AUSTRALIAN SUSTAINABLE BUILT ENVIRONMENT COUNCIL

LOW CARBON, HIGH PERFORMANCE

How buildings can make a major contribution to Australia's emissions and productivity goals

May 2016

TABLE OF CONTENTS

A Summary Report outlining the key findings of this Full Report is available via www.asbec.asn.au.

INTRODUCTION

Australia's built environment presents a profound and cost-effective emissions reduction opportunity. It is critical that policies and actions to realise this potential are implemented.

As the peak body for sustainability in the built environment, the Australian Sustainable Built Environment Council (ASBEC) provides a collaborative forum for organisations who champion a vision of sustainable, productive and resilient buildings, communities and cities.

In 2008, ASBEC released *The Second Plank*, a report which demonstrated that buildings make a significant contribution to emissions, yet offered some of the most affordable forms of greenhouse gas abatement in the economy. *The Second Plank* outlined a suite energy efficiency of policy measures for buildings which could enhance the planned emissions reduction scheme.

This new report updates the findings in *The Second Plank*, provides current modelling of potential emissions reductions from the sector, and sets out a policy roadmap towards 2050. The Paris Climate Change Agreement represents a step-change in thinking about the global actions and necessary pathways to address the challenge of climate change. We now know that the long term goal must be net zero emissions.

Low Carbon, High Performance provides a comprehensive analysis of the sector's performance over the last decade, an exploration of the opportunities at hand, and a policy suite that will pave the way for a smooth and economically efficient transition to zero net emissions.

Importantly, *Low Carbon, High Performance* shows how high performing buildings can provide a cost-effective and quality-of-life-enhancing solution to Australia's emissions reduction commitments. This means a national zero carbon buildings plan, stronger minimum standards, ambitious action by industry and governments, targeted incentives and programs, energy market reform and a suite of critical enabling data, information, education and training measures.

Our market leaders have demonstrated the capability to deliver rapid improvements in the quality and performance of buildings, and our industry stands ready to deliver this more broadly across the sector, providing opportunities for significant reductions in Australia's emissions over a short period of time.

ASBEC and its members call upon policy makers to adopt these measures. We look forward to working collaboratively with all spheres of government, towards facilitating the transition of Australia's building sector towards an economy for the future. This will be critical in achieving the future liveability, productivity and sustainability of our communities and cities.

Ken Maher
President
Australian Sustainable Built Environment Council

EXECUTIVE SUMMARY

The emissions task: As a signatory to the Paris Climate Change Agreement, Australia has now committed to the global transition to zero net emissions, and to reaching net zero emissions nationally around 2050.

This report: This report is intended to outline for policy makers the potential for the Australian built environment sector to make a major contribution to meeting this goal, as well as other national priorities including improving energy productivity, supporting innovation, making efficient use of current and future infrastructure, and creating healthier, more liveable cities.

Achievements in buildings energy performance: The technology already exists today to achieve zero carbon buildings. Market leading Australian property companies have demonstrated the potential for energy performance improvements over the past decade, consistently topping international green building benchmarks with world-leading sustainable buildings. These and other improvements across the sector have led to emissions reductions of over 180 megatonnes; nearly 20 times the annual emissions of Australia's largest coal fired power station. The uptake of solar PV has been rapid and continues apace.

The opportunity: Even without technological breakthroughs, our modelling indicates that cost-effective energy efficiency and fuel switching can reduce projected 2050 emissions from buildings by more than half. There is sufficient opportunity for distributed solar PV to eliminate remaining emissions, resulting in zero carbon buildings by 2050, if barriers can be overcome.

The benefits: Implementing all of the energy efficiency opportunities identified in this report could deliver almost $20 billion in financial savings by 2030, in addition to productivity benefits and improvements in quality of life for Australian businesses and households. Buildings could also meet over half of the national energy productivity target, and more than one quarter of the national emissions target.

The challenge: While market leaders have achieved substantial improvements, the main challenge for policy makers is to extend this progress across the sector as a whole. To date, energy intensity has improved only 2 per cent across the commercial sector and 5 per cent in residential. Accelerating actions across the sector will require strong policy support to address persistent barriers and impediments to energy efficiency and distributed energy.

Recommendations: To address these issues, ASBEC is calling for the establishment of a national plan to coordinate policy development and implementation, with a suite of policies across five themes:

1. **A national plan with supporting policy frameworks and governance arrangements**, including long-term and interim targets, clear responsibility at a Ministerial level, coordination of action across different levels of government and different government departments and agencies and public reporting requirements;

2. **Mandatory minimum standards for buildings, equipment and appliances** with an future trajectory aligned with the long-term goal of net zero emissions;

3. **Targeted incentives and programs** to motivate and support higher performance in the short- to medium-term, including incentives, the use of government market power and targeted programs and support;

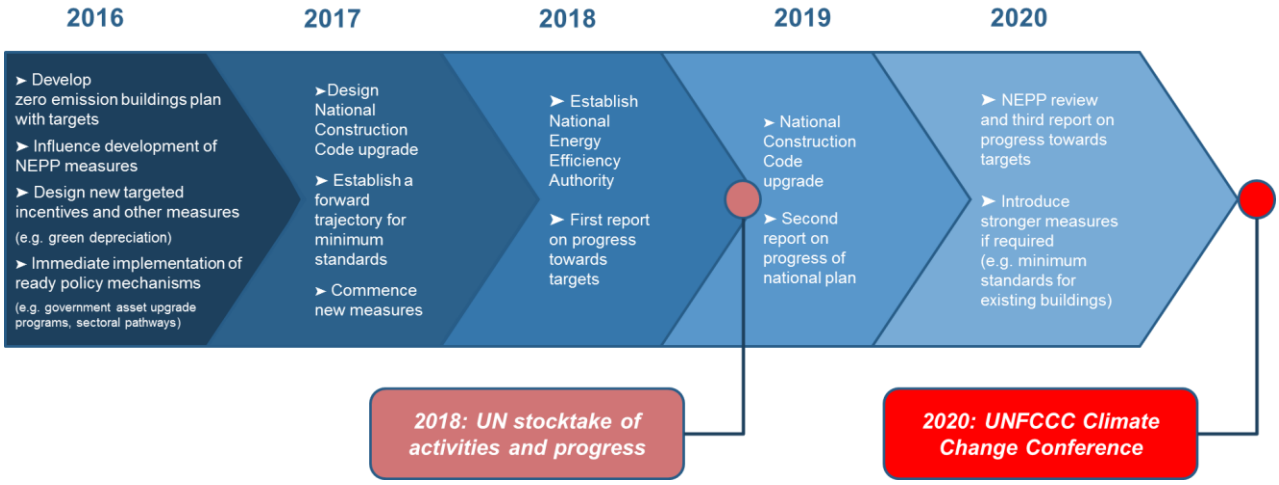
4. **Energy market reforms** to ensure that the energy market supports roll-out of cost-effective energy efficiency and distributed energy improvements;

5. **A range of supporting data, information, training and education measures** to enable informed consumer choice, and support innovation, commercialisation and deployment of new technologies and business models.

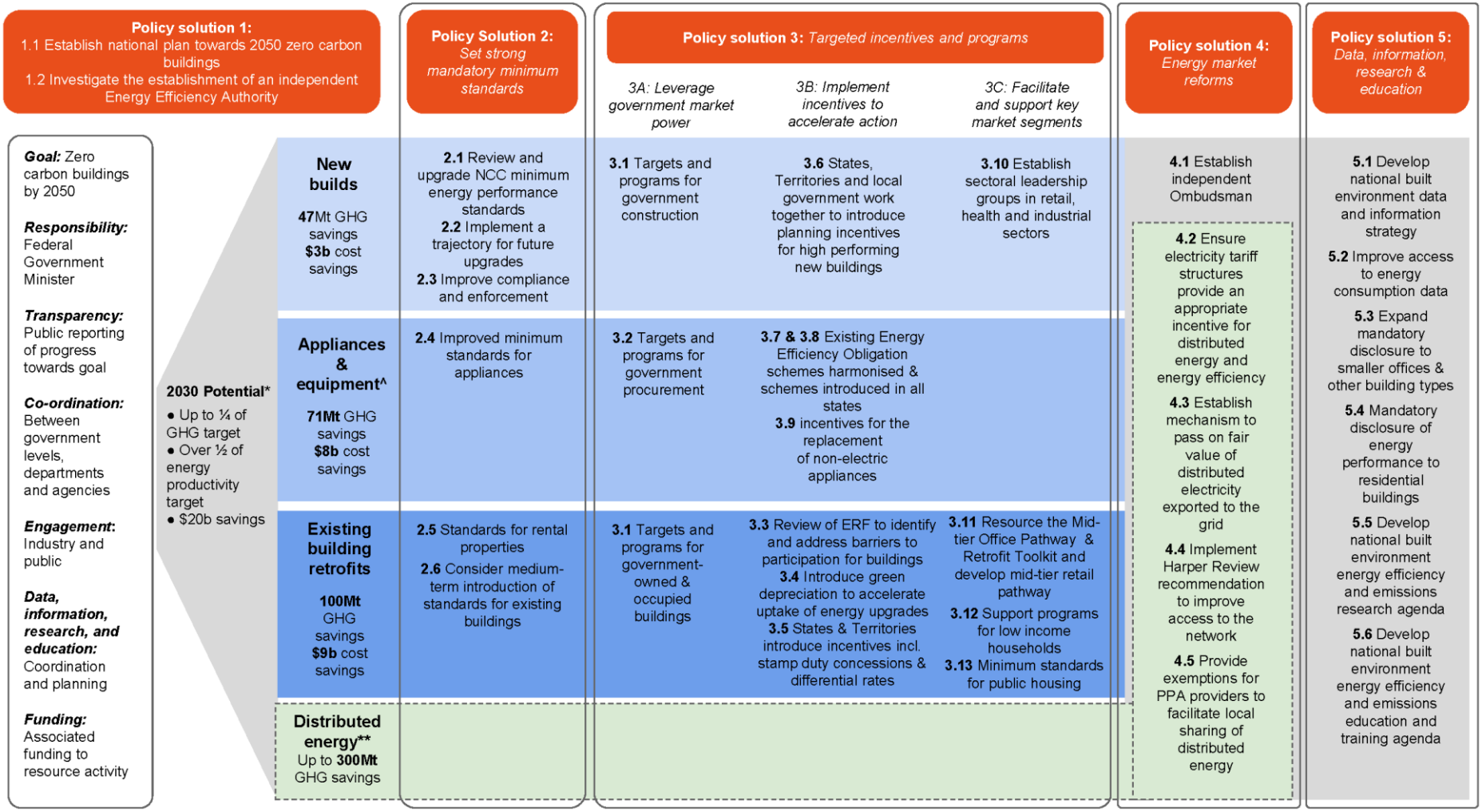
The cost of delay: Implementing the recommendations in this plan is urgent. Just five years of delay in implementing the opportunities in buildings could lead to over $24 billion in wasted energy costs and over 170 megatonnes of lost emission reduction opportunities through lock-in of emissions intensive assets and equipment.

Figure 1 provides an indicative timeline for implementation of the recommendations in this report.

Figure 1. Five year implementation timeline



Outline of proposed National Plan Towards 2050 Zero Carbon Buildings



* Figures shown reflect the cumulative net energy cost savings and emissions reductions between 2015 and 2030 available from each segment; ^ Includes appliances and equipment in new and existing buildings; ** Represents upper range of projections of distributed solar PV; Financial savings not calculated; EEOs = Energy Efficiency Obligation schemes; ERF = Emissions Reduction Fund; AER = Australian Energy Regulator; PPA = Power Purchasing Agreement

Summary of policy recommendations

#	Recommendation	Rationale	Indicative timeline
Policy Solution 1 - Create a National Plan Towards 2050 Zero Carbon Buildings and improve governance			
1.1	**Establish a National Plan Towards 2050 Zero Carbon Buildings**	Opportunities presented by energy efficiency and emissions reductions in the built environment sector are large but the impediments are numerous and complex. Numerous stakeholders are involved, including multiple levels of government, multiple different government departments, agencies and regulators, and multiple private and community sector stakeholders. Overcoming this level of complexity requires supportive governance arrangements, including: • targets for emissions and energy in the built environment; • coordination of activity across levels of government and government entities; • regular public reporting of progress; • public and industry engagement; • coordination and planning of research, education and training; and • clear responsibility for implementation, review and updating over time.	By end 2016, establish a working group to develop national plan By June 2017, establish national plan
1.2	**Investigate the establishment of an independent Energy Efficiency Authority**	An independent authority could coordinate energy efficiency policy development and implementation, and evaluation and reporting of the effectiveness of energy efficiency policies. This would provide greater regulatory certainty and stability.	By June 2017, report on options for the establishment of an independent authority, for implementation by the end of 2017

Policy Solution 2 - Set strong mandatory minimum standards			
2.1	**Review and upgrade minimum energy performance standards in the National Construction Code**	Minimum standards for commercial buildings currently lag far behind best practice, and need to be updated urgently. A range of other potential improvements to both residential and commercial standards have been proposed.	Commence immediately for implementation at the scheduled 2019 Code update
2.2	**Implement a trajectory for future upgrades to minimum energy performance standards in the National Construction Code**	Currently the Code is updated every three years, but the minimum energy performance standards are not necessary adjusted at this point. Establishing a trajectory for upgrades would enable industry to prepare for higher standards in the future and reduce the regulatory uncertainty and burden associated with ad hoc upgrades.	Commence investigation immediately
2.3	**Improve compliance and State/Territory-level enforcement of standards**	Recent reports have provided increasing evidence of under-compliance with existing NCC requirements. The NEEBP is focusing on this issue, and should be supported to continue to promote improved compliance and enforcement through improved compliance tools, and to monitor the impact of these tools and identify additional improvements required to address under-compliance. States and Territories should also work to improve their enforcement regime.	2016-17
2.4	**Implement the recommendations of the GEMS Review to expand, strengthen and accelerate future improvements in minimum equipment and appliance standards**	The GEMS review identified opportunities to improve minimum energy performance standards for appliances and equipment, and the process for updating standards over time. These recommendations should be implemented.	By June 2016
2.5	**Develop a proposal for introduction of minimum standards for rental properties**	Low income and vulnerable households in rental properties face much stronger barriers to improving the energy performance of their homes than other households, particularly split incentives and power imbalances with landlords. This provides a strong consumer protection rationale for	Develop proposal by the end of 2016, for implementation by June 2017

		introducing mandatory minimum standards. In addition, improving the performance of rental properties would reduce the burden on state and territory budgets of providing financial assistance to households unable to pay energy bills.	
2.6	**Undertake a review to investigate the introduction of minimum energy performance standards for existing buildings**	Minimum standards for existing buildings may be justified if the suite of measures in the NEPP fail to drive sufficient retrofitting activity. Simply signalling the future introduction of minimum standards may in itself drive substantial additional activity. Further investigation would be required to understand the need, potential impacts, timelines and costs and benefits of this measure.	In 2017, for potential introduction from 2020
Policy Solution 3 - Targeted incentives and programs			
Policy Solution 3A - Leverage government market power			
3.1	**Commonwealth, State and Territory governments should set ambitious targets for government-owned and occupied buildings and for government procurement, and implement mechanisms to facilitate these improvements**	Government-occupied premises account for 14 per cent of the identified opportunity for energy efficiency improvements. Governments can use their strong market presence drive large improvements in energy performance, which will provide leadership and demonstrate the benefits of improved energy performance, deliver financial savings for government budgets, reduce costs for others and build skills and capability, and improve public facilities such as schools and hospitals. Programs to improve energy use in government operations are well understood, and could be rapidly expanded to jurisdictions that do not currently have them in place.	Review existing programs (where they exist) in 2016, and establish new/improved programs by June 2017
3.2	**Commonwealth, State and Territory governments should fund programs to support local governments to improve their efficiency**	Local governments have more limited skills and resources to identify and implement energy upgrade projects and improvement programs. Commonwealth, State and Territory governments should individually or jointly fund programs that provide access for local governments to advisory teams that can assist them to implement similar energy improvement programs.	By June 2017

Policy Solution 3B - Implement incentives to accelerate action			
3.3	**A review should be undertaken of the Emissions Reduction Fund to identify and address barriers to participation for buildings**	Of the 129 contracts awarded in the second ERF auction, only three projects used the one available buildings method. The ERF in its current form appears to be unsuited to incentivising emissions reductions in buildings, and following the next auction scheduled for April 2016 should be reviewed to identify and address barriers to participation for buildings. This review should include consideration of whether a portion of the ERF funds should be redirected to other incentives or programs better suited to buildings.	By end 2016
3.4	**The Commonwealth should introduce green depreciation to accelerate uptake of energy upgrades to existing commercial buildings at the time of refurbishment**	The Commonwealth is currently considering a range of potential tax reforms, and should include consideration of green depreciation in this context. Green depreciation would influence building owners undertaking refurbishments to include green measures at the same time. By allowing investors to defer tax payments, green depreciation can reduce the 'timing gap' problems of energy efficiency investments, where early capital expenditure must be incurred at the outset but financial savings accrue over the life of the asset. Green depreciation would appear as a revenue loss on government budgets, but would be offset by increased tax revenue in later years.	By end 2016
3.5	**States and Territories should introduce incentives for high performing buildings, and as a priority investigate the introduction of stamp duty concessions and differential council rates in partnership with**	A number of States and Territories are currently developing energy efficiency, renewable energy and climate change mitigation strategies, including Victoria, Queensland and South Australia. These work programs should include consideration of the introduction of incentives for retrofitting existing appliances, for new buildings and for the purchase of high efficiency equipment and appliances. Priority should be placed on: • Stamp duty concessions for high performance homes, which could have a similar impact to green depreciation by targeting the point	By mid 2017

	local government	at which homeowners are considering making investments in their home prior to sale; • Planning incentives such as density bonuses and green door policies, which could support accelerated deployment of high performing new buildings by targeting one of the highest priorities for new building developers - the cost, time invested and uncertainty of planning processes	
3.6	**States, Territories and local government should work together to introduce planning incentives for high performing new buildings**	Planning incentives such as density bonuses and green door policies could support accelerated deployment of high performing new buildings by targeting one of the highest priorities for new building developers - the cost, time invested and uncertainty of planning processes.	By June 2017
3.7	**Existing Energy Efficiency Obligation schemes should continue to be harmonised and integrated**	Harmonising and integrating existing schemes will reduce transaction costs, reduce the cost of expanding to other states and territories, reduce administrative costs particularly for smaller jurisdictions and reduce the cost of reviews and updates. Victoria and New South Wales are already working on harmonising and integrating their schemes, and this should be extended to other jurisdictions and potential new schemes. Existing and new schemes should seek to include project-based methodologies that reward deeper retrofits rather than single product replacements.	By end 2016
3.8	**Energy Efficiency Obligation schemes should be introduced in Queensland, Western Australia, Tasmania and the Northern Territory**	Jurisdictions which do not currently have schemes should introduce them and design them to integrate with existing schemes.	By June 2017

3.9	**Energy Efficiency Obligation schemes should begin to incorporate incentives for the replacement of non-electric appliances**	Non-electric appliances will eventually need to be phased out, and Energy Efficiency Obligation schemes should be reviewed to ensure that they are not incentivising installation of new non-electric appliances (e.g. gas water heaters) and eventually, to introduce incentives for the replacement of existing electric appliances. This should be initially piloted in states with rapidly decarbonising electricity supply, such as South Australia.	Remove incentives for installation of new non-electric appliances by end 2017 Design and introduce pilot measures in states with low grid emissions intensity by end 2017, for extension to other jurisdictions by 2020
Policy Solution 3C - Facilitation and support for distinct market segments			
3.10	**Consider the establishment of sectoral leadership groups in retail, health and industrial sectors**	Government can help facilitate the establishment of sectoral leadership groups for market segments with strong consolidation, either nationally or in regions, cities or districts. These groupings can help market leaders overcome common barriers and accelerate improvements in their own buildings. In turn, this can have an effect on the broader market by demonstrating the potential for improvement and the benefits of doing so, and by changing mainstream practices within the supply chain. The Better Buildings Partnership in Sydney is an excellent example, and a similar model could be extended to other areas and other sectors, particularly retail, health and industrial sectors where strong consolidation exist.	In 2016-17, piloting in local government areas, States and Territories currently reviewing energy and climate strategies. Potential expansion in 2018-19.
3.11	**Resource the Mid-tier Office Pathway and develop mid-tier retail pathway.**	Offices and retail represent the largest share of the identified opportunity in the commercial sector. Despite improvements in the top-tier, mid-tier building owners still face significant barriers to realising these energy savings and the associated benefits. The opportunity is significant. For example, mid-tier offices are estimated to make up 52 million square meters of the 64 million square meters of office space in Australia. A	Mid-tier National Office Pathway resourced immediately for implementation over the next five years.

		multifaceted approach to connect and transform these sectors is required. Significant work has already been undertaken in the mid-tier office sector, culminating in the development of the industry-led Mid-tier National Office Pathway including the Building Retrofit Toolkit. If resourced, this pathway could be implemented within the next five years. A similar approach should be taken for mid-tier retail.	Industry-led pathway for small retail to be resourced and scoped in 2016 for development and implementation in 2017.
3.12	**The Commonwealth, States and Territories should develop end-to-end support programs for low-income households**	Low income households tend to live in more inefficient dwellings than other households, spend more of their household income on energy, and face stronger barriers to upgrading including strong split incentives between tenant and landlord and low capability to fund upgrades. Poor housing can increase the financial and health vulnerability of low income households, creating a strong rationale for establishment of targeted end-to-end programs aimed at low-income households. Programs should be developed building on insights from the NEPP best practice guidelines project and the Commonwealth Low Income Energy Efficiency Project.	Scoping of potential programs in 2016 for implementation in 2017
3.13	**State and Territory governments should establish rising minimum standards for public housing and facilitate funding mechanisms to facilitate public housing retrofits**	State and Territory governments control a substantial portion of low-income housing stock through public housing. There is a strong case for standards to be introduced for existing assets, and mechanisms be provided to facilitate upgrades of these publicly owned assets to unlock emissions reductions and support low income households reduce their cost-of-living.	Investigation in 2016 for implementation in 2017

Policy Solution 4 - Energy market reforms			
4.1	**Establish an independent industry Ombudsman or other independent authority to investigate and recommend solutions to address energy market barriers**	Australia's energy market rules and regulations have a strong impact on the ability of built environment stakeholders to implement energy efficiency and distributed energy in buildings. However, the processes by which these rules and regulations are set are extremely complex, limiting the ability of non-technical experts including built environment stakeholders to participate. A number of these processes are underway at the moment. The establishment of an independent Ombudsman or other independent authority to investigate and recommend solutions to address energy market barriers experienced by distributed energy, energy efficiency and built environment stakeholders over time, and voice their concerns in the context of energy market processes and reforms, would help ensure that these processes support and do not disincentivise cost-effective uptake of energy efficiency and distributed energy.	By end 2016
4.2	**Ensure that electricity tariff structures provide an appropriate incentive for distributed energy and energy efficiency, including through the current shift to 'cost-reflective pricing'**	Electricity distribution network service providers are currently implementing a shift towards more cost-reflective pricing for electricity. This may result in an increase in fixed charges, which could create a strong disincentive for the installation of distributed solar PV, as well as a disincentive to improving energy efficiency. Electricity network companies currently develop their own proposals for tariffs. A better approach would be to establish a national process similar to the CSIRO Future Grid Forum to develop 'model tariff structures' to help guide the AER's consideration of new tariff proposals.	Establish a national process in the first half of 2016
4.3	**Establish a mechanism to identify and pass on to distributed generators the fair value of distributed**	Electricity generated locally by distributed generators including solar PV systems may deliver a range of network benefits that are not currently recognised in the rate paid to generators. A mechanism should be established to identify any benefit identified, and pass this on to distributed	Following the completion of current Rule Change proposals and inquiries (expected to be resolved in 2016).

	electricity exported to the electricity grid	generators.	
4.4	**Establish standards for connection of embedded generators and implement the recommendation of the Harper Review of Competition Policy to improve access to the electricity network**	Connection of distributed generators to the electricity network presents a strong barrier to further uptake of medium-scale solar PV and other distributed energy, as a result of a lack of standardisation, un-transparent costs and delays and a lack of an effective access regime. These barriers need to be addressed. Two processes exist to address these issues. The Clean Energy Council (CEC) is currently investigating the possibility of standardisation of connection processes, while the Harper Review of Competition Policy recommended improvements in the access regime for energy networks.	The CEC project is due to report in 2016, and standards could be implemented in 2017. Commence work on the implementation of the Harper Review recommendation immediately.
4.5	**The Australian Energy Regulator (AER) should provide exemptions for Power Purchasing Agreement (PPA) providers as has been provided already in Victoria to facilitate local sharing of distributed solar and other distributed energy**	Exemptions for PPA providers would significantly reduce transaction costs and barriers to entry for businesses seeking to install distributed energy systems including solar PV and sell the electricity to the occupants of the building or nearby buildings. This model could apply to building owners seeking to install solar PV and on-sell the electricity to tenants, or to energy companies that install solar PV on others' roofs and sell the electricity to the tenants.	Short term, 1-2 years
Policy Solution 5 - Improve energy data, information, research, education and training			
5.1	**Develop a national built environment energy data and information strategy in partnership with relevant**	Energy data and information is currently managed by a range of different organisations. Many other policies and programs rely on the data collected and tools administered by these organisations. For example, the Commercial Building Disclosure Scheme requires disclosure of energy	Development in 2016 alongside related NEPP measures, for implementation by June 2017

	industry and research organisations	performance based on NABERS ratings, while the National Construction Code references the NatHERS residential rating tool to set the minimum energy performance standard for homes. A national strategy should be developed to ensure that ongoing improvements in energy data and information are coordinated and funded.	
5.2	**Improve access to energy consumption data**	For energy consumption data to be useful, it is essential that it is accessible to both consumers and third party service providers at low effort, at low or zero cost and via cloud-based smart phone apps the current process for accessing energy consumption data is not streamlined and varies depending on the geographic location and electricity distribution network service provider. An inquiry should be undertaken as part of NEPP Measure 24 ('improving the exchange of market data') to investigate ways to facilitate better access to energy data, with consideration of the establishment of a central, streamlined and highly accessible open data platform for energy consumption and performance data. The platform should also facilitate public access to aggregated and de-identified data for researchers.	Investigation in 2016/17, for potential implementation in 2017
5.3	**Expand mandatory disclosure to smaller offices and investigate the possibility of requiring disclosure for other building types**	The Commercial Building Disclosure (CBD) scheme requires large commercial office buildings (above 2,000 m^2) to disclose their NABERS energy rating at the point of sale or lease. In combination with government and large corporate tenant leasing requirements, this scheme has been instrumental in driving improvements in the large office sector. The Commercial Building Disclosure review recommended extending this scheme to all commercial offices above 1,000m^2, and ASBEC supports this recommendation. The needs of other building types outside the office sector may be different, however the potential expansion of disclosure policies to other building types should be investigated.	Implementation in 2016

5.4	**Implement mandatory disclosure of energy performance for residential buildings, beginning with pilots in one or more jurisdictions**	In the residential sector, disclosure is already required for homes at the point of sale or lease in the ACT, with good results. There is a strong case to extend residential disclosure to other jurisdictions, beginning with a pilot in one or more states over the next two years, while developing the framework for implementation of a nationally consistent scheme in 2018. This will also allow time to investigate potential improvements in and harmonisation of residential rating schemes.	Piloting in 2016-18, and implementation of national scheme from 2018
5.5	**Develop a national built environment energy efficiency and emissions research agenda, and establish a permanent energy efficiency and distributed energy research institution**	Australia has a very well-developed set of research and innovation entities, including in particular the CRC for Low Carbon Living working on primary research relating to energy and emissions in the built environment amongst other areas, ARENA which provides funding for early stage renewable energy technologies and the Clean Energy Finance Corporation to support commercialisation. What is missing in Australia is a mechanism to coordinate research on built environment energy efficiency and emissions. To fill this gap, it is recommended that government consider the development of a permanent national built environment energy efficiency and emissions research agenda and the establishment of a national built environment research body. In addition, ARENA's mandate should be expanded to include energy efficiency, building on the work of the CRC for Low Carbon Living, and the forthcoming establishment of Innovation and Science Australia.	Development of a national strategy in 2016-17 Expansion of ARENA's mandate in 2017
5.6	**Develop a national built environment energy efficiency and emissions education and training agenda**	In recognition of the broad need for upskilling amongst many different industry sectors, the national buildings plan should include the development of a national built environment energy efficiency and emissions education and training agenda and co-ordination with existing industry bodies such as the Energy Efficiency Council and Clean Energy Council, and education and training institutions such as the Industry Skills Council and AQSA.	Development of national strategy in 2016 for implementation in 2017

LIST OF ACRONYMS

ASBEC:	Australian Sustainable Built Environment Council
AER:	Australian Energy Regulator
AUM:	Assets under management
BASIX:	Building Sustainability Index
BAU:	Business as Usual
BBP:	Better Buildings Partnership
CBD:	Commercial Building Disclosure
CFL:	Compact Fluorescent Lamp
E3:	Equipment Energy Efficiency
EEFIG:	Energy Efficiency Financial Institutions Group
EPC:	Energy Performance Contracting Process
ERF:	Emissions Reduction Fund
EUA:	Environmental upgrade agreement
GEMS:	Greenhouse and Energy Minimum Standards
GDP:	Gross Domestic Product
GHG:	Greenhouse Gas
GBCA:	Green Buildings Council of Australia
GRESB:	Global Real Estate Sustainability Benchmark
HFC:	Hydrofluorocarbon
INDCs:	Intended Nationally Determined Contributions
kWh:	kilowatt hours
LED:	Light Emitting Diode
MACC:	Marginal Abatement Cost Curve
$MtCO_2e$:	Million tonnes of carbon dioxide equivalent
MW:	Mega Watt
NABERS:	National Australian Built Environment Rating System
NatHERS:	Nationwide House Energy Rating Scheme
NEPP:	National Energy Productivity Plan
NEM:	National Energy Market
NPV:	Net Present Value
FFO:	Funds From Operations
PJ:	Petajoule
PPA:	Power Purchasing Agreements
ROI:	Return on investment
R&D:	Research and development
Solar PV:	Solar Photovoltaic
Under2MoU:	Under 2 Memorandum of Understanding

SCOPE AND CONTEXT FOR THIS REPORT

The Australian Sustainable Built Environment Council (ASBEC) is the peak body of key property sector organisations committed to a sustainable built environment in Australia. ASBEC's membership consists of industry and professional associations, non-government organisations and government observers who are involved in the planning, design, delivery and operation of Australia's built environment.

In 2008 and 2010, ASBEC published the *Second Plank Report* and the *Second Plank Update*, which considered the opportunities for energy efficiency improvements in buildings to 2050.[1] This report builds on these previous reports to reflect changes in government policy relating to climate change and energy, and in the international context following the 2015 Paris Climate Change Agreement. The report covers emissions associated with the operation of buildings, both residential and commercial. It includes emissions associated with electricity consumption, gas use and leakage of refrigerant gases. Its scope aligns with the definition of 'zero carbon operational' buildings in the ASBEC report *Defining Zero Emission Buildings*[2]. The report does not include:

- embodied emissions from the materials and manufacture of appliances and equipment
- emissions associated with the construction, renovation or maintenance of buildings
- transport emissions associated with travel to and from buildings
- emissions associated with waste that leaves buildings

The exclusion of construction emissions is particularly important to bear in mind, especially when considering the difference in emissions from new and existing buildings. While new buildings are generally less emissions intensive in their operation than existing buildings, this difference can be offset by additional emissions associated with their construction. Likewise, the exclusion of emissions associated with waste and transport are a result of the scope of this report only, and these sources of emissions will need to be taken into account by government when designing policy measures for buildings, and by industry when designing, renovating, constructing and operating buildings. Finally, while the report includes emissions from warehousing, logistics, distribution and other 'light industrial' buildings in the 'commercial' category, it excludes emissions from factories and other heavy industrial buildings and manufacturing sites.

This report assumes no national carbon price, and a business-as-usual scenario for the electricity grid which results in only a 6.8 per cent reduction in grid emissions intensity by 2040. As previous work by ClimateWorks Australia (ClimateWorks) and ANU shows, grid decarbonisation will be required in order to transition to a zero net emissions economy in the long term. Some form of broad incentive such as a carbon price will be required to drive this energy system transition. Further detail on the assumptions underlying the modelling for this report is contained in the attached Modelling Assumptions document.[3]

[1] ASBEC, 2010
[2] ASBEC, 2011
[3] Note also that all references to years in this document are references to financial years ending in that year (e.g. '2015' refers to the '2014-15' financial year) and all references to dollars are 2014 real dollars.

