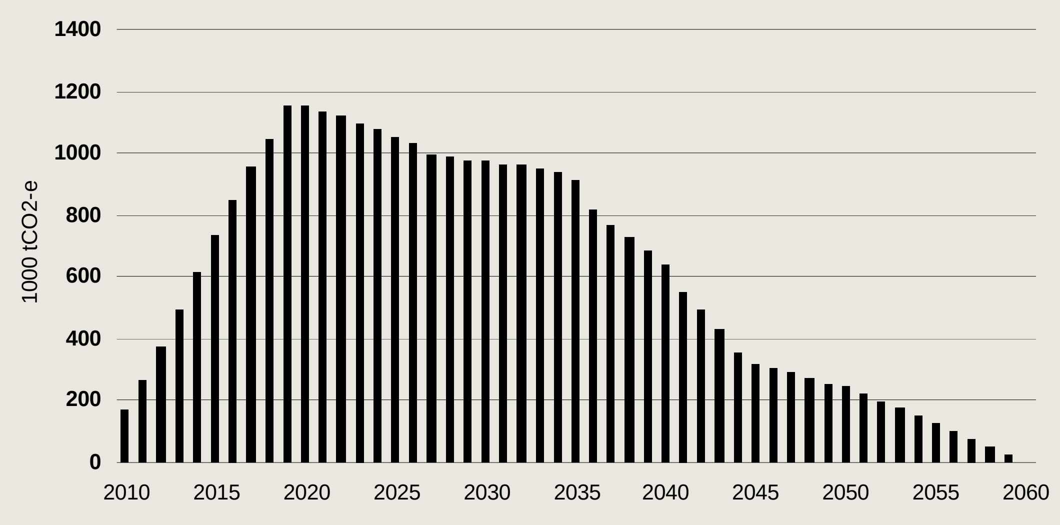
[28] That is, assets relating to internal loads accrue energy savings for 7 years, and 35 years for building systems.

continued beyond the assumed 40 years, the total GHG abatement achieved by the policy would increase.[29]

Chart 7.7 plots the annual abatement achieved by the proposed amendments to 2020 (separated by Class 1 and 2 buildings). It is useful to consider the chart with respect to four key phases.

- Over the period 2010-2020, the number of ‘post 2010 BCA buildings’ is rapidly increasing, and so too then does abatement.
- At the end of the policy’s life (2020), the size of the ‘affected’ stock remains constant. However, over this period the emissions intensity of electricity declines more rapidly, reducing the annual abatement achieved both per building and overall.
- From 2050, cohorts of buildings built under the 2010 BCA begin to retire. As they do so, the stock of post 2010 BCA dwellings reduces (as does their contribution to GHG abatement).
- Eventually in 2060 (some 40 years after the last cohort of buildings are added to the stock), all buildings built during the 2010-2020 period are assumed to have retired, and therefore no longer contribute to GHG abatement.

7.29 **Annual greenhouse gas abatement**



Data source: CIE estimates based on Australian Government (2008) and DCC (2009).

The GHG abatement that can be expected from the proposed amendments would represent about one per cent of the Government’s

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[29] That said, it should also noted that the emissions intensity of electricity by 2050 is expected to be well below current levels. Therefore, while GHG abatement will increase with a building life, the increase will not be of an equivalent proportion.

abatement target of 138 Mt CO2-e.[30] While this may appear to be a relatively small contribution, there are several key advantages to pursuing GHG abatement in the building sector.

First, the abatement achieved through the proposed BCA amendments is likely to be low cost. It is now well documented, that energy efficiency investments in the building sector can provide significant low cost, or even negative cost, GHG abatement (CIE 2007). Given the costs and benefits assessed here, abatement can be achieved at a *negative* cost of $70 per tonne of CO2-e.

That is, *as well* as reducing GHG emissions, the measures improve community welfare. By comparison, the Treasury estimates that the carbon price under the CPRS will be around $35 per tonne of CO2-e by 2020. The reduced abatement cost signifies an increase in overall efficiency, and implies that fewer resources need be diverted (from other economic activities) in order to meet the Government’s emissions target.[31]

Second, much of the abatement achieved by the CPRS — especially in the years after 2020 — is achieved by either switching to alternative and renewable energy sources, or by taking advantage of yet to be developed carbon-capture and storage technologies. Implicitly, the Government has assumed that a) the necessary technologies will be available by this time; b) that they will be cost effective; and c) that the economy will have installed the necessary infrastructure to realise this potential. If nothing else, the Government’s assumptions clearly involve some risks. The abatement provided by alternative means — such as through energy efficiency — acts like an insurance policy against these risks. That is, energy efficiency can reduce GHG emissions without relying on future technological improvements and increases in capacity.

Third, the abatement achieved by the proposed amendments are ‘locked in.’ The amendments specifically alter the building shell, and in doing so they *install* an amount of GHG abatement that is somewhat autonomous from behavioural change, economic activity, price responses and shifting preferences. Again, it is convenient to think of the abatement delivered by the amendments as an insurance policy against unexpected factors that may affect the abatement potential of other sectors in the economy.

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[30] 138 Mt CO2-e represents a 5 per cent reduction in emissions (relative to 2000 levels) by 2020.

[31] Furthermore, while it is possible that the abatement achieved might impact on the carbon price, estimating the magnitude of this would require the use of a computable general equilibrium model, and is outside the scope of this study.

Again, it is important to note that GHG emissions have only been estimated for those buildings in the ABCB sample. The amendments' impact on the energy savings — and, therefore, GHG emissions — have not been estimated for Building Classes 3, 7 and 8. The estimates in chart 6.7 therefore underestimate the potential GHG abatement from the proposed amendments. Indicatively, the omitted buildings are estimated to be about two-fifths of the commercial stock (CIE 2009a), however the relative impact on energy consumption for these building Classes is unknown.

Table 7.8 reports the annual GHG abatement by building for each of the eleven sample locations.

7.30 **Annual GHG abatement, tC02-e**

	Form 1: Office	***Form 2: Office***	***Form 1: Retail***	***Form H: Health***	***Form H: School***
	2000m^2	***198m^2***	***2000m^2***	***2880m^2***	***2880m^2***
Darwin	115.4	9.9	206.0	412.4	144.3
Brisbane	87.8	6.4	142.1	269.2	128.4
Mt Isa	63.7	7.2	143.7	415.8	121.1
Kalgoorlie	69.3	6.4	129.2	252.0	130.7
Adelaide	79.8	5.6	130.7	283.4	80.4
Sydney	79.8	5.6	130.7	283.4	80.4
Perth	79.8	5.6	130.7	283.4	80.4
Melbourne	76.7	6.6	129.7	189.4	101.8
Hobart	58.4	3.5	133.0	123.1	84.2
Canberra	58.4	3.5	133.0	123.1	84.2
Thredbo	na	2.2	na	127.6	100.9

Data source: CIE estimates.

Ancillary benefits

Improving the thermal performance of buildings confers a range of non-financial benefits in addition to reductions in energy-related expenditures. These benefits include (Energy Efficient Strategies 2002) improved amenity values, health improvements, productivity boosts and 'green premiums' (in the form of higher rent and occupancy rates). These benefits, however, are difficult to measure and value. A review of the literature provides mainly qualitative discussions of these benefits.

Health benefits are associated with improved indoor air quality, limitation on internal temperature swings and elimination of condensation and associated mould growth. One study reports that people remain indoors

90 per cent of the time and pollutants indoor exceed 10 to 100 times the pollutants outdoors (Kats 2003). Improving indoor air quality can lead to lower rates of absenteeism, respiratory diseases, allergies and asthma. Lighting, temperature and ventilation are found to influence illness symptoms such as headaches, eyestrain, lethargy, loss of concentration and mucosal symptoms.

Productivity improvements can also be achieved. According to Heerwagen (2002) various research studies have measured improvements in workers' productivity due to sound indoor environmental quality. One study found that better control of indoor conditions increases productivity of clerical activities by 7 per cent, of logical thinking activities by 2.7 per cent, of skilled manual work by 3 per cent and of very rapid manual work by 8.6 per cent. Studies in Canada, Europe, United Kingdom found similar results. Greater control over ventilation, lighting, temperature and daylighting has proven to increase average workforce productivity (7.1 per cent from lighting control, 1.8 per cent from ventilation control and 1.2 per cent).

Green buildings have also been reported as a good strategy for employee attraction and retention. They provide a greater aesthetic and comfort that contribute to better work environments. In turn, this may contribute to reduced stress and improved overall psychological and emotional functioning. Again, citing Heerwanger (2002):

> The presence of particular, positive, spirit-lifting features in the interior environment also helps develop positive emotional functioning and serves as a buffer to discomforts and stresses. These features include daylight, sun patches, window views, contact with nature and overall spatial design.

This conclusion is backed by other studies. For example, a study on Herman Miller Greenhouse in Holland based on pre and post occupancy analysis found workers in the new building had higher job satisfaction, work spirit and greater sense of belonging compared to the old building.

Lastly, reduced health problems may mean less insurance costs and litigation. A study mentioned in Heerwanger (2002) concludes that:

> … energy efficient building improvements can reduce insurance losses due to their potential to improve indoor air quality. One company cited, a provider of professional liability insurance to architects and consulting engineers, paid out more than $24 million for claims related to heating, ventilating, and air conditioning between 1989 and 1993. The claims involved over- or under-heated buildings, inadequate ventilation or inadequate cooling.

Electricity generation and network impacts

The proposed BCA changes will deliver gains in the form of avoided costs enjoyed by electricity generators and the businesses delivering power to end users. These will be modest gains. The relatively small impact on energy conservation compared to BAU will make it unlikely that generation augmentation plans, already heavily impacted by the likely implementation of the CPRS and renewable target requirements, will be altered as a result of the envisaged changes to commercial consumption. Reductions in generation operating costs will occur but are unlikely to be more than 0.2 per cent below BAU costs. Avoided carbon costs will be of a similarly small order of magnitude, along with any unserved energy savings.

More substantial savings may be realised in the network businesses due to favourable demand reduction responses that reduce their unit costs. Based on studies prepared to evaluate other energy conservation measures, it is estimated that average annual savings attributable to the proposed BCA changes could reach $30 million by 2030 in this subsector relative to BAU. The present value of such savings could be as much as $280 million (discounted at 7 per cent real).[32]

A detailed discussion of the impacts of the proposed BCA amendments in energy networks is provided in appendix G.

Gas network impacts

Just as the proposed amendments are likely to reduce electricity consumption, they are also likely to reduce gas consumption. Although these impacts might be quite marginal, it might still be reasonable to expect that the amendments might still have an impact on the gas sector as they might on electricity.

Unfortunately, a comparable body of literature is not available to conduct the sophisticated analysis necessary to provide a robust estimate of the impact on gas networks (or the gas market more generally). Further, any attempt to do so would be speculative at best. Consequently, these impacts have not been quantified in this analysis.

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[32] This estimate assumes a ‘ramp-up’ phase of 5 years (in which no benefits are accrued) and $30 million per year thereafter.

8 Net impact assessment

The net impact of the proposed changes has been assessed at both the individual building and economywide level. The results of this analysis are reported below.

All estimates have been calculated using a 7 per cent real discount rate. This reflects requirements of OBPR However, where the results in the Consultation RIS used a 5 per cent discount rate, appendix E provides a review of international literature relating to evaluating energy efficiency policies, and the choice of discount rate. How the choice of the discount rate affects the central case is discussed in the sensitivity analysis.

Net impact on buildings

Table 8.1 below presents the estimated net impact on the ABCB’s building sample. The impacts have been assessed using the assumptions about length of policy and asset lives and a real discount rate of 7 per cent.

The results in table 8.1 demonstrate that the impact of the provisions varies widely across building types and climate zones. Depending on location, occupancy and building type, it is estimated that the proposed amendments could impose an impact (per square metre of gross floor space) of between -$250 and $340. In some areas for certain buildings, the net impact is negative (that is, a net cost). For other segments of commercial buildings, the net impact is positive (that is, a net benefit). Generally, the greatest beneficiaries are retail and healthcare buildings.

In the table, a BCR greater than one implies the net impact of the proposed changes for the particular building, in the particular location is positive. In other words, the associated savings in energy expenditures outweigh the direct capital costs. Depending on the building, occupancy and location, BCR ratios ranged from 0.11 to 3.42. The BCRs for healthcare and retail buildings were on average the largest of all buildings. Form 2 offices reported a BCR less than 1 in almost all locations.

8.31 Net impact

	Form 1: Office 2000m^2	*Form 2: Office 198m^2*	*Form 1: Retail 2000m^2*	*Form H: Health 2880m^2*	*Form H: School 2880m^2*
Present value of net impact (NPV) $ per square metre of gross floor area					
Darwin	67.6	2.1	172.1	259.3	26.8
Brisbane	34.2	-49.6	102.6	180.5	48.3
Mt Isa	-64.7	-109.7	63.5	338.7	-17.9
Kalgoorlie	-39.7	-104.1	28.4	76.0	6.0
Sydney	33.0	-50.9	97.1	195.5	-23.8
Adelaide	48.7	9.9	118.4	225.8	-14.0
Perth	33.0	-50.9	97.1	195.5	-23.8
Melbourne	4.1	-34.7	53.1	23.7	7.8
Hobart	-46.0	-89.0	27.3	-47.7	-36.6
Canberra	-19.0	-73.1	82.3	-11.3	-9.6
Thredbo	na	-247.7	na	-40.2	-36.0
Annualised NPV $ per square metre of gross floor area					
Darwin	5.22	0.16	13.29	20.02	2.07
Brisbane	2.64	-3.83	7.93	13.94	3.73
Mt Isa	-4.99	-8.47	4.91	26.16	-1.38
Kalgoorlie	-3.07	-8.04	2.19	5.87	0.46
Sydney	2.55	-3.93	7.50	15.10	-1.84
Adelaide	3.76	0.76	9.14	17.44	-1.08
Perth	2.5	-3.9	7.5	15.1	-1.8
Melbourne	0.32	-2.68	4.10	1.83	0.60
Hobart	-3.55	-6.87	2.10	-3.68	-2.82
Canberra	-1.47	-5.64	6.36	-0.87	-0.74
Thredbo	na	-19.13	na	-3.11	-2.78
Benefit–cost ratio					
Darwin	1.71	1.02	2.81	2.86	1.24
Brisbane	1.28	0.70	1.87	2.28	1.44
Mt Isa	0.63	0.54	1.40	2.99	0.89
Kalgoorlie	0.70	0.45	1.23	1.49	1.05
Sydney	1.38	0.62	2.34	3.11	0.77
Adelaide	1.58	1.12	2.71	3.42	0.87
Perth	1.4	0.6	2.3	3.1	0.8

(Continued on next page)

8.1 **Net impact** (continued)

	Form 1: Office	*Form 2: Office*	*Form 1: Retail*	*Form H: Health*	*Form H: School*
	2000m²	*198m²*	*2000m²*	*2880m²*	*2880m²*
Melbourne	1.05	0.68	1.73	1.20	1.11
Hobart	0.56	0.28	1.30	0.62	0.62
Canberra	0.82	0.41	1.91	0.91	0.90
Thredbo	na	0.11	na	0.75	0.74

Note: Estimates are presented in 2009 dollars with a 7 per cent real discount rate.

Source: CIE estimates based on data provided by the ABCB and BMT & ASSOC.

8.32 **Net impact assessment, Australia**

Present value of net impact (NPV)	*Annualised NPV*	*Benefit–cost ratio*
$ million	$ million	BCR
1138.1	82.5	1.61

Note: Net impact figures in 2009 dollars; discount rate is 7 per cent real. Figures relate to buildings belonging to Classes 5, 6 and 9 and exclude impacts on Classes 3,7 and 8 buildings.

Source: CIE estimates based on data provided by the ABCB and BMT & ASSOC.

Net impact on the economy

The net impact analysis at the economywide level reports:

- the results of the net impact assessment for the central case;
- a sensitivity analysis; and
- a discussion on the distribution of impacts.

Central case

Economywide, the proposed amendments to the BCA are expected to:

- impose costs with a present value of around $1.8 billion; and
- produce benefits with a present value of around $2.9 billion.

On net then, the impact of the proposed amendments is expected to produce a benefit to the economy of around $1.1 billion (in net present value terms). This can be interpreted as a having a BCR of 1.61 (table 8.2). Importantly, there is a difference between when costs and benefits are incurred. While capital outlays are incurred at the time of construction, energy savings are achieved annually and accumulate as the affected building stock grows.

Importantly, the net impact assessment has been conducted on only those buildings provided in a sample of buildings from the ABCB. No information was provided or assessed relating to buildings belonging to Classes 3, 7 or 8. Including these buildings in the sample would increase both costs and benefits, and consequently the impact on the amendments' NPV is ambiguous. If costs and benefits of those building Classes represented in the analysis are indicative of those excluded, then it is unlikely that the amendment's BCR would be altered by any significant degree.

Distribution of impacts between landlords and tenants

The analysis presented in previous chapters of the report mainly focuses on the impacts of the proposed BCA amendments on owners–occupiers of commercial buildings. However, a major concern relating to the proposed energy efficiency measures is the existence of split incentives (commonly referred to as the landlord–tenant problem).

As mentioned before, split incentives is a key market barrier to the provision of energy efficient buildings. This impediment refers to the fact that the costs and benefits of energy efficiency investments may accrue to different agents. In this case, the problem is that the first owner of a commercial building will be deemed responsible for the investment in higher cost energy efficiency technologies and practices (that is, for building a more energy efficient building than they would otherwise), while the tenant will receive the benefits of these measures in the form of reduced energy bills.

Arguably, owners of new commercial buildings will be disadvantaged by the proposed BCA measures due to one of the underlying market failures that motivated the amendment of the code in the first place. However, this will only be the case if potential tenants and buyers of commercial buildings systematically undervalue the improvements in energy efficiency.

While the existence of rental premiums and additional capital gains for energy efficiency buildings are not yet proven in all cases, efforts are underway to quantify these benefits and many studies have analysed how 'green' attributes of buildings are valued by tenants and investors. For instance, the Green Building Council's (GBC) report Valuing Green (2008) analyses how a Green Star rating can affect property values based on case studies of Green Star buildings and interviews with Australian property owners, valuers and developers.[33] Key findings of the GBC survey are that:

- the majority of investors surveyed in Australia would pay more for a Green Star building. The improved marketability of these buildings is their main current competitive advantage: they are easier to sell and lease, which reduces vacancy times and hence income losses; and
- while some tenants are willing to pay the rental cost of achieving Green Star, a rental premium is not yet proven in all cases. However, according to the report, in the longer term the industry expectation is that rental growth, tenant retention and operating cost savings will become the key drivers for the market value of Green Star buildings.

The GBC report also discusses the results of an extensive literature review on the valuation of green buildings. This review acknowledges that, while there is greater recognition of green attributes in the valuation of buildings, documented valuations of buildings incorporating green features are few and far between. Despite this, the GBC provides some estimates of the benefits of green buildings quantified in the literature. For instance, the GBC refers to a study of the US market by McGraw Hill that found that green buildings delivered the following added value:

- operating costs decreased by 8 to 9 per cent;
- building values increased by 7.5 per cent;
- return on investment (ROI) improved by 6.6 per cent;
- occupancy ratio increased by 3.5 per cent; and
- rent ratio increased by 3 per cent.

While studies providing tangible evidence of the value of green buildings are not numerous enough to extrapolate general rules from, the GBC study noted that tenant willingness to pay for Green Star buildings is expected to increase in the future. The implication of this is that it will lead to long-term rental growth, and this in turn will be a significant driver for the market value of green buildings.

Against this background it is clear that, while concerns about the landlord–tenant issue are somewhat justified, they should not be overstated.

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[33] Green Star is a comprehensive, national, voluntary environmental rating system that evaluates the environmental design and construction of buildings.

9 Other impacts and implementation issues

Considered in this chapter are:

- the expected impacts on industry capacity;
- competition effects; and
- the review process.