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1. THE EMISSION REDUCTION TASK

Summary of key points

- The Paris Agreement confirmed that global emissions must be reduced to near net zero well before the end of the century
- This goal is well recognised by governments, corporates and investors internationally and within Australia
- For developed countries like Australia, net zero emissions would likely have to be achieved by around 2050 to stay within the recommended carbon budget

1.1. Global momentum towards zero net emissions

The Paris Agreement confirmed that net global emissions must be reduced to near zero well before the end of the century

In December 2015, all 196 of the world's governments signed the Paris Agreement, committing to reduce emissions to limit increase in the global average temperature to well below 2 °C and pursuing efforts to limit the temperature increase to 1.5 °C.[4] Stabilising atmospheric greenhouse gas emissions at any level requires reducing net global emissions to zero before the remaining 'carbon budget' is expended - the 'carbon budget' refers to the total amount of emissions that the world could release over a period of time that is consistent with a given rise in global temperature.[5] The Intergovernmental Panel on Climate Change has found that limiting temperature increases to below 2 degrees means reaching zero net emissions globally between 2050 and 2100.[6] Developed countries will need to reach zero net emissions earlier, as emissions from developing countries are expected to continue to rise for some time.

The need to reduce emissions to net zero or 'decarbonise' is now well recognised internationally by governments, corporates and investors. Governments at all levels have begun to make ambitious national and sub-national commitments to make substantial cuts in their own levels of emissions in the short term, and target deep reductions over the longer term. These include the world's largest emitters, as well as more than 120 sub-national governments (including South Australia) through the 'Under2MoU'. Some of the world's largest corporations are recognising that climate change is not only a major risk (ranked the number one global risk according to a survey of experts undertaken for the World Economic

[4] UNFCCC, 2015
[5] Climate Change Authority, 2014, p 43.
[6] IPCC, 2014

Forum[7]), but it is also an economic opportunity. Over 1,700 companies across 20 sectors – including household names like Coca-Cola, Bank of America, Apple, Walmart and Starbucks - have made commitments through the United Nations Framework Convention on Climate Change to reduce emissions, improve energy efficiency, use renewable energy and enact internal policies.[8] Likewise, many of the world's largest investors and asset owners are also now recognising the long-term investment risks associated with greenhouse gas emissions, climate change and carbon regulation. Large investors are progressing from measuring and understanding climate related risks to taking action to reduce those risks in their portfolio.

1.2. Australian emissions policy

The zero net emissions goal has been acknowledged at the highest levels of Australia's government - for developed countries like Australia, zero net emissions would likely have to be achieved by around 2050 to stay within the recommended carbon budget

As a signatory to the Paris Agreement, Australia has now committed to the goal of reducing global emissions to zero net emissions. The Australian Climate Change Authority has calculated Australia's share of the global 'carbon budget' at 1per cent of the global total and concluded that Australia should be aiming to reduce emissions to net zero by about 2050.[9] The zero net emissions goal has been acknowledged at the highest levels of government:

> *"Paris...is a step along the way to achieving a net zero-emissions world. That is what we need to do in order to safely arrest global warming."*
>
> - Prime Minister Malcolm Turnbull

> *"[The Paris Agreement will require a] long-term transition to an emissions neutral and climate resilient world"*
>
> - Foreign Minister Julie Bishop

> *"...we need to see the world committing to net zero emissions in the second half of the 21st Century"*
>
> - The Hon Bill Shorten MP

The current national emissions reduction target is to reduce emissions by 26-28 per cent below 2005 levels by 2030, however as part of the Paris Agreement, all countries have agreed to 5 yearly reviews of their national targets starting from 2020, with the requirement that new pledges be higher than the previous pledge and reflect the highest possible level of ambition. Australia's Climate Change Authority recommended that Australia commit to higher targets than the current 26-28 per cent below 2005 levels, and noted that the current target is at the lower end of targets set by Australia's peers[10], suggesting that higher targets can be expected at some point. The government has also scheduled a review of Australia's

[7] Penny, 2016
[8] South Australian Government, 2015 b, p7
[9] Climate Change Authority, 2014, p 102.
[10] Climate Change Authority, 2015, p2.

climate change policy in 2017, with a focus on the ERF and its safeguard mechanism, which begins July 2016.

Emissions reductions are also a key goal of the National Energy Productivity Plan (NEPP), which is targeting a 40 per cent improvement in energy productivity by 2030, and includes a range of measures aimed at improving energy efficiency in buildings in particular (see chapter 5 below for more detail).

The zero net emissions goal has broad support across Australian governments, political parties and leading corporates and community organisations

Ambitious action to reduce emissions has support from the current Federal Opposition, which has set a goal for Australia to achieve zero net emissions by 2050, targeting a 45 per cent reduction in emissions below 2005 levels by 2030.

At a sub-national level, Australian states and territories are also raising the bar, with South Australia leading the way with a commitment to achieving zero net emissions by 2050[11]. The ACT has a target of zero net emissions by 2060, with interim targets of 40 per cent below 1990 levels by 2020 and 80 per cent below 1990 levels by 2050[12].

The zero net emissions goal has also been acknowledged by leading corporates and community organisations in Australia. The **Australian Climate Roundtable** has stated its support for action to limit global temperature increases to 2°C, noting that this requires most countries, including Australia, to eventually reduce greenhouse gas emissions to net zero or below. Signatories include some of Australia's largest and most influential organisations, including the Australian Aluminium Council, Australian Industry Group, The Climate Institute, Business Council of Australia, Australian Council of Social Service, Energy Supply Association of Australia, Australian Council of Trade Unions and the Investor Group on Climate Change. Through the **We Mean Business** initiative, two of Australia's largest energy companies (AGL and Origin Energy), and the big four banks have made strong commitments to reduce emissions in line with international commitments[13].

1.3. Global momentum towards low emissions buildings

Governments, large corporates and investors are all putting in place strategies to deliver higher performance buildings that contribute to national emissions goals

The largest economies in the world are setting ambitious energy and emissions targets for buildings, including:

- **EU:** From 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings and by 31 December 2020 all new buildings are nearly zero-energy buildings.[14]

[11] South Australian Government, 2015 a
[12] ACT Government, 2014
[13] ANZ, 2015; Westpac Group, 2015; NAB, 2015.
[14] European Union, 2010 (Directive 2010/31/EU on the energy performance of buildings)

- **US:** By 2030, any commercial building newly constructed in the US must be zero net energy, with 50 per cent of the commercial building stock of the US zero net energy by 2040 and all commercial buildings in the US by 2050.[15]
- **India:** From 2030, all newly constructed buildings in India must be net zero energy, which is defined as a building that produces at least as much energy as it uses in a year, when accounted for at the site.[16]

At a sub-national level, some examples include the California Green Building Standard, which outlines that all new residential construction must be zero net emissions by 2020, adding all new commercial construction by 2030. For existing commercial buildings, 50 per cent will be retrofitted to zero net emissions by 2030. The Washington State Energy Code Roadmap outlines a 70 per cent efficiency improvement compared to 2006 for residential and non-residential construction. They have committed to constructing increasingly efficient homes and buildings that help achieve the broader goal of building zero net emissions homes and buildings by 2031.

Australian states are also driving improvements in building energy performance, with South Australia aiming to improve the energy efficiency of government buildings by 30 per cent compared to 2001 levels by 2020. The ACT also has strategies to improve the energy efficiency of new and existing commercial and residential buildings and installing cogeneration and trigeneration technologies in large buildings[17].

At a city level, a leading example is the Cambridge City Council in the UK, which is targeting zero net emissions municipal buildings by 2020, residential by 2022 and multi-family, commercial, institutional and labs by 2025. The City of Sydney has committed to reducing the energy consumption of the city's buildings by 31 per cent on 2006 levels by 2030[18], and the City of Melbourne has a target of being zero net emissions in its operations by 2020, and to increase the average National Australian Built Environment Rating System (NABERS) (or equivalent) rating of commercial buildings to 4 stars by 2018.[19]

As government policy focus increases and **major investors** signal their intention to address carbon exposure in their assets, leading companies across the property sector are treating the energy performance and emissions intensity of the buildings they design and build as both a risk to be managed and an opportunity to attract additional investment, over and above the direct financial benefits. Key initiatives include:

- **The Montreal Carbon Pledge**: 117 organisations representing over US$100 billion in investments have signed as of December, 2015. The pledge is a commitment to measure and publicly disclose the carbon footprint of investment portfolios on an annual basis. Signatories include HESTA, VicSuper and the AXA Group.

[15] United States, 2007 (Energy Independence and Security Act of 2007)
[16] India, 2011 (Strategy Roadmap for Net Zero Energy Buildings in India)
[17] ACT Government, 2011, p17
[18] City of Sydney, 2015
[19] City of Melbourne, 2014, p4

- **Global Investor Statement on Climate Change:** Signed by over 400 investors with more than $24 trillion in assets. The Statement sets out steps that institutional investors, both asset owners and asset managers, can take to address climate change, and calls on governments to support a new global agreement on climate change by 2015.
- **G20 Energy Efficiency Investor Statement:** Signed and endorsed by 39 investors managing close to US 4 trillion, including California State Teachers Retirement System, Cbus Super and Calvert Investment. Signatories recognise the need to fully embed energy efficiency into their investment process.

2. THE BUILT ENVIRONMENT SECTOR AND EMISSIONS

Summary of key points

- Buildings account for nearly one quarter of Australia's emissions, divided almost equally between residential and non-residential buildings
- Without further actions, emissions from buildings are expected to reduce by 2 per cent by 2030, and 7 per cent to 2050, taking into account business-as-usual improvements in energy efficiency and distributed energy
- Emissions can be reduced through energy efficiency, switching from gas and other fossil fuels to electricity, and zero emissions electricity. Residual emissions can be offset, resulting in zero carbon buildings.

The built environment sector is comprised of commercial and residential buildings. Residential buildings include detached houses, attached dwellings and buildings containing two or more sole occupancy units. Commercial buildings house a range of activities, including offices, retail, cafes/restaurants, warehousing, education, accommodation, health services and a range of other uses.[20]

The key decision makers within the built environment are developers, building owners, building managers and tenants, all of whom are highly diverse and differ across different asset classes. A range of other stakeholders are involved in decisions relating to development, design, construction, operation and maintenance of buildings including financial institutions, developers, architects, engineers, builders, tradespeople, product suppliers, facility managers, valuers and building surveyors.

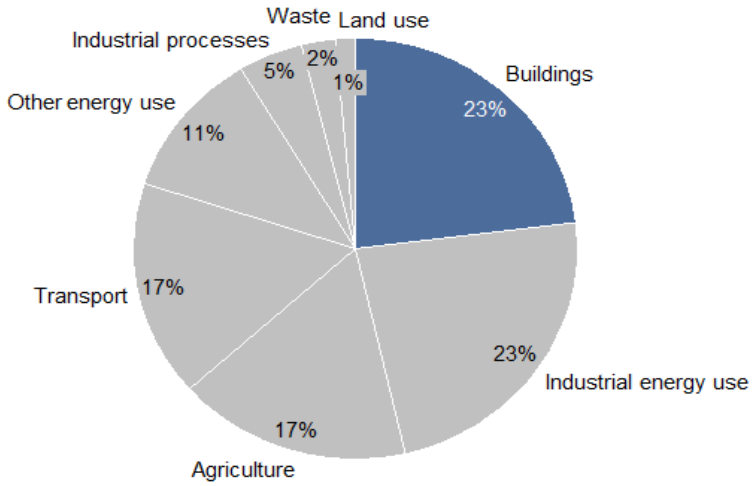
2.1. Emissions profile

Buildings account for almost one quarter of Australia's emissions, divided almost equally between residential and non-residential buildings

In 2013, total emissions from the commercial and residential building sub-sectors accounted for 127 $MtCO_2e$, or nearly one quarter of Australia's national emissions[21]. Grid-supplied electricity consumption by buildings was responsible for 86 per cent of the sector's emissions, and the remainder came from direct fuel combustion such as gas or wood for heating, hot water systems and cooking.

[20] ASBEC, 2008, p7.
[21] Department of Industry, Innovation and Science, 2013

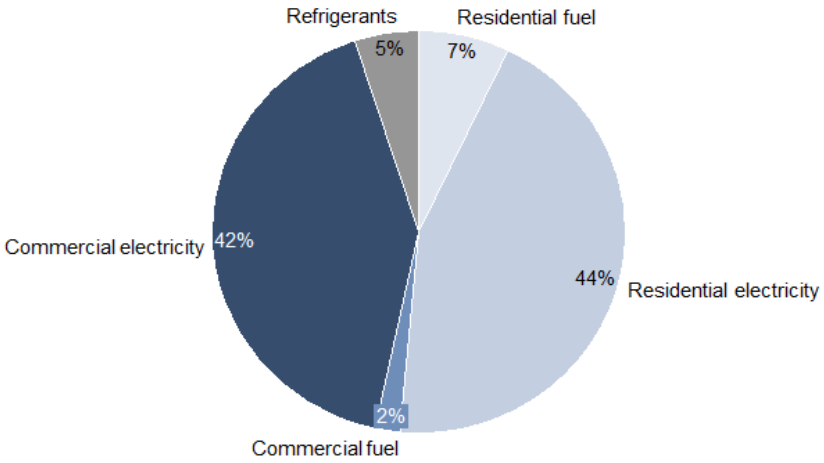
Figure 7: Breakdown of Australian emissions and sector coverage in 2013 (% of total emissions, $MtCO_2e$)



Source: ClimateWorks Team Analysis based on Department of Industry, Innovation and Science, 2013 and Energy Supply Association of Australia, 2015

In 2013, energy use from residential buildings were responsible for slightly more than half (51 per cent) of total emissions in the buildings sector. The majority (86 per cent) of residential emissions result from the consumption of grid-supplied electricity, with the remainder coming from on-site combustion of fuels such as gas or wood for heating, hot water systems and cooking. Commercial buildings contribute the remainder of the sector's emissions, with more than 95 per cent coming from consumption of grid-supplied electricity. A small share (around 5 per cent) of buildings emissions come from leakage of refrigerant gases from air-conditioners and fridges.

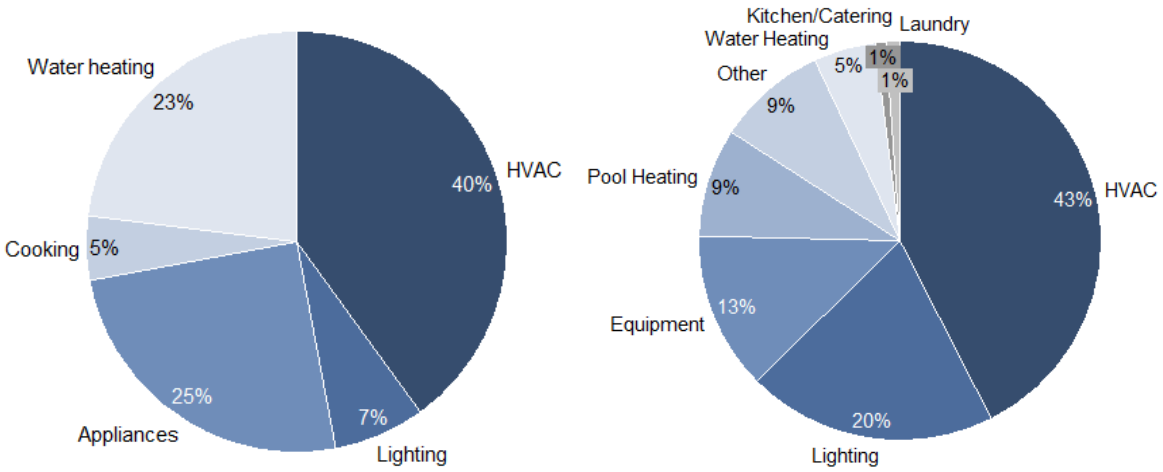
Figure 8: Breakdown of building emissions by building type 2013 (% of total emissions $MtCO_2e$, 2013)



Source: ClimateWorks Team Analysis

Commercial and residential buildings have different energy use profiles. Most energy in commercial buildings is consumed by heating and cooling and lighting systems, although energy use is highly variable across the sector depending on the specific building use. In residential buildings the main energy uses are space conditioning (particularly heating), water heating and appliances and equipment. As numbers of in-home appliances and equipment proliferate, it is expected that the share of household energy consumption associated with appliances and equipment could increase, particularly if standby power consumption is not dramatically improved.

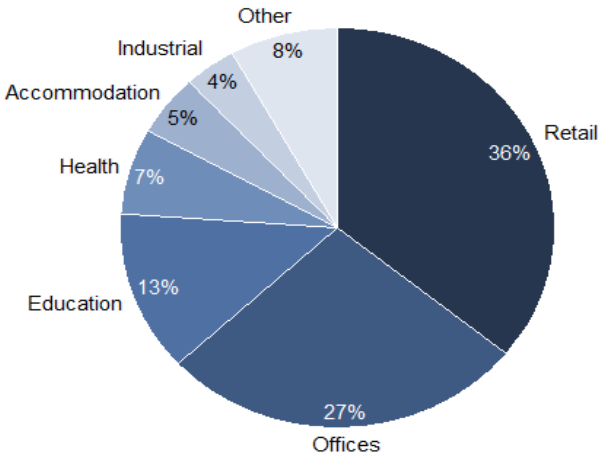
Figure 9: Breakdown of residential (left) and commercial (right) energy by end use (% of total energy consumption)



Source: Energy Consult, 2015; Pitt&Sherry, 2012

Within the existing commercial building stock, the retail sub-sector accounted for approximately 36 per cent of energy consumed in 2012. Stand-alone office buildings were the next highest energy user, consuming approximately 26 per cent of commercial energy use, with education contributing 13 per cent and health facilities consuming 7 per cent.

Figure 10: Breakdown of commercial building energy use by building type, 2012 (% of total energy consumption, PJ)

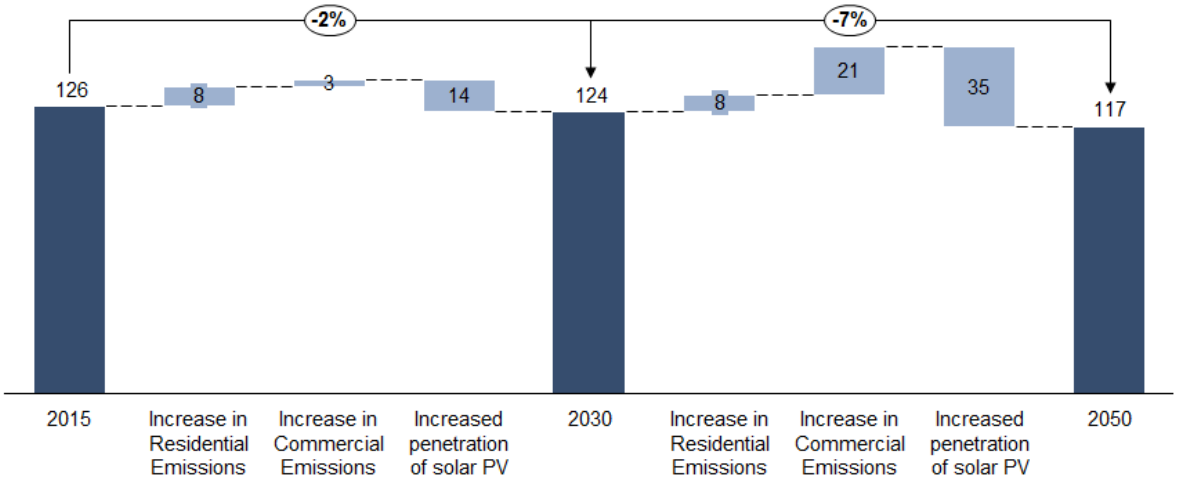


Source: ClimateWorks Team Analysis based on Pitt&Sherry, 2012

Without further actions, total emissions from buildings are expected to remain relatively stable over the period to 2050, with increased emissions from energy consumption offset by substantial ongoing uptake of distributed solar PV

This change in emissions is a result of increased energy use in buildings that is offset by a greater uptake of distributed solar PV. The increased energy use results as the housing and commercial buildings stock increases and is offset by business-as-usual (BAU) improvement in energy efficiency resulting from current policies such as improved building standards, and incremental improvements in technology. Overall, emissions are projected to remain relatively constant over this period without further actions.

Figure 11: Emissions projections without further action ($MtCO_2e$)



Source: ClimateWorks Team Analysis

2.2. How can emissions in buildings be reduced?

Emissions from buildings can be reduced through a combination of on-site and off-site measures, including energy efficiency, switching to electricity, low carbon electricity and offsets

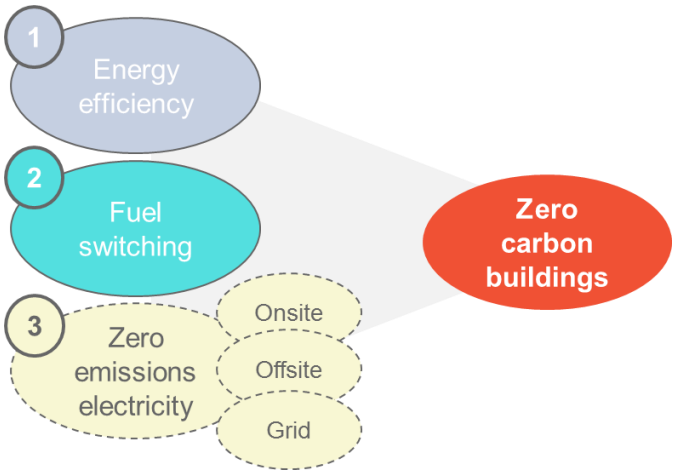
The technologies exist today to reduce emissions from buildings to zero. These can be grouped into four actions:

1. **Energy efficiency:** Improvements in the efficiency of energy-consuming appliances and equipment, and improvements to the thermal efficiency of the 'shell' or 'envelope' of the building. The most significant opportunity to improve energy efficiency is during design, construction and fitout of new buildings, and at the point of replacement of existing appliances, equipment and refurbishment of existing buildings
2. **Fuel switching:** Switching appliances and equipment that use gas, wood or other fuels to electric alternatives. These are mostly made up of heating and cooking appliances and equipment, which can be switched to electric reverse-cycle air conditioners and induction cooktops.
3. **Zero carbon electricity:** Deployment of on-site distributed energy systems such as solar PV, or procurement of off-site low carbon electricity through a power purchase agreement. Emissions from electricity consumption in buildings can also be reduced through decarbonisation of the electricity grid.

In the short- to medium- term, high quality offsets can be used to address residual emissions. Ambitious owners and developers can use offsets to deliver zero net emissions buildings in the coming years. However, it is important to ensure the priority for reducing emissions from buildings is through building envelope, appliances and equipment improvements, rather than offsets, to avoid locking in higher than necessary energy consumption and an ongoing need to purchase offsets into the future. In addition, offsets will be needed to balance emissions from activities and processes in other sectors that can't be decarbonised as easily as buildings, such as non-energy emissions from steel and cement manufacture. By mid-century it is expected that the cost of reducing residual emissions will be high and the availability of offsets constrained[22].

[22] ClimateWorks, 2014

Figure 12: Actions to achieve zero emission buildings



The modelling undertaken for this report focuses on fuel switching and energy efficiency opportunities, including:

- **Heating and cooling** improvements through:
  - Improved building **'envelope'** including better design, glazing, insulation and weatherproofing to reduce air and heat/cool leakage and reduce the need for mechanical heating and cooling;
  - Installation of more efficient heating and cooling **equipment** (air conditioners and heaters), including equipment that uses more efficient and lower global warming potential refrigerant gases, and better maintenance of this equipment;
- **Hot water** improvements, through replacement of electric resistance hot water heaters with heat pumps and efficient instantaneous heaters;
- **Elevators, commercial equipment and small appliance** improvements through purchase of high efficiency models at point of replacement;
- **Lighting** improvements through switching from halogen to CFL and LED lighting.

Analysis of distributed energy opportunities is based on recent third party modelling and projections.

3. ACHIEVEMENTS OVER THE LAST DECADE

Summary of key points

- Improvements in buildings energy performance over the past decade have decoupled energy consumption from growth, and saved over 186 MtCO2e and $28 billion (gross) in avoided energy bills
- The large office sector has achieved a step change in energy performance, with strong drivers including reporting programs which have enabled government and large corporate tenants to demand high performing office space
- Increasing interest from large investors in the energy performance of their property investments has begun to drive activity more broadly amongst market leading property companies - large Australian property companies are now recognised in international benchmarks as global leaders in energy and sustainability
- Broader improvements have been driven by government programs and regulations, including improved minimum energy performance standards for buildings, appliances and equipment
- However, progress has been slow outside the market leaders, with overall energy intensity improving by only 2 per cent across the commercial sector and 5 per cent in residential
- Deployment of distributed solar PV has been rapid, with more than 5,000MW of distributed solar capacity installed, equivalent to more than 2,600 single wind turbines

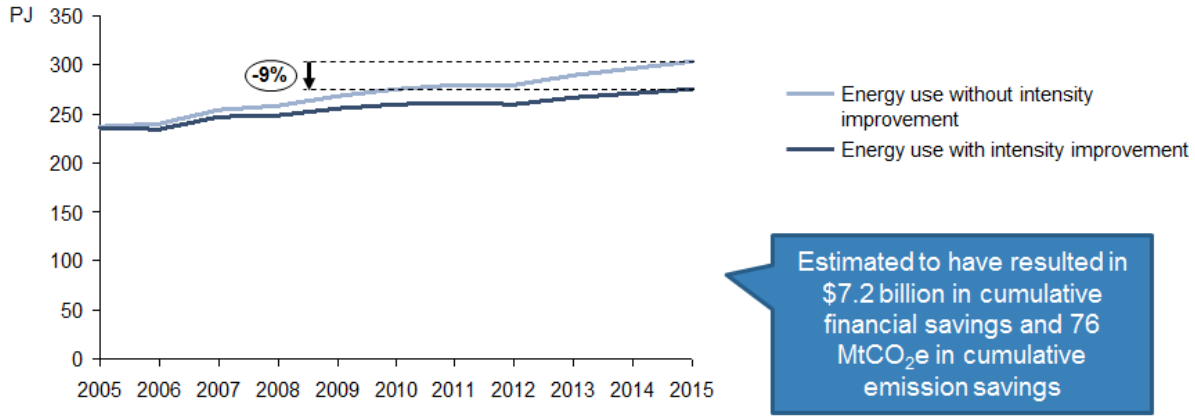
3.1. Energy efficiency achievements

Improvements in buildings energy performance over the past decade have decoupled energy consumption from growth, and have saved over 186 MtCO2e of cumulative emissions since 2005, and over $28 billion (gross) in avoided energy bills over this period

Despite an uncertain policy environment, there have been substantial improvements in the energy performance of buildings over the past decade.

Figures 13 and 14 below show the 'intensity effect'[23] over the past decade, based on analysis by the Federal Government Office of the Chief Economist[24]. The upper lines in each chart indicate how much energy would have been consumed by residential and non-residential buildings with growth in number of households and non-residential floor space if no energy efficiency improvements had been undertaken. The lower lines show actual energy consumed. The chart indicates that energy efficiency improvements have delivered a 15 per cent reduction in energy use across residential buildings compared to what would have been used if no efficiency improvement had been achieved, and 9 per cent across non-residential buildings, a total of more than 100 PJ in energy savings across all buildings, equivalent to 8 per cent of total annual energy demand in 2014. This improvement also resulted in avoided emissions of 186 $MtCO_2e$ of greenhouse gases since 2005.

Figure 13: Savings from energy intensity* improvements - commercial (PJ)

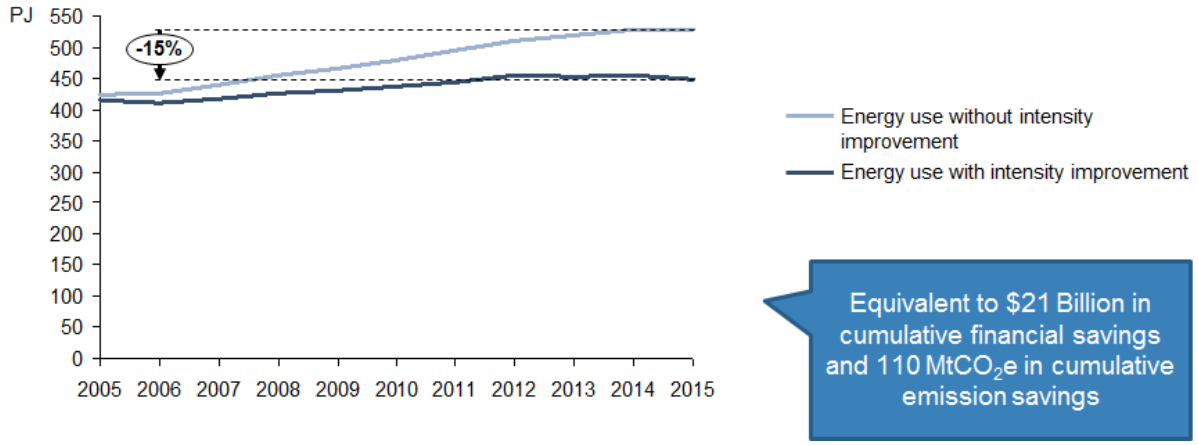


Source: ClimateWorks Team Analysis based on Office of the Chief Economist, 2015a

[23] The 'intensity effect' is attributable to energy efficiency and productivity improvements. OCE analyses three factors that contribute to a change in energy use: (1) the activity effect, which reflects the increase in floorspace driven by growth in the economy and population (2) the structural effect, which reflects changes in energy intensity resulting from changes in the activity mix, for example a shift towards lower intensity services (3) the intensity effect, which reflects improvements in energy efficiency and productivity.

[24] Office of the Chief Economist, 2015a.

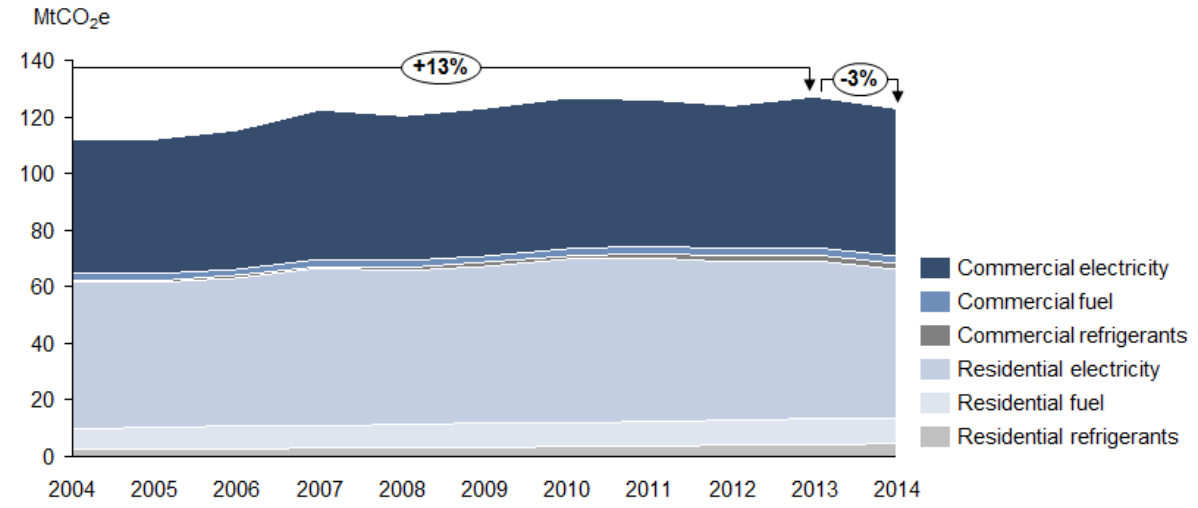
Figure 14: Savings from energy intensity* improvements - residential (PJ)



Source: ClimateWorks Team Analysis based on Office of the Chief Economist, 2015a

Historically, emissions from the built environment grew in line with growth in population and economic activity, but this trend has slowed over the last decade and now appears to have reversed. In 2015, emissions from buildings fell 3 per cent from a peak in 2013-14 due to a decline in emissions from electricity (emissions from refrigerant gases and other fuels continued to grow), a result which can be explained in part by improved energy efficiency, as discussed below.

Figure 15: Annual emissions over the past decade ($MtCO_2e$)



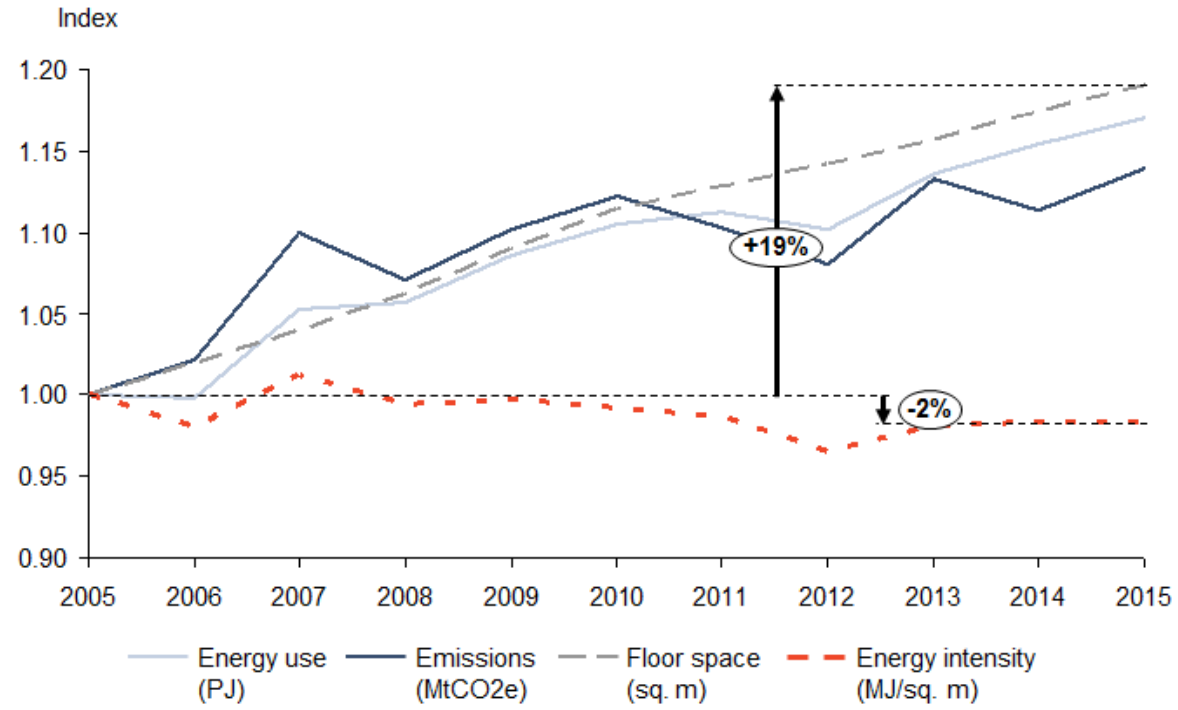
Source: ClimateWorks Team Analysis

Despite these improvements, overall energy intensity across the sector has only slightly improved, indicating that the achievements of market leaders have not yet spread to the majority of buildings

Figures 16 and 17 show that emissions and growth in buildings have begun to decouple. Over the past decade, the 'energy intensity' of buildings has declined, even as total sector energy consumption has grown with increases in commercial floorspace and numbers of houses.

However, improvements across the sector have been only moderate. In commercial buildings, energy intensity improved by 2 per cent, most of which can be explained by improved minimum energy performance standards for buildings, appliances and equipment, government programs and a step-change in the energy performance of market leaders, particularly in large offices (see ClimateWorks' *Tracking Progress* report[25] and 'drivers' section below).

Figure 16: Commercial sector energy growth indices ($MtCO_2e$, PJ, $)

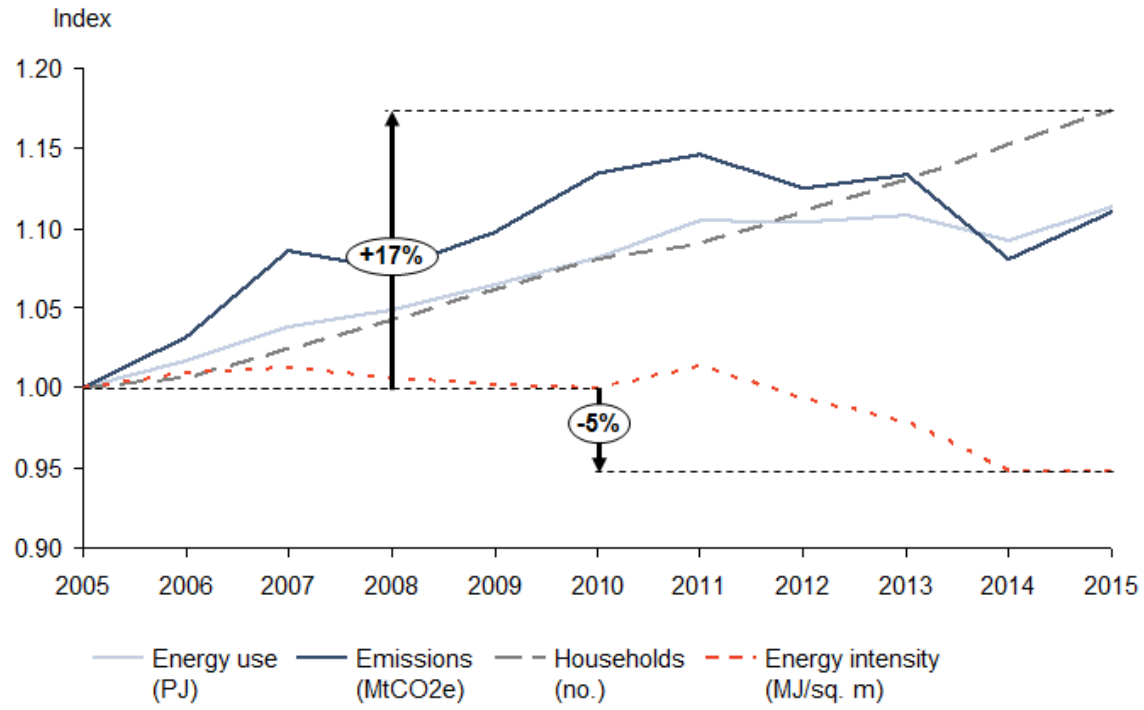


Source: ClimateWorks Team Analysis

[25] ClimateWorks, 2013.

An improvement in energy intensity of five per cent has been observed in residential buildings, particularly during the last two years. This can largely be explained by improvements in minimum energy performance standards for residential buildings, appliances and equipment (see 'drivers' section below), which have led to a drop in particular in energy used for space conditioning, lighting, appliances, equipment and water heating[26].

Figure 17: Residential sector energy growth indices ($MtCO_2e$, PJ, $)



Source: ClimateWorks Team Analysis

These energy efficiency improvements are estimated to have reduced energy bills over the past decade by more than $28 billion gross[27], made up of $21 billion for households and $7.2 billion for businesses (both tenants and building owners) for the period 2005 to 2015.

The full economic impact of investments in energy efficiency and distributed energy over the past decade is likely to be substantially higher as a result of re-investment of energy savings back into the economy, new economic opportunities resulting from improved energy productivity, or innovation resulting from the additional focus on energy (see, for example, Buildings Alive case study in Section 3.1.1).

[26] Energy Consult, 2015, p 25.
[27] Estimating capital costs of these improvements is not possible due to lack of available data.

3.1.1. Drivers of recent energy efficiency achievements

Over the past decade, market leaders particularly the owners of large office portfolios have achieved a step change in energy performance, while broader improvements have been driven by government programs

Despite an uncertain policy environment, substantial improvements in energy efficiency have been achieved over the past decade, particularly in market leading offices. This has been driven in large part by industry-led initiatives such as the creation of the Green Building Council of Australia. Government policies have also delivered improvements across the sector more broadly. Drivers of energy efficiency activity in buildings were the subject of detailed analysis by ClimateWorks in the 2013 report Tracking Progress - Buildings[28], and the findings from that report are summarised and updated below.

New commercial buildings

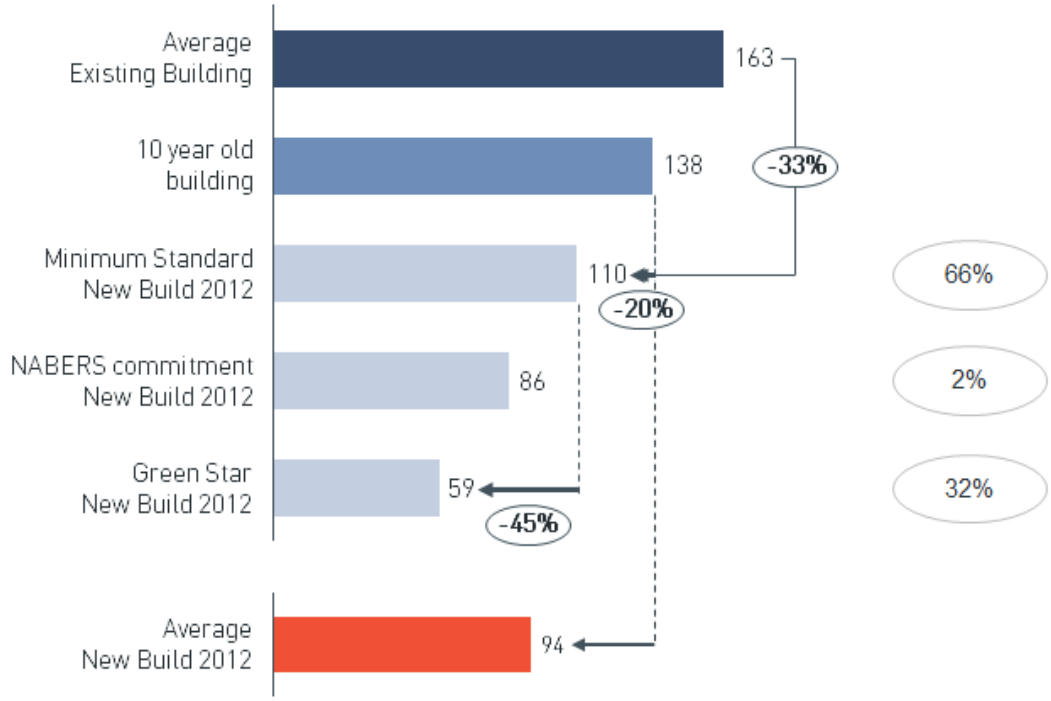
The past decade has seen strong improvements in the energy performance of new office 'base building' energy use, and some improvements in remaining building types due to increased standards. This improvement has particularly been driven by:

- Demand by large corporate tenants and government departments for high performing office space, leading to competition amongst building owners to attract these tenants and supported by the development of effective environmental performance rating programs including Green Star and NABERS, along with mandatory disclosure of energy performance via the Commercial Building Disclosure (CBD) program;
- Demand from investors for high performing assets, supported by investor indices such as the Global Real Estate Sustainability Benchmark (GRESB) and the Dow Jones Sustainability Index;
- Strengthening of minimum energy performance standards for new buildings, appliances and equipment;
- Improvements in skills in building design, construction and management, and technological improvements.

The most striking improvements have been made in the large office market, driven by growing demand from government and large corporates for more sustainable, efficient and productive workplaces. This is illustrated by increased numbers of new buildings with Green Star ratings and NABERS commitments, which significantly out-perform existing buildings and new buildings built to mandatory minimum standards.

[28] ClimateWorks, 2013.

Figure 18: Comparison of emissions intensity factors for offices, kgCO2e/m2[29] (% breakdown of offices built in 2012)

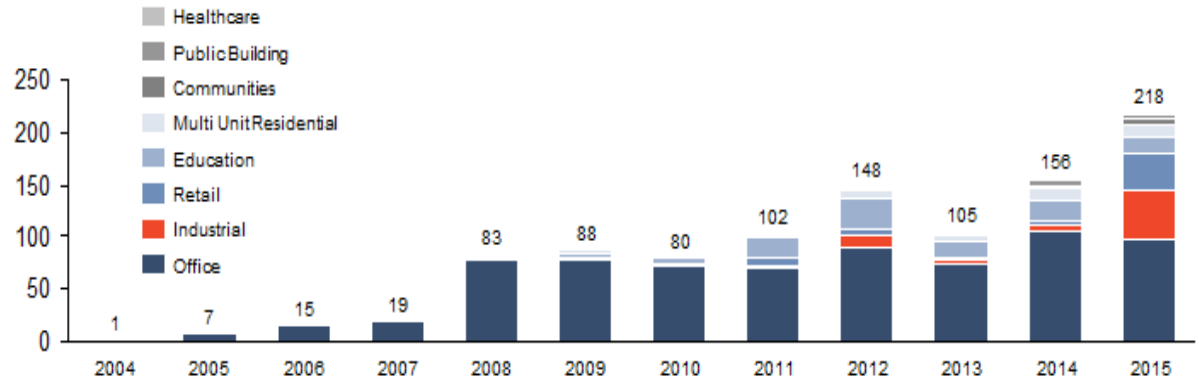


Source: ClimateWorks, 2013

While most of the observed activity has been in offices, other sectors such as education, retail and industrial have also begun to accelerate. Figure 18 illustrates numbers of Green Star rated buildings over time, showing that the new building ratings ('design, as built') have traditionally been dominated by offices, but in recent years other building types have begun to seek ratings, in particular industrial and retail assets. Industry stakeholders suggest that this increase in activity is a result of increased investor demand for improved energy performance and reporting, and a result of the availability of Green Star - Performance ratings.

[29] ClimateWorks, 2013

Figure 19: Green Star certified projects by building type (#)



Source: Green Building Council of Australia analysis

As a result of this activity, Australian property portfolios have been recognised internationally as exceptionally high performing and attractive investments. A number of Australia's major property portfolios are represented on the Dow Jones Sustainability Index, including Dexus, GPT, Lendlease, Mirvac, and Stockland, with Stockland winning the 2015 title of world's most sustainable real estate company in the 2015 Dow Jones Sustainability Index, won in the previous year by GPT Group[30].

[30] RobecoSAM, 2015

Table 1: Financial performance and sustainability achievements of Australia's leading property companies (2015)

Mirvac[31]
$15 billion of assets under management (AUM), 36% increase stat profit 4% increase operating profit, 94% occupancy in Investment portfolio. Settled ~2,300 residential lots.
Carbon intensity 33% below 2009, energy bill reduction of $29 million since 2009. 5.1 star NABERS Energy average for Office portfolio. 80KW solar installed.
Stockland[32]
Over $15 billion of real estate assets. Owns, manages and develops a range of properties including shopping centres, office assets, residential communities and retirement villages.
World's most sustainable real estate company - World Dow Jones Sustainability Index. GRESB Regional Leader for Diversified Real Estate. Issued Australia's first corporate green bonds.
GPT[33]
$18.7 billion in AUM, 34% increase in net profit after tax, 96% occupancy of office assets.
39% reduction in energy intensity and 59% in emissions intensity since 2005, placed 1st or 2nd in DJSI for Global Real Estate for past 7 years. Certified Carbon Neutral (CCN).
Investa[34]
55% reduction in emissions intensity since 2004, only Asia Pacific property organisation to commit to setting an emissions reduction Science Based Target, certified for Sustainable Responsible Investment by RIAA
Dexus[35]
Portfolio over $19 billion, 52% increase in net profit, 22% increase in Funds From Operations.
GRESB: DEXUS Office Trust ranked 1st Listed office Oceania, CCN since 2011.
Lendlease[36]
$11.4 billion in AUM, $619 million in profit after tax.
On the DJSI for Global Real Estate 2001 to 2014. Aims to achieve 20% reduction in emissions intensity and energy intensity of operations by 2020.
AMP Capital
$180 billion in Funds Under Management, which includes $20.753 billion in property assets.
38% reduction in absolute CO_2e emissions FY09-14, average office NABERS Energy rating of 4.1 Stars.

[31] Mirvac, 2015 a; Mirvac, 2015 b
[32] Stockland, 2015 b
[33] GPT, 2015 a; GPT, 2015 b
[34] Data from Investa.
[35] Dexus, 2015
[36] Lendlease, 2015 a; Lendlease, 2015 b

Figure 18 from the 2015 GRESB clearly illustrates the impact of these energy and other sustainability-related achievements, with Australian property portfolios on average ranked far ahead of the main overseas markets on sustainability performance.

Figure 20: 2015 GRESB results

Existing commercial buildings

While less progressed than new commercial buildings, there have also been improvements in the retrofit market, mostly amongst market leaders and government assets but also more broadly across the market, driven by government programs such as state Energy Efficiency Obligation Schemes and improved standards for appliances and equipment. Much of this improvement has been facilitated by the development of robust environmental performance rating tools, in particular Green Star and NABERS.

With the introduction of Green Star Performance, the number of non-office buildings obtaining ratings has jumped. It is understood this is being driven in particular by increased investor demands for better performing assets (see Figure 20 above).

In addition to capital upgrades, building owners have achieved substantial energy savings through better energy management, in part driven by improvements to the collection of energy data and new approaches to analysing that data and delivering it to building managers in a useful form (see case study on the following page).

Energy innovation

Australian energy data start up goes global

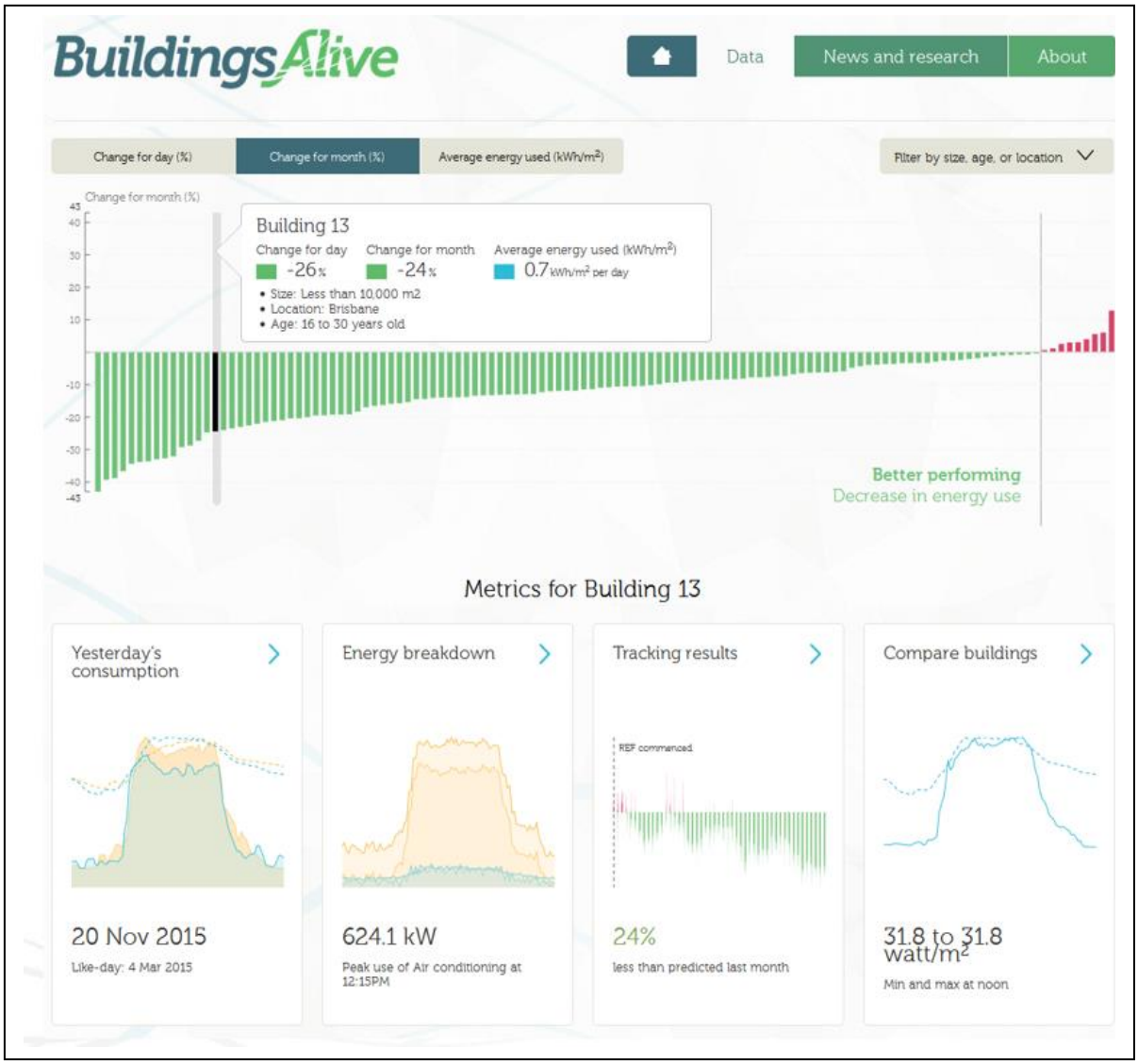
Buildings Alive specialises in helping building owners, operators and technicians enhance the performance of their buildings. Buildings Alive provides services to almost 200 large office buildings, shopping centres, academic buildings, laboratories and other complex buildings spanning over 3.3 million square metres in Australia and the United States.

Buildings Alive has developed Rapid Efficiency Feedback (REF), sending automated daily email messages to building owners, operators and technicians with actionable energy performance information. On average, buildings receiving their services for more than six months have cut energy use by more than 15 per cent - the majority were already regarded as highly efficient and 'optimised' prior to the commencement of their service, showing that most buildings can perform much better than generally believed.

Buildings Alive grew out of a program initially developed by Investa Office to improve the energy performance of its assets, driven in part by the CBD program which required large office owners to disclose the building's NABERS rating at the point of sale or lease. The company received a grant from Commercialisation Australia – a competition-based funding organisation for innovation and start-up enterprises which was abolished in 2014.

Buildings Alive started in Sydney and now has offices in California servicing North America, and France servicing the EU. In the northern hemisphere they are concentrating on relationships with major institutions that have a transatlantic focus. The team has deep technical expertise across all domains relevant to the assessment, fine-tuning, prediction and communication of building performance. Their team has wide-ranging international experience and high level qualifications in mathematics, physics, statistics, mechanical and building services engineering, finance and economics, electrical and control systems engineering and software development.

Buildings Alive's benchmarking and research portal, enabling dynamic evaluation of a building's performance relative to others (next page)



New residential buildings

New buildings have achieved a step-change through improved minimum energy performance standards for homes in the National Construction Code and for appliances and equipment, although there are strong concerns about under-compliance. Further, improvements in the energy efficiency of appliances and equipment has been offset to a degree, by an increase in the numbers of appliances and equipment.

Many projects now demonstrate how very high performing homes can be achieved at low cost, and a number of zero net emissions homes have been built using a combination of improved design, high-efficiency appliances and equipment and on-site energy production.

Existing residential buildings

In the existing residential sector, improvements have been driven primarily by improved appliance standards, as well as Energy Efficiency Obligation Schemes in a number of states, and incentives and rebates for installation of efficient products, appliances and equipment.

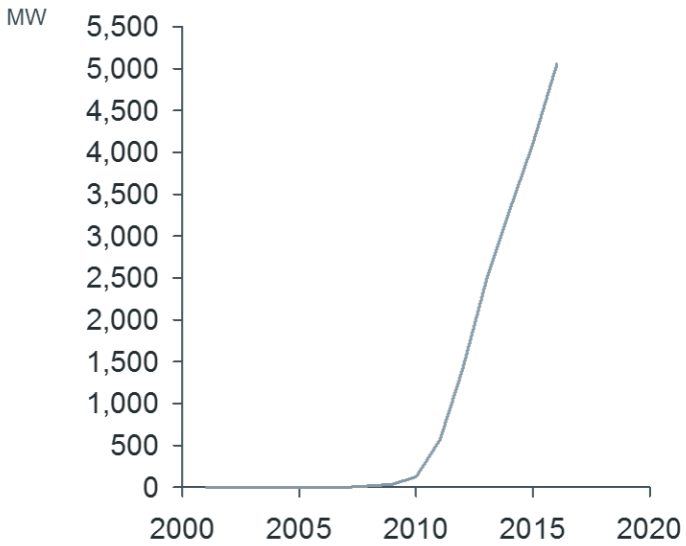
While deep retrofitting of homes is not yet mainstream, a number of demonstration projects are showing how effective and affordable such retrofits could be if impediments can be overcome.

3.2. Deployment of distributed energy

Australia has the largest number of installed household solar systems in the world, with medium-scale commercial systems beginning to accelerate and battery storage on the verge of commercialisation

Distributed solar has experienced exponential growth across Australia, driven initially by generous incentives provided by government and by rapid reductions in the cost of solar PV technology. Even with the removal of feed-in tariffs for small-scale solar PV, deployment has continued at a rapid rate, and Australia now has around 5,000MW of distributed solar capacity installed, equivalent to more than 1,600 single wind turbines[37]. As of 2014 (Figure 22 below), Australia had over 1.1 million solar systems installed, but this number is now reported to be much higher (over 1.5 million systems)[38].

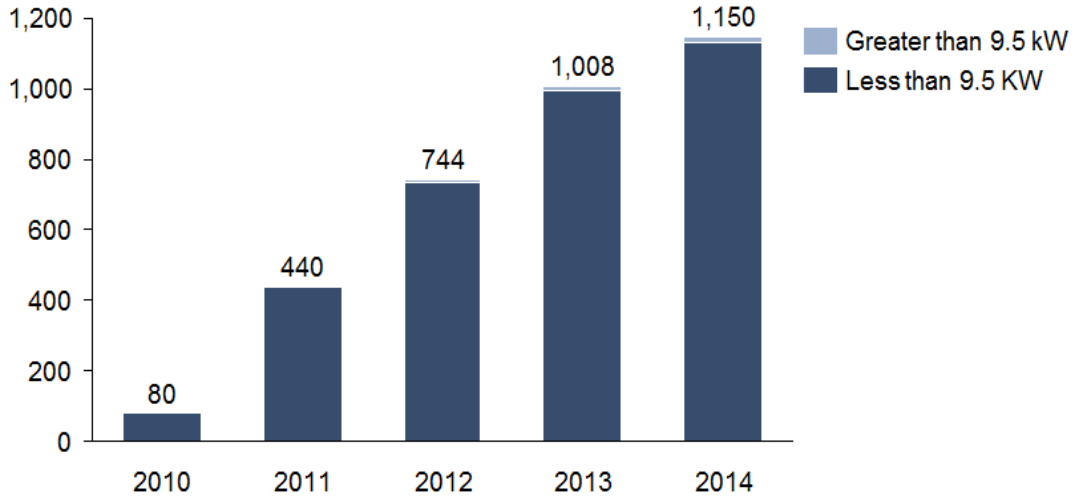
Figure 21: Cumulative installed capacity of solar PV (MW)



Source: Australian PV Institute, 2016

[37] Based on 2.5MW capacity single turbines.
[38] See http://reneweconomy.com.au/2016/australian-solar-industry-celebrates-the-new-year-by-ticking-over-1-5m-pv-systems-86022.

Figure 22: Cumulative number of solar PV installations by system capacity (# ,000s)



Source: Australian PV Institute, 2016

Commercial solar has experienced a slower start, but has also seen rapid growth over the past five years, in particular through the development of new business models.

Cogeneration and trigeneration are proven technologies that have been effective in the past, and could still deliver emissions reductions in the short- to medium-term, especially for assets where it is more difficult to switch to electricity (e.g. some applications in hospitals). In these examples, cogeneration and trigeneration can be a good option for optimisation of gas use.

However, in order to be compatible with an eventual transition to net zero emissions, gas assets would need to be replaced with zero carbon energy sources before 2050, either through electrification or switch to biogas. In later decades, deployment of gas-fired assets therefore also represents a risk of lock-in. In addition, the uptake of cogeneration and trigeneration has been slow compared to the uptake of solar PV, with only an estimated 245MW of installed cogeneration and trigeneration installed as of 2013[39]. This is largely due to ongoing increases in natural gas prices and increasing cost-competitiveness of solar.[40] This report has therefore focused on solar PV.

3.3. Case studies of high performance buildings

Across all building types, there are now examples of both new and existing buildings which have achieved very high energy performance and very low or 'positive' emissions. This demonstrates that the technologies and capabilities exist within the Australian property sector to broaden the achievements to date beyond the market leaders, if the right conditions exist. A number of examples are provided on the following pages.

[39] ClimateWorks 2013.
[40] Clean Energy Council, undated.

Commercial new build

New office

The first zero net emissions office building in Australia

In 2010 Grocon completed the Pixel building, located in Carlton, Melbourne. The building achieved a score of 104 points under the Green Star rating system for building design (75 points is the benchmark for 6 Star Green Star). It gained extra points for innovation, a vacuum toilet system, an anaerobic digestion system and reduced car parking.

Features of the building include high efficiency lighting with daylight control and solar PV and wind turbines, which generate more electricity than is required by the building. A new structural concrete was developed for the building, which has significantly reduced embodied carbon. A large proportion of the building envelope is able to be removed and re-used in order to reduce the future footprint of the building when it is demolished.

For more information visit: www.pixelbuilding.com.au/

First Australian property fund B Corp demonstrates the power of sustainable returns

Impact Investment Group is a leading Australian impact investment funds manager and Australia's first funds manager to obtain B Corporation certification[41]. IIG's vision is to advance a new model of business that intentionally promotes economic, social and environmental prosperity. IIG sources and develops investments that generate social and environmental value throughout the investment's life, as well as delivering strong financial returns for investors.

IIG is already delivering on this goal. In 2015 it increased property assets under management by 64 per cent, launched two new funds and has almost 100 per cent occupancy across its real estate portfolio. The company has recorded impressive sustainability achievements, including:

- Achieving net zero grid electricity consumption for its Byron Bay Quicksilver property by focusing on operational efficiency and sustainable procurement / operation of rooftop solar installation;
- Committing to install a 230 MWh/yr solar system and Tesla storage batteries at its Dream Factory startup hub in Footscray, Melbourne and upgrading the property's energy rating from an estimated zero to 6 Star NABERS rating.
- Committing to become zero net emissions across its portfolio (off-set by wind and solar assets), obtain Green Star - Performance certifications across the portfolio, deploy on-site rooftop solar and green roof/urban farming installations across its portfolio where feasible and invest further in renewable energy[42].

For more information visit: http://www.impact-group.com.au/

[41] 'B Corps' are 'for-profit companies certified by the nonprofit B Lab to meet rigorous standards of social and environmental performance, accountability, and transparency'. See https://www.bcorporation.net/.
[42] Impact Investment Group, unpublished.

New education

160kW solar array produces more power than the building uses

The Sustainable Buildings Research Centre at the University of Wollongong New South Wales is a 6 Star Green Star - Education Certified rated building, which produces 62 per cent fewer greenhouse gas emissions and use 51 per cent less water than the average Australian building. The design and build focused on technological capability and financial viability. Electrical Engineer for the project, Dr Duane Robinson, said "There are a number of systems that don't require a lot of expense, like insulation...for a couple of thousand dollars you can achieve some large savings in your energy bill."

Features include natural ventilation, indoor environmental quality features and extensive monitoring and building control systems for operating efficiency. It is built from locally sourced materials, which contribute to the regional economy. The building is Australia's first candidate for Living Building Challenge certification, known as the built environment's most rigorous performance standard. The building will be reviewed for certification after being in operation for 12 months.

For more information visit: sbrc.uow.edu.au

New education

The greenest public building in Western Australia

The Green Skills Training Centre at Perth's Central Institute of Technology is a 6 Star Green Star - Education certified vocational education and training building. The $17 million centre is used by CIT students studying sustainable building and construction, it aims to show students best practice sustainability measures including the best available technology and construction methodology.

A 50 inch LED TV screen provides continuous data on the building's energy and environmental status. The building operates at net zero energy as the building's solar power is generated both by roof panels mounted on sawtooth roofing, and facade-integrated panels. The system has been designed to have the capacity to generate all the energy needs of the centre, making it feasible for it to operate off-grid. The blackwater recycling plant room can be viewed through windows from inside and outside the building so it can be used as a teaching tool for students. The building includes an ISO 14001 certified steel frame that can be taken apart and reused at the end of the building's life, and timber used is sourced from forest certification schemes or re-used.

Michael Thompson, AECOM senior engineer, buildings applied research and sustainability said "this building demonstrates what's possible from an open-minded approach to environmentally sustainable design."