Each are discussed in turn below.

Industry capacity

The current energy efficiency requirements in the BCA can be achieved by installing roof, wall and ceiling insulation in the main with single clear glazing sufficing for modestly sized windows and glazed doors. With insulation offering diminishing returns, the greatest benefit is in the use of high performance glazing (AWA 2009, p.3). The proposed BCA 2010 effectively changes the glazing requirement from single clear to tinted and/or double glazing for the same glazing area and frame. Alternatively designers may choose to have smaller windows or a combination of reasonable glazing performance and smaller windows. These changes raised concerns about the capacity of industry to respond to the BCA 2010 thermal performance requirements (to meet demand).

In response to these concerns, the ABCB invited the window industry to conduct an assessment of the capacity and capability of the industry (serving both the housing market and the commercial building market) to meet a significantly increased demand for high performance glazing by 1 January 2011.

The Australian Window Association (AWA) conducted a survey among its members aimed at discovering the capability and capacity of the window industry to be able to supply products to meet the new 6 star energy efficiency requirement in housing and the increased levels of energy efficiency for commercial buildings in Australia.

The AWA membership comprises 360 manufacturing members. The AWA received responses to the survey from 166 members (equivalent to approximately 46 per cent of their membership). The AWA survey included both fabricators and system suppliers. Of the total number of respondents, 92 per cent (or 152 respondents) were fabricators and 8 per cent (or 14 respondents) were system suppliers. The fabricator demographic was made up of a mix of small, medium and large suppliers.

Results from the fabricators survey follow below.

- Most fabricators have access to products that perform higher than the current norm for the industry (currently 75 per cent have access to a window with significant performance in U Value and SHGC).
- Most window fabricators currently have the capability to produce double glazed windows (86 per cent of them are currently fabricating high performance products).
- Manufacture of double glazed windows and doors is not a large proportion of the overall products being manufactured. For 70 per cent of fabricators, the production of double glazed windows and door represents 30 per cent or less of their total production.
- Fabricators have the ability to increase the production of double glazed window and door products to move this product range to be the major product line (75 per cent of their production). The majority of the respondents (76 per cent) suggested that they can do this within a 12 month period. Further, there was positive feedback from the respondents that there will be minimal withdrawal from the industry.
- However, fabricators identified the following difficulties associated with increasing manufacture of double glazed windows and door products:
  - lead-times will increase with the change to the manufacturing mix and there will be a reduction in production efficiency due to the added complexity of double glazed window and door systems;
  - costs will be higher due to increased site glazing, additional cost to product, extra staff and contractors, re-tooling, training, and increased stock and space required in premises (around 28 per cent of the respondents may require new premises);
  - increased OH&S issues due to weight of product including manual handling, transport and possibly an increase in injuries;
  - possible increase in imports at standard sizes, reducing work for local businesses;
  - possible supply issues on extrusion, hardware and glass. Increased complexity in manufacturing process which impacts production time and precision (more room for error).
- Most fabricators (58 per cent) will require capital investment to increase production of double glazed windows and doors. Responses ranged

from $20 000 to $1 000 000 dollars to be invested depending on the size of the fabricator. Investment would generally be required for lifting equipment, tooling, and creating site glazing departments, transport equipment, increased stock and some possible IGU lines.

Key results from the system suppliers' survey follow.

- System suppliers can make tooling available for fabricators to manufacture double glazed windows and doors within a six-month period but significant investment is required by this section of the industry for the redesign of suites.
- Most systems suppliers (86 per cent) have a full range of double glazed windows and doors available for fabricators to supply to the housing and commercial market.
- For double glazed window and door systems to become mainstream suites in the market, redesign will be needed by some of the systems suppliers. Most of this redesign work required can be completed within 18 months.

In addition to the survey conducted by AWA, information on capacity of the glass industry to supply high performance products was supplied by the Australian Glass and Glazing Association (AGGA) and Viridian. The key points about glass availability are summarised below.

- Tinted glass products—there is unlimited supply of tinted glass products available from local and international sources. This means that the glass industry can supply the products to meet the required demand even with significant increases.
- Low E glass products —new Viridian coating line capable of producing 40 000 tones per annum which is 4 times the current market penetration. Imported product is also available from many suppliers.
- IGU products — the current utilisation of national IGU capacity is running at between 50–70 per cent. Capacity can be increased depending on demand. New IGU lines are being installed throughout the country increasing capacity further. The large commercial market generally sees more imported product being utilised rather than locally manufactured product.

It follows then, that there is access and availability of high performance products and the industry has the capacity and capability to meet a significant increase in demand for these products. However, doing so will impose extra costs on fabricators and system suppliers which in turn will impact the cost of the products. The AWA report indicates that survey respondents would be investing up to $20 million; this could mean investment for the whole industry of around $50 million (AWA 2009, p. 37).

Additional details about this survey can be found in AWA (2009).

Competition effects

The principles of best practice regulation outlined in COAG (2007) set out specific requirements with regards to regulatory process undertaken by all governments. In particular, Principle 4 of Best Practice Regulation states that:

> in accordance with the Competition Principles Agreement, legislation should not restrict competition unless it can be demonstrated that:
>
> > a. the benefits of the restrictions to the community as a whole outweigh the costs; and
> >
> > b. the objectives of the regulation can only be achieved by restricting competition.

As such, COAG requires that all RISs include evidence that:

- the proposed regulatory changes do not restrict competition; or
- the changes can potentially restrict competition but the public benefits of the proposed change outweigh the costs and the objectives of the changes can only be achieved by restricting competition.

A preliminary assessment indicates that the proposed BCA changes can potentially reduce competition through:

- a reduction of choice available to consumers as a result of the mandatory use of more energy efficient materials in the construction of new buildings; and
- a reduction in the number of suppliers and/or numbers — at least in the short run — of products available in the market if existing products have to be redesigned/ improved in response to more stringent BCA requirements.

This potential reduction in competition could lead to higher prices than otherwise and increase the costs of complying with the new BCA measures. However, the BCA measures will also increase demand for energy efficient products, which may result in no net reduction in competition but just a shift in the mix of products supplied in the market. At the time of writing the consultation and Final RISs, there was insufficient information to allow TheCIE to fully assess the net effect that the proposed BCA amendments will have on competition in all the different industries affected by the new measures.

However, the survey conducted by the AWA and described in the previous section provides information that can be used to assess the likely effects of the BCA measures on competition in the windows and glass industry.

Results of the AWA analysis show that the proposed changes are not likely to reduce competition in this industry. In particular, the study shows that:

- there will be minimal withdrawal from the industry as a result of the proposed BCA changes (95.3 per cent of the survey respondents said they will continue in the industry if demand for double glazed window and door products increases to 75 per cent);
- most fabricators have access to products that perform according to the increased energy efficiency stringency proposed in the BCA; and
- while some products need to be redesigned to meet the new BCA requirements, the industry is capable of doing most of the redesign work required, and this work can be completed within 18 months.

While the AWA study sheds some light into the likely impacts on competition in the windows and glass industry, further information is required to assess the likely competition effects on other industries affected by the BCA changes (including the construction industry). [34] In this respect, the consultation process that followed the release of this RIS served as a good opportunity to overcome some of these gaps in knowledge and gather information about the extent to which the proposed changes will impact the market structure of other relevant industries.

Despite the potential effects on competition in industries other than the windows and glass industries highlighted above, the analysis conducted for this RIS shows that:

- the community benefits of proposed changes to the BCA outweigh the costs. In particular, this RIS demonstrates that every one dollar of costs generates 2.05 dollars of benefits to the community; and
- from the range of viable policy options identified in Chapter 3, the proposed regulatory option (an amended BCA) is the best way of achieving the government objectives.

Therefore, the proposed changes to the BCA are considered to be consistent with the Competition Principles Agreement outlined in COAG (2007).

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[34] For instance, the ability of builders to understand and apply the changes needs to be evaluated.

Review

Effective regulation is an important tool for delivering Australia’s social and economic goals. However, over-regulation is a major concern to all Australian businesses and to the community generally. Therefore regulation needs to be introduced and managed in a way that does not impede economic activity or impose unnecessary costs.

The ABCB recognises that the BCA needs to be continually developed and enhanced to take into account new initiatives, research and practices. The ABCB also recognises that the BCA needs to be reviewed periodically to ensure it continues to reflect contemporary and future regulatory needs (ABCB 2007b).

The proposed changes to the BCA would be subject to review in the same way as any other provision in the BCA. The ABCB allows any interested party to initiate a Proposal for Change (PFC) process to propose changes to the BCA. This is a formal process which requires proponents of change to provide justification to support their proposal.

PFCs are considered by the ABCB’s Building Codes Committee (BCC) each time it meets. The role of the BCC, which consists of representatives of all levels of government as well as industry representatives, is to provide advice, guidance, and make recommendations relating technical matters relevant to the BCA. If the proposal is considered to have merit, the BCC may recommend that changes be included in the next public comment draft of the BCA, or for more complex proposals, it may recommend that the proposal be included on the ABCB’s work program for further research, analysis and consultation.

This process means that if the measures proposed in the 2010 BCA are found to be more costly than expected, difficult to administer or deficient in some other way, it is open to affected parties to initiate a PFC. The fact that the BCA is reviewed and, if necessary, amended every year means that the lead time for changes can be relatively short.

Additionally, to encourage continuous review and feedback on the BCA the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. In particular, a continuous feedback mechanism exists and is maintained through State and Territory building control administrations and industry through the BCC. These mechanisms ensure that opportunities for regulatory reform are identified and assessed for implementation in a timely manner.

Apart from reviewing the technical content of the BCA, the States and Territories can review which parts of the BCA are called up in their building regulations and whether they wish to substitute their own jurisdictional appendices for certain general provisions. Alternatively, they may decide that new general provisions make it unnecessary to maintain separate provisions. In some cases State or Territory building regulations may themselves be subject to 'sunset' or regular review clauses (Wilkenfeld 2009).

As with all other aspects of the BCA, the effectiveness and observed impacts of the proposed energy efficiency measures should be monitored. The analysis in this RIS has been undertaken based on the best information currently available and it will be necessary to verify how the building industry and suppliers of energy efficient materials and equipment do in fact respond.

10 Consultation process

This chapter provides details about the current ABCB consultation processes and additional energy efficiency specific consultation for the commercial proposal. It is organised under three headings:

- a discussion about the ABCB Consultation Protocol;
- an overview of the ABCB Impact Assessment Protocol; and
- a summary of the ABCB communication strategy and consultation process for the 2010 BCA.

Where Chapter 5 presented an overview of the submissions that were received in the consultation period, and following on from the change in discount rate as presented in Chapters 6, 7 and 8, Chapter 11 will present further sensitivity analyses on other issues raised in submissions to the Consultation RIS.

ABCB Consultation Protocol

The ABCB is committed to regularly review the BCA and to amend and update it to ensure that it meets changing community standards. To facilitate this, the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. In particular, a continuous feedback mechanism exists and is maintained through state and territory building control administrations and industry through the Building Codes Committee. These mechanisms ensure that opportunities for regulatory reform are identified and assessed for implementation in a timely manner.

All ABCB regulatory proposals are developed in a consultative framework in accordance with the Inter-Government Agreement. Key stakeholders are identified and approached for inclusion in relevant project specific committees and working groups. Thus, all proposals have widespread industry and government involvement.

The ABCB has also developed a Consultation Protocol, which includes provisions for a consultation process and consultation forums. [35] The Protocol explains the ABCB's philosophy of engaging constructively with the community and industry in key issues affecting buildings and describes the various consultation mechanisms available to ABCB stakeholders.

The ABCB's consultation processes include a range of programs that allow the ABCB to consult widely with stakeholders via:

- the proposal for change process;
- the release of BCA amendments for comments;
- regulatory impact assessments;
- impact assessment protocol;
- research consultations;
- reporting directly to ministers responsible for buildings; and
- international collaboration.

The Protocol also ensures that the ABCB engages with their stakeholders via a range of events and information series through:

- the Building Codes Committee (BCC) with representatives from a broad cross section of building professions and all levels of government;
- its consultation committees;
- public information seminars;
- its biennial National Conference;
- its technical magazine, the Australian Building Regulation Bulletin (ABRB);
- its online technical update, ABR Online;
- its free 1300 service advisory line which provides information for industry and the general public to clarify BCA technical matters and access technical advice about provisions; and
- the ABCB website.

ABCB Impact Assessment Protocol

The ABCB Impact Assessment Protocol ensures that the impact assessment processes are accountable and transparent, and allow for

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[35] Available on http://www.abcb.gov.au/index.cfm?objectid=49960DC7-BD3E-5920-745CE09F1334889C.

significant stakeholder consultation and participation. The impact assessment processes include the following.

- Proposals for change (PFC) which require a change-proposer to justify any projected amendment to the BCA, in accordance with COAG regulatory principles. All PCFs are consulted on and considered by the BCC.
- Preliminary Impact Assessments (PIA) which allow for early-stage impact analysis of proposed changes to the BCA. Although complementary to the PFC process, a PIA allows for a more thorough impact assessment to be carried out by the ABCB.
- Regulation Impact Statements (RIS) which provide a comprehensive assessment of the impacts of proposed regulation in accordance with COAG Guidelines.

ABCB communication strategy and consultation process for the BCA 2010 energy efficiency proposal

The communication strategy for the new energy efficiency requirements in BCA 2010 comprises a three pronged approach as outlined in the sections below. Additionally, a schedule of key events and outputs is provided in table 9.1.

1. A series of stakeholder presentations rolled out over 12 months. Several of these major events involving live web casts made available for download shortly after the event. In addition, the proposed new energy efficiency provisions will be a key focus of the BCA 2010 information seminar series. Stakeholders to be kept informed of upcoming events via email alerts and information alerts on the website.
2. Complementary information supporting that communicated at the key stakeholder presentations, national conference and information seminars disseminated via additional awareness and training materials such as:
   - resource kits;
   - handbooks (existing building, housing extension and on-site construction);
   - self-paced on line training modules;
   - feature articles in publications (for instance ABRB and E-ABR);
   - documents (for instance the regulatory proposals and RIS), placed on the ABCB website;

  - tools (for instance, glazing and lighting calculators), placed on the ABCB website; and
  - FAQ page on the website, including responses to 1300 enquiries.

3. Maximise multiplier opportunities by engaging with State & Territory administrations, industry associations and educational institutions and their constituents/members. The ABCB will:
   - forward the schedule of proposed key events in table 10.1 to organisations for the promotion of upcoming events;
   - provide assistance with the efforts of key organisations to disseminate information to their constituents/members;
   - offer to attend and to speak at prime national conferences of key stakeholders; and
   - offer to attend meetings of peak educators and universities.

10.33 Schedule of key events and outputs

Event	***Key dates***	***Outputs***
Post proposal development		
COAG agreement to new energy efficiency requirements for BCA 2010	28 May 2009	Stakeholder Information Forum in Canberra. Q&A session. Information dissemination about energy efficiency project.
Consultation Draft of BCA proposal released for public comment	17 Jun 2009	Stakeholder Presentation of BCA draft proposal. Full day format, am Vol One, pm Vol Two. Live web cast with moderated Q&A session. Explain proposed BCA changes & encourage submission of comment.
	19 Jun 2009	On demand web cast of BCA draft proposal presentation available for download on website. Broad dissemination of information & request for comment.
Email alerts to subscribers, peak industry bodies and registered parties	Ongoing	Regular email alerts about Energy Efficiency developments and events sent to BCA subscribers, peak industry bodies and those who have registered their interest. Stakeholders invited to register to receive information about Energy Efficiency developments.
Energy Efficiency updates on website	Ongoing	Regular alerts, up to date information and new documents uploaded to Energy Efficiency page on website.
FAQ page on website	Ongoing	Inbox for questions established. 1300 inquiry relating to Energy Efficiency monitored. Q&As regularly uploaded to Energy Efficiency FAQ page on website.
Spring edition of ABRB	25 Aug 2009	Several energy efficiency articles featured.
Consultation RIS released for public comment	Sep - Oct 2009	Stakeholder Presentation of Consultation RIS. Half day format. Web cast with moderated Q&A session. Explain RIS findings & encourage submission of comment.

10.1 **Schedule of key events and outputs** (continued)

Event	*Key dates*	*Outputs*
	Oct 2009	On demand web cast of Consultation RIS presentation available for download on website. Broad dissemination of information & request for comment.
National Conference BAF 2009	23 Sep 2009	Energy Efficiency day. Presentation on proposed BCA provisions & changes. Workshop on using software.
Subject to Board/Government decision		
Summer edition of E-ABR	Feb 2010	Several energy efficiency articles featured.
BCA 2010 Information Seminar series to capital cities	Mar – April 2010	Stakeholder Presentation of key amendments included in BCA 2010. Full day format, am presentations, pm workshop. May include training on using software for 6Star Energy Efficiency (ABSA). Training to encourage practitioner uptake of software, demonstrating it is easy to use, making practitioners more comfortable with using software.
Resource Kit, Modules 3 & 4 updated	Apr–Jun 2010	Update training resource to mirror new BCA provisions.
Existing Building, Residential Extension and On-site Construction Handbooks updated	Apr–Jun 2010	Update handbooks to mirror new BCA provisions.
Glazing and Lighting Calculators updated	Apr–Jun 2010	Update calculators to mirror new BCA provisions.
Electrical Appendix to AS3000 updated	Apr–Jun 2010	Update Electrical Appendix to AS3000 to mirror new BCA provisions. (and possible new Handbook developed).
Self paced on-line training modules	Apr–Jun 2010	New modules in energy efficiency / calculators developed for online training.

Source: ABCB.

11 Consultation sensitivity analysis

This chapter considers the implications for the BCR for elements of optimism and pessimism bias, as well as contentions of fact drawn out through the stakeholder consultation period.

The main issues of fact and methodology that are considered here are:

- Discount rate

The main issues of optimism bias that were raised and are considered here are:

- Building costs

The main issues of pessimism bias that are considered here are:

- Electricity and carbon prices

The results and discussion in this sensitivity analysis section are scenario based. That is, where there are issues raised, the impact that these changes in estimates and assumptions could have on the BCR presented in the draft RIS are estimated. This methodology of sensitivity analysis, in contrast to the monte-carlo based sensitivity analysis provides insight into the direct effect of individual assumption changes rather than a collection of assumption changes.

Discount rate effects

The utilisation of a 5 per cent discount rate in the Consultation RIS, below the general practice set out by the OBPR raised a number of queries throughout the consultation period. In this section, the impact of a 5 and 7 per cent discount rate on the value of thermal energy savings as well as the regional BCRs are presented.

The national level results from different discount rates are presented in table 11.1 below. That is, where a 5 per cent discount rate is used, net benefits of $2.13 billion are estimated with a BCR of 2.05. The use of a 7 per cent discount rate results in $1.14 billion of net benefits to the Australian economy with a BCR of 1.61.

Building and compliance costs

Although estimated by an independent quantity surveyor, the additional building costs estimated and reported in the Consultation RIS are, by their very nature, somewhat theoretical and untested. Moreover, because there

11.1 **Present value of net impact, economywide, $million**

	Net impact	***Benefit Cost Ratio***
	$ billion	BCR
Total – 5 per cent discount rate	2.13	2.05
Total – 7 per cent discount rate	1.14	1.61

has not been an independent ex post assessments of the costs incurred with the introduction of the BCA 2006 energy efficiency measures, some uncertainty surrounds the estimates of increased building costs. That being said, there was only qualitative discussion around building cost estimates in stakeholder submissions.

Where there is the potential for building and compliance costs to have been underestimated, a premium on projected fabric costs has been used to estimate the effect on the BCR. A 10% higher fabric construction cost value results in $935 million net benefit and BCR of 1.44. This should be balanced with potentially lower fabric costs, also by 10 per cent, that would provide $1.34 billion of net benefits and a BCR of 1.81.