For more information visit: central.wa.edu.au

New precinct

Australia's first large scale zero net emissions precinct

Barangaroo South is a Lendlease redevelopment of the southern 7.5 hectares of a former container wharf in Sydney's CBD. It will have a mix of uses, with commercial and residential buildings as well as shopping, dining, hospitality and public places.

The precinct will generate more renewable energy on and off site than will be used in the operation of the precinct. Barangaroo is one of only 18 global projects to be part of the C40 Cities-Clinton Climate Initiative's climate positive development program. The precinct is registered for Green Star - Communities rating.

Design features include enough on site solar generation to power all public spaces, a central blackwater treatment plant and off site renewable energy generation. Carbon offsets purchases will offset all energy, waste and commuter carbon emissions, making the precinct zero net emissions in operation. The energy efficient design of new buildings will be made through relevant rating tools including Green Star and NABERS for commercial buildings, BASIX for apartment buildings and Green Star for apartment buildings.

For more information visit: www.barangaroosouth.com.au/

Commercial retrofit

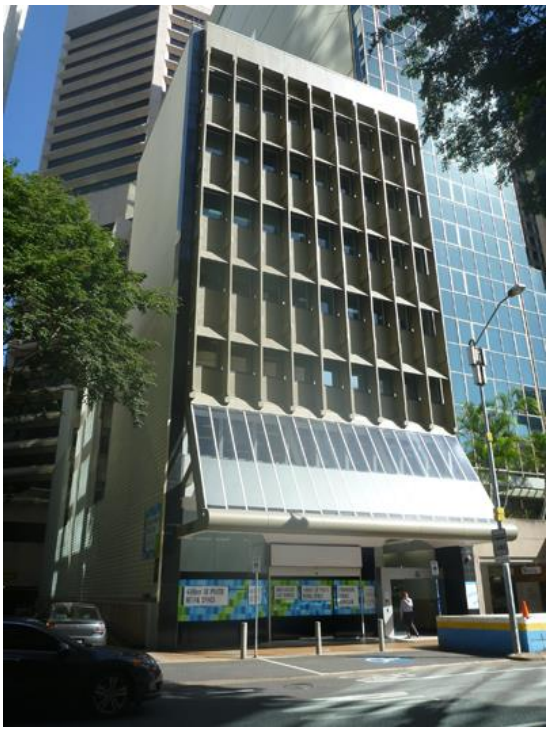
Office retrofit

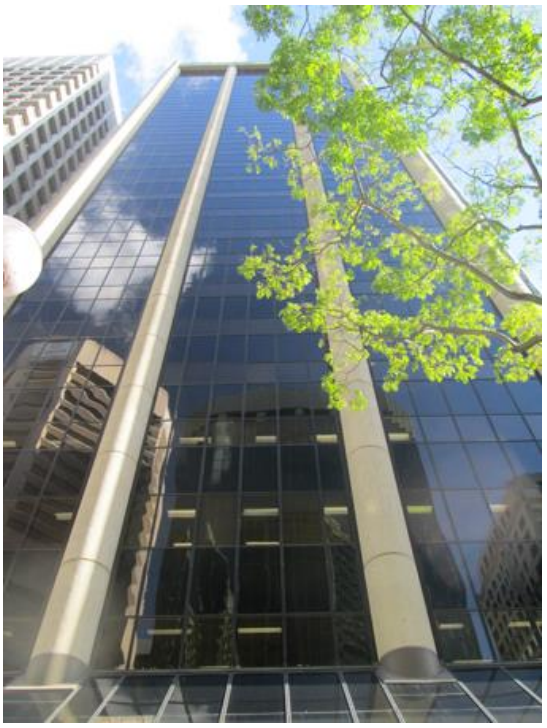
$64,000 annual saving from halving energy use

Norman Disney Young raised the NABERS energy rating of their Brisbane office from 0 in 2010 to 5 stars in 2012. The extensive retrofit cost $980,000 and focused on refurbishment of its mechanical services, building management system, electrics and replacing all existing appliances and equipment to the most energy efficient operation possible. The retrofit occurred while the building was fully tenanted and was only out of operation for one weekend.

The retrofit has reduced annual base building energy consumption by 54 per cent. Annual energy cost savings are approximately $64,000 per annum, the equivalent annual spend of 50 average households. Annual carbon emissions reductions are more than 300,000 tonnes of CO_2 and the upgrade has reduced peak demand on the grid by 33 per cent.

In 2014 Norman Disney Young won the Australian Institute of Refrigeration, Air Conditioning and Heating Award for Best Retrofit or Upgrade.





For more information visit: www.ndy.com/

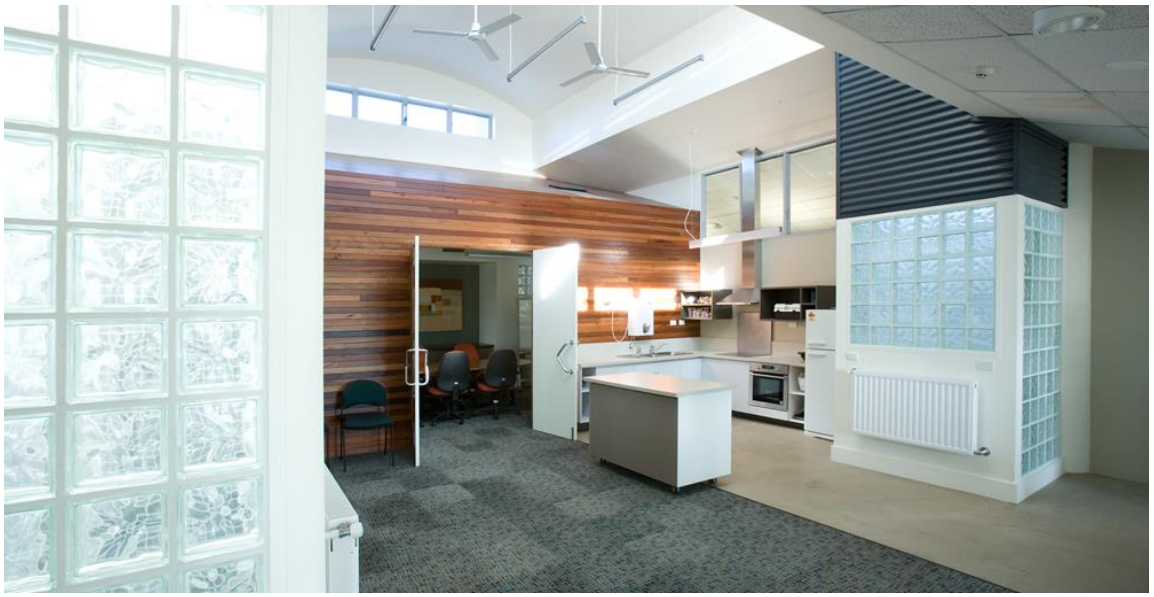
Office retrofit

Over 6 per cent productivity increase, equal to $300,000 per year in salary costs

Australian Ethical Investments used accepted conventional and low-technology design principles to retrofit Trevor Pearcey House in the ACT. Warren Overton who was, at the time, Managing Director of the company that performed stainability services, said “Trevor Pearcey House showed that exemplar environmental performance can be achieved on a conventional budget.” GBCA completed the third party certification.

Energy use has reduced by 52 per cent compared to pre-retrofit, saving approximately $20,000 per year. The bulk of the reduction was achieved through double-glazed windows, which cut heat demand by around eight per cent, lighting upgrades, which has halved lighting energy use, and new insulation, which has reduced the cooling load by 24 per cent.

In 2007, the building rated in the top 11 per cent in Australia for user comfort and satisfaction. An internal survey of staff perceptions found they felt healthier and more comfortable in the building, and have reported a 6.2 per cent increase in productivity. The company estimates this productivity improvement adds up to a benefit of around $1.5 million of extra value over five years. All this resulted in a 6 Star Green Star rating.



For more information visit: www.gbca.org.au/green-star/green-building-case-studies/trevor-pearcey-house/

Office retrofit

Reduction in energy usage has seen annual energy cost saving of almost $233,000 for building tenants

Mirvac and Investa's retrofit of 10-20 Bond Street, Sydney, saw the building achieve a 4 star Green Star rating and a 5 star NABERS Energy rating. Measures such as upgrading the lifts, updating the air conditioning and installing a trigeneration plant, significantly reduced demand for heating and cooling while supplying low-carbon electricity.

Improving energy efficiency and using electricity from low carbon sources reduced base building electricity consumption by 766,117 KWh, resulting in annual energy savings of more than 60 per cent. Paul Edwards, Mirvac's Sustainability Group General Manager said "This fantastic result shows what a difference we can make when we get on with the job of cutting energy use and delivering savings to our tenants."

From financial year 2013 to 2015 there was a 37 per cent reduction in carbon emission intensity, equating to reduced carbon emissions of 1,138 tons CO_2, this was achieved through energy efficiency and cogeneration. This resulted in Mirvac exceeding its company carbon intensity target three years ahead of schedule.

For more information visit: office.mirvac.com/office/10-20-bond-street,-sydney/

Residential new buildings

Lochiel Park Green Village

Lochiel Park is arguably Australia's most environmentally sustainable high performance residential estate. Started in 2005 from a vision to create the nation's model green village, Lochiel Park has been a showcase of environmentally sustainable technologies and practices which has proven the viability of low carbon living.

This living laboratory located in suburban Adelaide, South Australia comprising 100 dwellings has helped create a detailed understanding of low carbon homes and their impact, informing sustainable housing decisions nationally and throughout the world.

Through a detailed monitoring program since the estate's inception, the University of South Australia has documented key social, economic and environmental impacts. The Lochiel Park resident's value improved thermal comfort and wellbeing as well as the associated economic and environmental impacts. Living in a minimum 7.5 star homes with high efficiency appliances, equipment, smart controls and displays and roof top solar electricity and hot water has enabled over 60 per cent reduction in energy consumption and associated greenhouse gas emissions in comparison with the Australian average with substantial cost savings. Associated research has demonstrated a positive economic value proposition and documented the impact and learnings for industry and policy implications.

For more information visit: http://unisa.edu.au/lochiel-park

Zero net emissions home

Living without energy bills

CSIRO initiated the Australian Zero Emission House Project to demonstrate and evaluate how affordable zero net emissions housing could be achieved in Australia. This has resulted in the building of an eight star energy efficiency rated house located 30km North of Melbourne. The building includes off-the shelf building and renewable energy generation technologies, alongside new energy management technologies.

Features include a 6 kW solar panel array and a home energy management system. All living areas face north and the building has air-tight, passive design including extensive insulation and double glazing. These features have reduced energy consumption by 70 per cent compared to an average Australian home.

The building was modelled on Henley Property Group's "Kube" range, from which a six-star house costs $250,000. To upgrade to an 8 Star rating costs an extra $20,000 with an additional cost for solar panels. Following the build, a 24 month test phase was undertaken and a large family moved into the home. Without educating the occupants to optimise occupant behaviour, the house always returned a credit on the electricity bill, resulting in $2,000-3,000 saved per year.

For more information please visit: joshshouse.com.au

Residential retrofit

Zero net emissions home retrofit

Affordable blueprint for retrofitting existing homes

The University of Wollongong and TAFE Illawarra Institute (Team UOW Australia) have developed the Illawarra Flame House to show how a typical Australian 'fibro' home can be retrofitted to become zero net emissions. The project aimed to provide an affordable and achievable blueprint to inspire Australian homeowners and the local and national building industry. It also aims to inspire accelerated development and adoption of advanced building energy technology in new and existing homes.

Features of the Illawarra Flame House include 9.4KW PV system, natural ventilation and extensive insulation. Building material was selected for low embodied energy and local production. A line for non-essential appliances and equipment was added allowing all standby items to be switched off at one point. Prefabricated pods are added to the original building and are cheaply and efficiently manufactured off-site.

The design beat 20 finalists to win the 2013 Solar Decathlon in Datong, China. Students were required to build and operate a house that is advanced, appealing, energy efficient and cost effective. The team finished with score of 957.6 out of a possible 1000 points as well as receiving first place awards in categories such as engineering, architecture and solar application.[43]

For more information please visit: illawarraflame.com.au/house.php

[43] Fitzpatrick, 2013

Distributed solar

Turning shopping centres into power stations

In 2015, Stockland installed one of the largest single rooftop solar PV system in Australia at the Shellharbour Shopping Centre. Stockland set a 1.35 MW renewable energy target for their retail portfolio, equivalent to 321 average residential systems.[44] Between Shellharbour (1.22MW) and three smaller projects, Stockland has reached 1.36 MW of renewable energy and achieved its renewable energy target. This project achieved a 4 Star Green Star - Retail certification.

Before building they completed technical and financial feasibility assessments, which determined that the best return on investment from solar PV is achieved through creating a new business model. The model involves Stockland selling electricity directly to retail businesses in their centre. The success of this model is achieved by selling most of the electricity to retailers in the centre at a reasonable price and avoiding exporting electricity to the grid, which returns a lower price.

The system generates on average 4,789 kWh per day, the equivalent of more than a quarter of the centre's daily base building power requirements. The system will offset 1,700 tonnes of CO_2 annually.

The cost of the system was $2.1 million and payback is estimated to be seven years "While we have installed a number of smaller solar PV systems, and learned from the experience, it is only now that the economics and time is right for us to set a renewable energy target and commit to a range of projects across our portfolio." Daniel Buchanan, the head of Stockland operations for the region.

For more information please visit: shoppingcentres.stockland.com.au

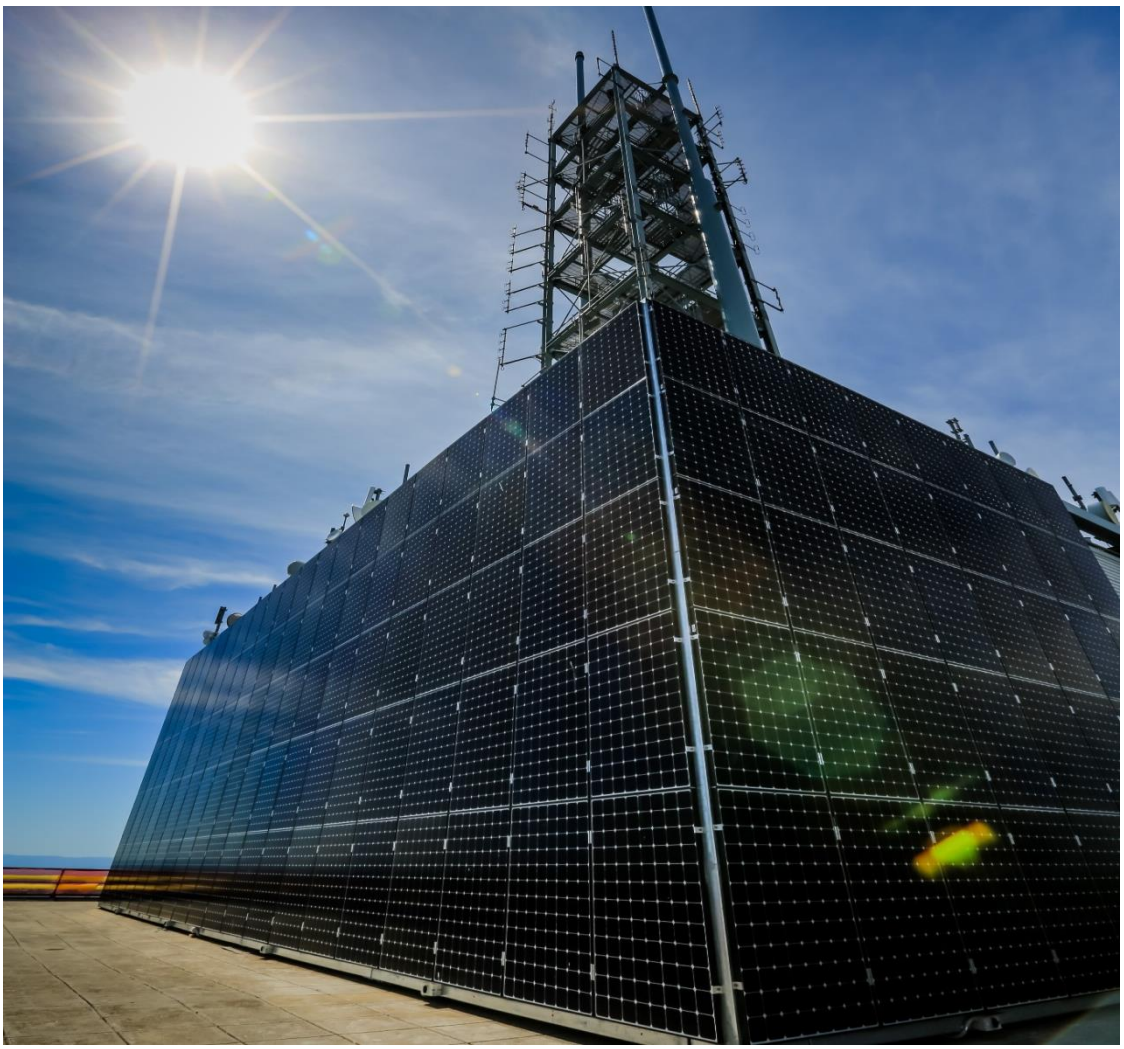
[44] ClimateWorks analysis from 2014 data

101 Collins Street, Melbourne

Panels in the sky

101 Collins owners and management team have a strong focus on sustainability, looking to continually improve on their 4 star NABERS building rating for energy. Following a tenant sustainability survey carried out in 2008 a number of energy efficiency initiatives were undertaken, including extensive energy efficiency lighting upgrades and replacement of the primary heating and cooling chillers.

In 2015, a study into solar PV viability resulted in the installation of a 59.4kW system made up of 180 vertically oriented solar panels, positioned 191 metres above street level. At a cost of $230,000, the system will produce around 47,000 kilowatt hours of energy each year (equal to the annual energy use of about 12 homes), and avoid 59 tonnes of CO_2 annually. Since 2008, base building energy use at 101 Collins Street has reduced 44 per cent. The solar system is expected to produce annual energy savings of $7,000 per annum.



For more information visit: melbourne.vic.gov.au/.../case-study-**101-collins**.doc

4. THE OPPORTUNITY

Summary of key points:

- Opportunities exist to completely decarbonise the built environment sector by 2050 through three key steps: energy efficiency, switching to electric appliances and equipment and generating zero carbon electricity
- Cost-effective energy efficiency opportunities could cut average energy consumption of buildings by more than one quarter by 2030 and over half by 2050
- By 2030, the energy savings associated with these measures and fuel switching could deliver cumulative net financial savings of almost $20 billion to the households, businesses and government entities that invest in them
- Emissions from gas combustion and other fuels in buildings can be largely eliminated through a switch to electric alternatives
- Remaining energy consumption can be met through zero emissions electricity, including distributed solar PV on buildings and decarbonisation of the electricity grid
- These opportunities are not expected to be implemented under current policy settings - further policy support will be required to overcome barriers preventing uptake

This report has assessed the opportunity for buildings to achieve zero net emissions by 2050, the timeframe required for developed countries under the Paris Climate Change Agreement to limit warming to below 2 degrees. This assessment includes:

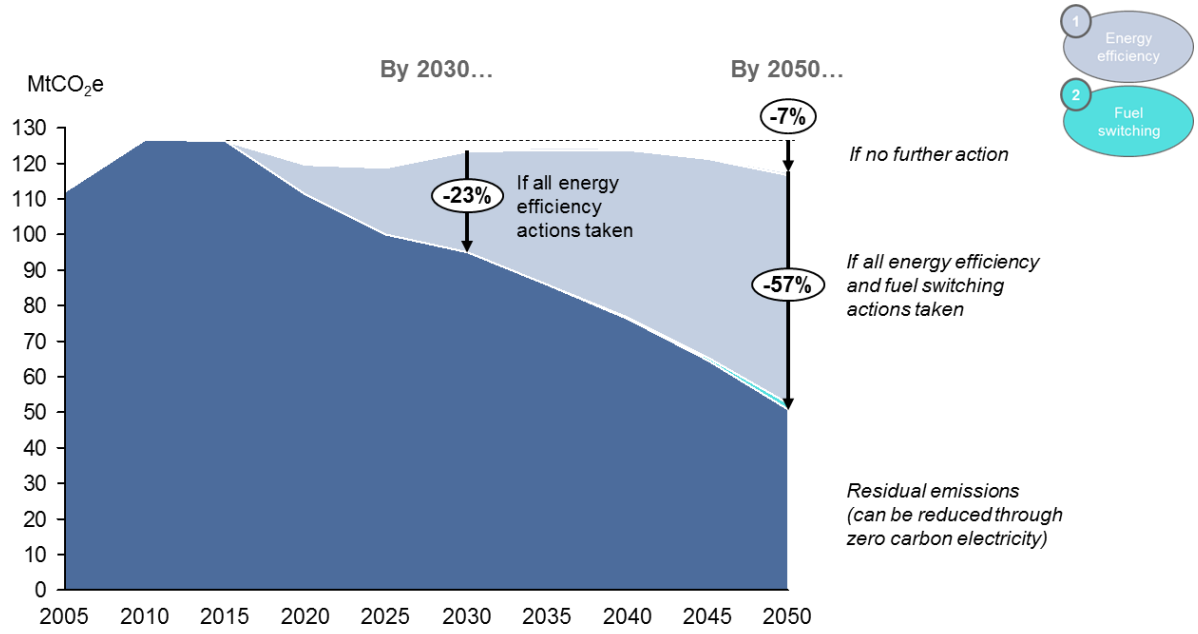
- **Energy efficiency:** Modelling of the potential for energy efficiency across new and existing residential and commercial buildings, through measures that are technologically proven, commercially available and provide a positive return on investment
- **Fuel switching:** Modelling of the potential for buildings to use electric alternatives to gas and other non-electric appliances and equipment
- **Decarbonised electricity supply:** Analysis of the potential for distributed energy and grid decarbonisation, drawing on recent third party research

This report finds that opportunities exist to completely decarbonise the built environment sector by 2050 through these three steps.

Emissions from buildings are projected to reduce by 7 per cent to 2050 under current policy settings. This ‘business-as-usual’ scenario includes substantial emission reductions expected under current policy settings from both energy efficiency and distributed energy, which would not be guaranteed if existing policies were wound back.

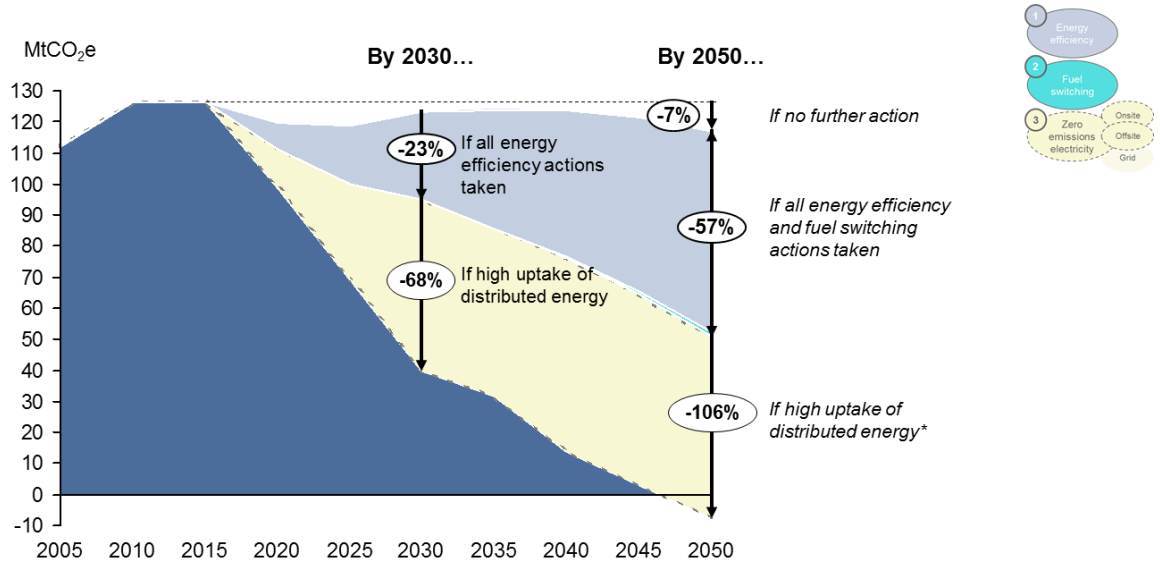
Identified energy efficiency opportunities above business-as-usual could cut projected emissions from buildings by 23 per cent by 2030 and 55 per cent by 2050, even without technological breakthroughs. This is equivalent to around 64 $MtCO_2e$ of avoided emissions in 2050. It includes emissions reductions achieved through switching to more efficient air conditioning and refrigeration appliances and equipment which also use refrigerant gases with lower global warming potential (see breakout box below). Fuel switching away from gas and other fuels to electricity could save approximately a further 2 $MtCO_2e$, and is important to enable decarbonisation of the sector by 2050. Both of these opportunities have been modelled as part of this analysis, and the results are presented in Figure 23 below.

Figure 23: Built environment emissions and energy efficiency and fuel switching opportunities to 2050 ($MtCO_2e$)



Remaining emissions from buildings can be reduced through low carbon electricity. According to current projections, distributed solar PV uptake in 2050 above business-as-usual could avoid as much as 58 $MtCO_2e$ of emission abatement, and more than enough to eliminate all remaining emissions from buildings. This is illustrated in Figure 24.

Figure 24: Built environment emissions and opportunities to achieve zero carbon buildings ($MtCO_2e$)

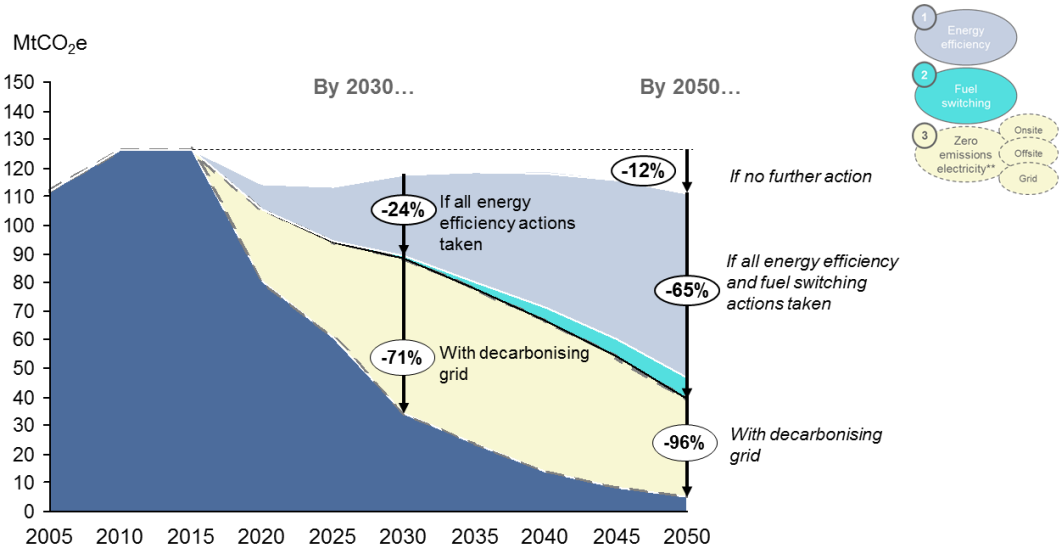


* Distributed energy potential presented in this chart is based on the modelled potential uptake of distributed solar PV from the Future Grid Forum *Rise of the Prosumer* scenario (Graham et al, 2015).

Source: ClimateWorks team analysis

The above scenario focuses solely on emissions reduction opportunities in the built environment itself, and does not include substantial decarbonisation of the electricity grid. An alternative scenario based on ClimateWorks and ANU's *Deep Decarbonisation Pathways* project, which includes less ambitious uptake of distributed solar PV (similar to the business-as-usual scenario used in this report) and complete decarbonisation of the electricity grid by 2050, is presented in Figure 25.

Figure 25: Built environment emissions reductions with decarbonising grid ($MtCO_2e$)



* In this scenario, there is a small amount of residual emissions from energy use that is difficult to switch to electricity, which would need to be offset.
** From ClimateWorks and ANU, *Pathways to Deep Decarbonisation in 2050* (2014)

Source: ClimateWorks team analysis

4.1. Energy efficiency potential

Energy efficiency has been widely recognised as the first step in any emissions reduction strategy, in large part because energy efficiency opportunities are low cost and usually deliver a return on investment in the form of energy savings. This report shows the scale of opportunity to improve energy efficiency in new and existing residential and commercial buildings through:

- **Envelope:** Improvements in the 'envelope' of buildings, such as insulation and sealing cracks and gaps to avoid air leakage;
- **Appliances and equipment:** Improvements to the appliances and equipment used within buildings, including heating and cooling equipment, water heaters and small appliances;
- **Building management:** Some improvements in the management of buildings, such as better monitoring and optimisation of appliances and equipment.

Only opportunities that have a positive net present value (NPV) have been included, meaning that they deliver a financial return to the investor over the lifetime of the building, appliance or equipment. This assessment takes into account capital costs and energy savings over the lifetime of the asset (but not transaction costs). In addition, only measures that are known, technologically proven and commercially available have been modelled. Emissions reductions achieved through switching away from the use of high global warming potential refrigerant gases have been included in the energy efficiency results[45]. See the attached Modelling Assumptions document for more details.

These modelled opportunities are above 'business-as-usual', meaning that they are currently blocked by a range of barriers and impediments, discussed in section 5.2. Additional policy measures and support are required to capture these opportunities.

4.1.1. Results by energy savings

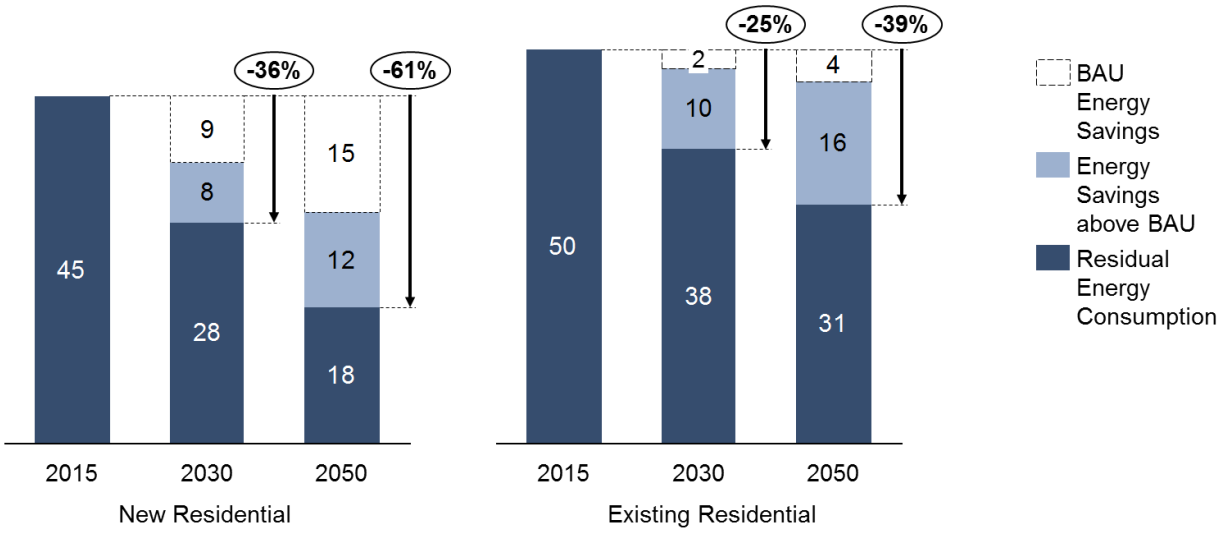
Cost-effective energy efficiency opportunities could cut the average energy consumption of buildings by more than one quarter by 2030 and more than half by 2050

By 2030, implementation of all identified energy efficiency opportunities could reduce the required energy consumption for the average new home by over one third (36 per cent), and of the average existing home by one quarter (25 per cent). Average energy consumption of new commercial buildings could be reduced by 36 per cent per square metre of floor space

[45] Many of the gases used for refrigeration such as HFCs have a very high global warming potential, thousands of times more potent than carbon dioxide. When these gases leak into the atmosphere during operation or decommissioning, they can have a substantial impact on Australia's emissions. The use of 'natural refrigerants' such as ammonia, carbon dioxide and some hydrocarbons instead of HFCs has the potential to significantly reduce the energy consumption of these processes and also eliminate the emissions of these highly potent synthetic greenhouse gases. Australia has already committed to work to fast track work to reduce domestic HFC emissions by 85 per cent by 2036, and it is expected that nearly all refrigerant emissions can be phased out by 2050.