Industrial electricity prices

Throughout the draft RIS, due to data limitations, industrial electricity prices were assumed to be the same as residential electricity prices. Where stakeholder responses have indicated that this may not reflect industry practise due to discounts applied to larger electricity users, an illustrative example of the effects is presented here.

Without exact information on the relationship between residential and industrial electricity prices, an assumption of a 15 per cent discount has been applied. Assuming approximately a 15 per cent discount to industrial electricity users compared to residential users, results in a value of net benefits of $739 million and a BCR of 1.39.

Electricity and carbon prices

The BCR estimates in the draft RIS consider only one climate policy scenario, CPRS-5. Benefits from reduced electricity use in dwellings has been estimated based on Treasury projections of movement in average Australian wholesale electricity prices, accounting for State based retail differences, under the CPRS-5 scenario. In this scenario, global GHG emissions are required to stabilise at 550ppm, with Australia’s national emissions reaching 5 per cent below 2000 levels by 2020. By 2050, Australia’s emissions are required to be 60 per cent below 2000 levels.

CPRS-5 is the least stringent climate policy scenario that has been modelled by Treasury in the report “Australia’s Low Pollution Future”. Further policy scenarios that have been considered are:

- CPRS-15: By 2050 Australia's emissions are 60 per cent below 2000 levels, as with CPRS-5, however they are required to be15 per cent below 2000 levels by 2020;
- Garnaut-10: By 2050 Australia's emissions are 80 per cent below 2000 levels, and in the medium term, 10 per cent below 2000 levels by 2020;
- Garnaut-25: By 2050 Australia's emissions are 80 per cent below 2000 levels, as with Garnaut-10, however, they are required to be 25 per cent below 2000 levels by 2020.

Increased stringency of emissions targets has the effect of increasing the projected costs of wholesale, and hence retail, electricity prices in Australia. The impact of these policy scenarios on the estimated net benefits and BCR of the proposed changes to the BCA 2010 are presented in table 11.2.

11.2 **Present value of net impact, economywide, $million**

	Net impact	***Benefit Cost Ratio***
	$ billion	BCR
Total – no climate policy	-0.203	0.87
Total – CPRS-5	1.138	1.61
Total – CPRS-15	1.211	1.65
Total – Garnaut-10	1.156	1.62
Total – Garnaut-25	1.792	1.97

The introduction of CPRS-15 policy would have the effect of increasing the estimated net benefits of the proposed changes to BCA 2010 to $1.2 billion (due to the increased value of thermal and lighting savings), further increases in climate policy stringency to Garnaut-25 would result in approximately $1.79 billion of net benefits and a BCR of 1.97.

If there was no carbon price introduced, and hence BAU electricity prices prevail into the future, introducing the proposed energy efficiency changes in the BCA would result in net costs to the Australian economy of $203 million, with a BCR of 0.87.

Monte Carlo sensitivity analysis

Where the previous sensitivity analyses have provided a discrete estimation of single parameter changes within the estimations, the following Monte Carlo simulation allows a test of the combined effects of changing the underlying assumptions. These variations in key assumptions are presented in table 11.14, and reflect the uncertainties both considered throughout the report, as well as those raised in the consultation period.

This sensitivity analysis tests how influential the central case is to variances in underlying assumptions. First, the net impact and the BCR are evaluated at different discount rates to test how the analysis is specifically affected by this result. Second, a Monte Carlo analysis is employed to test the sensitivity of the central case to all key parameters employed. The Monte Carlo analysis varies all key parameters around their mean values and recalculates the benefits and costs to explore the effect of their potential interactions on the results. Included in the Monte Carlo analysis are the following:

- the discount rate;
- growth of the building stock;
- compliance costs;
- energy savings;
- energy prices;
- HVAC savings;
- refurbishments;
- network savings;
- government costs; and
- industry costs.

The specific elements tested and their respective parameters used in the Monte Carlo analysis are identified in table 11.3. Where possible, the analysis has attempted to be consistent with the parameters used in ABCB (2006b).

11.3 Variables tested in the sensitivity analysis

	Specific values tested/ per cent deviation from most likely value	***Values/range tested***	***Distribution***
Discount rate (per cent)	Specific	3,5,7,9,11	Discrete uniform
Growth of the building stock	Range	+/- 25	Uniform
Compliance costs	Range	+/- 50	Uniform
Energy savings	Range	+/- 20	Uniform
Electricity prices	Range	+50 , -20	Uniform
Gas prices	Range	+50 , -20	Uniform
Refurbishments (per cent)	Specific	0, 10, 20, 30	Discrete uniform
HVAC capacity savings	Range	+/- 20	Uniform
HVAC capacity costs	Range	+/- 30	Uniform
Generation and network impacts	Range	+/- 20	Uniform
Government costs	Range	+/- 20	Uniform
Industry costs	Range	+/- 20	Uniform

Note: All variables tested in comparison to the parameters used in the central case (most likely value).

Source: CIE estimates.

The Monte Carlo analysis was conducted over 60 000 simulations, with each simulation randomly selecting values for each variable (within the ranges specified in table 11.3). The results of the Monte Carlo analysis are reported for key variables in table 11.4. Given the likely ranges of the variables used in this report, the Monte Carlo analysis reports that on average the impact of the amendments is a net benefit of $1.92 billion. On average, the BCR of the amendments is 1.91.

Charts 11.5 and 11.6 below report histograms of the Monte Carlo analysis for the net impact and BCR respectively. The histogram shows the net impact to be regularly (99.9 per cent of all cases) greater than 1. In 39 per cent of simulations, the BCR exceeded 2. This indicates that even after allowing key variables to vary widely, the proposed amendments are still likely to produce a net benefit to the economy. While there remains some degree of uncertainty with the standard deviation of the net impacts approximately three quarters of the average net impact estimate (see Table 11.4) the central case is likely to be relatively robust.

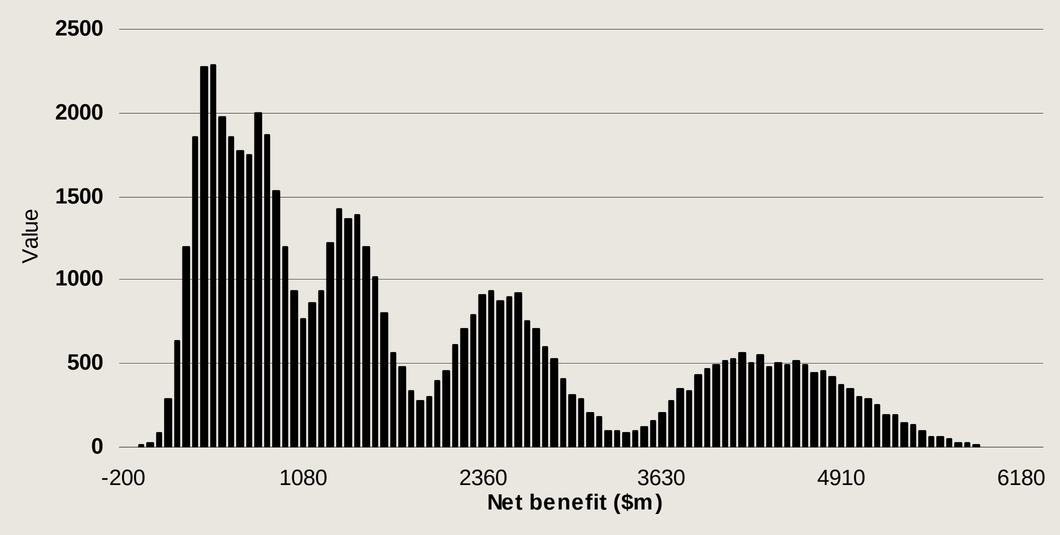
11.34 Monte Carlo simulation results

	Costs	*Benefits*	*Net impact*	*BCR*	*Annual GHG abatement in 2030*	*Abatement cost*
	$ million	$ million	$ million		Kt CO2-e	$/tCO2-e
Minimum	975	1457	-159	0.90	942	-168
Median	1870	3253	1430	1.74	1202	-45
Maximum	3244	8556	6149	3.97	1510	5
Average	1902	3754	1920	1.91	1205	-60
Standard deviation	353	1717	1476	0.61	123	45

Note: All variables tested in comparison to the parameters used in the central case (most likely value). Results based on 60 000 iterations.

Source: CIE estimates.

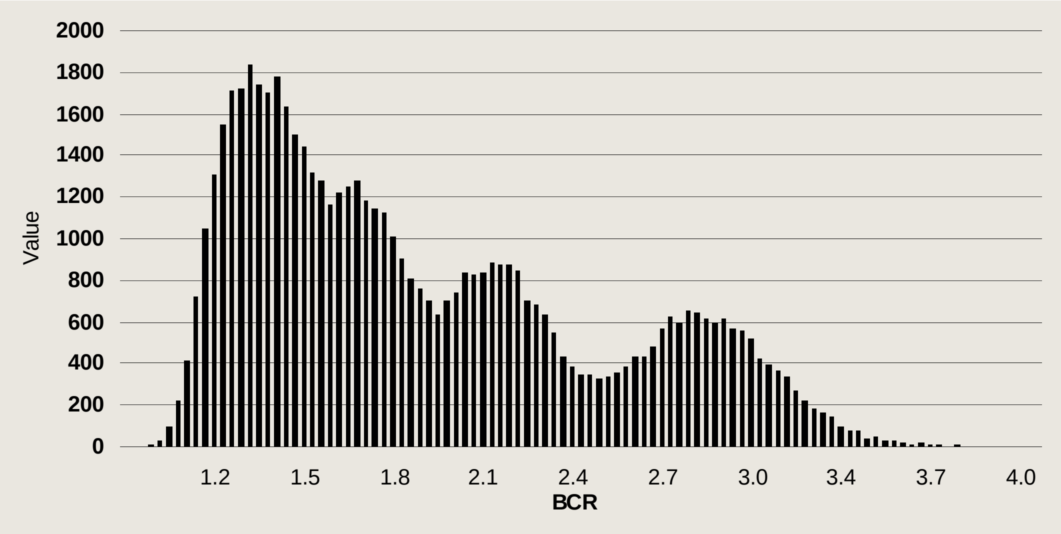
11.35 Histogram of Monte Carlo analysis on net impact



Note: All variables tested in comparison to the parameters used in the central case (most likely value). Results based on 60 000 iterations.

Source: CIE estimates.

11.36 **Histogram of benefit–cost ratio results**



Note: All variables tested in comparison to the parameters used in the central case (most likely value). Results based on 60 000 iterations.

Source: CIE estimates.

11.37 **Sensitivity analysis — discount rate**

Discount rate	*Net impact*	*BCR*
Per cent	$ million	BCR
3	3872	2.73
5	2132	2.05
7 (central case)	1138	1.61
9	549	1.31
11	189	1.11

Source: CIE estimates.

Discount rate

The timing factor of the amendments is very important to the analysis. Capital outlays are relatively large and take place at the beginning of the period, while energy savings are small but are enjoyed over the life of the building.

The dynamic nature of this analysis will therefore means that the discount rate employed is likely to significantly influence the results. In present value terms, the further out are energy savings, the lower their value.

The discount rate used to calculate the net impact for the central case was 57 per cent. Table 11.7 reports the net impact of the amendments, together with the BCR, measured using the alternative discount rates recommended by OBPR (3, 5, 7, 9 and 11 per cent real).

The results in table 11.7 show that the net impact of the amendments is still positive at higher discount rates of 7 and 11 per cent (at a 3 per cent discount rate the net impact more than triples). This suggests that while the findings of the analysis are influenced by the choice of discount rate the view that the amendments are welfare improving is likely to be valid using alternative rates.

12 Conclusion

This RIS has assessed the net impact of a set of proposed changes to the Building Code of Australia, as it applies to commercial buildings (Class 3 and 5 to 9).

It should be noted that this RIS does not formally analyse alternative non-regulatory and quasi-regulatory approaches. Rather it confines itself to only considering the impacts of the proposed BCA amendments. This recognises that:

- COAG has already acknowledged the need to adopt a range of policies and tools so as to address the diversity of market barriers that exist;[36] and
- the BCA is already in place and these amendments are only acting to increase its stringency.

The findings of the Consultation RIS were that the proposed changes to the BCA had the potential to deliver a small net benefit to the Australian economy, but the gains were marginal. The benefit to cost ratio was estimated at 2.05. This means there might be a $2.05 benefit for each dollar of cost the changes would impose. The Consultation RIS also pointed out that some uncertainty surrounded the findings.

Submissions responding to the Consultation RIS have raised a wide variety of issues. For some of the issues raised there is no strong evidence to conclude that there is either a particular optimism or pessimism bias. For instance, in the case of intangible benefits and intangible costs, the arguments tend to be speculative and theoretical without much empirical verification. To a large extent, it is likely that these are relatively small and the benefits and costs tend to off-set each other. At a minimum they create some uncertainty.

In other cases, quantitative evidence has been provided and where it has its potential impact has been assessed. That said, the evidence has not been able to be verified, and some of it is controversial. However, taken at

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[36] The key point is that a suite of complementary measures to the CPRS are needed.

face value, it can have substantive impacts on the preliminary benefit to cost results.

Disaggregated results by building type and city are presented in Table 12.1. The differences across regions and across building types are driven by a number of factors, such as climate, building type and design, and summer cooling requirements. For example, cooler climate areas that do not have a significant cooling load through summer have reduced ability to generate savings from improved envelope efficiency. In contrast, commercial buildings in hotter regions, with high cooling loads through the majority of the day, have a greater ability to gain energy use savings from reduced cooling requirements and improved envelope efficiency. Buildings with a smaller area also have a reduced ability to take account of efficiencies of scale in implementation than do larger buildings.

12.1 Net impact assessment, by region and building type

	Form 1: Office 2000m^2	*Form 2: Office 198m^2*	*Form 1: Retail 2000m^2*	*Form H: Health 2880m^2*	*Form H: School 2880m^2*
Present value of net impact (NPV)	$ per square metre of gross floor area				
Darwin	67.6	2.1	172.1	259.3	26.8
Brisbane	34.2	-49.6	102.6	180.5	48.3
Mt Isa	-64.7	-109.7	63.5	338.7	-17.9
Kalgoorlie	-39.7	-104.1	28.4	76.0	6.0
Sydney	33.0	-50.9	97.1	195.5	-23.8
Adelaide	48.7	9.9	118.4	225.8	-14.0
Perth	33.0	-50.9	97.1	195.5	-23.8
Melbourne	4.1	-34.7	53.1	23.7	7.8
Hobart	-46.0	-89.0	27.3	-47.7	-36.6
Canberra	-19.0	-73.1	82.3	-11.3	-9.6
Thredbo	na	-247.7	na	-40.2	-36.0
Benefit–cost ratio					
Darwin	1.71	1.02	2.81	2.86	1.24
Brisbane	1.28	0.70	1.87	2.28	1.44
Mt Isa	0.63	0.54	1.40	2.99	0.89
Kalgoorlie	0.70	0.45	1.23	1.49	1.05
Sydney	1.38	0.62	2.34	3.11	0.77
Adelaide	1.58	1.12	2.71	3.42	0.87

Perth	1.4	0.6	2.3	3.1	0.8
Melbourne	1.05	0.68	1.73	1.20	1.11
Hobart	0.56	0.28	1.30	0.62	0.62
Canberra	0.82	0.41	1.91	0.91	0.90
Thredbo	na	0.11	na	0.75	0.74

Note: Estimates are presented in 2009 dollars with a 7 per cent real discount rate.

Source: CIE estimates based on data provided by the ABCB and BMT & ASSOC.

The results of the analysis in the Final RIS estimate that the net impact to the Australian economy as a whole from the proposed changes to the BCA will be approximately $1.1 billion of net benefits with a BCR of 1.61.

Discount rate

There was limited discussion of the effect of discount rates from stakeholders, however, noting some general discussion around the variable:

- The Office of Best Practice Regulation suggests a higher discount rate should be used, so, to be consistent with other Commonwealth benefit cost evaluations and decision making, a higher discount rate could be used.
- Commercial building owners who will incur the costs up front and the benefits much later, are likely to have a higher discount rate. Not taking account of this means ignoring a major net cost being imposed on consumers. Ignoring this cost would mean the analysis is not comprehensive nor complete.

The implication of this one factor reduces the estimated BCR from 2.05 to 1.61.

A key underlying factor in the choice of discount rate is whether the costs and benefits are being evaluated at a social or private level. Where a private evaluation is being undertaken, the appropriate discount rate is closely associated with the private decision making process of individuals. However, if the effects of the regulation are being evaluated at a social level, where there is the potential for benefits to be accumulating for a number of years, as well as to future generations, there is scope for these future benefits to hold a greater value, and hence attract a lower discount rate.

Building costs

While there was some qualitative comment surrounding potential underestimation of additional capital costs, there was very limited quantitative evidence supplied.

Where there were qualitative reports of underestimates of building costs, an illustrative increase of 10 per cent above those modelled in the Consultation RIS results in a reduction of the BCR from 1.61 to 1.44. This is balanced with an illustrative 10 per cent reduction in fabric costs, resulting in a BCR of 1.81.

Energy prices

Also controversial is argument by some stakeholders that energy prices used in the analysis may be underestimated. Accepting the most stringent climate change policy scenario modelled by either Treasury or Garnaut (Garnaut-25 rather than CPRS-5 used in the Consultation RIS), net national benefits increase by 57 per cent and the benefit to cost ratio climbs from 1.61 to 1.97. Given the many uncertainties relating to climate change policy the Garnaut-25 scenario must be treated as feasible. However, although feasible, it could be argued that as electricity prices rise due to the CPRS, the arguments for BCA2010 diminish. With higher electricity prices builders and consumers will face increased incentives to adopt energy saving technologies without regulation forcing them to do so. The arguments relating to the need for stricter energy efficiency codes to address market failures are also diminished by rising energy and electricity prices, a major reason for the CPRS.

Overall consideration

This RIS does not formally analyse alternative non-regulatory and quasi-regulatory approaches. Rather it confines itself to only considering the impacts of the proposed BCA amendments. This recognises that:

- COAG has already acknowledged that need to adopt a range of policies and tools so as to address the diversity of market barriers that exist; and
- the BCA is already in place and these amendments are only acting to increase its stringency.

Given this, the following summarises the overall outcomes of the analysis and public consultation process.

There are estimated net national benefits of approximately $1.1 billion due to the proposed changes, and a BCR of 1.61. These are slightly lower than the initial estimates provided in the Consultation RIS which indicated net benefits of approximately $2.1 billion and a BCR of 2.05. These differences are driven by the choice of discount rate. Following the consultation period, including advice from OBPR, the results in the Final RIS utilise a discount rate of 7 per cent, higher than the 5 per cent utilised in the Consultation RIS.

Further discussions raised through the consultation period identified a number of uncertainties in the methodology and assumptions in the Consultation RIS. While there was limited quantitative discussion presented on the scale of these uncertainties, the main topics of concern included the choice of discount rate, estimation of building costs and projections of electricity prices. Other issues that were raised included methodological questions specific to building types that have been addressed in the body of the Final RIS.

A thorough review of the evidence and arguments submitted in response to the Consultation RIS indicate that there is a balancing of both the upside and downside risks as presented in the Consultation RIS.

The results as presented in table 12.1 demonstrate that the impact of the provisions varies widely across building types and climate zones. Depending on location, occupancy and building type, it is estimated that the proposed amendments could impose an impact (per square metre of floor space) of between -$250 and $340. In some areas for certain buildings, the net impact is negative (that is, a net cost). For other segments of commercial buildings, the net impact is positive (that is, net benefit). Generally, the greatest beneficiaries are retail and healthcare buildings.

A BCR greater than one implies the net impact of the proposed changes for the particular building, in the particular location is positive. In other words, the associated savings in energy expenditures outweigh the direct capital costs. Depending on the building, occupancy and location, BCR ratios ranged from 0.11 to 3.42.

The BCRs for healthcare and retail buildings were on average the largest of all buildings. Form 2 offices reported a BCR less than 1 in almost all locations. Also, the BCR for Canberra and Hobart is generally lower than other cities for all building types. Therefore, if small offices (Form 2) and the changes for Canberra and Hobart were excluded from the proposal the overall BCR would improve. Excluding buildings where there is a net cost would also be consistent with the COAG Best Practice Regulation Guide, particularly Principle 3 which requires adopting the option that generates the greatest net benefit for the community. Excluding certain buildings from the proposed (more stringent) energy efficiency provisions would also be consistent with the National Strategy for Energy Efficiency (NSEE). NSEE Measure 3.2.1 states that a key element of the measure is for a *‘package of energy efficiency measures for implementation in 2010 – for new buildings and major new work in existing buildings which meets a benefit to cost ratio of 2:1’*.

On balance, based on the evidence as it now stands, the proposal outcomes suggest that there is scope for net national benefits of approximately $1.1 billion (with a BCR of 1.61), including potential net costs applicable to small offices and to locations such as Canberra and Hobart.

The Monte Carlo based sensitivity analysis presented in the Final RIS supports this position. Indeed, the average BCR presented in the Monte Carlo analysis was 1.9, indicating that there is additional scope for upward movement in the estimated BCR as it is presented in the Final RIS.

Appendices

A Details of the proposed BCA amendments

Draft Energy efficiency provisions in BCA Volume One (applicable to Class 3 and Class 5 to 9 buildings)[37]

Section A: Part A1 — Interpretations

Climate zones

The climate zone map has been updated to include changes to local government areas in Western Australia and a note has been added under Figure 1.1.4 to clarify that climate zone 8 is the BCA defined *alpine area.*

A note under Figure 1.1 has been added to clarify that climate zone 8 is the BCA defined *alpine area*.

Conditioned space

It is proposed to remove the word ‘controlled’ from the definition because the space may be air-conditioned indirectly by exhausting conditioned air from another space through say a cleaner’s room or stairwell.

The exemption in the definition of envelope is proposed to be amended as part of this clarification.

Shaft power

To simplify provisions it is intended to delete the definition of motor input power and rely on the single definition of shaft power in conjunction with a requirement for efficient power drives and the MEPS for motors. The shaft

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[37] Note that there have been some minor changes to the proposed technical provisions as a result of public comment. These changes have not been included in this section as they had no influence on the costings used in this final RIS.

power will be the power delivered to a pump or fan by a motor. Some sectors of industry have sought this change.

Thermal calculation method

The definition was developed at a time when house energy rating software was less accepted as it is now. The definition is only used in respect of NatHERS software and to simplify the provisions it is proposed to remove it and its associated definitions of cooling load and heating load.

Renewable energy certificate

This definition describes an established way of quantifying the performance of solar water heater and heat pump water heaters. The Renewable Energy Certificates are issued by the Commonwealth Government and are suitable evidence of compliance.

Specification A1.3 — Documents adopted by reference

Three Australian Standards not currently referenced by the BCA are proposed as part of the provisions for a heater in a hot water supply system. These will need to be reviewed for compliance with the ABCB protocol for reference standards.

Section I

No change proposed.

Section J

Objective

It is proposed to change the Objective to only refer to greenhouse gas emissions attributed to operational energy rather than only energy efficiency. This is so as to accommodate new provisions that are intended to reduce greenhouse gas emissions without necessarily improving energy efficiency. For example, using a gas water heater instead of an electric one actually uses more energy (aspects such as insulation being equal) but is responsible for generating less greenhouse gas. This also better reflects the government’s goal.

Functional Statement

Likewise, it is proposed to change the Functional Statement by having a functional statement for both the energy efficiency of the building (i) and greenhouse gas emission reduction specifically for the services (ii).

Performance requirements

JP1 for the efficient use of energy and JP2 for the maintenance of features are to be retained unchanged.

A new Performance Requirement, JP3, is proposed requiring the energy that is used be from sources that generate less greenhouse gases. This proposed change affects electric floor heating systems and oil fired boilers and in 2011, may also include electric supply water heaters.

Verification method JV2

Verification Method JV2, which was a stated value for whole-of-building energy analysis simulations, was removed from the BCA in 2008 after an industry submission.

Verification method JV3 & Specification JV

Some changes are proposed for Verification JV3, Specification JV and guidance information in the Guide to the BCA, as a result of proposals made to the ABCB Office by users and a review by ACADS–BSG that was commissioned by the ABCB Office.

The most significant proposed change is to make certain aspects of the Verification Method and Specification JV optional instead of mandatory. Instead of the previously mandatory values for various aspects in the reference building when determining the energy allowance, the designer may use the characteristics of the subject building.

A number of less significant changes are proposed in order to clarify what is to be modelled and to provide more definition where needed.

Part J1 — Building fabric

There are a range of changes proposed and the more significant ones are discussed below.

J1.2 Thermal construction general

Industry has indicated that sub-Clause (a)(i) needs more clarification as to how insulation is applied at structural members and services. There are practical issues that have caused some interpretation difficulty with insulation at structural members. The proposed wording would permit insulation to be run up to members instead of being continuous and maintaining the R-Value at the member.

J1.3 Roof and ceiling construction

As a ceiling space in a commercial building often contains cabling, recessed lighting and air-conditioning plant, the roof insulation is usually strung over the purlins in a framed roof rather than being laid on the ceiling and the practical limit with current fixing methods is claimed to be around R 3.2 to R 3.7 downwards in most climate zones. Safety mesh for the installer's safety and fixings for cyclone protection are limiting issues. Manufacturers are developing innovative solutions and values within this range are proposed as practical limits.

Colour of roof

The ventilated roof/roof colour package in Sub-Clause (b) has been removed and a concession for colour included in table J1.3a. The ventilated roof evolved from the Housing Provisions and is not common for commercial buildings where roof spaces lighting and cabling result in the insulation being at the roof line.

There are studies that demonstrate that a light coloured roof reflects more solar energy that a dark one so a light coloured one is desirable where solar radiation is a problem. However, rather than mandating a light coloured roof as the only option, an approach of regulatory 'encouragement' is proposed.

Some work was carried out by the ABCB Office in 2005 and the results included in the provisions for BCA 2006. That work has been repeated and extended for these proposals. Similar results have been reported in a paper titled 'Effect of roof solar reflectance on the building heat gain in a hot climate' by Suehrcke, Peterson and Selby, 2008. Recent ABCB modelling indicates that in the hotter climate zones, the benefit from a light roof may be more than R1 of insulation. In mild locations there is no benefit and in cold areas, particularly alpine ones, the reverse is the case as solar heating is a benefit.

For a hotter climate, requiring the R3.2 downwards to be for a very light coloured roof (cream or off-white), R3.7 to be for a medium coloured roof (yellow, light grey or galvanised) and a higher Total R-Value for dark coloured roofs (red, green or brown), designers will be encouraged to select a light coloured roof. In this way, again, there is no significant cost impact, only a restriction in choice.

It is noted that some planning schemes may prohibit very light colours so in the hotter locations a surface solar absorptance of up to 0.4 is proposed for the R3.2 downwards.

Concrete roofs are inherently darker that 0.4 so will need to be painted or carry the maximum penalty but they do not have the same practical difficulty of fixing insulation over purlins of framed roofs.

Sub-Clause (c) for a concession where there is a small area of roof lights has also been removed because the roof light provisions themselves have also been tightened.

Compensation for loss of ceiling insulation

A new sub-Clause (e) and new table J1.3b is been proposed to require compensation for a significant loss of ceiling insulation due to the penetration of uninsulated services. It would not apply to many commercial buildings but only those with the insulation on the ceiling and ‘holes’ in the insulation.

The clause is similar to that in the Housing Provisions developed by James M. Fricker Pty Ltd. There need not be a cost impact, only a restriction on the number of down lights permitted. In any case this is a clarification as the required Total R-Value of the roof would be degraded by the downlights.

J1.4 Roof lights

Peter Lyons & Associates were commissioned by DEWHA to report on possible changes to the BCA in order to strengthen the roof light provisions. As a result of this report, the performance required of roof lights has been converted to National Fenestration Rating Council (NFRC) values from Australian National Average Conditions (ANAC) values and also increased in stringency. Some manufacturers’ products already achieve the proposed values while others will need a diffuser at ceiling level in order to meet the requirement.

The area allowances have also been reduced as large roof light areas are a major path for energy transfer. To get a greater allowance in residences, the software approach could be used.

The ‘free allowance’ of 1.5 per cent of the floor area has been removed requiring the minimum standard in table J1.4 to be met in all cases.

The exemption for roof lights required to meet Part F4 has also been removed in anticipation of a reduced F4 requirement for roof lights.

These proposals are consistent with the housing proposals.

J1.5 Walls

The title of Clause J1.5 and the lead-in to sub-clause (b) for commercial buildings is proposed to be changed in order to clarify that the provisions apply to any wall that is part of an envelope. This includes internal walls of a carpark, plant room or ventilation shaft. Part (a) will be for external walls and (b) for internal walls. Table J1.5b is now about internal walls rather than the simple 50 per cent of the current external wall provision.

Below ground walls

A new sub-Clause has been added to clarify that a below ground wall that is back-filled or otherwise ground coupled does not have to comply with the thermal provisions in other than climate zone 8. A basement conditioned space without glazing and a conditioned space above generally needs cooling in most climate zones. The only loads it has are lighting, people and internal equipment so the cooling benefit provided by the earth or rock face is, in most cases, beneficial. Climate zone 8 is the exception where, like a slab-on-ground floor, 2.0 Total R-Value is required.

Table J1.5

Table J1.5a has been amended to deal with external walls and table J1.5b for internal walls. The previous scope of J1.5a was residential buildings that are now covered by the software approach in Part J0.

As stringency increases the options become increasing complex so the table has been restructured with a base requirement and a ‘menu’ of reductions to the required Total R-Value. The reductions include colour, mass, shading, thermal conductivity and glazing index. These have been written around common building systems.

The current requirement in most climate zones is 1.8 Total R-Value and this can be achieved by a framed wall with R1.5 insulation in a 65 mm cavity. There is a cost benefit in increasing the added R-Value of insulation provided the wall construction cost is not significantly increased. Increasing the cavity to 90 mm can achieve a further R1.0 at a cost increase in insulation and framing. With some insulation systems the Total R-Value could be higher.

However, increasing the thickness of the wall beyond 90 mm is generally not cost effective. The additional framing cost alone is greater than the saving in energy cost. If the loss of rentable area is also considered 90 mm becomes even less cost effective. The exception is alpine areas where there is a greater potential to reduce energy consumption.

Colour of external wall

As for roofs, it is also proposed to give a concession on additional insulation for lighter coloured walls in some climate zones. This means that there is no change, or minimal change, in insulation levels for light coloured walls but a significant increase for dark coloured walls in most climate zones.

In this way, again, there is no cost impact, rather a restriction in choice. It is noted that some planning schemes may prohibit very light colours so a surface solar absorptance of 0.6 has been selected as the standard for determining an increase in Total R-Value. This is beige or cream. Two steps have been proposed with only dark walls being penalised.

As with roofs, this effect is reversed in climate zone 7 where solar heating is a benefit and darker coloured walls should be encouraged. This is less significant in climate zone 8 where the solar radiation falling on a surface is reduced by snow clouds.

Masonry walls

Currently there are ‘packages’ for high mass. One of the reductions to the Total R-Values proposed is for high mass walls and in most climate zones there is a greater reduction for a high mass wall with a low thermal conductance.

Walls with insulation space provided by a furring channel, top hat section or battens

Currently, if a wall has only a furring channel, top hat section or batten space for insulation there is a concession whereby the insulation Total R-Value need only be R1.4 provided the glazing complies with the index option B of table J2.4a. It is proposed to not permit this option in a building that would not have had glazing anyway, such as a theatre or cinema. It is also proposed to increase the stringency of this option by further restricting the amount of glazing permitted and in climate zones 1,2 and 3 require a light coloured outer surface.

Clause J1.5(b) — Trading conductance between walls and glazing

Currently, if a building in climate zones 4, 6, 7 and 8 does not use all of its window allowance the surplus can be used to supplement underperforming walls.

There is anecdotal evidence that in some cases the result of this provision has been walls with no insulation in buildings that were not going to have windows anyway. Clause F4.1 of the BCA only requires natural light in residential buildings, schools and early childhood centres so the result has effectively been a ‘free’ glazing allowance to use to avoid insulating walls.

In addition, some in industry feel that Section J is unnecessarily complex and this calculation, called a ‘UA’ calculation in some energy codes, is one of the more complex aspects. In any case, there is already a wall–glazing trading option where furring channels are used. Therefore it is proposed to remove this concession so that all walls must have at least furring channels and the minimal insulation in table J1.5.

Internal envelope wall

Currently walls in an envelope (other than an external wall) in some climate zones are required to achieve at least a Total R-Value of 50 per cent of that of the external wall.

More detailed provisions are proposed covering three scenarios depending upon the enclosing of the space, the rate of ventilation of the space and the amount of glazing.

J1.6 Floors

Currently this Clause is about floors on ground or floors in the envelope with an unenclosed perimeter. It does not include floors that are part of the envelope and above or below plant rooms, car parks or even enclosed sub-floors. It has been found through modelling that a suspended floor, even if enclosed, uses more energy than a slab-on-ground in which free cooling is provided through direct contact with the ground.

Table J1.6 has been restructured. It now provides 3 levels of stringency. The first is where the space above or below the suspended floor is not enclosed. The second is where the space is enclosed and significantly ventilated with outside air while the third is also enclosed but ventilated with a nominal amount of outside air. The last is for a slab-on-ground in the colder climates.

This proposal will clarify the confusion between a ceiling under a roof top plant room and a suspended floor that is part of an envelope by treating the ceiling as being part of a suspended floor rather than as a roof/ceiling.

Part J2 — Glazing

As proposed for the various building fabric elements, the application of Part J2 excludes sole-occupancy units of Class 2 buildings and Class 4 Parts as these are covered by the new Part J0.

Currently there are two methods in Section J for assessing the compliance of glazing. Glazing Method 1 can be used for residential buildings and small shops. Glazing Method 2 is used for all other commercial type buildings although small shops can be assessed using Glazing Method 2 as well as Method 1.

By using the house energy rating software for Class 2 sole-occupancy units and Class 4 parts of buildings, Glazing Method 1 would only be used for Class 3 buildings and Class 9c aged care buildings. It is proposed to simplify Section J by removing glazing Method 1 and using Method 2 for Class 3 and Class 9c aged care buildings.

None of the compliance tables J2.3b, J2.3c or J2.3c need amending, only the constants in table J2.3a which set the allowance.

Natural light

The BCA has a minimum requirement for natural light in habitable rooms of residential buildings but not for commercial buildings. However, there is a body of knowledge on the psychological value of some connection with the outside environment, while some stakeholders also feel that there is an optimum window area to wall area ratio for energy efficiency — that is, the benefit of reducing solar load verses the extra energy used for internal lighting. While large windows may increase the load on the air-conditioning system, small windows limit natural light thereby increasing the dependence on artificial light which uses energy and, in turn, also loads the air-conditioning system.

Dr Peter Lyons in his report titled ‘Daylight, Optimum Window Size for Energy Efficiency: BCA Volume One’ demonstrated that with lighting levels to AS/NZS 1680 for interior and workplace lighting, the optimum window-to-wall ratio is somewhere around 10 per cent depending upon ceiling height, ceiling reflectivity, window distribution etc.

If a conservative limit of around 15 to 20 per cent minimum window-to-wall ratio is set, there is considerable scope for saving energy by avoiding excessive window area while still permitting a reasonable indoor–outdoor connection.

Commercial buildings other than residential

The energy indices in table A.1 (J2.4) of the BCA set the allowances for glazing in the various climate zones. These indices were developed on the basis of the response of the air-conditioning system to the glazing with the aim at the time of reducing the air-conditioning energy for a poorly designed but realistic building by 20 per cent.

The stringency can be increased by lowering the glazing allowance. This reduced stringency can then be achieved by using higher performance glazing, by improving shading in most locations or by reducing the glazing area. Table A.1 shows the equivalent average stringency reduction from BCA 2009 using higher performance glazing in the form 1 building.

The results show that on an annual energy consumption basis, double glazing is beneficial in all climate zones while the low-e coating modelled is beneficial in only the hotter climate zones. There are different low-e coatings that are tailored to the climate and direction of heat flow and the selection needs to be specific for a location with a hot summer and a cold winter.

A.1 **Glazing systems — percentage of BCA 2009 glazing stringency achievable using high performance glazing instead of standard glazing**

Glazing system	*Double glazing*	*Low-e glazing*	*Double & low-e glazing*
	%	*%*	*%*
Climate zone 1	72.2	83.2	66.1
Climate zone 2	83.5	89.7	78.3
Climate zone 3	77.7	85.3	71.0
Climate zone 4	62.5	99.9	63.5
Climate zone 5	67.4	100	68.6
Climate zone 6	52.5	100	68.7
Climate zone 7	49.1	100	61.0

Source: ABCB 2009b.

The situation with climate zone 8 (alpine areas) is different as the current glazing allowance is already based on double glazing.

There are a number of approaches that could be used to set a tougher stringency (that is, reduce the glazing allowance indices) but in the end, where there is an additional cost, the solution must be demonstrated to be cost effective.

The approach used was to reduce the glazing allowance by the above percentages for double glazing (except for climate zone 8 where the reduction was made the same as for climate zone 7). As glazing is, in most cases, more costly than walls, this order of reduction would mean that a designer could actually meet the allowance by reducing the area of single glazing at a capital cost saving rather than an additional capital cost. As indicated by the Lyons' study, this would not compromise natural lighting. Alternatively, a designer could still achieve the currently allowed glazing size using higher performance glazing systems which would be at an additional capital cost for the glazing but at a lower life cycle cost, and when the saving in air-conditioning plant capital cost, most likely a net capital saving as well. The designer may also choose to re-orientate the glazing or provide shading. It would be the designer's choice.

The stringency could be further increased by combining a reduction in glazing area with higher performance glazing but this is not proposed at this time. Under COAG principles, this solution would also need to be demonstrated as cost effective. The benefit provided by high performance glazing in a Class 5 building, is shown in table A.2.

A.2 **Double glazing system** Annual energy savings (MJ/m2.a)

Climate zone	*Form 1 building*	*Form 2 building*
1	26.6	40.0
2	8.6	18.0
3	25.0	31.7
4	12.6	28.4
5	15.5	20.9
6	39.2	32.8
7	37.6	29.6

Source: ABCB 2009b.

Table A.3 expresses the proposed reduction for glazing (other than shop front display windows) in terms of the BCA table J2.4a Option A glazing allowances. Option A is for complying walls.

Finally, the ABCB Office has received many questions about the term 'façade area', particularly where there are interstitial floors, plant room and other non-conditioned spaces. There has also been some confusion as to how façade area is measured and some concerns expressed that wall heights have been deliberately increased at the perimeter to gain a greater glazing allowance. The allowance is based on a maximum 3.6 metre slab to slab wall. It is proposed to modify the clause to explain that the facade area is that part of the wall exposed to the conditioned space.

A.3 **Possible reduction of BCA 2009 glazing allowance for a Class 5 building with complying wall insulation (Option A of table J2.4a)**

Climate zone	*BCA 2009*		*BCA 2010 proposal*		
	Table J2.4a energy index	*Percentage of a wall that is permitted to be glazed (with tinted single glass)*	*Stringency reduction based on being able to regain all the lost glazing area with double glazing*	*Table J2.4a reduced energy index*	*Percentage of a wall that is permitted to be glazed (with tinted single glass)*
		%	%		%
1	0.180	42.2	72.2	0.130	30.5
2	0.217	50.2	82.5	0.181	41.9
3	0.221	50.0	77.7	0.172	38.9
4	0.227	50.1	62.5	0.142	31.3
5	0.257	60.1	67.4	0.173	40.5
6	0.220	47.9	52.5	0.116	25.2
7	0.170	38.1	49.1	0.083	18.7
8	0.046	42.3	49.1	0.023	20.8

Source: ABCB 2009b.