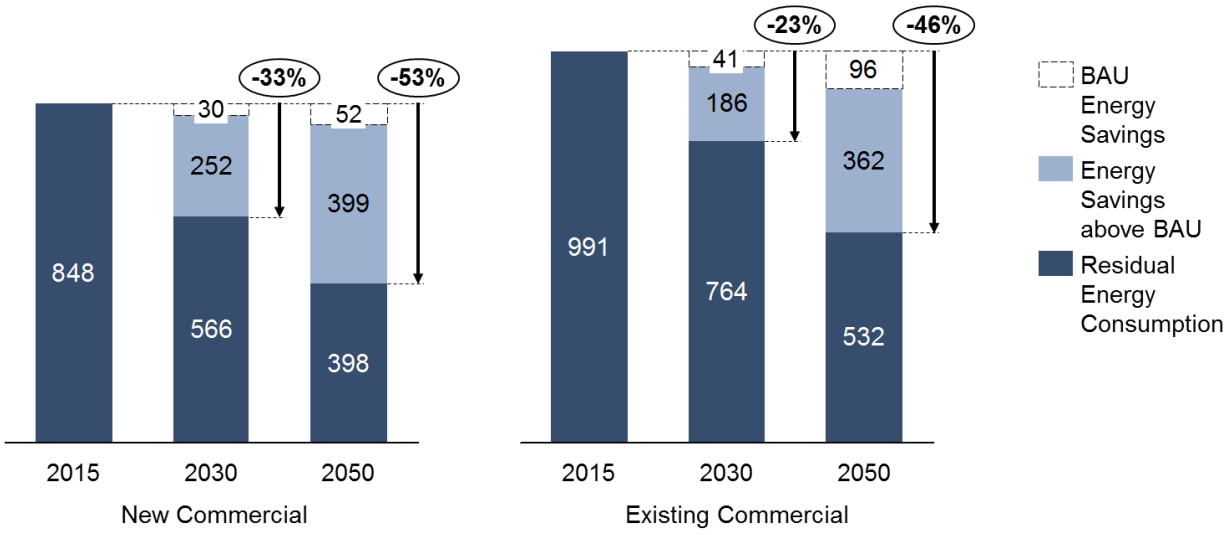
by 2030, and by 25 per cent for existing buildings. By 2050, energy efficiency could reduce the required energy consumption for most building types by around half. Note that Figures 26 and 27 below exclude energy savings resulting from fuel shifting, which can reduce energy consumption further because most electric appliances are more efficient than non-electric appliances.

Figure 26: Energy use per household in BAU and with high energy efficiency (GJ/household) (new - left, existing - right)



Source: ClimateWorks Team Analysis

Figure 27: Energy use per m^2 of commercial floor space in BAU and with high energy efficiency (MJ/m2) (new - left, existing - right)



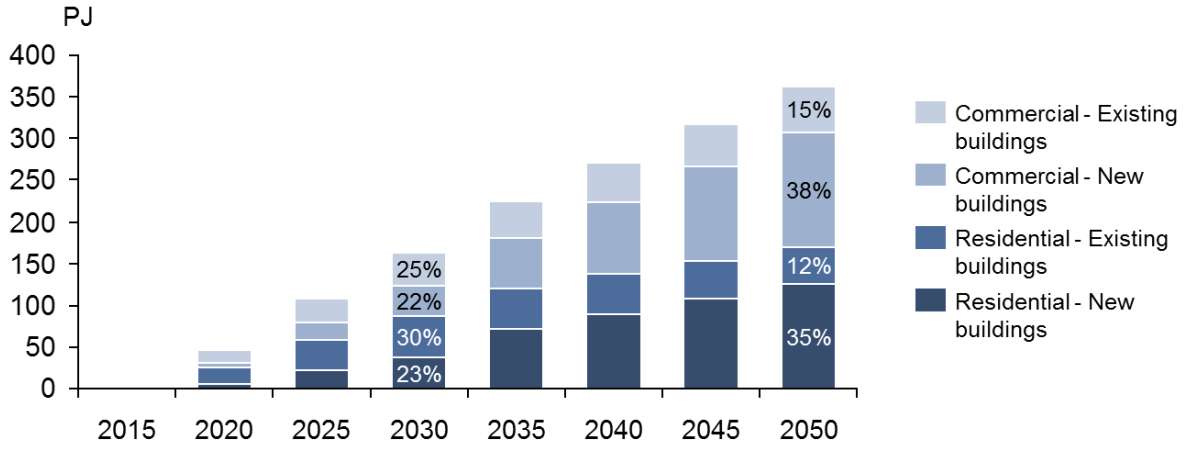
Source: ClimateWorks Team Analysis

Existing buildings represent almost three quarters of the annual energy savings potential in 2020, but new buildings become more important over time, growing to over 70 per cent of the potential savings in 2050

Each year of delay results in substantial lost energy and emissions savings, and wasted expenditure on energy for households and businesses. The majority of early energy efficiency opportunities are in retrofitting and replacing appliances and equipment in existing buildings. These opportunities account for almost three quarters of the energy savings in 2020.

Over time, the cumulative energy savings from new builds increases for both residential and commercial sectors, as new builds become a larger share of total building stock. In 2030, new builds make up 45 per cent of the annual opportunity, but this increases to 72 per cent by 2050. This highlights the crucial importance of new building standards, including mandatory standards in the National Construction Code, for future energy savings.

Figure 28: Annual energy efficiency potential* above BAU (PJ)



**Results before rebound effect*[46]
Source: ClimateWorks Team Analysis

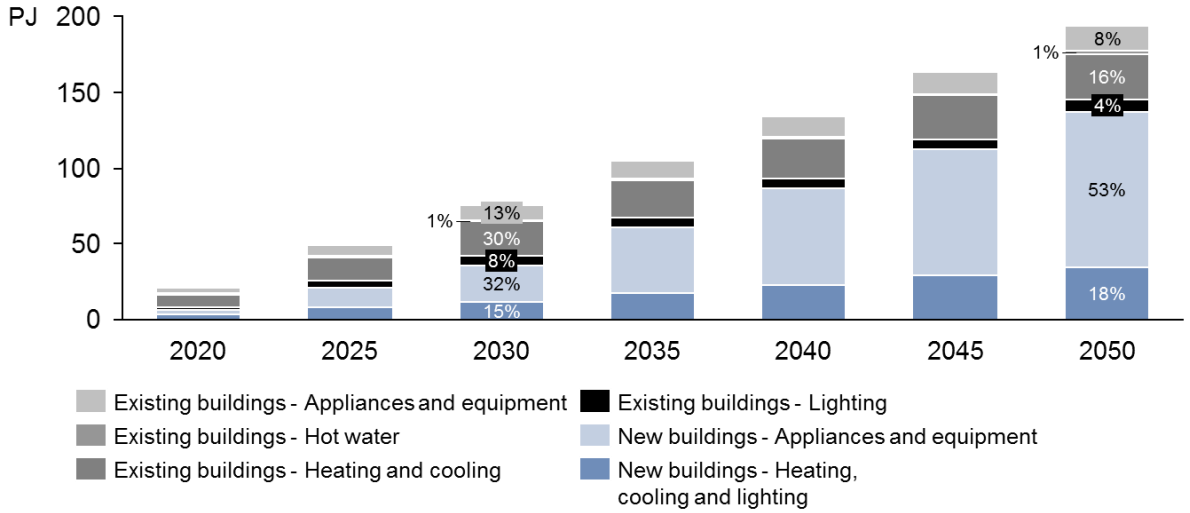
For commercial buildings, improvements in heating and cooling performance and equipment account for two thirds of the total energy savings opportunity, followed by appliances and equipment

Energy savings in the commercial sector are dominated by improvements in the building 'envelope' and heating and cooling appliances and equipment. As shown in Figure 28, these make up 62 per cent of the opportunity in 2030 in commercial buildings (32 per cent from new and 30 per cent from existing buildings). Appliances and equipment make up the largest remaining share (28 per cent).

[46] The rebound effect occurs when some of the savings from energy efficiency are cancelled out by changes in people's behaviour.

Figure 27 shows annual energy savings potential in commercial buildings over time, and shows the increasing impact of new buildings, which, by 2050, account for 71 per cent of the total opportunity. Most of this is achieved through reductions in building heating and cooling energy use as a result of improved building 'envelope' and heating and cooling appliances and equipment.

Figure 29: Annual energy savings potential above BAU for commercial buildings (PJ)

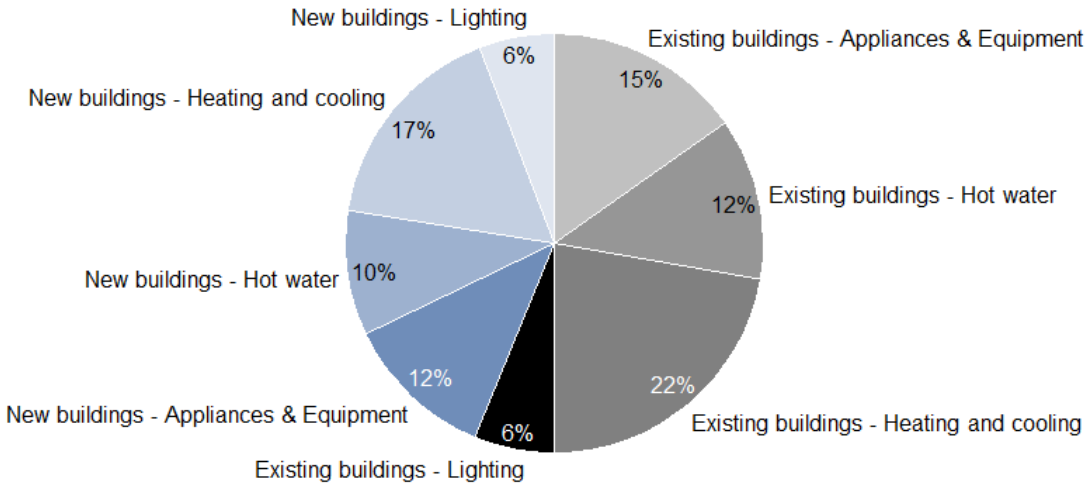


Source: ClimateWorks Team Analysis

In residential buildings, heating and cooling improvements represent the largest opportunity, followed by water heating and appliances

The 2030 opportunity in residential buildings is dominated by improvements in heating and cooling related energy use (38 per cent in new buildings, and 40 per cent in existing), including through improvements to the building envelope and upgrades of space conditioning equipment. The next largest opportunity is in water heating improvements, reflecting the generally poor efficiency of existing hot water heater stock and substantial improvements in water heating technology, particularly electric heat pumps. Appliances and equipment make up most of the remaining opportunity in 2030.

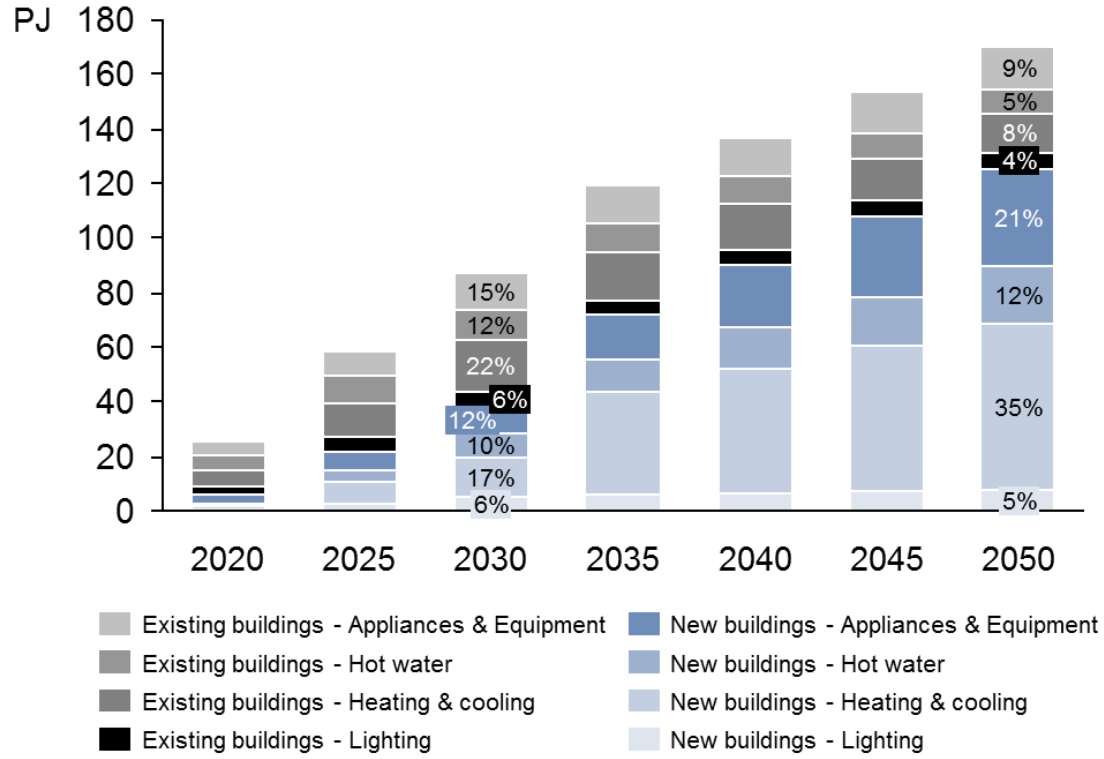
Figure 30: Annual energy savings potential in 2030 above BAU for residential buildings (% of total energy consumption, PJ)



Source: ClimateWorks team analysis

Demonstrating similar potential to commercial buildings, the energy savings potential for new residential buildings becomes the greatest share of the opportunity by 2050 (around 70 per cent of the total opportunity), with appliances and equipment in particular becoming a larger share of the opportunity (21 per cent) after heating and cooling (35 per cent).

Figure 31: Annual energy savings potential* above BAU for residential buildings (PJ)



**Results before rebound effect*
Source: ClimateWorks Team Analysis

4.1.2. Results by financial savings

This report identifies the scale of financial savings based on a discounted cash flow analysis of the modelled energy efficiency and fuel switching opportunities. This analysis is based on average capital costs and average energy savings for each modelled opportunity, and on projected electricity prices in a business-as-usual scenario[47]. A discount rate of 5 per cent has been applied to determine the present value of future energy savings.

It is important to note that the business-as-usual scenario used in this report does not include a carbon price or involve a substantial transformation of the electricity system away from high emissions generation. Such a transformation will be required in order to transition to zero net emissions, and would be expected to lead to higher electricity prices than in a business-as-usual scenario. Higher electricity prices would increase the value of energy efficiency measures beyond the levels reported below.

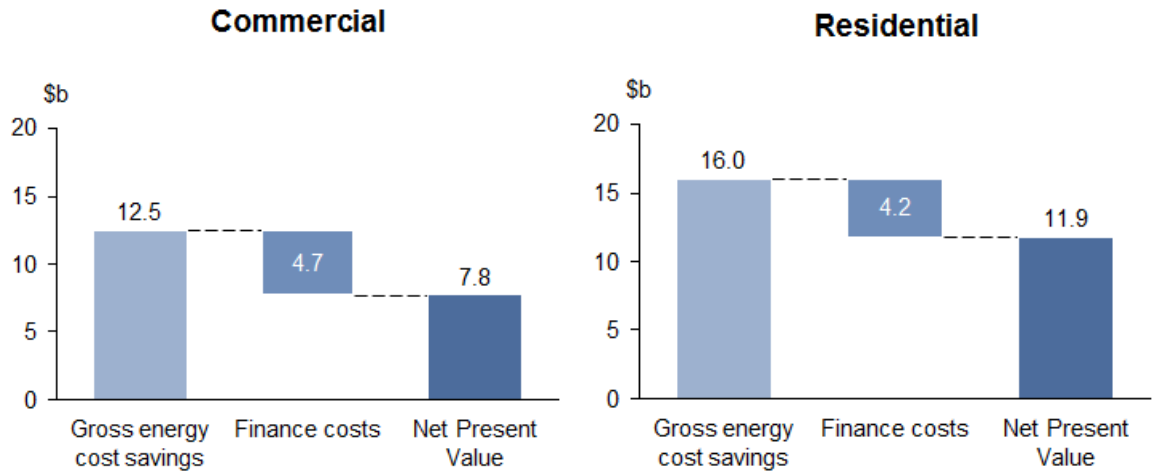
By 2030, the energy savings from energy efficiency and fuel switching improvements could deliver cumulative net financial savings of almost $20 billion to the households, businesses and government entities that invest in them

Figure 32 shows that implementing all identified energy efficiency and fuel switching opportunities would require new investment of $4.5 billion for the residential sector and $4.7 billion for the commercial sector in present value terms. This represents the cost of upgrading the building envelope of existing buildings, designing and constructing new buildings to a higher standard, and the incremental cost of purchasing higher efficiency appliances and equipment and switching to electric appliances.

Gross energy savings associated with these measures would total over $16 billion for households and over $12 billion for commercial buildings. After finance costs, the NPV of the energy savings to 2030 would total almost $12 billion for households and over $7 billion for commercial buildings. This represents a return-on-investment over this period of over $2 million for every million dollars invested. Despite the potential financial returns, these opportunities are blocked by market barriers and require policy action to overcome these.

[47] See the Modelling Assumptions document for further detail

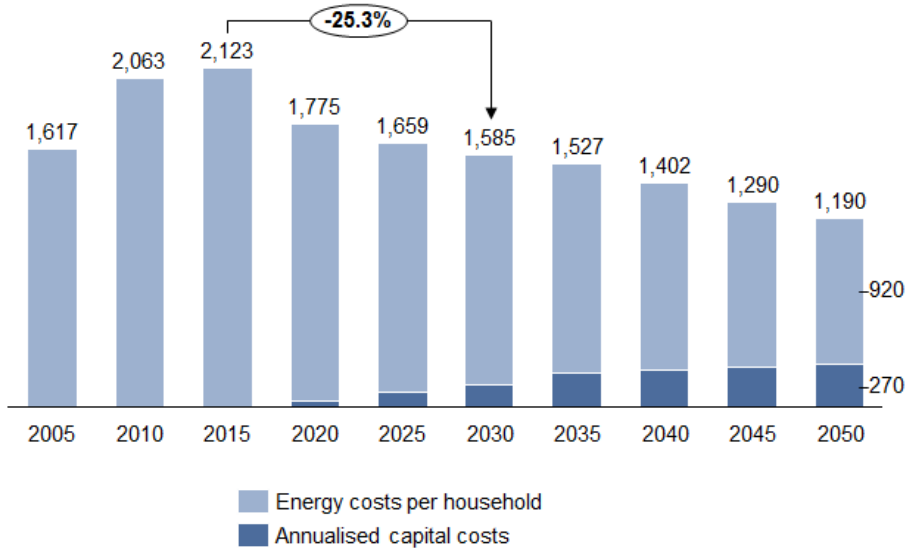
Figure 32: NPV of cumulative energy savings and financing costs of energy efficiency and fuel switch to 2030 ($b)



Source: ClimateWorks Team Analysis

Figure 32 shows that in a scenario where all of the energy efficiency and fuel switching opportunities identified in this report are implemented, the average household energy bill would reduce by over 25 per cent by 2030, a combination of decreasing electricity prices and savings from energy efficiency. This includes the finance costs ('annualised capital costs') associated with implementation of energy upgrades.

Figure 33: Annual energy costs and annualised costs of capital for energy savings measures per household ($/hh)[48]



Source: ClimateWorks Team Analysis

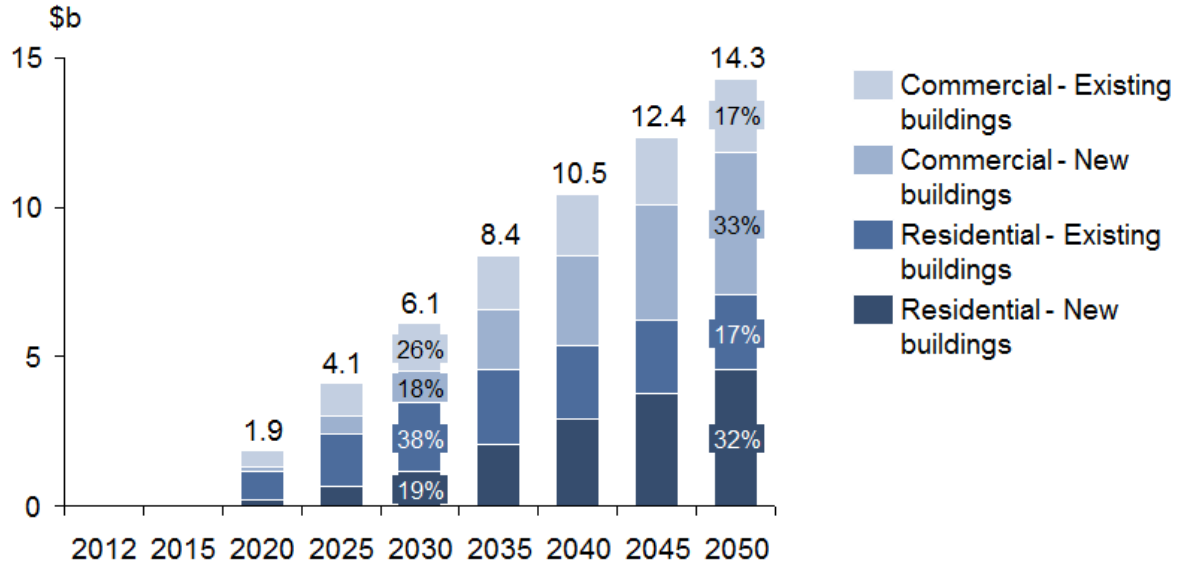
The benefits of energy efficiency in buildings are likely to greatly exceed this, and there are a range of technologies in development which could create new opportunities or reduce the cost of these measures.

The majority of the financial savings in early years come from existing buildings, but the share in new buildings increases over time

Figure 34 shows the annual net financial savings from these energy efficiency and fuel switching opportunities to 2050. As with energy savings, the majority of the early opportunities are found in existing buildings. Of the $6.1 billion in potential energy savings in 2030, 64 per cent is in existing buildings. However, the proportion of the opportunity available in new buildings increases over time from 37 per cent in 2030 to 67 per cent in 2050.

[48] As presented in the methodology appendices, the assumed real cost of electricity decreases by 6% to 2030 and then increases to 0.2% above 2015 levels by 2040 and beyond. This reduction in real electricity costs accounts for a proportion of the reduction in energy costs per household, particularly between 2015 and 2020. Electricity costs in the future are highly uncertain and will depend on factors such as regulation, emissions pricing and penetration of renewable generation.

Figure 34: Annual net energy cost savings ($b)

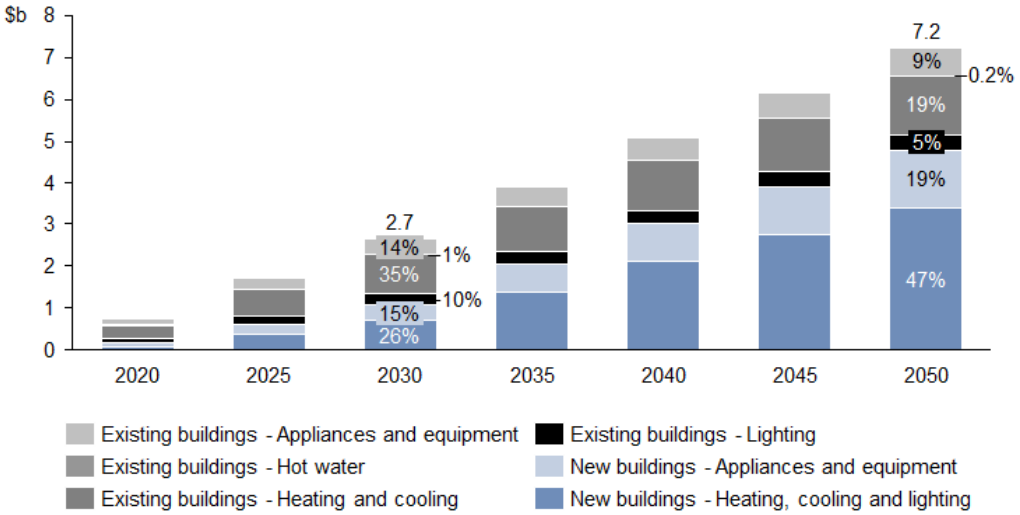


Source: ClimateWorks Team Analysis

Heating and cooling improvements account for the largest share of the opportunity in both commercial and residential, but by 2050 appliances and equipment particularly in residential become increasingly important

Figure 35 shows the breakdown of energy cost savings in commercial buildings by end use. Improvements in heating and cooling dominate throughout this period, with over half of the $2.7 billion potential savings in 2030 coming from these improvements.

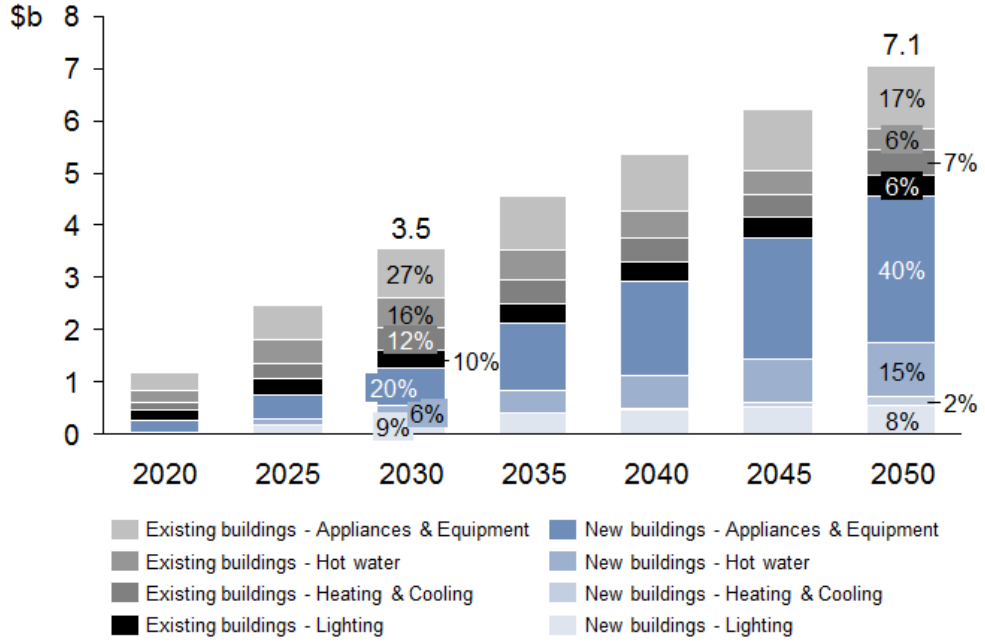
Figure 35: Net energy cost savings by end use - commercial ($b)



Source: ClimateWorks Team Analysis

Figure 35 presents the net financial savings by end use for residential buildings. It presents a similar picture to commercial buildings, except that appliances, equipment and hot water play a much larger role. This reflects the substantial improvements possible in hot water systems compared to existing, often very old stock, and the expected proliferation of appliances and equipment in households.

Figure 36: Net energy cost savings by end use - residential ($b)



Source: ClimateWorks Team Analysis

4.1.3. High level estimates by building use / asset class

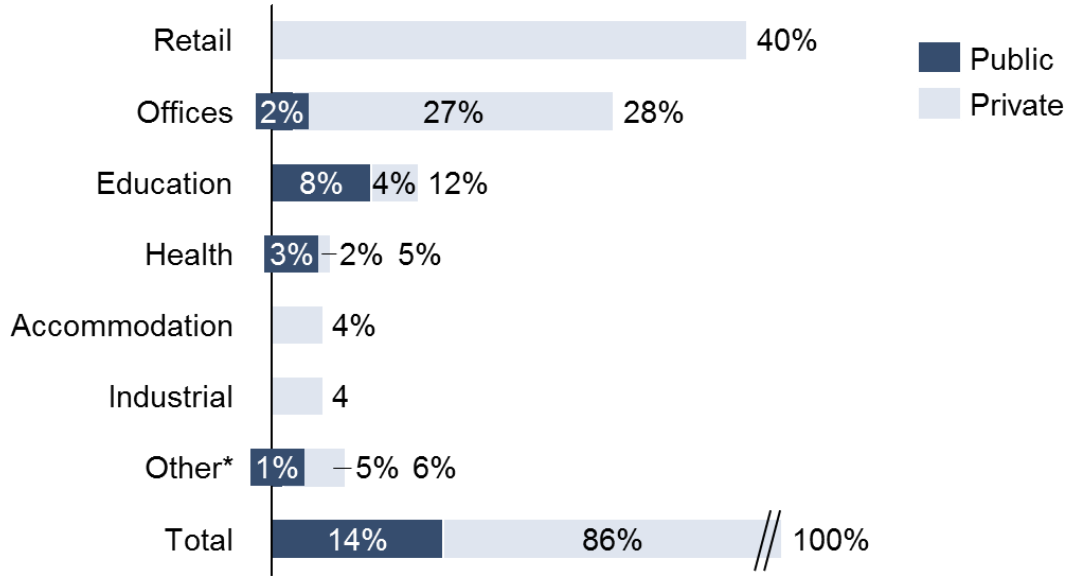
Buildings can be categorised based on the major building uses or 'asset classes'. This report classifies buildings according to the following categories:

- **Residential:** Public and private homes, including both owner-occupied and tenanted
- **Commercial:**
  - **Office:** All office space, including office space in mixed-use buildings
  - **Retail:** All retail including shopping centres, food retail and supermarkets, food services and a wide range of non-food retail
  - **Industrial:** Warehouses and cold storage, distribution and logistics centres, data centres and other light industrial (does not include manufacturing)
  - **Health:** Public and private hospitals and other health centres
  - **Education:** Public and private schools, universities, TAFEs and other training and education facilities
  - **Accommodation:** Hotels and other accommodation
  - **Other:** A range of other building uses

As noted above, just over half of the opportunity is available in residential buildings, with the remainder in commercial buildings. Figure 37 below provides order-of magnitude estimates on how much of the modelled energy efficiency opportunity in commercial buildings is available in each of these segments.[49]

The largest share of the opportunity is in retail, including shopping centres, supermarkets, large retail outlets and shopping strips - this reflects the high share of energy consumed by the retail sector. The next largest opportunity is in offices, followed by education. This breakdown is broadly aligned with the breakdown of total commercial energy consumption from each of these sectors as presented in Figure 8 above. This Figure also shows the substantial share (14 per cent) of commercial office space attributable to public entities, including public schools, hospitals and offices.

Figure 37: Estimates of energy efficiency opportunity by building use ($MtCO_2e$, %)



Source: ClimateWorks Team Analysis based on Pitt&Sherry 2012

[49] These are high level estimates only. They are based primarily on the share of new or existing floorspace or households attributable to each segment by building occupant, and the current share of energy consumed by each segment. These estimates do not take account of the differential energy use or opportunities in each segment. They are provided to indicate the order of magnitude distribution of energy efficiency opportunities, and further research including collection of more accurate and granular data than is currently available would be required to produce more accurate estimates.

4.1.4. The multiple benefits of energy efficient buildings

Improved energy efficiency can also deliver a range of other powerful benefits to households and commercial building owners and occupants, as well as public economic, productivity and energy system benefits

Many of the measures that deliver improved energy efficiency can also deliver a range of other benefits to households and commercial building owners and occupants, including:

- Increases in asset value and returns for owners of buildings
- Health and productivity improvements for tenants in commercial buildings
- Comfort and wellbeing for households, particularly low income households, which are susceptible to fuel poverty
- Improved resilience for building occupants, in particular resilience in the face of thermal fluctuations, and to changes in energy prices.

Energy efficiency also has the potential to deliver broader public benefits, over and above emissions reductions, including:

- Economic growth and job creation
- Improvements in national energy productivity
- Energy system benefits, for example through a reduction in peak demand and associated costs of peak generation and transmission infrastructure

These benefits are summarised in Table 2, and described in more detail in Appendix 1[50].

[50] Available via www.asbec.asn.au.