Shop front display windows

Of particular concern are shop front display windows as these are already struggling to comply with the BCA provisions, although there are some applications where past practices could be described as unnecessarily excessive, such as car showrooms. A 30 per cent or even a 20 per cent reduction in allowance would impact on display glazing and the loss of amenity would need extensive community consultation which is not possible in the time available. It is therefore proposed not to reduce the current allowance for display and shop front glazing in 2010.

Glazing option 'B'

Glazing option 'B' is for use in conjunction with walls that have only a furring channel, top hat section or batten space for insulation. It is more demanding in order to compensate for a thermally underperforming wall.

The revised proposal is based on maintaining the same relationship with the wall option for furring channels as currently exists.

Class 3 buildings and Class 9c buildings

To simplify the provisions it is proposed to move Class 3 buildings and Class 9c aged care buildings to Glazing Method 2 and remove Glazing Method 1. The current allowances under Method 1 has been converted to an equivalent allowances under BCA 2009 Method 2 and then reduced in the same manner as the allowances for other commercial buildings. These are shown in table A.4.

A.4 **Glazing for Class 3 and Class 9c aged care buildings**

Climate zone	*Reduction in glazing Method 2 indices for Glazing Method 1 equivalent*	*Proposed reduction in Method 2 indices*	*Annual energy saving (MJ/.m^2)*
	%	%	%
1	51.8	72.2	120.5
2	72.9	83.5	41.8
3	53.1	77.7	74.3
4	60.6	62.5	105.7
5	53.1	67.4	58.4
6	77.6	52.5	161.5
7	70.2	49.1	161.2

Source: ABCB 2009b.

It also means that table A.4 (J2.4a) will have another line for Class 3 buildings and Class 9c aged care buildings as well as shop front display windows and other building Classifications.

Part J3 — Sealing

There are a range of changes proposed and the more significant ones are discussed below.

Louvres

Clause J3.4b is proposed to be changed to remove the exemption for a louvred door, louvre window, or other such opening. This concession was introduced for housing in 2003 because it was understood that only one manufacturer at that time produced well sealed louvres. This exemption was continued in Volume One in 2005. Because commercial buildings are likely to be conditioned for long periods, the amount of energy lost through leaking louvres is considerable. With the exemption removed from Volume One, designers will still have the option of using better sealing louvres or isolating the louvred area from the conditioned space in the remainder of the building. It is not proposed to remove the exemption from Volume Two because houses are less likely to be air-conditioned for long periods and, with louvres, will benefit from ‘free-running’ during milder periods.

Entrances in J3.4

Clause J3.4d is proposed to be changed to require some control at all entrances, not just the main entrance as is the current requirement. This need only be a door closer.

The most significant proposed change is to remove the current exemption for cafés, restaurants and open front shops. There remains the option of a performance based solution but it would need an extremely efficient and large building to compensate for the considerable loss of conditioned air.

The loss of energy through this exemption far exceeds that saved through other provisions and questions the logic of insulating the other walls if one is missing.

Calking in J3.6

J3.6 has also been amended to require calking around the frame of windows, doors, roof lights and the like; not just architraves.

Other minor changes

There are also four minor changes proposed. Three are in order to remove variations. The first is in the Application Clause J3.1 to clarify that a building that is intended to be open is exempted from the sealing provisions. The second clarifies that the seal required on the bottom edge of a door in J3.4 is a draft protector. The third is for exhaust fans in J3.5 to be sealed in climate zone 5 in addition to climate zones 4, 6, 7 and 8. The last is in J3.6 and would require calking around the frames of external doors and windows which are potentially high leakage places.

Leakage testing

No requirement will be introduced in BCA 2010.

Part J5 — Air conditioning and ventilation

There are a range of changes proposed and the more significant ones are discussed, clause by clause, below.

J5.2 Air-conditioning and ventilation systems

Automatic deactivation of air-conditioning in a Class 3 sole-occupancy unit.

It is proposed to add a provision to J5.2 to only allow the air-conditioning of a Class 3 sole-occupancy unit to operate when there is a balcony or patio and the door to it is closed. This can be accomplished with a micro-switch, reed switch or proximity switch. This is not being proposed for Class 1 or 2 building as the users are paying for the electricity and more likely to act responsibly. In a Class 3 building there is not this incentive. Assuming a sole-occupancy unit of 30m^2 with a 4.5 kW air-conditioning load (drawing 2 kW) of electricity and the door open for 20 per cent of the time, the lost energy would cost close to $150 per year. The installed cost of a switch is approximately $300 giving a simple pay-back period of around 2 years.

Variable speed fans

A new provision is being proposed for J5.2 requiring the fan of systems that are designed for a varying air flow to have a variable speed motor. Speed control of motors is now cheaper than air dampers and the associated controls and results in lower energy consumption.

The Coffey Environments report titled ‘Section J — Review of Fan Power Provisions’ indicates that such a provision is cost effective with a 2:1 benefit to cost ratio.

Outside air economy cycle

It is proposed to modify sub-Clause (iv) for an outside air economy cycle by removing the exemption for a Class 6 restaurant, café or Class 9b building, by reducing the unit capacity threshold for installing an outside air economy cycle and by including climate zone 2. The reduction in the capacity threshold achieves a pay-back of around 5 years for an office building while for a restaurant, café or Class 9b building is longer but within a 2:1 benefit to cost ratio.

Fan power allowance

Also as a result of the Coffey Environments report titled ‘Section J — Review of Fan Power Provisions’, the fan power allowance for air-conditioning systems is proposed to be reduced. The report details the likely energy savings and the positive benefit to cost ratio for each element. All up, the package of pressure reductions for ducting, filters and coils, including the additional capital cost needed, achieves a 2:1 benefit to cost ratio.

The values in the Coffey report have been adjusted as the report expresses the building load in terms of the currently defined motor input power while industry has proposed changing that expression to the fan shaft input power.

The table has different shaft power allowances for sensible air-conditioning loads. The sensible load (the load that causes a rise in temperature) is used as this is the load with which the fan flow rate is determined.

Mechanical ventilation

There has been some confusion as to what an air-conditioning system does and what a ventilation system does. Sub-clause (b) has been restructured to clarify that mechanical ventilation is about the outside air provided to met the requirements of Part F4 with (ii) for when part of an air-conditioning system and (iii) when a stand-alone system.

Outside air

J5.2(b)(ii) in BCA 2009 permits the minimum outside air required by AS/NZS 1668.2 to be exceeded by up to 50 per cent. This apparently generous allowance was to accommodate air-conditioning systems that serve a series of rooms with slightly different outside air requirements. Anecdotal feed back has been that 50 per cent was too generous and that the value could be significantly reduced without any additional cost in most situations.

However, in some situations, such as where offices were served by the same system as a conference room, a separate system may now be needed. It is proposed to reduce the 50 per cent over supply allowance to 20 per cent.

It is also proposed to amend (and relocate) the current (b)(iii)(B) for a building where the number of people per square metre is 1 or less. The sub-Clause currently requires energy reclaiming or outside air volume modulation for a Class 9b building and it is now proposed to extend this to any other building with such a high density of people.

Ventilation system fans

In the same report, Coffey Environments recommended changes to the fan power allowance for ventilation system fans, again on the basis of them being cost effective with a positive benefit to cost ratio. The value has also been reduced by 10 per cent.

J5.4 Heating and cooling systems

The term ‘chilling’ has been changed to ‘cooling’ to include systems that use water at slightly higher temperatures.

Pump power allowance

Coffey Environments also prepared a report titled ‘Section J — Review of Pump Power Provisions’, recommending that the pump power allowances also be reduced. Again, the report details the likely energy savings and the positive benefit to cost ratios for each element. All up, the package of pressure reductions for control valves, coils and piping, including the additional capital cost needed, achieves a positive benefit to cost ratio with the likely future costs of energy. Also the report used a pump efficiency of 70 per cent which is difficult to always achieve so the values have been adjusted.

The recommendation for hot water pumps in the report was a single value irrespective of heating load so this has been converted into a rate based on a range of heating load. The calculations also used 80 W/m at 120 kPa and 70 per cent efficiency as the base case and after further consideration these have been adjusted to 100 W/m at 200 kPa and 50 per cent efficiency.

The public and industry are invited to review and test the proposals and provide comment where they feel that the proposals are either too tough, or not tough enough.

Again, at the request of industry, it is proposed to clarify that floor area measurement be ‘area of the floor of the conditioned space’ rather than the defined BCA term ‘*floor area*’. This is because only part of the building may be conditioned.

Variable speed pumps

Coffey's proposed text did not retain the 3,500 hours a year operation for pumps to justify variable speed control. Its removal simplifies regulation as the usage is not easy to estimate and in any case, most systems would operate for sufficient time for speed control to be cost effective.

Choice of fuel for heaters

A report by George Wilkenfeld and Associates investigated the potential benefit of regulating the energy source of various systems. It is titled 'Swimming pools and electric space heating — The case for coverage by the Building Code of Australia' and makes recommendations with respect fixed space heating. The report can be found on the energy page of the ABCB web site.

The proposal is to require gas to be preferred over oil and for heating other than by hot water, the prohibiting of electricity in most cases.

For heaters installed outdoors, a provision for automatically turning off is proposed. This would be by air temperature sensor, timer or motion detector.

Thermal plant

A report on improving the efficiency of thermal plant was prepared by Coffey Environments through DEWHA. It recommends improvements in the efficiency of boilers and improvements in the coefficient of performance of package air-conditioners.

Table J5.4d for the performance of a chiller has been reduced in scope by the removal of chillers for which there will be MEPS requirements by 2010.

Heat rejection plant

The heat rejection plant in sub-Clauses (e) to (h) have been simplified as a result of the change in the definition of shaft power causing the elimination of the need for a definition, and values, for input power.

Part J6 — Artificial lighting and power

J6.2 Interior artificial lighting

Commercial buildings

The BCA already contains provisions for lighting in commercial buildings in Part J6. This includes the maximum lighting power levels. A study by Lighting, Art + Science Pty Ltd, reviews the whole of Part J6, primarily to investigate the scope for increasing stringency but also to correct any anomalies and reviewing how the provisions are being interpreted in practice. The recommendations form the basis of this proposal and contain adjustments to the maximum illumination power density in table J6.2. The recommendations contain both reductions and increases in the allowances.

The most significant reduction proposed by the consultant is for the allowances for retail space, health care buildings, schools and laboratories. The default values for undefined areas have also been reduced.

The consultant's study was carried out prior to the COAG decision to further improve energy efficiency and some allowances have been further reduced below that recommended while some allowance that were proposed to be increased have remained unchanged, as no industry proposal for change had been received.

The public and industry are invited to review and test the proposals and provide comment and calculations where they feel that proposals are either too tough, acceptable or not tough enough.

Table A.5 summarises the current allowances, consultant recommended and proposed values. In commenting on the levels, it should be noted that the values can be increased for small areas and if a control device is installed.

A.5 **Summary of current allowances, consultant recommended and proposed values**

Space	***Illumination power density (W/m^2)***		
	CBA 2009	***Consultant's***	***Proposed***
Auditorium, church and public hall	10	10	10
Board room and conference room	8	10	10
Carpark — general	6	6	6
Carpark — entry zone (first 20 m of travel	25	25	25

Space	***Illumination power density (W/m^2)***		
	CBA 2009	***Consultant's***	***Proposed***
Circulation space and corridor	8	8	8
Control room, switch room and the like	10	10	8
Courtroom	12	12	12
Dormitory of a Class 3 building used only for sleeping	5*	6	6
Dormitory of a Class 3 building used for sleeping and study	10*	10	9
Entry lobby from outside the building	15	15	15
Health care — examination room	20	10	10
Health care — patient ward	10	7	7
Health care — children's ward	15	10	10
Kitchen and food preparation area	8	8	8
Laboratory — artificially lit to an ambient level of 400 lx or more	15	12	12
Library — reading room and general areas	10	10	10
Museum and gallery — circulation , cleaning and service lighting	8	8	8
Office — artificially lit to an ambient level of 200 lx or more	10	10	9
Office — artificially lit to an ambient level of less than 200 lx	7	8	7
Plant room	5	5	5
Toilets	5	5	5
Restaurant, café, bar, hotel lounge and the like	20	20	20
Retail space including a museum and gallery selling objects	25	20	20
School — general purpose learning areas and tutorial rooms	8	8	8
Sole-occupancy unit of Class 3 building	10*	5	5
Sole-occupancy unit of a Class 9c aged care building	10*	7	7
Storage — shelving no higher than 75 per cent of the aisle lighting height	8	8	8
Storage — shelving higher than 75 per cent of the aisle lighting height	10	10	10
Service area, locker room, staff room, and the like	3	5	5
Wholesale storage and display area	10	10	10

Note: * Means that the BCA 2009 requirement is lamp power density and not illumination power density.

Source: ABCB 2009b.

The proposal also breaks up a general category such as a dormitory into specific uses for which the power level can be reduced — that is, one used for sleeping only as against one used for sleeping and studying.

Because of industry feedback, the consultant also proposes to replace the room index for small and narrow rooms with a revised formula that more accurately reflects the objective. To avoid confusion with the current formula, it is proposed to rename the new formula as 'room aspect ratio'. It is also proposed to relocate it from under the adjustment factor table to under the maximum illumination power density table.

It should also be noted that in order to increase stringency, the small shop concession in J6.2(a)(i) has been removed.

J6.3 Interior artificial lighting and power control

It is proposed to exempt certain buildings from the maximum lighting area in J6.3(c) These buildings are ones in which the main lighting would either be on or off such as an auditorium, theatre, swimming pool or sports stadium.

The exemption in J6.3(g) is extended to a Class 9c building and possibly other buildings. The lead-in provides some explanatory text as to why there is the need for an exemption.

Part J8 — Commissioning and facilities for maintenance and monitoring

Part J8 already exists as 'access for maintenance' and it is proposed that it be extended to include other aspects such as commissioning and aspects that facilitate the ongoing operation of the plant including maintenance manuals and monitoring means.

J8.3 Commissioning of systems that use energy

In past submissions to the ABCB, practitioners have advocated the importance of correct commissioning of building services systems. For example, poorly commissioned outside air dampers will introduce more hot or cold outside air than Section F requires and so require more energy to cool or heat the air. Even worse, a heating system and a cooling system may be operating at the same time if the controls are not properly set.

There has been some reluctance in the past to include something that could be considered a matter of workmanship but with the government's desire to further improve the energy efficiency of building the proposal to include commissioning has been revisited. It should be noted that the BCA already includes commissioning through reference standards such as AS 1670.1, AS/NZS 1668.1, AS 1668.2, AS 2118 and AS/NZS 366.1.

J8.4 Information to facilitate maintenance

The focus is on manuals being provided to facilitate the ongoing maintenance required by Section I. It is difficult to carry out ongoing maintenance unless documentation is provided that describes the systems, how they were intended to operate and what were the settings of thermostats, dampers, thermal plant sequencing, balancing valves and control valves for water systems, etc, after commissioning.

J8.5 Facilities for energy monitoring

Facilities for energy monitoring takes some form of metering so that it is possible to know how much energy is being used in each significant building on a site. For a single building on an allotment metering the total energy use would be the responsibility of the supply authority but on a campus style site may have a number of buildings off the same supply authority meter making it difficult to tell which building has higher that expected energy use.

It is also proposed to require separate metering of the main services including the air-conditioning, lighting, appliance power, hot water supply and lifts, etc. Although appliance power is not regulated by the BCA, the monitoring consumption will assist energy management.

The energy efficiency of internal transport devices (lifts and escalators) are not currently included in the BCA although many stakeholders feel they should be included. As other energy consuming services are improved the energy used by lifts become an increasingly greater part of the remaining consumption and, even if the modern lift is efficient, those remaining in buildings being refurbished may not be. To date, the ABCB has not been able to get the support of the lift industry, however, it is proposed that the energy consumption of lifts be metered to enable their sequencing to be fine tuned or scheduling changed such as taking some out of service when there is a low demand.

Specification J5.2

Obrart & Co, a building services engineering consulting firm, was commissioned by the ABCB Office to review Specifications J5.2 and J5.4 in order to investigate the potential to increase the stringency and to consult with industry on its implementation. The Air-Conditioning & Mechanical Contractors Association has also made a submission highlighting some difficulties with the way the Specifications are being interpreted and suggesting some changes.

The first proposal is to change Total R-Value to R-Value or material R-Value. Philosophically the building fabric ‘insulating’ values in the BCA are best express in overall performance terms and even pipe insulation was expressed this way because of claims that plastic pipes were inherently insulated. However, the benefit is marginal. The Obrart & Co recommendation is to ignore the duct or pipe and state the added insulation required.

With the current provisions it is unclear whether return air ductwork passing through a conditioned space is exempt from requiring insulation. It is also unclear whether fresh air ductwork and exhaust air ductwork is exempt. In 3(d) It is proposed to clarify that they are both exempt.

Currently table 3 of Specification J5.2 is currently in two parts. The first permitted domestic type systems to be used, with domestic level of insulation, for systems under 65 kW capacity. This concession has now been removed as a system in a dwelling may only operate for less than a 1,000 hours per year while one in a commercial building will operate for in excess of 2,000 hours per year.

The recommendations on increased insulation in table 3 are based on reducing the per cent loss in energy through the ductwork or piping to less than 3 per cent.

Currently evaporative cooling ductwork has a lesser insulation requirement than heating or refrigerated cooling ductwork. Even with a damper at the ceiling, heated air can leak past the damper and travel along the ductwork in the winter and be lost through the ductwork walls. The clause is proposed to be modified to require the same level of insulation for heating and cooling ductwork.

Some other Obrart & Co recommendations have not been incorporated into this proposal at this time as peer review and more consultation is appropriate.

Specification J5.4

In addition to the Obrart & Co recommendations for clarification on the last conditioned spaces served, other exemptions, the change to material R-

Value and increasing stringency, Specification J5.4 has been amended to include piping for cooling water, steam and refrigerant.

Specification J6

The report by Mr Peter McLean of Lighting, Art + Science Pty Ltd, titled ‘Review of Section J6 of the BCA’ also contained recommendations for Specification J6. The report can be found on the energy page of the ABCB web site. The recommended changes to the Specification are relatively minor and of minimal cost impact. They have been incorporated into these proposals.

Proposals include the removal of lighting timers and minor amendments to the specifications for a time switch, motion detector and a daylight sensor and dynamitic lighting control device.

B Estimating economywide impacts

The analysis in this report has employed a building blocks approach to aggregate data on individual sample buildings to economywide estimates. This appendix describes how this was conducted and the assumptions used in the process.

Estimates of the amendments' costs and benefits were assessed for five sample buildings provided by the ABCB. These buildings included a range of forms and occupancy profiles (table B.1).

B.1 **Building forms and building types used in this RIS**

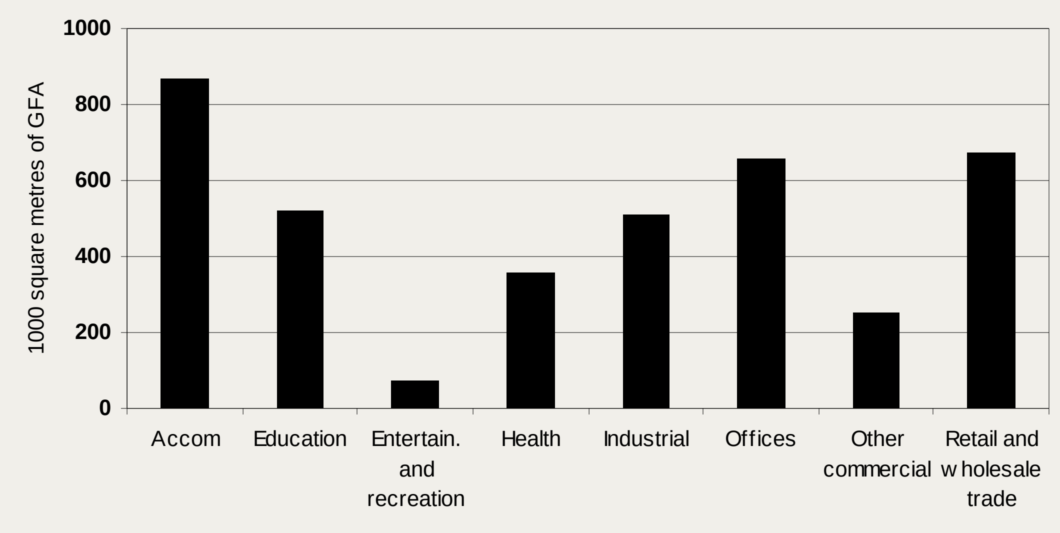
		Building form 1	***Building form 2***	***Building form H***
	Representative of BCA Class	3 storeys — 2000m2 GFA	Single storey — 198m2 GFA	Single storey — 2880m2 GFA
Office	5	✓	✓	
Retail	6	✓		
School	9b			✓
Hospital ward	9a and 9c			✓

Note: GFA = gross floor area. In ABCB (2006b), Form 1 and 2 were referred to as Building forms B and E respectively. Form H is a derivative of Form 1, but has a 'H' formation.

Source: The CIE.

Estimates of the size and growth of the Australian commercial building stock were obtained from CIE (2009a). These estimates are based on ratios of floor space and employment. Over the period 2010–20, the commercial floor stock is expected to grow by about 1.2 per cent per annum. Chart B.2 reports the average annual increase in the floor stock by use, and chart B.3 shows growth in the total commercial building stock.

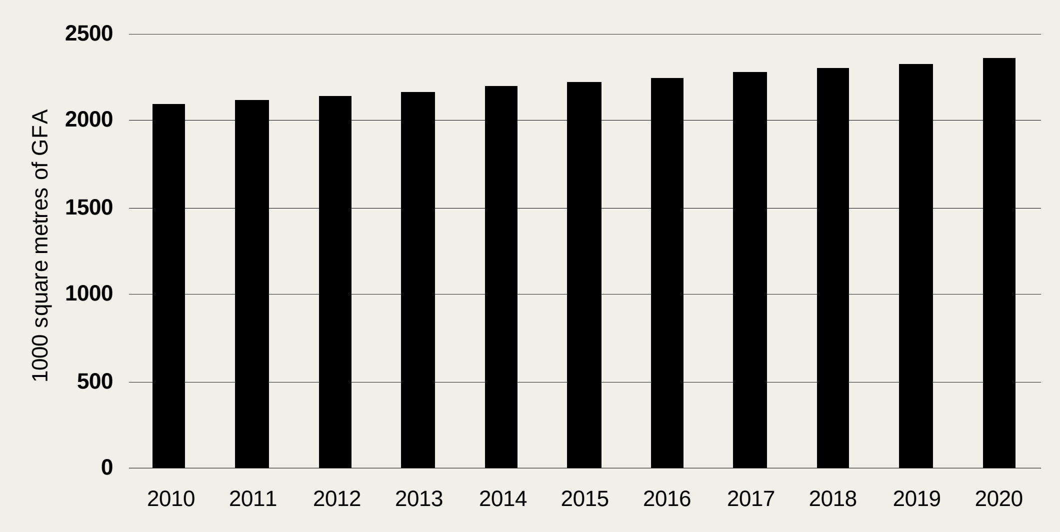
B.2 **Average annual increase of commercial building stock, by type**



Note: GFA = gross floor area. ‘Accom’ refers to ‘Accommodation, cafes and restaurants’ and does not include residential buildings.

Data source: CIE (2009a).

B.3 **New commercial building stock, 2010–20**



Note: GFA = gross floor area.

Data source: CIE (2009a).

Some concordance must be applied before the ABCB’s sample stock can be applied to the commercial forecasts. Categories of commercial floor space used in the forecasts are based on data provided by the Construction Forecasting Council (CFC 2009) and are loosely similar to ABCB building Classes. The concordance is defined in table B.4.

B.4 BCA Building Classes and CFC building categories

ABCB Building Class	*CFC building category*	*Included in ABCB sample?*
Class 3	Accommodation	✗
Class 5	Offices	✓
Class 6	Retail and wholesale trade	✓
Class 7	Industrial	✗
Class 8	Other commercial	✗
Class 9b	Educational	✓
Class 9a and 9c	Health care	✓

Source: CIE (2009a).

Similarly, the ABCB’s sample is provided for a set of representative locations. Estimates of energy savings and capital costs across the sample were assumed to be representative of the energy savings and capital costs incurred by all buildings (differentiated by building form and occupancy) of the same climate zone.

Having defined the above, estimates of the economywide impacts were obtained by multiplying compliance costs and energy savings by the commercial stock forecasts. Note that, the ABCB’s sample is not representative of all commercial building Classes which may be affected by the amendments. For those buildings where data has not been provided, no estimates have been constructed.

C Procedure for energy efficiency modelling

As mentioned in the main body of the report, the energy savings associated with the proposed amendments to the BCA energy efficiency provisions were estimated using energy simulation output data provided by the ABCB. This appendix provides additional details about the procedure used by the ABCB for modelling various energy efficiency features and defines the building forms, their systems and other criteria used. The information in this appendix was provided by the ABCB.

Buildings

The following three buildings are considered to represent the thermal performance of most of the buildings constructed today and are sufficiently diverse to test any proposed changes to the BCA Volume One Section J. They have been modelled as BCA 2009 compliant (where current stringency is being modelled, at the limit of compliance) and as follows.

a) As Greenfield sites with no over-shadowing.

b) Except for the square building, all buildings were modelled with the longitudinal building axis on an east–west orientation and a north–south orientation (across both orientations the variation in the building energy use varied by less than 5 per cent).

c) With glazing generally 6 mm single tinted on all four facades and with a glazing area to façade area proportion of approximately 40 per cent adjusted to just comply with Section J2 without projections, external shading devices or reveals. The glazing was modelled with internal Venetian blinds with a shading attenuation coefficient of 0.74. Venetian blinds were assumed closed on weekdays when the solar radiation exceeds 170 W/m^2 and assumed open at other times.

d) With the air conditioning systems.

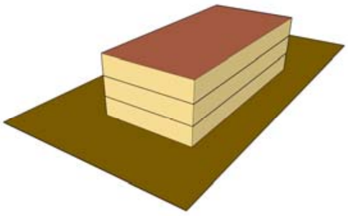
e) Specifically selected as being typical for each building form as described below.

f) Details as described under Services Details.

g) With building forms selected to accommodate variations in the area of external surfaces (roof and walls) to the Net Lettable Area (NLA). For BCA compliant buildings the lower the ratio of façade to NLA; the lower the impact of the external environment on the energy use of the building.

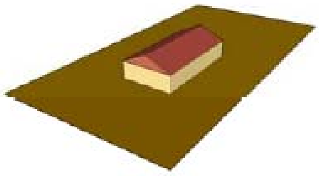
It should also be noted that there has been no ‘overlap’ or ‘double dipping’ with benefits achieved through the MEPS scheme. Modelling undertaken did not include for any benefits from equipment covered by MEPS, as has been agreed with DEWHA.

Building Form 1



- 3 storeys, all floors above ground and no car park under. 90 mm concrete block walls, 150 mm high density concrete roof, 150 mm high density concrete floors and the envelope elements with insulation to provide the required thermal R-value.
- 36.5 m long X 18.3 m wide X 3.6 m floor-to-floor; 2.7 m ceilings.
- External surface area / NLA ~ 1.1.
- 2 equal sized tenancies of 18.25 m x 18.25 m.
- Air-conditioning — 8 fan-coil units per floor (4 per tenancy), two air cooled chillers, heating and primary and secondary pumping and heating in the fan-coil units.
- Condenser water loop for tenant supplementary cooling.
- Allowances for domestic hot water and lifts.

Building Form 2



- 1 storey above ground and no car park under. Light weight FC walls, 100 mm concrete floor, metal deck roof and each envelope element with insulation to provide the required thermal R-value.
- 20 m long X 10 m wide X 3.3 m floor-to-eaves, 2.4 m ceiling.
- External surface area / NLA ~ 2.1
- 2 equal sized tenancies of 10 m x 10 m.

- Air-conditioning.
  - Generally 8 air-cooled split package air conditioners (4 per tenancy), with heating in each air conditioner.
  - For a restaurant 2 air-cooled split package air conditioners (1 per tenancy), with heating in each air conditioner.
- An allowance for domestic hot water.

Building Form H

- The building modelled has an ‘H’ shape, has 3 levels with the lower level on the ground, a pitched roof and no car park under.
- Each side of the H of the building was 33m x 13.5m (internal) with a long corridor of 1.5m wide and two cross corridors, each of half the width, of 1.75m wide.
- This provides, excluding the corridor, 20 rooms in total per level, each of 6.25m x 4m — that is, 10 per side of the H, 5 each side of the central corridor — in 3 room and 2 room groups with the cross corridor between them.
- The cross part of the H was a lift lobby of 4.8m x 8m.
- Construction is 90 mm concrete block walls, 150 mm high density concrete roof, 150 mm high density concrete floors and the envelope elements with insulation to provide the required thermal R-value.
- Glass areas are shown in the tables of results.
- The room groups were modelled to be air conditioned with a chilled water unit with either hot water heating (climate zone 4 to 8) or electric heating (climate zone 1 ,2 & 3).
- The lift lobby and the corridors on each side of the H were modelled to be air conditioned by separate FCU per level, a total of 3 FCUs per level.
- Chilled water was supplied from two equal sized air cooled chillers and hot water from two equal sized gas-fired boilers.
- Primary pumps were constant speed and secondary pumps variable speed (primary variable speed pumping was not modelled for the ChW as it was expected that a times the ChW flow for an actual building could be quite low and less than the minimum required by a chiller).
- 10. The air conditioned area of the H form building (including corridors and lift lobbies) is 2,788m² and the gross floor area is 2,880m².

Services details

a) The air-conditioning systems were modelled as follows.

  i. The space temperature being within the range of 20°CDB to 24°CDB for 98 per cent of the plant operation time.

  ii. The heating system in accordance with table C.1.

C.1 **Heating method used in the modelling**

BCA Climate zone	*Form 1*	*Form 2, H*
1, 2, 3	Electric resistance	Heat pump
4, 5, 6 & 7	Gas fired hot water	Heat pump with electric boost
8	Not applicable	

Source: ABCB.

- iii. The daily occupancy and operation profiles in Specification JV of BCA 2009.
- iv. Plant serving public areas of a Class 3 or Class 9c aged care building being available on thermostatic control 24 hours per day.
- v. The amount of ventilation required by Part F4.
- vi. The internal heat gains in a building:
  - a. from the occupants, at an average rate of 75 W per person sensible heat gain and 55 W per person latent heat gain, with the number of people calculated in accordance with the table C.1;
  - b. from hot meals in a dining room, restaurant or cafe, at a rate of 5 W per person sensible heat gain and 25 W per person latent heat gain with the number of people calculated in accordance with the Specification JV of BCA 2009;
  - c. from appliances and equipment, in accordance with Specification JV of BCA 2009; and
  - d. from artificial lighting, that is calculated in (b).
- vii. Infiltration values, for a perimeter zone of depth equal to the floor-to-ceiling height, of:
  - a. when pressurising plant is operating, 0.5 air changes per hour; and
  - b. when pressurising plant is not operating, 1.0 air changes per hour.
- viii. In other than a Class 6 shop or shopping centre, blinds being operated when the solar radiation on the glazing exceeds 150 W/m^2.
- ix. Furniture and fittings density of 20 kg/m^2.
- x. The R-Value of air films being in accordance with BCA Specification J1.2.
- xi. Heat migration across air-conditioning zone boundaries.

b) Artificial lighting modelled as one internal and four perimeter zones as the maximum allowable level under the BCA without any optional illumination power density adjustment factors. They are modelled with the daily profile in Specification JV of BCA 2009.

c) For a lift in a building with more than one Classification, proportioned according to the number of storeys of the part for which the annual energy consumption is being calculated.

Software

The energy analysis software was eQUEST 3.61 developed by James J Hirsch and Associates and approved by the California Energy Commission. The Australian representative for the software reports that it complies with the ABCB Protocol for Building Energy Analysis Software.

When modelling, the following locations are taken as typical. However, not all need to be modelled for all features and building forms:

C.2 **Typical locations**

Location	*BCA climate zone*
Darwin	1
Brisbane	2
Mt Isa	3
Kalgoorlie	4
Adelaide, Perth & Sydney	5
Melbourne	6
Canberra	7
Hobart	
Thredbo	8

Source: ABCB.

Modelling plan

Modelling is to be undertaken to determine energy use starting with all building forms being modelled as BCA 2009 compliant buildings.

Next the range of features identified will be modelled in ranking that reflects the greatest likely impact. The models are then to be progressively adjusted incorporating the most likely outcome from the previous feature modelled.

Features identified are as follows.

- Glazing.
- Roof insulation Total R-Values.

- Roof colour.
- External wall insulation Total R-Values.
- Wall colour.
- External wall compensation option.
- Internal wall insulation Total R-Values.
- Walls below ground Total R-Values.
- Ground coupled floors Total R-Values.
- Suspended floors over unenclosed area Total R-Values.
- Suspended floors over enclosed area such as a plant room or garage Total R-Values.
- Infiltration.
- Automatic switching of lights adjacent windows.
- Illumination power levels.
- Variable speed control on fans.
- Outdoor air cycle.
- Automatic modulation of outside air.
- Value for over supply of outside air.
- Threshold for fan power regulation.
- Stringency of fan power.
- Threshold for pump power regulation.
- Stringency of pump power.

D Energy markets and GHG emissions

It is important that the BAU is forward looking and provides and an accurate reflection of the likely state of the future Australian energy market. The key factor affecting Australian energy markets are likely to be the Australian Government's major policy initiatives. Specifically, the Australian Government's Carbon Pollution Reduction Scheme (CPRS) and expanded Renewable Energy Target (RET) are likely to have significant implications. This appendix discusses the likely impact of those policy changes on energy markets and greenhouse gas emissions, and presents projections used in this report.

Energy markets

It is important that the BAU is forward looking and provides and an accurate reflection of the likely state of the future Australian energy market. The key factor affecting Australian energy markets are likely to be the Australian Government's major policy initiatives. Specifically, the Australian Government's Carbon Pollution Reduction Scheme (CPRS) and expanded Renewable Energy Target (RET) are likely to have significant implications. Further, given the potential significance of this impact, this analysis draws directly on the Government's own modelling (Australian Government 2008 and MMA 2008b) to produce our estimates.

The Treasury (Australian Government, 2008) estimates that the CPRS and RET expansion will cause a significant increase in wholesale electricity prices (nearly doubling by 2020). Higher wholesale electricity prices flow into retail prices which are faced by households. The impact on average Australian retail electricity prices has been reproduced in chart D.1.[38] The steps taken to construct these estimates follow below.

- First, the average Australian retail electricity price was estimated for the year 2006 by combining data on the total expenditure on electricity from

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[38] The Treasury (Australian Government, 2008) do provide estimates of the expected impact on retail electricity prices, but the estimates reported are only indicative increases for certain periods between 2010 and 2050. Here, it has been assumed that the increase in wholesale electricity prices has been wholly passed on to the consumer.

the ABS Household Expenditure Survey (ABS 2006) and estimates of residential electricity consumption from ABARE (2008).

- Second, the change in the retail electricity price was next assumed to mirror changes in the Treasury's forecast of wholesale electricity prices under the CPRS-5 scenario. Retail prices were assumed to increase by the full amount of the wholesale price increase.
- Third, estimates were calculated by State and Territory based on ABS Household Expenditure data and ABARE estimates of energy consumption. Changes in retail prices at the jurisdictional level were estimated by replicating the proportional changes in the national average price.

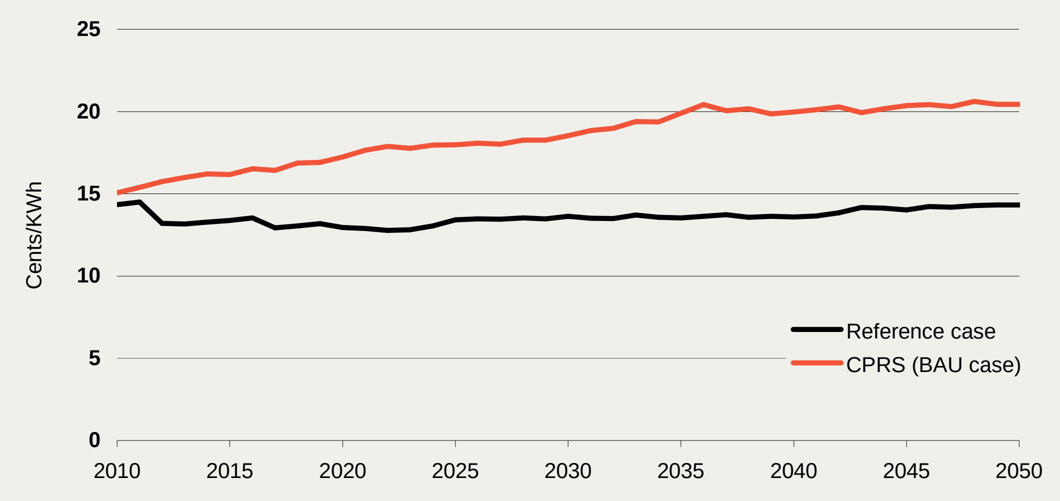
The first two steps in the methodology allow for determination of the impact on the average retail price of electricity across Australia transposed from projected changes in average wholesale electricity prices. The simplifying assumption made was to assume that the full increase in wholesale electricity prices is mirrored in the changes in retail electricity prices – that is, there is full cost pass through to consumers.

The third step allows for estimation of state by state changes in average retail electricity prices by accounting for current estimations of household expenditure across States. The initial household expenditure data from the ABS is utilised to determine the current average retail price. Future projections of state specific prices are based on the current average retail price with fluctuations and growth again mirroring changes in the average retail price across Australia. That is, while the trend in retail electricity prices is identical across states (following the path projected by the Australian Treasury for average wholesale prices) the realised level of average retail prices differs across states. The differences in the levels are determined by the differences measured in current average retail prices and these differences are maintained across the projection period.

By 2030 average retail electricity prices are expected to be 36 per cent higher than the reference case, and 43 per cent higher in 2050. This is relatively consistent with the Treasury's reported estimates.

Note that it would be expected the increase in electricity prices would have *some* effect on the amount of energy consumed. However, because the demand for electricity is relatively unresponsive to changes in price (CIE 2007), it is unlikely that this effect would be large. In any case, for this exercise it is not necessary to estimate the amount of energy consumed with and without the proposed amendments. Rather, what is necessary is to show the change the amendments will induce. And for this purpose, it is

D.1 **Forecasts of average retail electricity prices, cents per KWh**



Note: CPRS case relates to the CPRS-5 scenario as modelled by the Treasury in Australian Government (2008).

Data source: CIE estimates based on Australian Government (2008).

not necessary to forecast how the CPRS will impact on the projections outlined in chart D.1. Where, estimates have extended beyond the Treasury's forecasts, estimates are assumed to remain constant at 2050 levels.

Notably, the impact of the Government's major policy initiatives on gas prices is less well understood. In a report commissioned by the Treasury, MMA (2008b) estimated the implications introducing the CPRS would have for different fuel sources — gas included. MMA estimated that the CPRS would increase gas prices by about 40 per cent by 2020 and remain relatively constant thereafter. These estimates[39] under pin the forecasts of gas prices used in this analysis.

Estimating gas prices employed a similar method as was used for electricity prices.