Table 2: Multiple benefits of energy efficient buildings

BENEFITS FOR HOUSEHOLDS AND BUSINESSES	
Increases in asset value and returns for building owners	Green Star rated offices are correlated with **7% higher** rent, **19% higher** operating income and **29% lower** capital expenditure compared to the broader office market.[51]
Reduced maintenance costs	LED lights require replacement on average every **ten years** while a halogen light bulb may last only **one year** before burning out.[52]
Productivity improvements	Thermal discomfort from poor design has been linked to a **10% reduction** in employee performance.[53]
Reduced fuel poverty for low income households	Increasing a home's energy rating from 2 to 5 Energy Stars can result in a **54% reduction** in energy required for thermal control, equal to **$600** savings/**25% reduction** in annual energy bills.[54]
Health benefits for households	Minimising temperature fluctuations and mould through improved envelope construction can lead to **improved physical and mental health**, particularly among children and the elderly.[55]
Increased productivity, health improvements	Benefits are realised by governments from **avoided** hospitalisation and pharmaceutical costs and business from **fewer** days absent from work. Addressing indoor air quality through energy efficiency measures could save the EU economy as much as EUR **190 billion annually**.[56]
Improved resilience for building occupants	6.5% of deaths in Australia are attributed to cold weather, and 0.5% to hot weather. Approx. 40% of a household energy is used to achieve thermal comfort. Building climate responsive homes and upgrading existing homes can **reduce household and system costs and reduce the chance of illness.**[57]
PUBLIC BENEFITS	
Economic growth and job creation	In Australia, office retrofitting alone could create **10,000 direct** and **27,000 indirect** jobs. In the US, $166 billion in energy productivity investments each year could result in **annual savings** of over **$327 billion** nationwide in 2030.[58]
Improvements in Australia's national energy productivity	Energy efficiency and distributed energy could deliver up to **one quarter** of the 2030 national emissions reduction target, and **more than half** of the 2030 national energy productivity target.[59]
ENERGY SYSTEM BENEFITS	
Reduction in peak demand	Energy efficiency and distributed energy can reduce the need for higher cost peaking generation and additional transmission infrastructure.

[51] The Property Council/IPD, 2013
[52] ClimateWorks, 2015
[53] World Green Building Council, 2014
[54] ACOSS, 2013 p4
[55] IEA, 2011 p116
[56] IEA, 2011, p22
[57] Barnett, 2015
[58] Alliance to Save Energy, 2013, p12
[59] ClimateWorks analysis, 2016

4.2. Switching to electricity

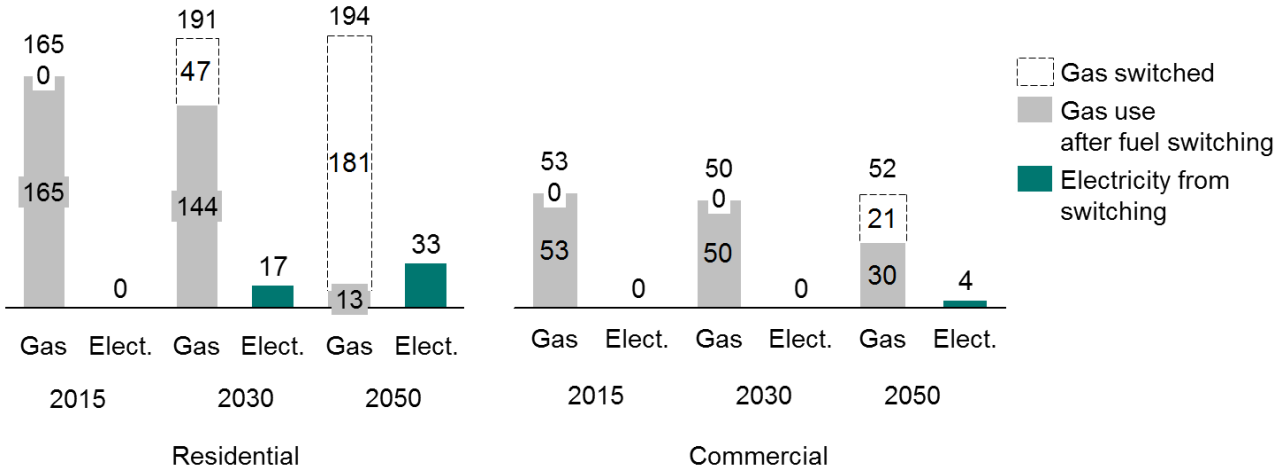
Emissions from gas combustion in buildings can be largely eliminated through a switch to electric alternatives

While the majority of emissions from buildings come from electricity consumption, there are some end uses still supplied by other fuels, primarily gas for water heating, space heating and cooking. In a net zero emission environment, emissions from non-electric applications such as gas will need to be either offset or avoided by switching to electricity from zero emissions sources such as distributed solar PV and large-scale wind and solar.

The majority of these non-electric applications can be switched to electric alternatives, as appliances and equipment reach the end of their life and are replaced. Analysis for this report indicates that over 90 per cent of non-electric fuel use in residential buildings can be switched to electricity by 2030, and over 40 per cent in commercial buildings.

The remaining gas use in 2050 is assumed to be from a small number of old residual gas appliances fuelled by bottled LPG, and some specialised equipment in the commercial sector. In order to achieve a zero carbon building sector by 2050, those emissions would need to be reduced to zero by either shifting gas use to biogas, finding other ways to shift those end uses to electricity, or offsetting those emissions for example through exporting excess solar electricity in the grid or purchase of offsets from other sectors.

Figure 38: Switch from direct fuels to electricity in residential (left) and commercial (right) (PJ)



Source: ClimateWorks Team Analysis

Switching to electricity is preferred over offsets in this analysis due to the fact that switching is a relatively low, once-off cost at the time of replacement, whereas offsetting is an ongoing cost. Further, there are many other sources of greenhouse gas emissions that are more difficult to eliminate than gas use in buildings - for example, long-haul freight, shipping, aviation, steel and cement manufacture and livestock. These could create high demand for offsets, increasing the price and creating a strong case to switch gas and other fuel use in buildings to electricity rather than rely on offsets.

4.3. Generating low carbon electricity

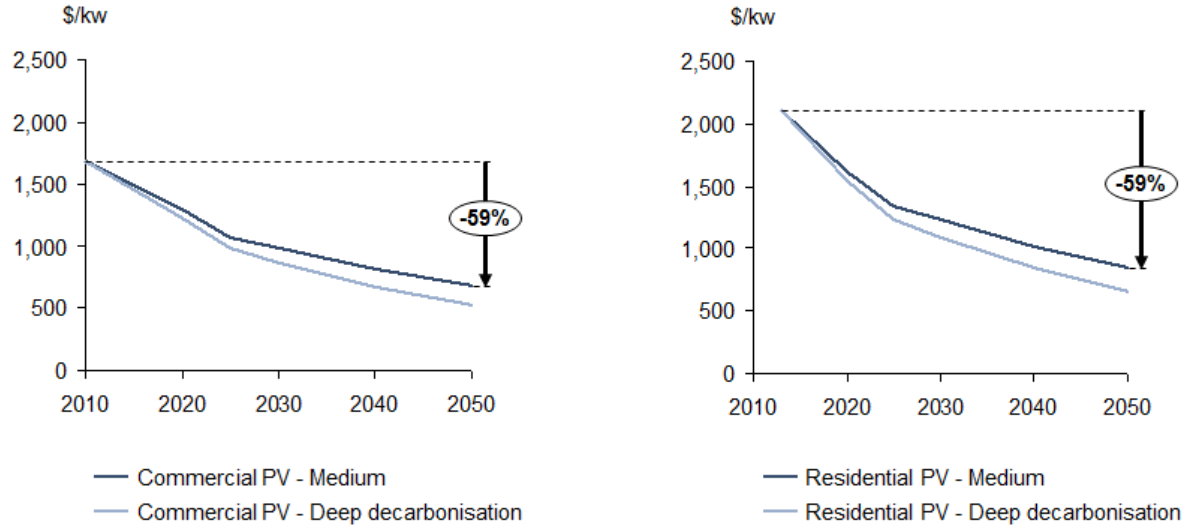
Remaining energy consumption in buildings can be met through zero emissions electricity, including distributed solar PV on buildings and decarbonisation of the electricity grid

Energy efficiency can reduce energy consumption in buildings by more than half by 2050, while fuel switching can eliminate most non-electric energy consumption. Remaining emissions from electricity consumption in buildings can be eliminated through the production of zero emissions electricity.

4.3.1. Distributed solar PV and batteries

This report is focused on opportunities to reduce emissions in buildings. The largest opportunity for zero emissions electricity production in buildings is through distributed solar PV. The cost of solar PV has dropped rapidly, and is expected to continue to drop by more than half by 2050. This is expected to drive continued growth in distributed solar deployment.

Figure 39: Solar PV cost projections (2015 $/kw)



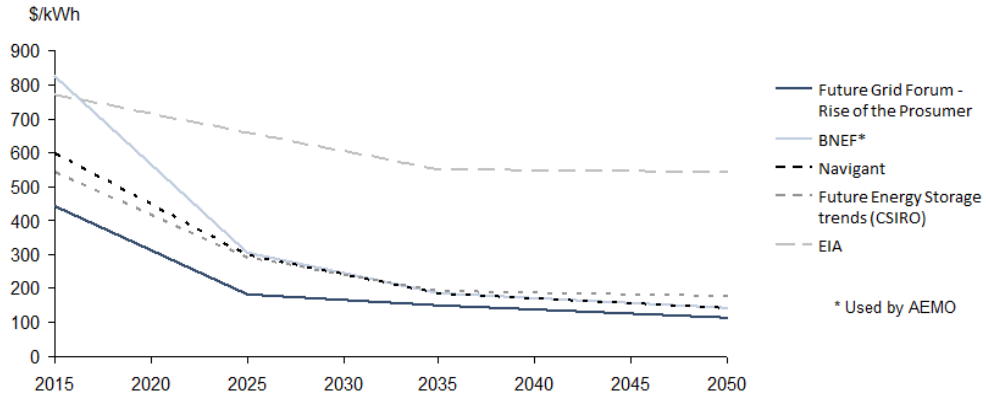
Source: Graham et al., 2015

Battery storage offers the potential to unlock enormous additional potential for distributed solar, by overcoming the fundamental issue of variability of electricity production. With battery storage, building owners can install larger solar systems and instead of exporting excess electricity to the grid and receiving a low price for it, they can store energy for later use on-site, offsetting the need to purchase electricity from the grid. Batteries also offer the potential to address concerns from electricity network operators about the impact of large amounts of variable distributed electricity on their ability to manage the network.

The cost of battery storage systems has been declining rapidly in recent years as a result of scaling up of production by companies including Tesla. Costs have dropped by 14 per cent on average every year, from around $1,000 per kWh in 2007 to around $410 per kWh in

2014, and are projected to continue dropping into the future (see Figure 40 below). A recent report suggested that integrated solar PV and battery storage systems 'could be viable for households [in 2022] under current tariff structures'[60].

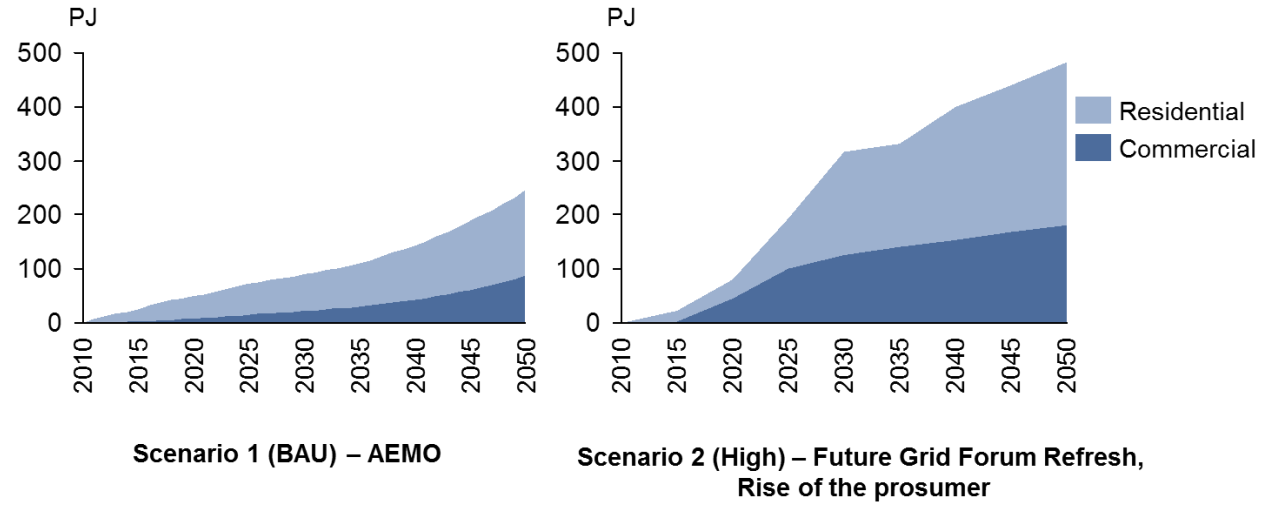
Figure 40: Battery capital cost projections ($m)



Source: Graham et al. 2015; Brinsmead et al., 2015; Fitzgerald et al., 2015; AEMO, 2015

While technology improvements are expected to drive ongoing deployment of solar PV and battery storage, the precise level of future uptake is highly uncertain. This is due to the fact that the cost-effectiveness of distributed solar PV is highly dependent on the evolution of energy market reforms, electricity tariffs and prices paid to distributed solar PV generators for excess electricity sent back to the electricity grid. Recent projections (see Figure 41) illustrate that even the lowest projections of uptake of distributed solar PV see a eight-fold increase between 2015 and 2050, with the highest projections resulting in more than 19 times more solar PV than in 2015.

Figure 41: Projections of solar PV from recent studies*



Source: AEMO, 2015; Graham et al. 2015

[60] Brinsmead et al, 2015.

In this report, Scenario 1 has been used as the business-as-usual scenario. Scenario 2 has been used as a high scenario if conditions and policy settings are advantageous for the deployment of distributed solar PV. In this scenario, electricity tariff structures remain volume-based (i.e. electricity bills are determined primarily by the amount of electricity consumed), as opposed to shifting to fixed charges that are imposed regardless of the amount of electricity purchased. This maximises the return from distributed solar PV systems. Over time, structures evolve to enable solar PV systems and batteries to become an integrated and important element of the larger electricity system.[61]

In this 'high' scenario, generation from distributed solar PV in 2050 is about double that projected in the BAU scenario.

4.3.2. Broader grid decarbonisation

If Australia is to meet its international commitments to achieve zero net emissions, a transformation of the electricity supply sector will be required. This means that achieving zero emissions buildings is likely to involve a combination of distributed solar PV as discussed above, as well as decarbonisation of grid-supplied electricity.

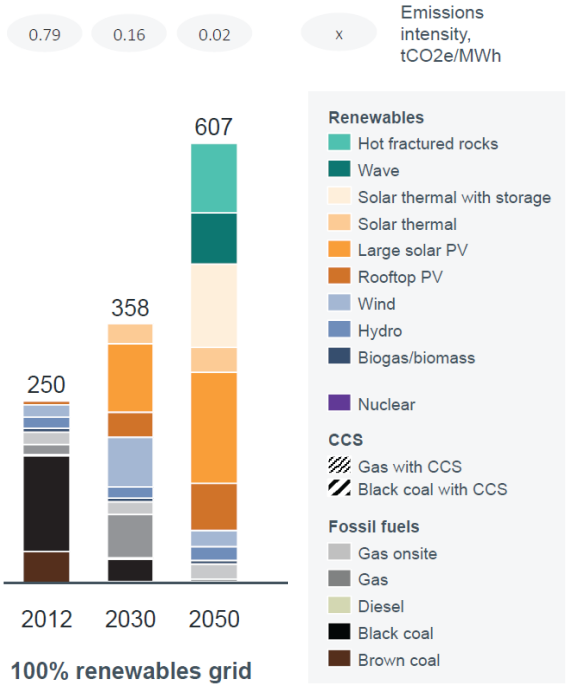
ClimateWorks and ANU - in partnership with CSIRO - modelled one such scenario as part of the 2015 Deep Decarbonisation Pathways Project[62]. This scenario outlines Australia's transition to a zero net emissions energy system, using a mix of renewable energy technologies, including hydro, wind, solar, and geothermal (see Figure 42 below). Modelling included analysis of storage and other technologies required to manage the intermittency of renewables. In this scenario, a moderate amount of distributed solar PV is deployed, similar to the business-as-usual scenario used in this report. However, this is based on assumptions from 2014 – a more recent study[63] using similar assumptions found that improvements in technology could lead to this level of demand being met with a higher share of distributed solar PV (approximately halfway between the BAU and High scenarios presented above).

[61] For further detail on this scenario, see Graham et al, 2015, p 16-17

[62] Further detail is available in the full report *Pathways to Deep Decarbonisation in 2050: How Australia can prosper in a low carbon world: Initial Project Report* and in the accompanying Technical Report, both available via the ClimateWorks website.

[63] *Graham et al. 2015*.

Figure 42: Generation in 100% renewables grid scenario (TWh)

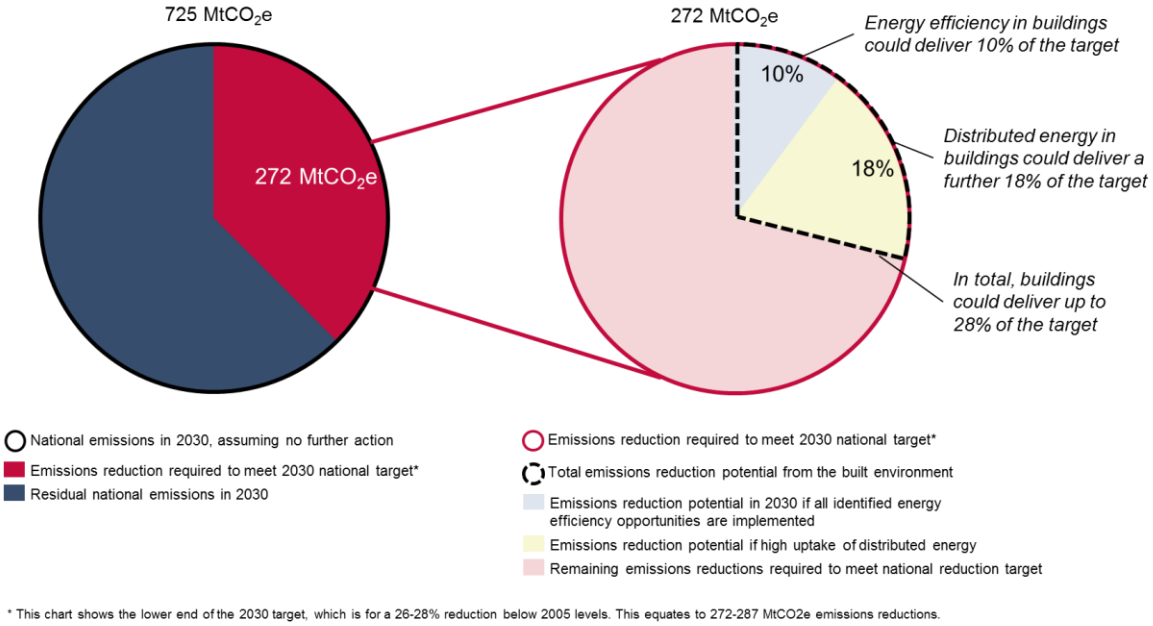


4.4. Contribution to national targets

The built environment could deliver up to one quarter of the national emissions reduction target, and over half of the national energy productivity target

Implementing all off the energy efficiency and fuel switching opportunities identified in this report could deliver over 28 $MtCO_2e$ in emissions reductions by 2030, equivalent to 10 per cent of the national 2030 emissions reduction target. Distributed solar PV could provide up to an additional $50MtCO_2e$, which would bring the total contribution from the built environment sector to more than one quarter of the national target.

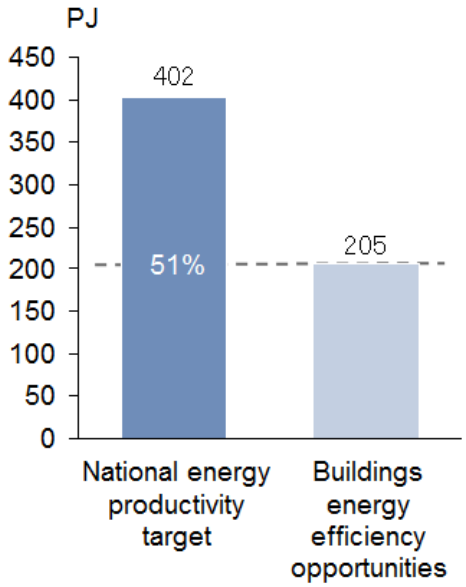
Figure 43: Potential contribution of built environment opportunities to 2030 national emissions target ($MtCO_2e$)



Source: ClimateWorks Team Analysis; Department Of Environment, 2015a; Department Of Environment, 2015b

The energy efficiency opportunities identified in this report alone could deliver over half of the national energy productivity target, as shown in Figure 44. Distributed solar PV could deliver substantial additional improvements in energy productivity, but have not been modelled as part of this analysis because it does not affect final energy use but primary energy use and an official translation of the NEPP target was not provided in terms of primary energy use.

Figure 44: Potential contribution of built environment energy efficiency opportunities to 2030 National Energy Productivity Target (PJ)



Source: ClimateWorks Team Analysis

4.5. Potential upside from emerging technologies

A range of exciting technologies are emerging as more effort and resources are directed internationally towards decarbonisation - with the right support, these could unlock more opportunities or improve returns

This report focuses on technologies which are already available and commercially viable or well on the way to commercialisation, taking into account expected improvements in technology and cost reductions. However, a range of new technologies in development are likely to unlock new opportunities to reduce emissions and reduce the cost of transitioning to zero net emissions in the timeframe required. These include:

- High efficiency appliances and equipment
- New building products or techniques that improve the capability of buildings to provide a comfortable indoor environment without the need for mechanical heating and cooling
- Energy management systems that reduce energy wastage
- Distributed energy generation technologies, particularly new solar and storage

It has been well documented that with the right incentives and market conditions, technology is able to progress much faster than expected. Some of the most advanced and potentially transformative of these technologies are described in the table below.

Table 3 outlines emerging but market-ready and cost-effective efficiency measures that could result in substantial future energy savings.

Table 3: Emerging technologies[64]

TECHNOLOGY	DESCRIPTION	KEY FACTS	STATUS
Low-cost sensors[65]	Monitoring, controlling, optimising lighting and heating and cooling systems and fault detection.	Could reduce building energy consumption by 20-30%.	Costs reducing rapidly, US Department of Energy working on $1-10 prototype.
Building-integrated Photovoltaics[66]	PV modules integrate directly into a building, in place of ordinary building materials.	Improves climate performance and reduces operational cost and embodied energy.	Not yet price-competitive on the retail scale with conventional panels.
Smart thermometers[67]	Control residential heating and cooling systems and can sense, communicate and respond automatically.	React to price signals to change temperature set points, or to cycle heating and cooling to reduce peak demand.	New technology, already some evidence showing they reduce home energy use.
Geothermal heating and cooling[68]	Natural heat from shallow earth is transferred into building, reverse process cools.	Can reduce annual household energy expenditure by 75%.	Rebate schemes exist in the US, Canada and UK. Gaining interest in Australia.
Smart glass (SageGlass®)[69]	Can switch between clear and tinted glass using a small electric charge, depending on heat and light conditions.	Takes advantage of natural light, which can reduce a building's energy consumption, enabling cost savings.	US Department of Energy provided $72 million loan guarantee to support construction and operation.
Real-time feedback on energy use[70]	Technologies provide customers and utilities real-time data on electricity use.	Energy savings result from greater understanding and control of energy use.	Being deployed at a large scale. Primary drivers are improved reliability and control.
Prefabrication[71]	Off-site factory construction of building elements.	Reduced costs and construction time, high level of customisation.	Widely used in Europe, gaining interest in Australia.

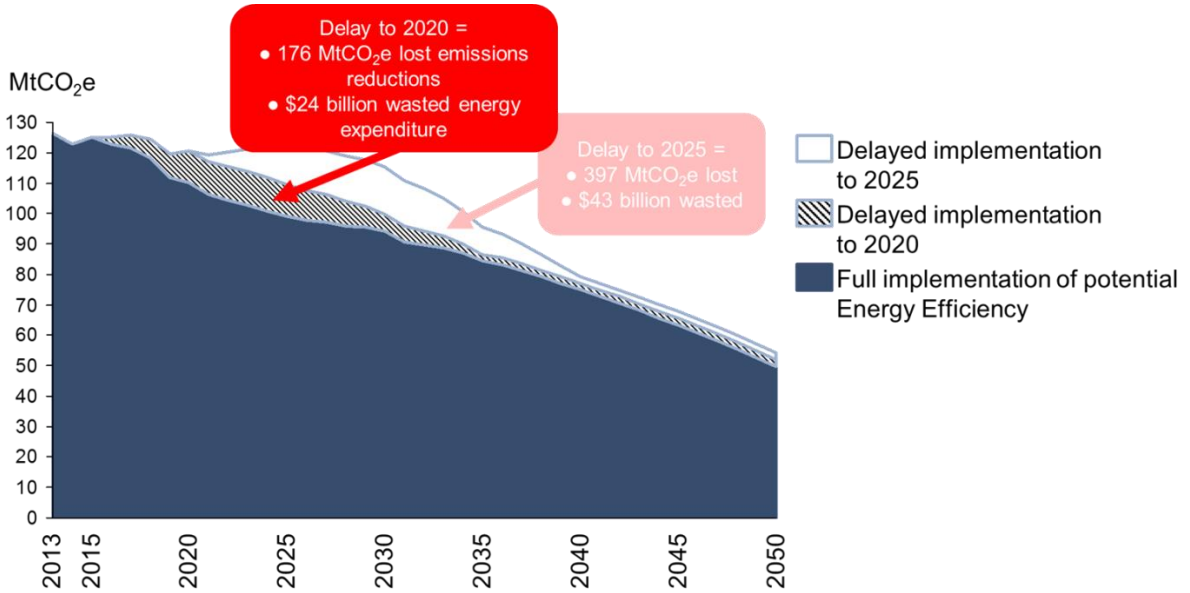
[64] ACEEE, 2015.
[65] Office of Energy Efficiency & Renewable Energy, 2015
[66] Solar Choice, 2015
[67] ACEEE, 2015
[68] Direct Energy, 2012
[69] SageGlass, 2016
[70] ACEEE, 2015
[71] Green & Newman, 2014

4.6. The high cost of delay

Buildings and the equipment within them are long-lived assets. Delay in overcoming obstacles to improved energy performance risks locking in high levels of emissions and poor energy performance for decades to come. Just five years delay would lead to $24 billion in lost energy savings for households and businesses to 2030 and the cumulative loss of 176 $MtCO_2e$ reduction opportunities. A further five years of delay would lead to the loss of an additional 221 $MtCO_2e$ (bringing the total loss to 397 $MtCO_2e$) of emissions reductions.

The opportunities that are lost are primarily those relating to the construction of new buildings (which exist for many decades) and installation of long-lived equipment such as hot water and Heating, Ventilation and Air Conditioning. Both of these are hard to retrofit in the short term, resulting in the lock-in of high emissions for decades.

Figure 45: Cost of delay ($MtCO_2e$)



Source: ClimateWorks Team Analysis

5. POLICY SOLUTIONS TO MAXIMISE AUSTRALIA'S CARBON EMISSIONS REDUCTIONS

Summary of key points:

- ASBEC is calling for the establishment of a National Plan Towards 2050 Zero Carbon Buildings
- In order to overcome the complex set of barriers and impediments preventing additional emissions reduction activity, a suite of policies are required, including:
  - The plan itself, including long-term and interim targets, clear responsibility at a Ministerial level, coordination of action and public reporting;
  - Mandatory minimum standards
  - Targeted incentives and programs
  - Energy market reforms
  - A range of supporting data, information, training and education measures

5.1. Policy principles

As this report demonstrates, the built environment sector represents a substantial opportunity for the achievement of national emissions reduction targets at least cost and meeting international commitments to reduce net emissions to zero. At the same time, the sector can deliver financial savings to households and businesses, and improve the productivity of the Australian economy and the health and wellbeing of its citizens.

Where market failures or other impediments prevent these opportunities from being captured and the benefits of doing so are greater than the costs, government intervention and support should be provided. Importantly, the assessment of costs and benefits of any particular policy designed to support emissions reductions in buildings should not be overly narrow, and needs to reflect the full benefits, which include:

- The contribution to least-cost national emissions reductions with a view to achieving zero net emissions within a 2050 timeframe, in line with the Paris Climate Change Agreement to which Australia is a signatory
- The non-energy benefits of energy efficiency and distributed energy in buildings, including those around health and productivity

Where these benefits are difficult to quantify, effort should nevertheless be made to incorporate them into cost-benefit analysis of particular policy interventions.

In recognition of the extreme diversity of the built environment sector, policies need to reflect and cater to the diversity of the sector and thus be developed in consultation with diverse sectoral representation, and with clear, certain and predictable governance arrangements.

This would include provision for appropriate and sustained engagement with relevant industry groups to ensure effective implementation, monitoring, evaluation and adjustment of policies over time.

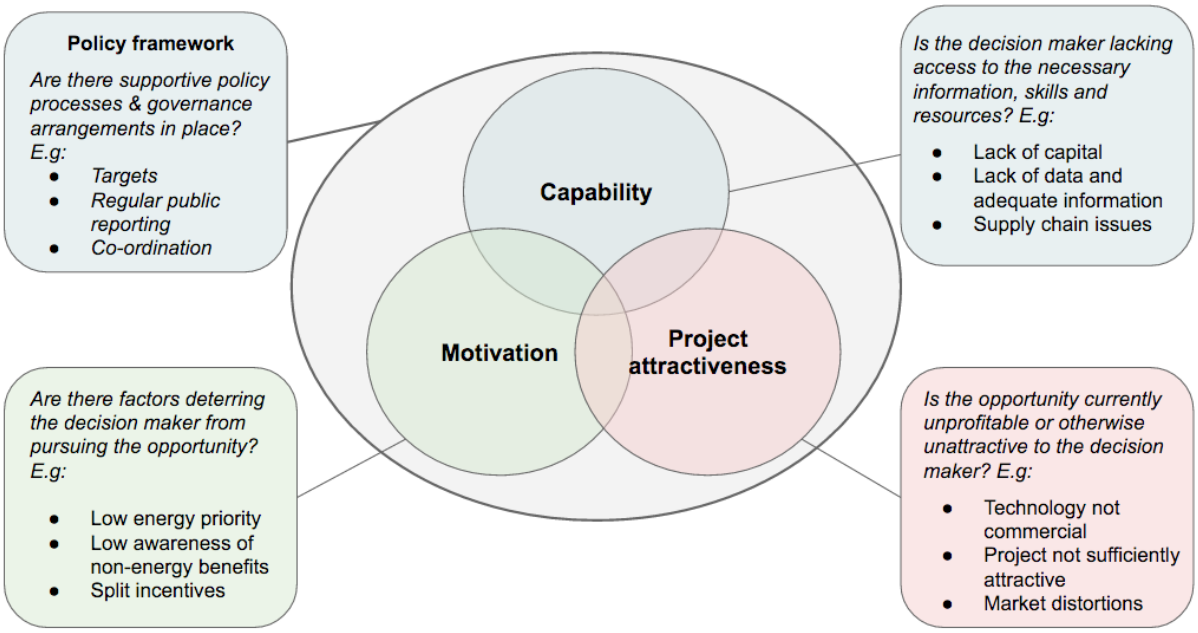
Given the extreme diversity of building owners and tenants, and the complexity of impediments preventing further action to improve energy performance, government measures should include a combination of mandatory measures ('sticks'), incentives and other measures to motivate and support higher performance ('carrots') and enabling measures to provide the right conditions for least-cost, large-scale action.

Finally, noting the fragmentation of the sector across many different jurisdictions and levels of government, policy measures need to seek national consistency of processes and programs where possible, while allowing for competition between jurisdictions to enable leaders to take additional actions.

5.2. Barriers and impediments

An extensive review of barriers and impediments to energy efficiency and distributed energy was undertaken for this report. These can be grouped into four interrelated categories, as summarised in Figure 46 below and described in more detail in Appendix 2[72]:

Figure 46: Barrier and impediment framework



[72] Available via www.asbec.asn.au.