- First, the average Australian retail gas price was estimated for the year 2006 by combining data on the total expenditure on gas from the ABS Household Expenditure Survey (ABS 2006) and estimates of residential gas consumption from ABARE (2008).
- Second, the change in the retail gas price was next assumed to mirror changes in the MMA's forecast of city node gas prices in NSW (see

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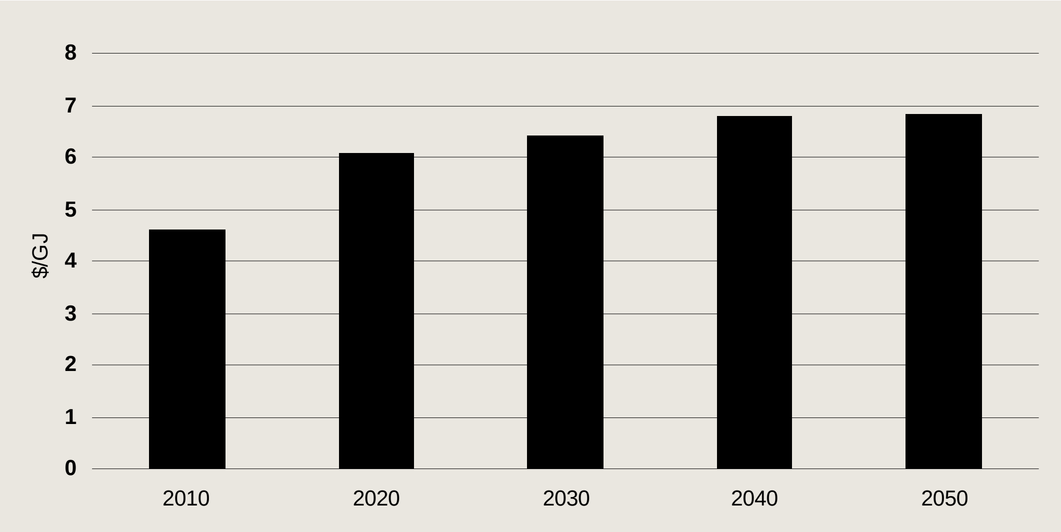
[39] MMA (2008) uses city node gas prices in NSW as an indicator of Australian gas prices. Note that this data source differs from that used to estimate gas prices in CIE (2009a), which was based on forecast wholesale prices of IGCC and did not include the effects of the CPRS.

chart D.2). Retail prices were assumed to increase by the full amount of this price increase.

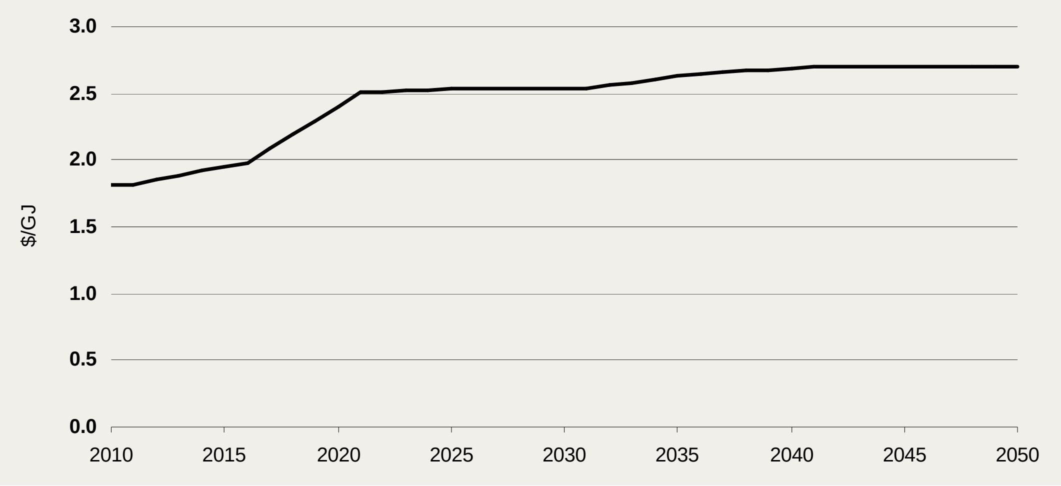
Estimates of retail gas prices are reported in chart D.3. Again, where it has been necessary to continue estimates beyond the forecasts below, it has been assumed that forecasts remain constant at 2050 levels.

D.2 **Trends in city node gas prices, NSW**



Data source: MMA (2008b)

D.3 **Australian average retail gas price, cents per MJ**



Data source: CIE estimates based on MMA (2008b), ABS (2006) and ABARE (2008).

Lastly, it should be noted that in the BAU case only the CPRS and the expanded RET scheme have been accounted for. The effects of no other State, Territory or Australian Government policies have been modelled. This includes:

- smart meters;

- mandatory disclosure;
- subsidies to promote energy efficiency in the building sector; or
- any other government initiatives.

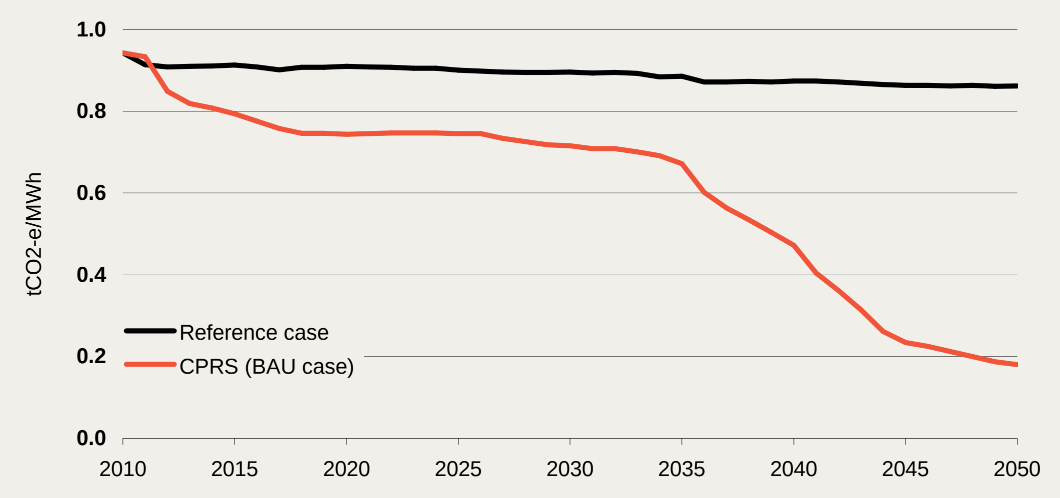
Greenhouse gas emissions

The CPRS is expected to have a significant impact on the emissions intensity of electricity.

The CPRS provides incentive to electricity generators to produce electricity with fewer emissions. Whether this can be achieved by sourcing alternative fuel sources (RET requirements will encourage this also), or by retro fitting existing facilities, the CO2-e emissions per KWh consumed are expected to fall. A forecast of the emissions intensity of electricity consumption is reported in chart D.1.[40] Between 2010 and 2050, the emissions intensity of final electricity consumption is expected to fall by over 80 per cent.

The Treasury do not estimate emissions intensity of electricity beyond 2050. It has been assumed that emissions intensity remains constant at 2050 levels for all years thereafter.

D.4 **Emissions intensity of electricity**



Note: CPRS case relates to the CPRS-5 scenario as modelled by the Treasury in Australian Government (2008).
Data source: CIE estimates based on Australian Government (2008) and DCC (2009).

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[40] This estimate differs from the emissions intensity of electricity *generation* reported in Australian Government (2008). The Treasury's modelling of the CPRS did not report the emissions associated with electricity distribution. Emissions from distribution have been accounted for using the ratio of scope 3 and scope 2 emissions as reported in DCC (2009).

The emissions intensity of gas is expected to remain constant over the period at 51.2 kg CO2-e per GJ. This figure is as reported in the National Greenhouse Accounts (NGA) Factors report for 2009.

E Discount rates for RISs in other countries

There is a vast amount of literature on the ‘correct’ method to determine the discount rate for RISs. The chosen discount rate would need to correctly reflect the opportunity cost of the displaced resources by the policy action. Those resources can refer to capital or consumption.

There are mainly three ways to approach the discounting exercise:

- the Opportunity Cost of Capital (OCC), which can be based on:
  - the average market interest rates (pre-tax rates of return); or
  - the Government’s borrowing rate (risk-free rate of capital).
- the Social Time Preference Rate (STPR), which reflects consumer’s time preference/utility and are based on:
  - market after-tax interest rates (interest rate on savings); or
  - consumer’s valuation of future consumption (implicit discount rates); and
- the social Weighted Average Cost of Capital (WACC) which combines the marginal cost of foreign resources with the above two approaches.

Discount rates based on OCC reflect financial concerns on the use of resources (returns), while discount rates based on STPR reflect ethical issues on treatment of future generations.

New Zealand, Canada and Australia seem to converge on using a real WACC of between 7 and 8 per cent for undertaking RISs. Victoria, the EU and the US use a OCC based on the risk-free rate of capital (Treasury bonds). The UK’s recommended discount rate is a STPR based on consumer’s utility (see table E.1).

E.1 Discount rates for RISs in various countries

Country	*Recommended discount rate*	*Comments*
	%	
UK	3.5	*Basis of the rate* Represents the Social Time Preference Rate (STPR).It is based on comparisons of utility across different points in time or different generations. It takes into account the time preference of individuals, the elasticity of the marginal utility of consumption and the annual growth in per capita consumption. *Range* No recommendation on specific range for sensitivity analysis. *Adjustment for time period* If analysis is done for a period over 30 years, is recommended to lower the discount rate. *Year of the recommendation* Updated rates for 2009.
USA	3 and 7	*Basis of the rate* 7 per cent represents an OCC rate based on the average before-tax rate of return to private capital. Rates of around 3 per cent are recommended when regulation primarily and directly affects private consumption. Uses a STPR based on the historical real rate of return on long term government debt (interest rates on Treasury Notes and Bonds of specified maturities) *Range* No recommendation on specific range for sensitivity analysis. *Adjustment for time period* The STPR ranges from 0.9 to 2.9 per cent depending on the time frame (from 3 to 30 years). *Year of the recommendation* Updated rates for 2009.
Canada	8	*Basis of the rate* Represents a real WACC. Includes costs of funds from three sources: the rate of return on postponed investment, the rate of interest (net of tax) on domestic savings, and the marginal cost of additional foreign capital inflows. The weights are equal to the proportion of funds from each source existing on the market. *Range* No recommendation on specific range for sensitivity analysis. *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 2007.

(Continued on next page)

E.1 **Discount rates for RISs in various countries** Continued

Country	*Recommended discount rate*	*Comments*
	%	
EU	4	*Basis of the rate* It represents an OCC rate based on a real rate of return. It broadly corresponds to the average real yield on longer-term government debt in the EU since the early 1980's. *Range* State members may have their own guidelines for undertaking RISs (that is, Ireland 5 per cent and Denmark 6 per cent). *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 2009.
NZ	8	*Basis of the rate* Represents a real WACC rate. The pre-tax return from investments in the private sector as a measure of the opportunity cost of capital for public sector investments. *Range* Differentiated discount rates are provided depending on the application: buildings 6 per cent, infrastructure 8 per cent and technology 9.5 per cent. No specific discount rates are suggested for sensitivity analysis. *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 2008.
OECD	3-12	*Basis of the rate* Represents a real OCC for various countries. The rate is based on the average of commercial interest reference rates plus a margin. *Range* No specific discount rates are suggested for sensitivity analysis. *Adjustment for time period* Rates vary according to the period to be discounted. For Australia, recommended rates go from 6.6 per cent, for periods under 15 years, to 7 per cent, for periods up to 30 years. *Year of the recommendation* Updated rates for 2009.

(Continued on next page)

E.1 **Discount rates for RISs in various countries** Continued

Country	***Recommended discount rate***	***Comments***
	%	
Australia		
▪ OBPR	7	*Basis of the rate* Represents a real WACC. It is a social rate that accounts for consumption and capital opportunity cost. *Range* Sensitivity analysis is recommended using 3 and 11 per cent rates. *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 2007.
▪ NSW	7	*Basis of the rate* Represents a real OCC rate. *Range* Sensitivity analysis should be undertaken using rates of 4 and 10 per cent. *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 1997.
▪ QLD	8	*Basis of the rate* Based on a real pre-tax discount rate. *Range* Sensitivity analysis should be undertaken using rates of 6 and 10 per cent. *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 1999.

(Continued on next page)

E.1 **Discount rates for RISs in various countries** Continued

Country	***Recommended discount rate***	***Comments***
	%	
- VIC	3.5	*Basis of the rate* Represents a real OCC, based on an average of the ten year Commonwealth bond rate (risk free opportunity cost of capital), after adjusting for the expected inflation rate. *Range* No specific discount rates are suggested for sensitivity analysis. *Adjustment for time period* No suggestions are made for different timeframes. *Year of the recommendation* 2007.

Note: UK (United Kingdom), USA (United States of America), EU (European Union), NZ (New Zealand), OECD (Organization for Economic Co-operation and Development), OBPR (Office of Best Practice Regulation), DFA (Department of Finance and Administration), NSW (New South Wales), QLD (Queensland), VIC (Victoria).

Source: UK Department for Business, innovation and Skills (2007), NZ Department of Treasury (2008), European Commission (2009), OBPR (2007),OECD (2009), US Office of Management and Budget (2008), Queensland Treasury (1999), The Cabinet Office of New South Wales (1997), Treasury Board of Canada Secretariat (2007),Victorian Competition and Efficiency Commission (2007).

F HVAC optimisation

The improved thermal performance of new commercial buildings may have implications for the choice of HVAC capacity and building optimisation during the design phase. A building's HVAC plant needs to be of sufficient capacity to ensure that comfortable temperatures can be maintained within buildings under most climatic conditions (ABCB 2006b). As thermal performance improves, the dependence on HVAC plant to provide this comfort decreases. And it follows then, that building designers — acting rationally and informed — will seek to alter HVAC specifications to take account of these expected changes.

To account for the change in optimal HVAC plant capacity, the cost estimates provided by BMT & ASSOC have been adjusted accordingly. Estimates of the cost savings associated with the change in HVAC capacity for chillers and boilers are provided respectively in tables F.1 and F.2 below. [41] Rawlinsons (2008) reports the unit cost of HVAC capacity at between $200 and $300 per Kw. For both chillers and boilers, a unit cost of $250 has been used to calculate the cost savings. Costs savings are further tested in the sensitivity analysis.

Tables F.1 and F.2 report the following information:

- the optimal HVAC capacity (in Kw) under the BAU and under the proposed amendments (for chillers and boilers);
- the per cent reduction in optimal HVAC capacity (for chillers and boilers); and
- the cost savings per square metre due to the change in optimal HVAC capacity.

On average, the optimal required chiller capacity decreased by about 20 per cent (a saving of about $10 per square metre). The optimal required boiler capacity decreased by about 4 per cent (a saving of $4 per square metre). Notably, in the hottest climates, it has been assumed that no boiler exists.

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[41] The changes in required HVAC plant capacity were estimated by the ABCB.

F.1 Impact on optimal HVAC capacity requirements — chillers

	BAU	*2010 BCA*	*Reduction*	*Cost savings*
	Kw	Kw	%	$/m2
Form 1 – office				
Darwin	444	361	18.6	10.3
Brisbane	401	327	18.4	9.2
Mt Isa	493	426	13.6	8.4
Kalgoorlie	516	408	20.9	13.5
Sydney, Adelaide, Perth	444	350	21.1	11.7
Melbourne	406	307	24.3	12.3
Hobart, Canberra	288	214	25.7	9.2
Form 1 – retail				
Darwin	491	379	22.8	14.0
Brisbane	510	411	19.5	12.5
Mt Isa	528	456	13.7	9.0
Kalgoorlie	567	464	18.1	12.8
Sydney, Adelaide, Perth	543	423	22.1	15.0
Melbourne	452	320	29.2	16.5
Hobart, Canberra	405	258	36.3	18.4
Form 2 – office				
Darwin	44	37	15.6	8.6
Brisbane	40	33	17.3	8.7
Mt Isa	47	39	17.7	10.6
Kalgoorlie	49	37	24.5	15.3
Sydney, Adelaide, Perth	47	36	24.0	14.1
Melbourne	41	27	33.8	17.4
Hobart, Canberra	28	20	29.1	10.2
Thredbo	25	21	14.8	4.7
Form H – hospital ward				
Darwin	512	407	20.4	9.1
Brisbane	441	345	21.7	8.3
Mt Isa	512	407	20.4	9.1
Kalgoorlie	594	472	20.5	10.6
Sydney, Adelaide, Perth	510	319	37.4	16.6
Melbourne	448	350	22.0	8.5
Hobart, Canberra	330	297	10.1	2.9
Thredbo	340	298	12.2	3.6

(Continued on next page)

F.1 Impact on optimal HVAC capacity requirements — chillers
(continued)

	BAU	**2010 BCA**	**Reduction**	**Cost savings**
	Kw	Kw	%	$/m2
Form H – school				
Darwin	588	477	18.9	9.6
Brisbane	532	419	21.2	9.8
Mt Isa	554	450	18.7	9.0
Kalgoorlie	712	570	20.0	12.3
Sydney, Adelaide, Perth	446	489	-9.7	-3.7
Melbourne	541	423	21.7	10.2
Hobart, Canberra	409	335	18.0	6.4
Thredbo	285	249	12.8	3.2

Source: CIE estimates based on data provided by the ABCB.

F.2 Impact on optimal HVAC capacity requirements — boilers

	BAU	**2010 BCA**	**Reduction**	**Cost savings**
	kW	kW	%	$/m2
Form 1 - office				
Darwin	0	0	na	0.0
Brisbane	0	0	na	0.0
Mt Isa	0	0	na	0.0
Kalgoorlie	297	261	12.2	4.5
Sydney, Adelaide, Perth	236	217	8.0	2.4
Melbourne	249	222	10.8	3.4
Hobart, Canberra	209	184	11.8	3.1
Form 1 - retail				
Darwin	0	0	na	0.0
Brisbane	0	0	na	0.0
Mt Isa	0	0	na	0.0
Kalgoorlie	401	346	13.6	6.8
Sydney, Adelaide, Perth	333	278	16.5	6.9
Melbourne	356	280	21.4	9.5
Hobart, Canberra	333	262	21.4	8.9

(Continued on next page)

F.2 Impact on optimal HVAC capacity requirements — boilers

	BAU	*2010 BCA*	*Reduction*	*Cost savings*
	kW	kW	%	$/m2
Form 2 - office				
Darwin	37	31	15.6	0.7
Brisbane	34	28	17.4	0.7
Mt Isa	40	33	17.9	0.9
Kalgoorlie	42	32	24.5	1.3
Sydney, Adelaide, Perth	40	30	23.9	1.2
Melbourne	35	23	34.0	1.5
Hobart, Canberra	24	17	28.8	0.9
Thredbo	21	18	14.6	0.4
Form H – hospital ward				
Darwin	0	0	na	0.0
Brisbane	0	0	na	0.0
Mt Isa	0	0	na	0.0
Kalgoorlie	346	311	10.3	4.5
Sydney, Adelaide, Perth	256	244	4.8	1.5
Melbourne	283	267	5.8	2.1
Hobart, Canberra	262	270	-3.1	-1.0
Thredbo	352	345	2.2	1.0
Form H – school				
Darwin	250	248	0.9	0.3
Brisbane	434	391	10.0	5.5
Mt Isa	423	375	11.2	5.9
Kalgoorlie	717	575	19.8	17.8
Sydney, Adelaide, Perth	452	492	-8.9	-5.0
Melbourne	547	428	21.7	14.8
Hobart, Canberra	437	364	16.8	9.2
Thredbo	350	314	10.4	4.5

Source: CIE estimates based on data provided by the ABCB.

G Electricity generation and network impacts

Currently, the commercial sector accounts for approximately 23 per cent of total electricity consumption. Thermal efficiency modelling suggests that the proposed changes in the BCA are likely to reduce electricity consumption in that sector such that, by 2020, overall energy consumption will be 0.5 per cent lower than it would otherwise have been. Total consumption Australia wide in that year will be 1379 GWh lower than it would otherwise have been. The comparable reductions in 2030 would be a similar 0.4 per cent saving (1206GWh). As a proportion of commercial buildings' consumption this means that by 2020 the sector would be 2.1 per cent more efficient than currently (1.5 per cent in 2030).

In common with other demand side reduction measures, changes brought about by the proposed amendments to the BCA have the potential to affect outcomes for electricity generation operators, transmission and distribution (T and D) network operations and the retail businesses ultimately supplying residential, commercial and other customers. The gas supply and distribution network is also affected, though principally as suppliers to electricity generators. The gas industry effects are treated as second order effects for purposes of the RIS and are not considered in detail here.

The energy efficiencies generated by the BCA changes present opportunities for energy savings that translate into avoided supply side costs, and therefore benefits at these different points in the electricity supply chain. These energy savings, depending on their size and timing, have the potential to:

- defer costly augmentation of generation and T and D capacity;
- relieve network stress at peak times, reduce load losses and Unserved Energy demand (USE);
- reduce generation operating costs. (The latter, in an environment where there are carbon charges will in part be the result of reduced purchases of carbon credits compared to a higher consumption scenario. It is important, to avoid double counting, that if these GHG related benefits

are calculated and accounted for separately they not be included as benefits here); and

- reduce hedging costs within the national electricity market.

These potential benefits will, in turn, flow through in varying degrees to customers through lower increases in prices than would have otherwise occurred. The flow through will depend on the degree of effective competition in the wholesale and retail electricity markets. Benefits in the form of avoided costs that are not passed through will manifest as higher profits for suppliers' owners. No attempt is made here to allocate these benefits. Benefits to end users as calculated in this study are valued at average energy tariffs *before* the impact of the BCA change measures. They will therefore tend to underestimate the value of end user benefits to the extent that they exclude any beneficial cost pass through effects.

The avoided energy costs attributable to the proposed BCA changes will have an avoided energy network cost component that relates to the impact of these measures on the capital augmentation costs of the supply networks and on operating costs compared to a BAU set of outcomes. Energy generation, transmission and distribution businesses will be faced with investment decisions that reflect demand growth, modified by the effects of the CPRS which are embodied in the BAU case.

Any reduction in electricity consumption in response to the measures will be accompanied by potential changes in the *load profile* facing suppliers because the measures are likely to impact on the relationship between peak and average load in the systems of the various jurisdictions. That impact will vary from State to State because of climatic differences, the differing relative importance of the commercial, residential and other sector in each State and the difference between the peak – non peak consumption patterns of the various sectors in each jurisdiction. There is not sufficiently detailed information on individual jurisdictions to numerically analyse likely load profile change impacts.

Savings affected in the commercial sector will be in a sector which already has a much flatter load profile than the similarly sized residential sector. The difference between off peak and peak demand is less dramatic than in the residential sector. In the absence of measures to control it, the load profile of the residential sector is expected to deteriorate further in coming years, largely because of increasing penetration rates of home air conditioning. Savings in total consumption in the commercial sector, while contributing benefits by way of some avoided costs, will have their potential contribution limited by any such deterioration in the overall load profile. Modelling by ACIL Tasman discussed in further detail below suggests that even with the mitigating effects of increased electricity prices that will accompany an emissions trading scheme, maximum demand relative to total consumption will continue to deteriorate somewhat between now and 2020.

Peak demand from the commercial sector coincides with afternoon cooling requirements of commercial premises on hot days. This peak tends to be somewhat earlier than the overall evening peak generated by residential cooling requirements.

The impact on avoided costs of suppliers will depend on both the magnitude and timing of the reductions in energy consumption relative to the base case. Savings are cumulative and will start from relatively low levels as the share of commercial electricity consumption accounted for by *new* commercial property stock is currently around only 1 per cent in the first few years of the new BCA. It is from this small but growing share and the extension of the provisions to buildings being renovated and refurbished, that any code-generated avoided costs to suppliers will arise.

Estimates of any impact of the BCA change measures on generation or transportation of energy need to be made in the light of forecast capacity growth directed at managing expected consumption growth, peak demand growth and variability. Impacts on suppliers will be twofold — the effect on total consumption and the effect on maximum demand. Ideally, potential BCA impacts would reflect the change in expected share of peak and non-peak load demand attributable to that part of the energy consuming sector impacted by the BCA changes — in this case the new commercial building sector. This breakdown is not available. The package of measures that would be implemented under the BCA changes may have a small impact on the relationship between maximum demand and total consumption through the change in the load profile of the new and renovated commercial buildings sector. While the cumulative impact on total consumption has been estimated, the effect on maximum demand, brought about through these load profile changes, has not.

The impact on the electricity component of the energy sector (and indirectly on the gas sector through changes in gas fired power stations and gas pipe networks delivering to generators) of the BCA-driven electricity savings will depend on the following:

- any avoided operating costs achieved through ‘load smoothing’ because of the reduction in peak demands relative to other demands compared to their BAU levels;
- any reduction or delay in augmentation of generating, transmission or distribution network capacity because of this effect;

- any reduction in operating costs due to BCA induced reduction in total consumption;
- any reduction or delay in capacity due to this effect; and
- any reduction in hedging or other costs due to BCA induced changes in the load profile.

These effects will take place in an environment in which the CPRS, renewable energy targets and potential climate change will be driving large scale investment in both energy generation and distribution investment, as discussion below illustrates.

Potential effects on the generation sector

Peak load effects on the capital costs of the electricity sector stem from the need to have back up capacity and/or additional interconnection network capacity to supply extreme demand levels that typically prevail for less than 1 per cent of the year. Systems which operate with a typical load factor of 60 per cent, involving peak, intermediate and base loads may have base load factors as high as 90 per cent and peak load plant with load factors of 10 per cent or lower. Reserve capacity set as a buffer over and above estimated maximum demand can amount to 10 per cent or more of the total capacity. Average peak loads are typically at least 50 per cent above average loads. (Critical peaks on extreme (hot) days can be much higher than this.)

Residential use currently contributes disproportionately to peak demand, and the need for peak load capacity, particularly through the impact of summer loads driven by home air conditioning, whose penetration is increasing. The commercial sector, in contrast, while contributing to mid afternoon strength of demand, tends to be out of phase with the overall late afternoon – early evening peak coinciding with the switch on of residential cooling (or heating). While accounting for 28 per cent of total consumption, *residential* use could more reasonably be considered to underpin 35 per cent of maximum demand — when peak influences are added to the commercial, industrial and mining demands. [42] Any

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[42] In this review no direct estimate has been obtained as to the share of peak demand attributable to the residential sector. However, if, in the extreme case residential demand is responsible for most of the 50 per cent difference between peak loads and average load, then, rather than approximating households ‘capacity share’ on the basis of their share of total consumption driving 28 per cent of the capacity needs Australia- wide, this capacity share is better approximated as 35 per cent. (This assumes 28 per cent of the average load with a weight of .67 and 50 per cent of the peak load with a weight of .33, giving 0.35). Data for the regulated residential sector

significant reduction over time in peak demand growth rates relative to total consumption growth would have the effect of supporting a given level of total consumption at lower cost of supply and at lower price to consumers than otherwise. The BCA measures proposed for commercial buildings will help to reduce maximum demand, but marginally — because of the nature of the load profile they are impacting.

The commercial sector can be expected to contribute somewhat less to *maximum demand* than its share in *total consumption* indicates. Any estimated percentage change in commercial total consumption can be expect to be represented by a less than proportionate change in maximum demand on the system as a whole, unless the proposed BCA changes have most of their impact on commercial *peak* demand. In the absence of further detailed information on the likely breakdown of the contributions to energy savings of the proposed BCA measures, it will be assumed that, if for instance, a 2 per cent reduction in total commercial building energy consumption equates to a 0.5 per cent reduction in overall consumption, the equivalent impact on overall *maximum demand* will be 0.5 per cent or less.

Impacts on augmentation of generation capacity

Whether demand reductions relative to BAU will affect generation augmentation decisions will depend on the size of the reduction relative to the size of the planning regime, available reserve capacity or ‘headroom’ the load profile at any time and the underlying consumption growth rate.

Through time, in the BAU case, generating capacity will need to grow to accommodate growth in maximum demand and provide reserve capacity. ACIL Tasman (2008), in a report for Energy Supply Association of Australia (ESSA) estimates increases in maximum demand of more than 5,800 MW between the present and 2020 with a 10 per cent emissions cap in place. This represents more than 530MW annually in additional generating capacity, even before allowing for preservation of headroom.

In assessing the implications of the proposed BCA measures for avoided capital costs we would ideally calculate the reduction in the long run

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for NSW 2004 suggests that this sector contribute roughly 50 per cent of the rise in the evening peak consumption. ESSA in a submission to the Productivity Commission inquiry into energy efficiency in 2005 reported that, of the 15per cent of peak demand that occurs for just 24 hours per year in Sydney, 75per cent stems from domestic air conditioners.

marginal capital cost of supply brought about by the measures' impact on the maximum demand for energy in each year and the impact of that on the least cost capacity augmentation program. This cannot be done as such since the least cost steps in the BAU capacity augmentation program that suppliers will need to follow to satisfy demand with adequate reserve capacity is not readily calculable. Those steps will depend in part on the impact of emissions trading and renewables plant substitution and the price effects of those influences on consumers' energy use.

However, any potential impact of the BCA measures on the energy supply networks' long run marginal cost of supply needs to be seen in the context of the scale of capacity changes and the costs accompanying them that will occur in a BAU context that includes CPRS and RET pressures. ACIL Tasman (2008) have estimated that electricity generating capacity investment costs of $33 billion will be expended between now and 2020 to meet a 10 per cent reduction in emission targets and a 20 per cent RET by that date. A further $4.5 billion would be required as augmentation of the electricity transmission network and gas pipe line augmentation to meet these caps and targets.

In capacity terms an additional 15 000 MW of capacity would be required to 'replace stranded plant, satisfy the MRET and meet load growth' ACIL Tasman (2008 p.3). Retirement of 6 700 MW is likely to be required. ACIL Tasman modelling suggests a 13–14 per cent increase in maximum demand to 48 048 MW from a current 42 212 MW (29 per cent growth without the targets). Suppliers will need to bring on additional capacity to meet this growth while retiring existing assets to progressively change the generation mix to comply with renewables targets.

Modelling for the RIS suggests that between 2010 and 2020 total electricity consumption will grow by 12.7 per cent (30 per cent by 2030) and that total consumption by commercial buildings will grow by 21 per cent in the absence of the proposed BCA measures but with the CPRS in place.[43] The proposed BCA measures will depress these growth rates by 2020 to 12.2 per cent and 18.4 per cent respectively. Total consumption will be 0.5 per cent lower than it would be in the absence of the measures. The effect of these changes is that the estimated share of commercial buildings consumption in total consumption of electricity will remain approximately constant at around 23–24 per cent, rising marginally by 2030 to 26 per cent.

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[43] This is somewhat more pessimistic than ACIL Tasman projections for the household sector where here are assumed to be stronger responses to the projected 24 per cent increase in real tariffs that emerge from their modelling.

Modelling by ACIL Tasman provides estimates of the relationship through time of total consumption and maximum demand with CPRS and renewable targets in place. With a 10 per cent CPRS cap for the electricity sector and 20 per cent renewables target there is a small change in the relationship between modelled total consumption and maximum demand between 2010 and 2020. (The ratio of total GWh of total consumption to MW maximum demand falls from 5.45 to 5.3 signifying a slight deterioration in the relationship between peak and average loads, despite the fact that CPRS effects and targets are modelled to slow the growth rate in maximum demand more than they slow the growth rate in total consumption will bring about relatively larger conservation in the household sector than in the economy at large.)

To assess whether the predicted energy savings are likely to defer generation augmentation it is useful to refer to conclusions from other studies which have modelled demand reduction measures. One of the most recent is the work done by consultants CRA (2008a) as an input to the evaluation of the net benefits of introducing smart metering. CRA states (p.30) that ‘while the peak demand reductions that result...are small in percentage terms, in absolute terms they comprise 200 to 300 MW depending on the functionality and jurisdiction. Although these are not small numbers it must be noted that this level of demand is still well within the band of statistical uncertainty of system peak within these jurisdictions and therefore it is quite possible that they could be significantly or totally discounted in generation capacity investment decisions.’ The report goes on to assume that this will indeed be the case.

It is reasonable to infer from this that if the energy savings in each jurisdiction resulting from the proposed BCA changes are likely to be less than 200 MW when expressed in terms of maximum demand, then there will be no savings from deferral in generation augmentation. The 0.5 per cent savings in total consumption flowing from the proposed BCA measures by 2020 represents a saving in total electricity consumption of 1379 GWh nationally compared to BAU in 2020. By 2030 that conservation effect will be slightly weaker at 1206GWh. Applying the same initial ratio between total consumption measured in GWh and maximum demand (MW) as is implied by the ACIL–Tasman modelling (5.45 in 2009) this would correspond to a reduction of 253 MW in maximum demand *nationally* below BAU in 2020 and 221 MW 2030. This would not explicitly allow for the (unknown) potential improvement in the relationship between maximum demand and total consumption brought about by the BCA changes. Accordingly, since the overall maximum demand savings in any individual jurisdiction will be a fraction of this MW figure they will be very unlikely to defer significant investment in generation augmentation in this timeframe.

Impacts on operating costs of generation

Operating costs do not fall proportionately with reductions in supply. The impact of energy savings on the operating costs of generation businesses cannot be estimated directly for purposes of this RIS. However, an insight into the likely upper bound of these savings can be obtained from the smart meters studies referred to above. In the market modelling performed for that inquiry the highest impact scenario (in which penetration rates of smart meters was assumed to be 35 per cent and there was high functionality of metering combined with an element of direct load control) maximum demand (peak demand) savings in any of the Australian jurisdictions was calculated to be 4.2 per cent below the base case (which involved no smart metering but included carbon pricing effects.) The conservation effect in these studies (the impact on total consumption) varied between 3 per cent and 7 per cent depending on functionality. (This compares with a 2030 conservation effect of less than 0.5 per cent estimated for the proposed BCA changes). The resulting national smart meter – plus DLC impact on operating costs in 2030 was estimated to be a 0.73 per cent reduction below base case. The corresponding NPV of operating cost savings was put at $381 million when calculated over the period 2007 to 2030 with an 8 per cent discount rate.

The gains from these demand side measures arise partly from the flattening effect on the load curve that would have a less pronounced counterpart in the measures envisaged in the code changes although it is not possible to compare the two directly. However, the ultimate conservation effects relative to BAU are much stronger in the metering modelling than in the BCA change case (up to 14 times). While the differing impacts on load profile of the two sets of measures remains uncertain it seems likely that, given the large end point disparity in total conservation effects between the modelled smart meter impacts and the BCA changes, the operating cost savings of the latter would be unlikely to be more than 0.1 per cent.[44]

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[44] An alternative view might be taken that operating costs are approximately 30 per cent of unit costs of generation businesses. Assuming that average commercial tariffs cover unit costs of generation, transmission, distribution and retail, and that the generation sector accounts for approximately 45 per cent of total unit costs, the NPV of generation savings evaluated in this way over the period to 2030 would yield savings of approximately $277 million, or approximately $18 on an annualised basis. This conclusion requires further evaluation.

These savings are distinct from the carbon cost savings to generators that would accompany conservation. In the smart meter case these were projected to be approximately 1 per cent below BAU costs (with an NPV value of $267 million in the smart meter case), but again on the basis of substantial conservation effects.

There will also be some impact on savings from reductions in unserved energy (USE) demand resulting from any improvement in load profiles brought about by the BCA measures. On the basis of the smart meter study estimates these could be expected to be intermediate between the operating cost and carbon cost savings.

Other avoided cost impacts

Network businesses also stand to benefit from favourable demand reduction responses to the extent that they reduce unit costs. Again there is the potential for gains through deferred capital expenditure, improved system load factor, and possibly an improved system reliability and return on fixed assets.

The individual network complexities prevent the calculation of these relevant components. However, again information from the smart metering studies provides a reasonable reference point. In estimating the network augmentation deferral benefits from demand reduction via smart meters and DLC, CRA (2008b) have used an annualised cost of network capacity for each jurisdiction, based on data provided by the network distribution businesses. They report that these costs ranged between $115/kVA/yr to $165/kVA/yr. Adjusted by a power factor of 0.85 (to convert kVA to kW) for the residential sector these were then used to estimate the value to a network of a reduction in end use demand of 1 kVA, with a default value of $130/kW/yr for businesses for which data was not available.

Estimated network avoided costs approached in this way are relatively large for the case considered by CRA (2008b) under assumptions of high penetration of smart meters (35 per cent) and contributory direct load control. Average annual savings to distribution businesses were estimated at $212 million over the period 2009–30 with an NPV value of $1.1 billion.

As in the case of impacts on generation businesses the impacts of BCA measures can be expected to be an order of magnitude smaller than these. However, by 2020, if BCA induced measures are resulting in reductions of 253 MW relative to BAU (corresponding to constant relationship between maximum demand and total consumption) the corresponding annual network savings at an assumed value of $130/kW would be approximately $34 million and would decline slightly from this level to around $30 million by 2030. This figure would likely be an upper bound as the network savings from smart metering and DLC are skewed by the effect of those measures in favour of peak load savings.

Again these savings need to be seen in the context of network investment costs driven by load growth and CPRS responses estimated to be worth more than $4 billion over the next 10 years.

Conclusions

The proposed BCA changes will deliver gains in the form of avoided costs enjoyed by electricity generators and the businesses delivering power to end users. These will be modest gains. The relatively small impact on energy conservation compared to BAU will make it unlikely that generation augmentation plans, already heavily impacted by the likely implementation of the CPRS and renewable target requirements, will be altered as a result of the envisaged changes to commercial consumption. Reductions in generation operating costs will occur but are unlikely to be more than 0.2 per cent below BAU costs. Avoided carbon costs will be of a similar small order of magnitude, along with any unserved energy savings.

More substantial savings may be realised in the network businesses due to favourable demand reduction responses that reduce their unit costs. Based on studies prepared to evaluate other energy conservation measures, it is estimated that average annual savings attributable to the proposed BCA changes could reach $30 million by 2030 in this subsector relative to BAU. The present value of such savings could be as much as $280 million (estimated using a 7 per cent real discount rate).[45]

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[45] This estimate is highly conservative, assuming a ‘ramp-up’ phase of twenty years (in which no benefits are accrued) and $30 million per year thereafter.

H Consultation process

Submissions to the Consultation RIS were received from the following organisations and individuals.

1. Individual
2. Dincel Construction System
3. Individual
4. Individual
5. Frigrite air conditioning
6. MicroHeat technologies
7. Energy Modelling Steering Group
8. Electrical and Communications Association
9. Department of Innovation, Industry and Regional Development
10. Air conditioning and Mechanical Contractors' Association
11. Sustainability Housing
12. South Australian Department of Planning and Local Government, SA Energy Division, department for Transport, Energy and Infrastructure
13. Cement Concrete & Aggregates Australia, Think Brick Australia, Concrete Masonry Association of Australia and National Precast Concrete Association of Australia
14. AREMA
15. Penrith City Council
16. Royal Institute of Chartered Surveyors
17. Building Codes Queensland
18. Skylight Industry Association
19. Sustainable Energy Development Office
20. Master Builders Australia
21. Tamworth Regional Council.
22. Master Builders Queensland.
23. Munters
24. Australian Institute of Architects
25. Victorian Department of Planning and Community Development

26. KingSpan
27. Lighting Council of Australia
28. City of Sydney
29. NSW Planning
30. Property Council of Australia

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