Following an international literature review and consultation with industry experts, a suite of policy types have been identified that can help unlock this opportunity:

1. **Supportive policy frameworks,** including a national plan to coordinate actions at other levels of government and across government departments, agencies and policy processes such as energy market reform processes.
2. **Mandatory minimum standards,** including mandatory regulated standards for the energy performance of new buildings and new appliances, and potentially for existing buildings at the time of sale or lease.
3. **Measures to motivate and support higher performance,** which provide market stimulus to accelerate action in the short- to medium-term, including *incentives* to overcome low motivation or unattractive project returns, *use of government market power* to accelerate action over the short term and *targeted sectoral programs and support*.
4. **Measures to provide the enabling conditions,** including *energy market reform* to ensure that the energy market supports roll-out of cost-effective energy efficiency and distributed energy improvements, and a range of supporting *data, information, training and education* measures.

Table 4 shows at a high level how each of the policy types influences the main barriers and impediments to improved energy performance in buildings. This is a summary of a more detailed analysis of the impact of policy measures, which is provided in Appendix 3[73].

Table 4: Barriers and impediments mapped to policies

BARRIERS	POLICY TYPES				
	National plan	**Minimum standards**	***Targeted incentives and programs***	***Data, information, research, education***	***Energy market reforms***
Policy frameworks	Provide the goal and the 'glue' to coordinate actions				
Motivation	Send a strong signal and provide a vehicle for public engagement	Ensure minimum level of performance for least motivated	Provide incentives to go beyond minimum standards	Provide better public information on the benefits	
Capability	Provide a vehicle for industry engagement	Build industry capability through accelerated deployment	Build industry capability through improved performance Provide dedicated support for least equipped	Provide the data, information, training and education required to enable informed choice and quality service provision	
Attractiveness	Provide a vehicle for coordination of energy market reforms	Reduce cost of new technologies and approaches through accelerated deployment	Reduce costs of new technologies and approaches through accelerated deployment	Support innovation & commercialisation of new technologies & business models	Address barriers and market distortions affecting energy efficiency and distributed energy

Primary target

Secondary target

[73] Available via www.asbec.asn.au.

5.3. Outline of policy options and recommendations

This report identifies a suite of specific policies within the framework identified above that can be implemented in the next one to five years. These are summarised in Table 5 below and discussed in more detail in the following sections.

Table 5 – Outline of policy options, recommendations and page references

#	RECOMMENDATION	PAGE
Policy Solution 1 - Create National Plan Towards 2050 Net Zero Emissions Buildings and improve governance		
1.1	Establish a National Plan Towards 2050 Zero Carbon Buildings.	90
1.2	Investigate the establishment of an independent Energy Efficiency Authority.	90
Policy Solution 2 - Set strong mandatory minimum standards		
2.1	Review and upgrade minimum energy performance standards in the National Construction Code.	94
2.2	Implement a trajectory for future upgrades to minimum energy performance standards in the National Construction Code.	94
2.3	Improve compliance and State/Territory-level enforcement of standards.	94
2.4	Implement the recommendations of the GEMS Review to expand, strengthen and accelerate future improvements in minimum equipment and appliance standards.	96
2.5	Develop a proposal for introduction of minimum standards for rental properties.	97
2.6	Undertake a review to investigate the introduction of minimum energy performance standards for existing buildings.	97
Policy Solution 3 - Targeted incentives and programs		
Policy Solution 3A - Leverage government market power		
3.1	Commonwealth, State and Territory governments should set ambitious targets for government-owned and occupied buildings and for government procurement, and implement mechanisms to facilitate these improvements.	99
3.2	Commonwealth, State and Territory governments should fund programs to support local governments to improve their efficiency	99

Policy Solution 3B - Implement incentives to accelerate action		
3.3	A review should be undertaken of the Emissions Reduction Fund to identify and address barriers to participation for buildings.	101
3.4	The Commonwealth should introduce green depreciation to accelerate uptake of energy upgrades to existing commercial buildings at the time of refurbishment.	103
3.5	States and Territories should introduce incentives for high performing buildings, and as a priority investigate the introduction of stamp duty concessions and differential council rates in partnership with local government.	103
3.6	States, Territories and local government should work together to introduce planning incentives for high performing new buildings	103
3.7	Existing Energy Efficiency Obligation schemes should continue to be harmonised and integrated.	105
3.8	Energy Efficiency Obligation schemes should be introduced in Queensland, Western Australia, Tasmania and the Northern Territory.	105
3.9	Energy Efficiency Obligation schemes should begin to incorporate incentives for the replacement of non-electric appliances.	105
Policy Solution 3C - Facilitation and support for distinct market segments		
3.10	Consider the establishment of sectoral leadership groups in retail, health and industrial sectors.	106
3.11	Resource the Mid-tier Office Pathway and develop mid-tier retail pathway.	109
3.12	The Commonwealth, States and Territories should develop end-to-end support programs for low-income households.	110
3.13	State and Territory governments should establish rising minimum standards for public housing and facilitate funding mechanisms to facilitate public housing retrofits.	110
Policy Solution 4 - Energy market reforms		
4.1	Establish an independent industry Ombudsman or other independent authority to investigate and recommend solutions to address energy market barriers	113
4.2	Ensure that electricity tariff structures provide an appropriate incentive for distributed energy and energy efficiency, including through the current shift to ‘cost-reflective pricing’.	114

4.3	Establish a mechanism to identify and pass on to distributed generators the fair value of distributed electricity exported to the electricity grid.	115
4.4	Establish standards for connection of embedded generators and implement the recommendation of the Harper Review of Competition Policy to improve access to the electricity network.	116
4.5	The Australian Energy Regulator (AER) should provide exemptions for Power Purchasing Agreement (PPA) providers as has been provided already in Victoria to facilitate local sharing of distributed solar and other distributed energy.	117
Policy Solution 5 - Improve energy data, information, research, education and training		
5.1	Develop a national built environment energy data and information strategy in partnership with relevant industry and research organisations.	118
5.2	Improve access to energy consumption data.	119
5.3	Expand mandatory disclosure to smaller offices and investigate the possibility of requiring disclosure for other building types.	121
5.4	Implement mandatory disclosure of energy performance for residential buildings, beginning with pilots in one or more jurisdictions.	121
5.5	Develop a national built environment energy efficiency and emissions research agenda, and establish a permanent energy efficiency and distributed energy research institution.	122
5.6	Develop a national built environment energy efficiency and emissions education and training agenda.	122

The NEPP contains a number of measures relating to energy and emissions in the built environment, many of which align with or complement recommendations discussed below. In 2016, most of the measures in the NEPP are in an investigation or scoping phase, and many of the recommendations in this report can inform this scoping work and support industry engagement with the Commonwealth Department of Industry, Innovation and Science which is responsible for administering the NEPP. However, this report also includes a number of recommendations which are not included or contemplated in the NEPP.

Table 6, on the following page, maps the NEPP measures against the policy recommendations in this report.

Table 6: Mapping NEPP measures against ASBEC recommendations

ASBEC policy solutions	ASBEC recommendations		Related NEPP measures		Assessment	Comment
Policy solution 1: National plan for zero emission buildings	1.1	National Plan Towards 2050 Net Zero Emissions Buildings	n/a	National Energy Productivity Plan	Complementary	National plan could complent and enhance the NEPP and proposed Energy Efficiency Authority could help improve effectiveness of NEPP through reporting function.
	1.2	Establishment of independent Energy Efficiency Authority	16	More liveable, accessible and productive cities	Complementary	National plan could help inform and deliver elements of the Cities agenda. Potential for governance arrangements and coordination functions to be aligned.
Policy solution 2: Mandatory minimum standards	2.1	Review and upgrade the National Construction Code	31	Advance the National Construction Code	Aligned	
	2.2	Trajectory for future Code upgrades			Gap	Additional ASBEC recommendation for the establishment of a forward trajectory.
	2.3	Improve compliance with the Code	32	Improve compliance with building energy efficiency regulation	Aligned	
	2.4	Expand, strengthen and accelerate GEMS	30	Deliver a new Equipment Energy Efficiency prioritisation plan	Aligned	
	2.5	Introduce minimum standards for rental properties			Gap	
	2.6	Investigate introduction of minimum standards for existing buildings			Gap	
Policy solution 3: Targeted incentives and programs	3.1	Ambitious targets and programs for Cth, State and Territory government operations	12	Improve energy productivity in government operations	Increase ambition	
	3.2	Programs to support local governments to improve their efficiency			Increase ambition	
	3.3	ERF review to identify and address barriers to participation for buildings	2.b	Market mechanisms to capture societal benefits -Emissions Reduction Fund and safeguard mechanism	Gap	Measures not aligned - ASBEC recommendation calls for review of ERF
	3.4	Commonwealth introduce green depreciation			Gap	
	3.5	States and Territories introduce incentives for high performing buildings, with priority for stamp duty concessions and differential council rates			Gap	
	3.6	States and Territories to introduce planning incentives			Gap	
	3.7	Existing EEO schemes should continue to be harmonised and integrated	2.a	Market mechanisms to capture societal benefits - Jurisdictional schemes	Increase ambition	
	3.8	EEO schemes should be introduced in Queensland, Western Australia, Tasmania and the Northern Territory				
	3.9	EEO schemes should begin to incorporate incentives for the replacement of non-electric appliances			Gap	
	3.1	Establishment of sectoral leadership groups in retail, health and industrial sectors	7	Recognise business leadership and support voluntary action in business	Aligned	
	3.11 & 3.12	Resource implementation of the Mid-tier Office National Pathway actions including the Building Retrofit Toolkit	9.b	Expand commercial building ratings and disclosure - Extend rating schemes to other building types	Aligned	
	3.13	End-to-end support programs for low-income households	4	Support best practice services for vulnerable consumers		ASBEC recommendation calls for stronger measures to support low-income households
	3.14	Minimum standards for public housing and financing support			Gap	
Policy solution 4: Energy market reform	4.1	Independent energy market industry Ombudsman			Gap	
	4.2	Appropriate incentive for distributed energy and energy efficiency in electricity tariffs	1	Transition to cost-reflective pricing	Increase ambition	ASBEC recommendation calls for stronger measures
	4.3	Mechanism to pass on to distributed generators the fair value of distributed electricity exports			Increase ambition	No specifically related NEPP measure (NEPP measure 19 - Emerging technologies in the electricity system is relevant but non-specific)
	4.4	Establish standards for connection of embedded generators and implement the recommendation of the Harper Review of Competition Policy to improve access to the electricity network	21	Reform governance to keep pace with change	Gap	NEPP measure relates to the Review of Governance Arrangements for Australian Energy Markets, and does not contemplate implementation of the recommendation of the Harper Review of Competition Policy. No NEPP measure specifically related to standardisation.
	4.5	Exemptions for Power Purchasing Agreement (PPA) providers			Increase ambition	No specifically related NEPP measure (NEPP measure 19 - Emerging technologies in the electricity system is relevant but non-specific)
Policy solution 5: Data, information, research, training and education	5.1	Develop a national built environment energy data and information strategy in partnership with relevant industry and research organisations			Gap	A number of NEPP measures address energy data and information, but the NEPP does not envision the development of a national strategy
	5.2	Improve access to energy consumption data	22	Develop an Energy Use Data Model for better planning	Aligned	
			23	Competitive smart meter rollout	Complementary	
			24	Improve the exchange of market data	Aligned	
	5.3	Expand mandatory disclosure to smaller offices and other building types	9.a	Expand commercial building ratings and disclsoure	Aligned	
	5.4	Mandatory disclosure of energy performance for residential buildings	5	Improve residential building energy ratings and disclosure	Increase ambition	ASBEC recommendation calls for more rapid implementation
	5.5	Develop a national built environment energy efficiency and emissions research agenda, and establish a permanent energy efficiency and	13	Support innovation and commercialisation	Increase ambition	
			18	Collaborate internationally		ASBEC recommendation calls for stronger and more specific measures
	5.6	Develop a national built environment energy efficiency and emissions education and training agenda	25	Build service provider capacity	Aligned	

Policy Solution 1 - Create a National Plan Towards 2050 Zero Carbon Buildings and improve governance

Recommendation 1.1: By June 2017, a working group involving a responsible Federal Minister, relevant governments, industry bodies and experts to develop a National Plan Towards 2050 Zero Carbon Buildings that includes:

- targets for emissions and energy in the built environment
- coordination of activity across levels of government and different government entities
- regular public reporting of progress
- public and industry engagement
- coordination and planning of research, education and training, and
- clear responsibility for implementation, review and updating over time.

Recommendation 1.2: As part of the development of a national plan, investigate the establishment of an independent Energy Efficiency Authority to coordinate energy efficiency policy development and implementation, and evaluation and reporting of the effectiveness of energy efficiency policies, for implementation by the end of 2017.

Rationale

Opportunities presented by energy efficiency and emissions reductions in the built environment sector are large but the impediments are numerous and complex. Numerous stakeholders are involved, including multiple levels of government, multiple different government departments, agencies and regulators, and multiple private and community sector stakeholders.

It is well recognised that overcoming the level of complexity presented by energy efficiency policy in particular requires supportive governance arrangements that include:

- A National Plan Towards 2050 Zero Carbon Buildings that includes long-term and interim targets;
- An entity responsible for energy efficiency policy and implementation;
- Coordination mechanisms;
- Clear accountability.[74]

In recognition of this, the 2010 Prime Minister's Task Group on Energy Efficiency recommended the establishment of a single Ministerial Council on Energy Efficiency to drive whole-of-government support for energy efficiency policy, and a complementary independent authority to co-ordinate action nationally.[75] Over two thirds of countries now have a form of 'permanent, government sanctioned entity responsible for energy efficiency policies and

[74] Meadowcroft, 2012.
[75] Australian Government, 2015b.

implementation'[76]. This recommendation was not implemented, and in the years since the recommendation was made, a number of attempts to progress energy efficiency policy have stalled. The most notable of these is the National Strategy on Energy Efficiency, which was developed and administered through COAG. Many of the measures in the Strategy were ultimately not progressed nor was any formal decision announced to abolish, halt or transition the Strategy. It appears to have simply 'fallen through the cracks'.

By contrast, stable and certain governance arrangements can send a strong signal to the community, companies and investors and underpin planning and investment of time, resources and effort to prepare and innovate. Two key measures are recommended:

1. The establishment of a national plan for zero carbon buildings
2. Consideration of the possible establishment of an independent Energy Efficiency Authority to coordinate policy development and implementation, and evaluation and reporting of the effectiveness of energy efficiency policies.

Relationship to the National Energy Productivity Plan

The National Energy Productivity Plan (NEPP) outlines a set of measures relating to energy efficiency in the built environment. However, the effectiveness of the NEPP in overcoming the complexity of buildings energy efficiency policy may be limited by the absence of:

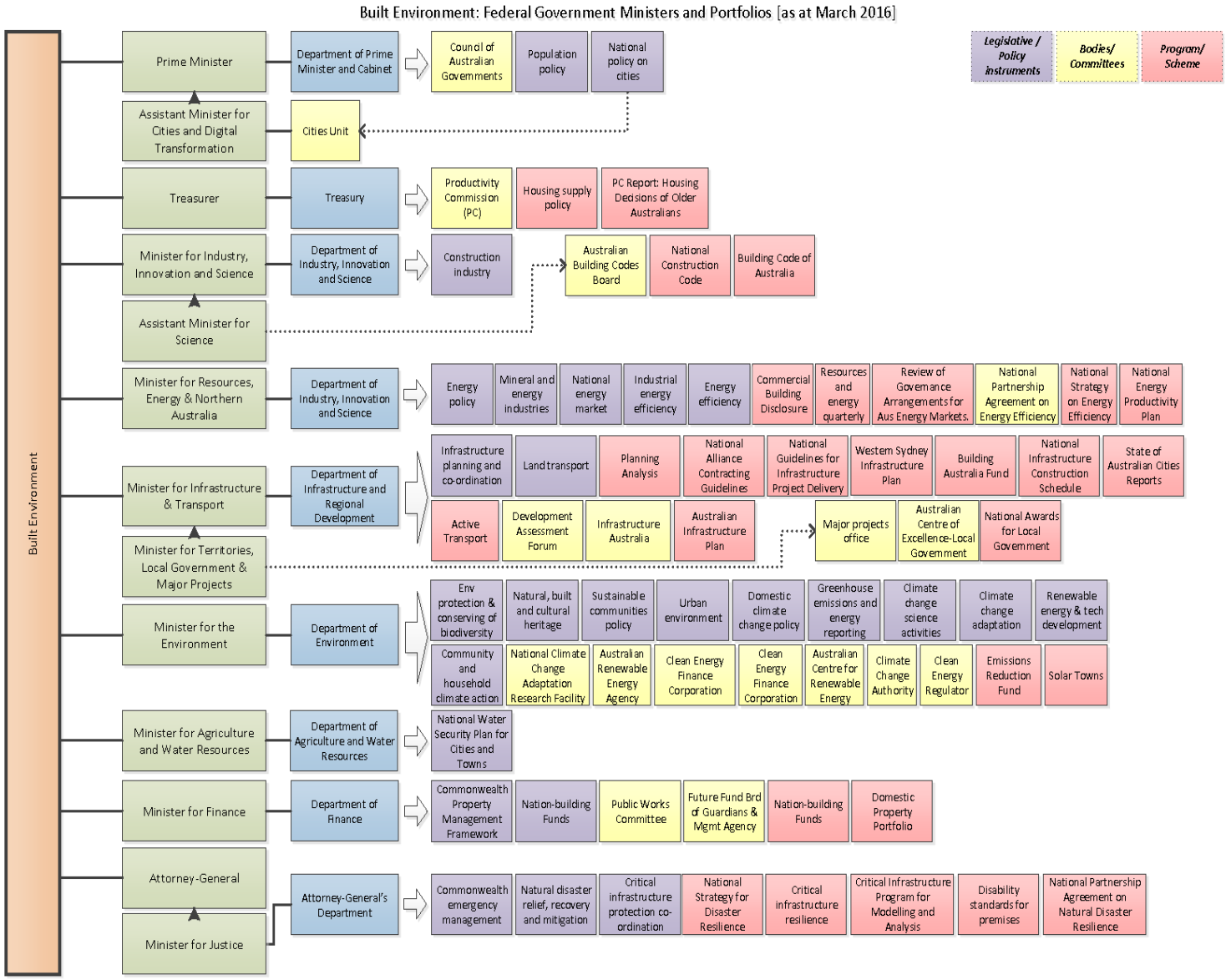
- Buildings-specific targets
- Regular public reporting requirements
- Associated funding for measures identified in the Plan

In addition, the Plan is much broader than buildings, which may constrain the capacity of the co-ordinating Minister (currently the Federal Minister for Energy and Resources) to undertake the level of coordination and engagement required.

Australia's policy landscape and governance arrangements related to built environment policy remain extraordinarily complex, as illustrated in Figure 47, produced in February 2016. While this map covers more than just energy efficiency and distributed energy, most of the policy instruments, government entities and policies identified are relevant to these issues. Further, this covers only the Federal level of government. State and local government are also important players.

[76] World Energy Council, 2010, p 45.

Figure 47: Map of Federal Government built environment landscape



A final issue is that the NEPP is focused on energy productivity, not emissions. As discussed above, the need to transition to a zero net emissions economy by around 2050 has implications for built environment energy policy. In particular, this end goal has implications for the lock-in of long-lived infrastructure that is not prepared to operate in a zero carbon environment.

Gas appliances are a prime example. Nearly all gas appliances within buildings can be switched to electric alternatives already, and considering the challenges involved in phasing out emissions in other sectors[77], which may require the purchase of offsets or sequestration of carbon, it is likely that gas appliances in buildings will not be a productive choice in a zero carbon environment. With an average life of around 10-15 years (but often much longer, particularly for less wealthy households), this implies that gas appliances should be disincentivised in the near future, and phased out by around 2030 at the latest. Similar considerations apply for building 'envelope'. The average building lifespan is around 28 years for commercial buildings and 47 years for residential[78], meaning that most of the buildings being constructed in the next 5-10 years will still be in operation in the 2040s and 2050s. These buildings will need to be compatible with a zero emissions environment in order to avoid unnecessary cost associated with offsetting, sequestration or replacement or refurbishment of redundant equipment and assets. This perspective makes for a very different calculation of what is the optimal level of energy efficiency or energy productivity of the buildings under construction today.

Timeline

Achieving a step change in buildings will require a sustained national effort. A National Plan Towards 2050 Zero Carbon Buildings dedicated to buildings will help to drive this effort, and coordinate actions across the country.

In 2016, many of the measures in the NEPP of relevance to buildings are under investigation, and industry input will be required to ensure that these measures are well designed. At the same time, additional measures recommended below should be further investigated and developed.

In the second half of 2016, a working group involving a responsible Federal Minister, relevant governments, industry bodies and experts could be established to develop the National Plan Towards 2050 Zero Carbon Buildings, incorporating measures from the NEPP and additional measures discussed below. It would be feasible to finalise the national plan by the end of 2016-17. The zero emission buildings plan should include annual public reporting of progress, and a major review in 2020 ahead of the 2020 UNFCCC[79] meeting.

[77] For example, technologies to completely eliminate emissions in cement production and agriculture have not yet been created.
[78] ClimateWorks analysis.
[79] United Nations Framework Convention on Climate Change.

Policy Solution 2 - Set rising mandatory minimum standards

Low motivation to prioritise energy performance of buildings and appliances, or to implement energy upgrades is a pervasive issue across many building owners and tenants and many service providers across the supply chain. Minimum energy performance standards can be a highly effective measure to overcome this issue by mandating improvements in energy performance in line with improvements in technology and processes. This is justifiable on the premise that consumers would choose higher performing buildings and appliances where doing so would place them in a better financial position, but are prevented from doing so by market failures such as information asymmetry and split incentives.

Regulated mandatory minimum standards are generally designed to deliver a 'minimum' level of performance, and as such are not suitable to deliver the full potential in buildings, and need to be complemented by mechanisms to incentivise performance beyond the minimum standard. However, if designed to incorporate a stable and predictable future trajectory, mandatory minimum standards can in themselves support these other mechanisms by sending a signal that regulation will be tightened in the future. This incentivises consumers and suppliers to prepare and innovate to develop solutions ahead of the tightened standards.

Standards for new buildings

Recommendation 2.1: Review and upgrade minimum energy performance standards for both commercial and residential buildings in the National Construction Code

Recommendation 2.2: Implement a trajectory for future upgrades to minimum energy performance standards in the National Construction Code which is aligned with the long-term goal of a net zero emissions economy by 2050

Recommendation 2.3: Improve compliance and State/Territory-level enforcement of standards

Rationale

Research shows that the minimum standard for commercial buildings significantly lags behind best practice, with Green Star rated new offices emitting around half the greenhouse gases of an office built to minimum standard. The minimum standard for commercial needs to be upgraded to reflect these improvements in technology and design capabilities. Analysis by Pitt&Sherry indicates the minimum energy performance standard for new buildings could be increased cost effectively[80] by 68 per cent for commercial buildings by 2020, and by 16 per cent for residential (excluding solar).[81]

[80] With a cost-benefit ratio of greater than 1

[81] Note that this analysis used discount rates of 5 per cent. Modelling undertaken for this report utilised a more conservative discount rate of 7 per cent.

New building standards have already improved the required energy performance of new commercial offices compared to ten year old offices by one third[82], and the move from 3.5-4 star requirements for homes to 5 star delivered an average 7% reduction in emissions for new homes, and the improved energy performance did not appear to come at a cost, with higher rated houses actually being built for around $5,000 less on average.[83]

A range of other potential improvements to the Code have been raised by various stakeholders, including reviewing and potentially upgrading the residential standards, establishing a forward trajectory to reduce regulatory burden and uncertainty, and redesigning the Code to be easier for practitioners to comply with, more useful for consumers, and easier for regulators to enforce, for example through a move to testing-based compliance. The last point could help address under-compliance which has been revealed through recent reports for both homes[84] and commercial buildings[85].

States and Territories are responsible for the enforcement of Code requirements. These governments should take steps to address under-compliance with minimum energy performance standards, including through support for the NEEBP. The NEEBP project is focused on working with industry and regulators to develop tools and resources to enable improved compliance with the NCC, and is continuing to work with pilot councils and industry experts to integrate its pilot NCC compliance tools into 'a web-based compliance product easily accessible to industry and regulators'. Ongoing support is required for this project and potentially others to monitor the impact of these compliance tools and track whether the lead to improved compliance or whether additional measures are required.

Timeline

ASBEC has established a separate Working Group to lead a project to seek improvements to energy performance standards for new buildings in Australia's National Construction Code. This can provide a vehicle for gathering and coordinating industry and expert input to potential Code improvements. This project is seeking to deliver a first report on potential Code improvements by June 2016, and a final report outlining recommendations by November 2016. The first stage of the project has been supported by the Victorian Government, but the second stage of the project requires funding support - this support would need to be received around May 2016 to enable the recommendations from the first stage to be progressed.

At the same time as stage one of the ASBEC project is ongoing, the Australian Building Codes Board is developing its 2016-17 work plan, which needs to be approved by the Building Ministers Forum[86]. It is important that this 2016-17 work plan include the development of increased mandatory minimum standards for commercial buildings, to be included in the 2019 Code update. This should occur by June 2016 in order to allow the ABCB to commence work on this matter in 2016-17.

[82] ClimateWorks, 2013
[83] CSIRO, 2013
[84] Ambrose M & Syme M, 2015
[85] State of South Australia, 2015
[86] The Building Ministers Forum includes Planning and Building Ministers from each State and Territory and the Commonwealth.

Standards for equipment and appliances

Recommendation 2.4: By June 2016, implement the recommendations of the GEMS review to expand, strengthen and accelerate future improvements in minimum equipment and appliance standards

Rationale

Like mandatory minimum standards for buildings, mandatory minimum standards for appliances can be a highly effective mechanism to overcome low motivation amongst many consumers to choose energy efficient appliances and equipment, even where these deliver financial returns over the life of the product.

The 2015 review of the Greenhouse and Energy Minimum Standards (GEMS) program provides a compelling summary of the evidence of how effective and financially rewarding mandatory minimum standards for equipment can be.[87] International impact includes reported net savings of €90 billion per year from European standards and labelling, equivalent to 1% of the EU's current GDP, and projected energy bill savings of US $900 billion by 2020 from US minimum equipment standards. In Australia, GEMS is projected to deliver between 60 and 70 Mt of greenhouse gas emissions (GHG) savings between 2014 and 2020, with an NPV of between $3.3 – 7.3 billion and a cost benefit ratio of 1.7 - 5.2. Before the introduction of mandatory minimum standards for household air conditioners, the rate of improvement in these appliances was around 0.5%, but grew to around 4% after they were introduced.

The 2015 review noted that Australian standards currently lag behind other countries and behind technological developments, and recommended the expansion of coverage and stringency of mandatory minimum standards for equipment and appliances, and improvements to the process for updating standards to accelerate updates and better align with international standards. Consideration should also be given to establishing a forward trajectory for mandatory minimum standards for appliances and equipment.

Timeline

The COAG Energy Council has released a response to the GEMS review[88], outlining timeframes for implementing each of the recommendations of the GEMS review over the period to April 2016. In addition, the NEPP includes a measure (Measure 30) to deliver a new prioritisation plan for the Equipment Energy Efficiency (E3) program, which it is understood is currently under development, although the timeline for implementation of this measure is not specified in the NEPP. Given these existing processes, it should be feasible to action the GEMS review recommendations by June 2016.

[87] DOIS, 2015

[88] *GEMS Review: Energy Council Response to the Recommendations*, July 2015, available via www.energyrating.gov.au/document/gems-review-2015-%E2%80%93-energy-council-response.

Standards for existing buildings

Recommendation 2.5: By the end of 2016, undertake a review led by a working group that includes relevant state and territory representatives and social services agencies to develop a proposal for introduction of mandatory minimum standards for rental properties, for implementation by June 2017

Recommendation 2.6: In 2017, undertake a review to investigate the need, options, benefits and costs of introducing minimum energy performance standards for existing buildings, for potential introduction from 2020

Rationale

Australia does not currently have mandatory minimum standards for energy performance of existing buildings except for major renovations, but mandatory minimum standards do apply for other building elements such as fire safety, where strong public benefit exists.

A strong public benefit already exists for rental properties. The poorest performing homes are often rental properties occupied by low income and vulnerable households, who have a greater need to contain living costs including energy costs, and less capability to engage with landlords to rectify very poor energy performance of rented properties. In this context, the introduction of mandatory minimum standards for rental properties could be justified as a consumer protection measure[89]. In addition to this, low income and vulnerable households are often the recipients of financial assistance from state and territory governments. Improving the quality of low income housing could reduce this burden, providing another reason to invest effort in this space.

The NEPP includes a project to develop a set of best practice guidelines for service providers to help 'reduce the barriers to vulnerable consumers effectively engaging with energy productivity measures and services'.[90] However, there are very strong structural barriers to low income households securing improvements in their rented homes, particularly the split incentive between renter and landlord, and the power imbalance between vulnerable renters and their landlords which means that many are reluctant to and not equipped to demand improvements. Mandatory minimum standards requiring the landlord to prove at the time of lease that the home meets the minimum standard would be much more likely to overcome these barriers than voluntary measures.

For existing buildings more broadly, the consumer protection argument is not as strong. However, minimum energy performance standards for existing buildings have been

[89] EEC, 2015
[90] NEPP Measure 4.

introduced in other countries as part of a broader strategy to reduce energy consumption and greenhouse gas emissions[91]. Introducing mandatory minimum standards for existing buildings may be justified on these grounds if other less stringent policy measures such as incentives and information fail on their own to drive sufficient levels of retrofitting activity. Simply providing a future date for the introduction of mandatory minimum standards for existing buildings may provide a sufficiently strong signal to spur additional retrofitting activity. It is noted that minimum standards for existing buildings would not necessarily align with standards for new buildings, and the National Construction Code may not be the appropriate mechanism for implementing mandatory minimum standards for existing buildings - rather this is likely to require action at a State and Territory level.

Timeline

The proposed review to develop a proposal for the introduction of mandatory minimum standards for low income and vulnerable households should be undertaken in 2016, for introduction at a State and Territory level in 2017.

The proposed review to investigate options for the longer-term introduction of mandatory minimum standards for existing buildings should be undertaken by the end of 2017. By this time, the NEPP will have been in place for two years, and there will be initial indications of the effectiveness of the suite of measures provided on retrofitting rates. This evidence will inform the proposed review, and help determine whether or when mandatory minimum standards should be introduced. An indicative timeframe for introduction of standards for existing buildings may be around 2020 ahead of the 2020 international UNFCC meeting where Australia will be asked to submit a more ambitious emission reduction target.

[91] For example, the French government applied mandatory minimum standards to existing homes in 2000. GBPN, 2014

Policy Solution 3 - Targeted incentives and programs

Policy Solution 3A - Leverage government market power

Government is a major presence in existing commercial buildings, particularly health and education (of which more than two thirds is public schools and universities), offices (of which 6 per cent is government-occupied) and other public buildings. In total, government-occupied premises account for 14 per cent of the identified emission reduction opportunity across commercial buildings.

Government can leverage this considerable market power to directly fund improvements to its own property assets and influence improvements in buildings which it occupies or over which it can exercise some level of influence.

Recommendation 3.1: Commonwealth, State and Territory governments should set ambitious targets for government-owned and occupied buildings and for government procurement, and implement mechanisms to facilitate these improvements

Recommendation 3.2: Commonwealth, State and Territory governments should jointly fund programs to support local governments to improve their efficiency

Rationale

Improving government buildings can:

- **Provide leadership and demonstration:** Improving government buildings can demonstrate to building owners more broadly the potential to improve energy performance and the benefits of doing so.
- **Deliver major budget savings:** For example, the former Victorian Greener Government Buildings (GGB) program delivered 28 large-scale projects with average savings of over 37 per cent across water, energy and emissions, and a return of investment of at least 12 per cent for all projects.
- **Reduce costs and build skills and capability:** Government leadership helps to accelerate deployment of new technologies and reduce the cost for others, and helps build capability and scale amongst energy efficiency service providers by providing a large, stable and certain flow of work. This can support development of effective business models for delivery of project, which can then be applied to other sections of the market.
- **Improve public facilities such as schools and hospitals**, with potential flow on benefits for health and educational outcomes.

A number of Australian governments already have targets for their buildings, for example the South Australian Strategic Plan targets a 30 per cent improvement in the energy efficiency of government owned and occupied buildings by 2020[92]. In addition, a number of government asset upgrade programs are already in place or in development. For example, the NSW Government Resource Efficiency Program requires:

- Energy efficiency projects to be undertaken on all government owned or leased sites
- Minimum 4.5 star NABERS Energy ratings to be achieved by June 2017 for offices and data centres
- Mandatory minimum standards for new electrical appliances and equipment
- Mandatory minimum standards for new buildings and fitouts from January 2015
- Identification of opportunities for solar leasing

Other measures that could be considered for inclusion in government buildings programs include:

- Establishing a mandate that government officers only use NABERS or Green Star accredited hotels that meet a best practice rating threshold.
- The establishment of a mandate that government construction contracts use Building Information Modelling.[93]
- Requiring contractors on government construction projects to meet a minimum level of energy efficiency training or accreditation, for example through the Master Builders Association[94] or Housing Industry Association. In addition, government could share its 'green procurement' templates, tools and resources with the private sector to help mainstream these approaches.
- Requiring all government building projects to achieve credible, third party energy certification.[95]

For all levels of government, there is often a lack of skills and expertise required to engage and manage energy experts. The States and the Commonwealth can jointly or individually fund the establishment of teams available to government officers whose responsibility it is to implement energy performance improvements, similar to the resource provided through the NSW Government Resource Efficiency Program (although this resource is not currently available to local government).

Timeline

These programs are now well understood and could be adopted relatively rapidly. The Commonwealth is currently in the process of reviewing and revising its own policy by the end of 2016. Other jurisdictions that do not have targets and associated programs should review existing programs in 2016 and seek to implement their own programs and targets by June 2017.

[92] South Australian Government, 2011, Target 61.
[93] The UK has recently implemented this requirement for all centrally managed government procurement. See Building Information Modelling Task Group, 2015.
[94] See www.mbavtraining.com.au/courses/sustainability/.
[95] In the US this has been found to help deliver higher energy performance by holding contractors and project teams accountable for incorporating green building requirements. See GAO, 2015.

In the same timeframe, the Commonwealth, States and Territories should aim to agree either separately or jointly to establish a funding mechanism to support local government to implement energy performance improvement projects.

Policy Solution 3B - Implement incentives to accelerate action

Notwithstanding the potential benefits, improving energy efficiency remains a low priority for many homeowners, renters, commercial building owners and tenants. This is a result of a mix of barriers and impediments, including:

- The relatively low expenditure on energy compared to other spending
- Complexity or perceived complexity of energy upgrade opportunities
- High upfront costs and long payback periods

Incentives can drive accelerated uptake of energy upgrade opportunities for:

- **New buildings:** While mandatory minimum standards can ensure a minimum level of performance, incentives can drive higher performance and innovation, helping to reducing the cost for others, building capacity amongst service providers, and demonstrating the potential and benefits;
- **Existing buildings:** Existing building retrofits have proven the hardest opportunity to capture, with generally low motivation amongst decision makers and a lack of strong regulatory drivers. Incentives can help capture the attention of building owners and tenants and motivate them to seek out and implement retrofitting opportunities;
- **Appliances and equipment:** As with new buildings, mandatory minimum standards can ensure a minimum level of performance, but incentives can drive higher performance and potentially bring forward investment to deliver earlier gains.

Providing access to the Emissions Reduction Fund for buildings

Recommendation 3.3: In the second half of 2016, a review should be undertaken of the Emissions Reduction Fund to identify and address barriers to participation for buildings, including the possibility of redirecting funds to support emissions reductions through Energy Efficiency Obligation schemes

Rationale

The Emissions Reduction Fund (ERF) is the Federal Government's central policy mechanism to drive emissions reductions. The ERF aims to target least-cost emissions reductions but to date has not had strong uptake in buildings where many of the lowest cost opportunities exist. Currently there is only one ERF method[96] available for buildings, the 'commercial building energy efficiency' method, which allows projects which deliver improvements in a building's NABERS energy rating to bid for funding.[97] Of the 129

[96] Methods set out the rules for estimating emissions reductions ensure reductions are genuine and additional to BAU (Department of Environment, 2015)
[97] Department of Environment, 2015

contracts awarded in the second ERF auction, only three projects used the commercial buildings method.[98] In its current form, the ERF appears to be unsuited to incentivising opportunities in buildings.

Industry experts cite the following as reasons for the ERF's failure to attract bids from the buildings sector:

- A barrier to entry presented by minimum bid sizes of 2,000 tonnes of annual emissions savings
- A requirement for multi-year contracts to be signed, which can create a risk that if savings do not eventuate, the building owner may be financially liable
- A combination of relatively high transaction costs to prepare and aggregate bids, alongside uncertainty about the price that will be received, and an expectation that the price maybe be relatively low compared to the other potential benefits of a project.

If the objective of the ERF is to provide financial incentives for least-cost emissions reductions, these issues need to be resolved by adjusting the design of the ERF. These could include:

- Reducing the minimum bid size for buildings
- Allowing partial opt-outs for building owners if expected emissions savings are not delivered in a particular year
- Establishing separate auction streams for buildings to reduce uncertainty about the likely price

These issues require further investigation. The review should include consideration of whether a portion of the ERF funds should be redirected to other incentives or programs better suited to buildings. However, the review should not prevent the introduction of other incentives in the meantime. Any such incentives could be designed to exclude projects receiving funding through the ERF to avoid double-dipping.

Timeline

The third ERF auction is scheduled for 27-28 April 2016. At the time of publication of this report, the auction had not yet been held, however it is understood that there is not expected to be a significant increase in use of the buildings method. The proposed review should be undertaken in the second half of 2016.

[98] Australian Government, 2015 a

Tailored incentives to accelerate emissions reduction activity in buildings

Recommendation 3.4: The Commonwealth should introduce green depreciation to accelerate uptake of energy upgrades to existing commercial buildings at the time of refurbishment

Recommendation 3.5: States and Territories should introduce incentives for high performing buildings, and as a priority investigate the introduction of stamp duty concessions for homes that meet a set and rising energy performance threshold, and the introduction of differential council rates in partnership with local government

Recommendation 3.6: States, Territories and local government should work together to introduce planning incentives for high performing new buildings

Rationale

Incentives that are tailored to the built environment sector are likely to have greater impact, especially if they are able to leverage existing drivers that are a higher priority than energy for building developers, purchasers, owners, and occupants.

The *Second Plank* report[99] undertook a review of available incentive mechanisms for buildings, and identified the following mechanisms:

- Private sector incentives, including:
  - White certificates (or Energy Efficiency Obligation schemes);
  - Energy retailer financed improvements
  - Green depreciation
  - Rates and charges relief, including discounts for high performing buildings on council rates, stamp duty or other charges;
  - Density bonuses, such as additional floor allowances for new developments that meet a threshold energy performance;
  - Green doors, where planning processes are expedited for 'green' developments;
- Publicly funded incentives, including:
  - Environmental qualifier for first owner's grants
  - Green banks

At the time, ASBEC recommended green depreciation and public funding of retrofits as priority incentives:

- **Green depreciation:** Green depreciation was recommended as one of the few ways in which government can influence building owners to include green measures in planned refurbishments. Green depreciation would apply to 'green' refurbishment capital expenditure and would allow the deferment of tax by reducing taxable income in early years in exchange for bringing forward investment. By allowing investors to defer tax payments, green depreciation can reduce the 'timing gap' problems of

[99] ASBEC, 2008

energy efficiency investments, where early capital expenditure must be incurred at the outset but financial savings accrue over the life of the asset. Green depreciation would appear as a revenue loss on government budgets, but would be offset by increased tax revenue in later years. This measure would need to be implemented by the Commonwealth government.

- **Public funding of retrofits:** Public funding of retrofits includes subsidies, rebates and grants intended to close the 'payback gap' and provide additional incentive to undertake investment in energy efficiency.

The case for green depreciation remains strong, and is recommended as a priority for the Commonwealth Government. This could drive action in particular in commercial building retrofitting.

In relation to public funding of retrofits, a range of public funding measures already exist, including subsidies for the installation of solar PV systems through the Commonwealth Renewable Energy Target, and subsidies for the replacement of inefficient appliances applied at a State level.

Two other measures have been identified by ASBEC as high priority for implementation by States, Territory and local governments:

- **Stamp duty concessions** for homes, which could have a similar impact to green depreciation by targeting the point at which homeowners are considering making investments in their home prior to sale;
- **Planning incentives** such as density bonuses and green door policies, which could support accelerated deployment of high performing new buildings by targeting one of the highest priorities for new building developers - the cost, time invested and uncertainty of planning processes.

It is also noted that a low level broad-based carbon abatement incentive (e.g. low level carbon price or emissions trading scheme) would be expected to drive some additional effort and attention by buildings stakeholders to energy and emissions, but targeted incentives or a much higher broad-based incentive would be needed to drive substantial additional actions in buildings.

Timeline

The Commonwealth is currently investigating potential reforms to the tax system. It is appropriate for green depreciation to be considered in the context of these reforms.

A number of States and Territories are currently developing energy efficiency and climate change mitigation strategies, including South Australia, Queensland and Victoria, and the potential for state-level incentives should be considered in the context of these reviews.

Expanding and strengthening retailer Energy Efficiency Obligation schemes

Recommendation 3.7: Existing Energy Efficiency Obligation schemes should continue to be harmonised and integrated, including rewarding deep retrofits by introducing project-based methodologies

Recommendation 3.8: By June 2017, Energy Efficiency Obligation schemes should be introduced in Queensland, Western Australia, Tasmania and the Northern Territory, and these should be designed to integrate with existing schemes

Recommendation 3.9: Energy Efficiency Obligation schemes should begin to incorporate incentives for the replacement of non-electric appliances alongside decarbonisation of grid electricity, and immediately be reviewed to avoid incentivising installation of non-electric appliances

Rationale

Energy Efficiency Obligation schemes are in place in New South Wales, Victoria, South Australia and the ACT. These schemes reward energy consumers who reduce energy consumption (e.g. through replacement of light globes) by requiring energy retailers to fund a set amount of energy efficient improvements each year. Energy Efficiency Obligation schemes have successfully incentivised third party aggregators to seek out and implement energy efficiency improvements in households and businesses.

A number of improvements could be made to existing Energy Efficiency Obligation Schemes to increase their impact:

- **Harmonise and integrate schemes:** Schemes are reviewed regularly to consider the inclusion of new technologies, products and methods. Harmonisation or integration of these processes between the different state schemes would reduce transaction costs, reduce the cost of expanding to other states and territories, reduce administrative costs particularly for smaller jurisdictions and reduce the cost of reviews and updates. Harmonisation could extend to reporting to ensure consistent data on the energy, emissions and cost savings achieved.
- **Include incentives for replacement of non-electric appliances:** As discussed above, gas and other non-electric appliances will need to be phased out, and Energy Efficiency Obligation schemes can begin to incentivise this switch, and need to avoid incentivising the replacement of inefficient electric appliances with more efficient non-electric appliances (e.g. replacement of electric resistance water heaters with gas water heaters).
- **Incentivise deeper retrofits:** A widespread concern with Energy Efficiency Obligation schemes is their ability to deliver deep retrofits, and indeed the risk that they can remove all of the ‘low hanging fruit’ in existing buildings, undermining the business case for returning to capture the harder or higher cost measures. Introducing project-based methodologies could encourage deeper retrofits, for

example the NSW scheme rewards projects that demonstrate an overall NABERS rating improvement.[100]

Those jurisdictions which do not have schemes (Queensland, WA, Tasmania and the Northern Territory) should introduce schemes.

Timeline
Processes are already under way to harmonise and integrated schemes in Victoria and New South Wales. These processes should continue and be extended to other jurisdictions.

Jurisdictions that do not have schemes should aim to introduce schemes by the end of the 2016-17 financial year, drawing on the experience of existing schemes.

The proposed inclusion of switching away from electric appliances in schemes needs to be introduced alongside decarbonisation of electricity supply. These measures should be introduced first in jurisdictions with a rapidly decarbonising electricity supply, for example South Australia over the next 2-3 years, before being rolled out to other jurisdictions in the medium-term (3-5 years).

Policy Solution 3C - Facilitation and support for distinct market segments

The breadth and diversity of the built environment sector is a major challenge for policy development. Government can tackle this issue by developing targeted approaches for particular market segments. Priority segments include:

- Market leaders
- Mid-tier building owners
- Low income and vulnerable households

Market leaders

Recommendation 3.10: Consider the establishment of leadership groups in retail, health and industrial sectors, to support innovation, develop collaborative solutions to common industry barriers and encourage mainstreaming of best practices

Rationale
Advances made by market leaders can have a substantial direct impact on emissions. It can also have an effect on the broader market by demonstrating the potential for improvement and the benefits of doing so, and by changing mainstream practices within the supply chain.

[100] The Victorian Government is currently undertaking a review into the possible introduction of project-based methodologies into its scheme. See www.energyandresources.vic.gov.au/energy/about/legislation-and-regulation/energy-saver-incentive/scheme-documents/Consultation-on-Project-based-assessments-in-the-VEET-scheme-October-2015.

There is an opportunity for government to lead or support industry-led groupings of market leaders in particular sectors or geographic regions in order to accelerate action.

The Better Buildings Partnership (BBP) is an excellent example of this kind of approach. BBP includes the major landlords and property managers of more than half of the Sydney city centre's commercial office floor space. Its aim is to 'develop collaborative solutions and initiatives to overcome ... barriers and achieve substantial improvements in the environmental performance' of members' buildings. A practical example of this approach is the BBP's best practice leasing standard, which is helping to mainstream the inclusion of green building measures in standard leases. This has helped drive an increase in the use of green leases to over 60 per cent in 2014.[101] In 2015, the Partnership reported that landlords in Sydney were more than halfway to their goal of cutting emissions by 70 per cent by 2030.[102] The City of Sydney has provided strong support for the BBP, including through Secretariat support.

This is particularly the case in sectors where there is consolidation of building development, ownership, management or occupancy within a few very large players. Table 6 outlines the consolidation of building ownership across the key building types, and shows that there is a high level of concentration of new building development for commercial segments. For residential development, there is a moderate level of concentration, with the top 100 developers controlling one third of the market. The ownership of existing buildings is much more fragmented, particularly for residential buildings. The highest levels of consolidation of ownership are found in office, retail, industrial and health sectors, where large companies are estimated to control between one third and two thirds of the market.

A similar approach could be taken in other sectors where a body of leading organisations with substantial market presence exists. In particular, consideration should be given to the establishment of this kind of group within the retail, health and industrial sectors where there is strong consolidation (see Table 7). Large residential developers also control a reasonable share of the new housing market, and a similar approach could be taken. The Collaborative Sustainable Housing initiative in NSW may be a good starting point for this grouping.

[101] BBP, 2014.
[102] BBP, 2015.

Table 7: Consolidation of building ownership and development[103]

Asset class	Level of consolidation
Residential	Developers exercise a high level of influence of housing design and construction. The top 100 developers control one third of the market, remainder is small developers. Ownership is extremely fragmented across millions of homeowners, landlords and tenants
Office	Institutional investors cover over half of the market by value[104]
Retail	Institutional investors cover over 90 per cent of the market by value[105]
Industrial	Institutional investors cover almost half of the market by value[106]
Health	Strong consolidation with three players controlling over two thirds of the market
Education	Consolidation of universities, but schools are reasonably fragmented, but there are existing relationships with government. State governments are the main driver of new developments.
Accommodation	Reasonably fragmented

[103] Unless otherwise indicated, content is based on input from industry experts
[104] Higgins (2013)
[105] Ibid
[106] Ibid

An alternative approach to the sectoral approach outlined above could include working with leaders in industry, local government and local communities to allocate particular geographic areas (e.g. urban precincts, regional centres, small towns) as cooperative 'clusters'. An example of this approach is the 2030 Districts initiative in the US, which has established districts in ten US cities involving a partnership between building owners, occupants, service providers, community representatives and local government[107]. The districts commit to targets for energy, water and transport improvements, and work together to progress towards these. In addition, a national network linking all the Districts has been established to share knowledge more broadly. Federal, State and local governments should consider working together to fund and establish this model in Australia.

Timeline
Expanded models for industry leadership groups could be developed in 2016 by local government regions or states currently reviewing energy and climate change strategies, for implementation as pilots in 2017, and potential expansion in 2018-19.

Small buildings

Recommendation 3.11: Resource the implementation of the Mid-tier National Pathway actions including the Building Retrofit Toolkit development and deployment, and support the industry led development of an energy efficiency pathway for the mid-tier retail sector.

Rationale
Offices and retail represent the largest share of the identified opportunity in the commercial sector.

As discussed above, in recent years, energy efficiency performance in the top tier of the office property market – generally Premium and A Grade assets held by property institutions – has increased significantly. However the balance of the commercial office building sector (those B, C and D-grade buildings commonly defined as the 'mid-tier') operate differently, and still face significant barriers to realising these energy savings and the associated benefits.

The opportunity is significant. Mid-tier offices are estimated to make up 52 million square meters of the 64 million square meters of office space in Australia, with an estimated 80,000 individual buildings and 'have lagged significantly in implementing energy retrofits and have lower NABERS Energy ratings (average of 2.4 stars), if at all.'[108]

[107] See www.2030districts.org/
[108] GBCA, 2015b

Mid-tier building owners are diverse in their size, business structure, investment strategy, risk appetite and understanding of energy efficiency benefits and opportunities. A multifaceted approach to connect and transform the sector is required.

There are a range of organisations are working to lift the energy efficiency performance of mid-tier office buildings. In 2015, the Green Building Council of Australia, with support from the Commonwealth Department of Industry, convened over 50 industry stakeholders to develop the *Mid-tier commercial office buildings in Australia: A national pathway to improving energy productivity*[109] ('Mid-tier Office National Pathway'). The Mid-tier Office National Pathway serves as an umbrella framework to guide the work of the different collaborators.

For example the Energy Efficiency Council recently completed *Building Retrofit Toolkit ('BRT') Scoping Study* that delivers against action item 1.3 and sets out a clear program for connecting with mid-tier owners and empowering them to take action.

Given the high level of established industry collaboration and investment to date, government should ensure appropriate resourcing of the Mid-tier Office National Pathway actions including BRT development and deployment. A similar approach should then be taken in the mid-tier retail sector.

Timeline
The Mid-tier National Pathway actions are underway and with appropriate resourcing could be fully delivered within five years.

Less work has been done on the retail sector. A feasible timeline for development of a plan for the retail sector is by June 2017.

Low income households

Recommendation 3.12: The Commonwealth, States and Territories should develop end-to-end support programs for low income households, building on the lessons learned from the Low Income Energy Efficiency Program

Recommendation 3.13: State and Territory governments should establish rising mandatory minimum standards for public housing and facilitate funding mechanisms to facilitate public housing retrofits

[109] GBCA, 2015b.

Rationale

Low income households tend to live in more inefficient dwellings than other households, and spend proportionally more of their household income on energy.[110] They often face persistent barriers which prevent them or their landlords from investing in energy efficiency to reduce energy costs, such as the split-incentive between landlords and tenants. This issue is particularly prohibitive for tenants in public and community housing[111].

Poor housing can increase the financial and health vulnerability of low income households, creating a strong rationale for establishment of targeted end-to-end programs aimed at low income households[112], including financial support and sustained facilitation support.

These programs should include an emphasis on engaging with the social services sector, community housing operators, local governments, and energy retailers with hardship programs, to build on these groups' established relationships with vulnerable households. Programs should also draw on the lessons learned from the Commonwealth Low Income Energy Efficiency Program, which funded trials of approaches to delivering energy efficiency services to low income households. The NEPP includes a measure[113] focused on developing a best practice guide for service providers working with vulnerable households. This process should also seek to identify additional support required from government.

Further options worth investigating include:

- Setting specific energy efficiency targets for low income households in Energy Efficiency Obligation Schemes, drawing on the South Australian example
- Setting mandatory minimum standards for rental homes to help prevent the lease of very poorly performing dwellings (see above).
- Identifying opportunities to finance new builds and building upgrades for highly efficient social housing, such as the recent initiatives by the Clean Energy Finance Corporation.

In addition to this, State and Territory governments should establish mandatory minimum standards for public-owned housing that increase over time and facilitate financing mechanisms (e.g. the Greener Government Building or NSW Government Resource Efficiency Program models) for upgrades of public housing. There are currently more than 320,000 public housing dwellings in Australia.[114] This could unlock emissions reductions at the same time releasing some of the pressure that public housing maintenance costs put on government budgets.

Timeline

NEPP measure 4 is due to report back by the end of 2016. This process should include investigation of what additional support the social services sector requires from government

[110] ABS, 2009; CEFC, 2016.
[111] CEFC, 2016.
[112] One Million Homes, 2015
[113] NEPP Measure 4.
[114] CEFC, 2016.

to support low income and vulnerable households to improve reduce their energy costs. Additional support mechanisms should be developed and implemented in 2017.

State and Territory Governments should investigate mechanisms to allocate additional funding to public housing retrofits in 2016, for implementation in 2017.

Policy solution 4 - Energy market reform

Involvement in energy market reform processes

Recommendation 4.1: Establish an independent industry Ombudsman or other independent authority to investigate and recommend solutions to address energy market barriers experienced by distributed energy, energy efficiency and built environment stakeholders over time, and voice their concerns in the context of energy market processes and reforms

Rationale

The current rules and regulations governing the operation of the National Energy Market (NEM) affect uptake of distributed energy and energy efficiency in a variety of ways:

- **Electricity tariff structures** can incentivise or disincentivise distributed energy and energy efficiency, with high fixed tariffs providing a disincentive and tariffs based more on the level of consumption providing a greater incentive;
- **Value for electricity exported** determines to a large degree the attractiveness of distributed energy installations;
- **Costs of connection** of distributed energy systems to the grid can affect the case for new distributed energy installations
- **Retailer licensing requirements** for distributed energy power purchasing agreements (PPAs)

The processes through which electricity tariffs, 'feed-in tariffs' for exported electricity and costs of connection to the electricity grid and retailer licensing requirements are set are extremely complex, limiting the ability of non-technical experts including built environment stakeholders to participate and ensure that these parameters do not unduly disincentivise distributed energy and energy efficiency improvements. Indeed, a number of reform processes are currently in progress that could have a major impact on energy efficiency and distributed energy, including the shift to 'cost-reflective pricing' and new standards for small-scale connections to the grid. The establishment of an independent ombudsman or other independent authority investigate and recommend solutions to address energy market barriers experienced by distributed energy, energy efficiency and built environment stakeholders over time, and voice their concerns in the context of energy market processes and reforms, would help ensure that these processes support and do not disincentivise cost-effective uptake of energy efficiency and distributed energy.

Timing

A number of energy market processes are taking place at the moment or in the near future. The establishment of an independent agent to coordinate input to these processes is therefore urgent and should be scoped in the first half of 2016 for implementation in the second half of 2016.

Impact of electricity tariffs

Recommendation 4.2: Ensure that electricity tariff structures provide an appropriate incentive for distributed energy and energy efficiency, including through the current shift to 'cost-reflective pricing'

Electricity distribution network service providers are currently implementing a shift towards more cost-reflective pricing for electricity. This may result in an increase in fixed charges - generally daily charges that are imposed regardless of how much electricity is purchased from the grid. If fixed charges become a higher proportion of electricity bills, this could create a strong disincentive for the installation of distributed solar PV, as well as a disincentive to improving energy efficiency. This is because fixed charges remain the same regardless of how much electricity is consumed on-site.

With technology costs for solar PV and battery storage likely to reduce to such low levels, some analysts have predicted that disconnection from the electricity grid will become an attractive proposition for a significant number of building owners, particularly households. Disadvantageous tariff structures could accelerate this process, and lead to what many commentators have described as a 'death spiral' where disconnections force distribution network service providers to increase charges on remaining customers, which drives more customers to disconnect.

Electricity network companies currently develop their own proposals for tariffs, which can make it extremely difficult for non-technical experts in energy market regulations to monitor these and participate in reform processes such as the shift to cost-reflective tariffs. A better process may be to establish a national process similar to the CSIRO Future Grid Forum to develop 'model tariff structures' in consultation with a range of industry and consumer groups that would encourage economically efficient investment in the energy market including in energy efficiency and distributed energy. It is not expected that these model tariff structures would be mandatory, but could help guide decision-making by networks and the Australian Energy Regulator.

Timing

The process for shifting to 'cost-reflective' pricing is currently underway, with new pricing arrangements set to take place from 1 January 2017[115]. Accordingly, it is urgent that this issue be investigated and potential solutions identified in 2016, to both inform the process of setting new tariffs and respond to the impacts that new tariffs might have when they come into force in 2017.

[115] See AEMC, Distribution Network Pricing Arrangements, www.aemc.gov.au/Rule-Changes/Distribution-Network-Pricing-Arrangements#

Value of exported electricity

Recommendation 4.3: Establish a mechanism to identify and pass on to distributed generators for the fair value of distributed electricity exported to the electricity grid

Rationale

Excess electricity generated on a building and exported to the grid current receives a very low rate (between 5 and 8 cents per kWh depending on the jurisdiction) when compared to the value for use on-site. However, there may be benefits provided by distributed generators that are not currently recognised or rewarded, including:

- **Lower burden on grid infrastructure:** Electricity generated locally is usually consumed nearby, imposing less of a burden on the electricity distribution network than electricity sourced from a centralised generator (e.g. a coal-fired power plant located outside a city). For this reason, the City of Sydney, Property Council of Australia and Total Environment Centre have recently proposed a rule change[116] to the Australian Energy Market Commission which would require distribution network service providers to calculate the value of distributed generators operating in their network and pass on this value to them.
- **Reduced peak demand:** Distributed energy paired with battery storage could be used to store energy from distributed solar systems at periods when demand is low and release this back into the system when demand is high. This can reduce the costs across the electricity network of meeting demand at peak periods, by reducing the need for higher cost 'peaking' plants that only operate at peak times, and by reducing the load on electricity transmission and distribution infrastructure. Again, the electricity market currently does not provide a mechanism for the value of this potential benefit to be passed on to the distributed generator.[117]

While it appears clear that a mechanism should be in place to facilitate distributed generators to receive the full benefits that their system provides into the electricity system, there is not yet agreement on the precise mechanism for doing so. Identifying an appropriate mechanism should be a priority for COAG and energy market regulators.

[116] See www.aemc.gov.au/Rule-Changes/Local-Generation-Network-Credits for details.
[117] CEC, 2016.

Timing

Two existing processes are relevant to this recommendation:

- The Victorian Government is currently undertaking an *Inquiry into the True Value of Distributed Generation to Victorian Consumers*
- The AEMC is considering a proposed Rule Change from the City of Sydney to credit local generators for the network value of excess electricity exported to the grid

Following the completion of these proposals and depending on their outcome, the Commonwealth, States and Territories should undertake an inquiry to determine the appropriate mechanism for calculating and passing on the value of exported electricity.

Cost of connection

Recommendation 4.4: Establish standards for connection of embedded generators and implement the recommendation of the Harper Review of Competition Policy to improve access to the electricity network

Rationale

Connection of distributed generators to the electricity network presents a strong barrier to further uptake of medium-scale solar PV and other distributed energy, as a result of:

- A lack of standardisation
- Un-transparent costs and delays
- A lack of an effective access regime

Two existing reform processes could help address these issues and should be supported:

- The Clean Energy Council is currently managing a project which is investigating the development of standards for distributed generators of between 10 kW to 5 MW[118]. The study will recommend whether standards should be adopted, and is due to report in June 2016. Standards would help reduce transaction costs associated with multiple different processes and standards for grid connection in place across the different electricity network companies.
- The Harper Review of Competition Policy recommended that the Australian Energy Regulator's role be divided between the ACCC (for consumer issues) and a new national access and pricing regulator, responsible for infrastructure regulation and access across a number of different industries[119]. Shifting the role of regulating network access to a new access and pricing regulator could help reduce barriers to entry for distributed generators in the same way as has occurred with telecommunications.

Timing

[118] Clean Energy Council, Future Proofing in Australia's Electricity Distribution Industry, http://fpdi.cleanenergycouncil.org.au/

[119] http://competitionpolicyreview.gov.au/final-report/.

The CEC project is due to report in June 2016, which would allow for implementation in 2017.

Implementing the Harper Review recommendation will require significant work and should be commenced immediately.

Retailer licensing requirements

Recommendation 4.5: The Australian Energy Regulator (AER) should provide exemptions for Power Purchasing Agreement (PPA) providers as has been provided already in Victoria to facilitate local sharing of distributed solar and other distributed energy

Rationale
The AER is currently developing a response to its consultation on innovative product offers in the national electricity market.[120] This could lead to the introduction of exemptions for PPA providers, as has been done in Victoria.

Exemptions for PPA providers would significantly reduce transaction costs and barriers to entry for businesses seeking to install distributed energy systems including solar PV and sell the electricity to the occupants of the building or nearby buildings. This model could apply to building owners seeking to install solar PV and on-sell the electricity to tenants, or to energy companies that install solar PV on others' roofs and sell the electricity to the tenants.

Timing
This reform could be implemented in the short term, as the regulatory process is already very progressed.

[120] http://www.aer.gov.au/retail-markets/retail-guidelines/regulating-innovative-energy-selling-business-models-under-the-national-energy-retail-law

Policy Solution 5 - Improve energy data, information, research, education and training

Energy consumption is not a field in which most consumers have strong knowledge or interest. Most consumers are focused on the services energy enables - lighting, heating and cooling, information technology etc. In addition, energy is complex. Energy use is highly variable across the building sector, efficiency projects are often technically complex, and the opportunities to improve energy performance are fragmented across numerous small projects and decision makers. In order to achieve large-scale improvements in the energy performance of buildings, this complexity must be both reduced, so that consumers can understand the choices available to them, and outsourced to third party service providers. This requires improvements in energy data, information, research, education and training.

Planning for ongoing improvements in energy data and information

Recommendation 5.1: By 2017, develop and implement a national built environment energy data and information strategy in partnership with relevant industry and research organisations, including a coordinated process for improving and expanding energy and environmental performance rating tools

Rationale

Energy data and information is currently managed by a range of different organisations:

- **Electricity distribution network service providers** collect energy consumption data via gas and electricity metering infrastructure
- **The Green Building Council of Australia** administers the Green Star energy and environmental rating system
- **The NABERS team within the NSW Office of Environment and Heritage** administers the NABERS energy rating system
- **The NatHERS administrator within CSIRO** administers the NatHERS residential energy rating system

Many other policies and programs rely on the data collected and tools administered by these organisations. For example, the Commercial Building Disclosure Scheme requires disclosure of energy performance based on NABERS ratings, while the National Construction Code references the NatHERS residential rating tool to set the minimum energy performance standard for homes.

A national strategy should be developed to ensure that ongoing improvements in energy data and information are coordinated and funded. This strategy should include:

- Opportunities to expand and improve the NABERS rating system;
- Opportunities to improve and harmonise residential rating tools[121], namely BASIX (which is in place in New South Wales) and NatHERS-based tools;

[121] ASBEC, 2016

- Opportunities to improve consumer engagement with these tools, including through co-operation with the real estate sector (e.g. the Liveability Institute's '17 Things' initiative[122]) and integration into existing property sale and leasing platforms such as Domain.com.au and Realestate.com.au.
- Opportunities to facilitate the consistent reporting of energy efficiency outcomes and achievements by the Commonwealth, States, Territories and private sector.

It is important to note that easier access to better data (as discussed below) would make it significantly easier and cheaper to expand and improve rating tools. It would also up opportunities to harness the power of new technologies and apps that could increase consumer engagement.

Timing
The NEPP contains a number of measures related to improving energy data and information, which will be implemented in 2016. These include:

- NEPP Measure 3, involving a review of the 'total energy customer journey' including a review of 'barriers to market provision and innovation in tools and services, and … tools and information provided by government';
- NEPP Measure 5, involving consideration of tools to improve information for residential buildings, and options for implementing a national approach to residential building energy ratings and disclosure;
- NEPP Measure 9, involving investigation of potential expansion of the NABERS rating tools.

A national strategy could be developed alongside these measures and completed by June 2017, for implementation in 2017.

Improving access to energy consumption data

Recommendation 5.2: Improve access to energy consumption data, with consideration of the establishment of a central, streamlined and highly accessible open data platform for energy consumption and performance data which is free or available on a cost-recovery basis

Rationale
For energy consumption data to be useful, it is essential that it is accessible at low effort, at low or zero cost and via cloud-based smart phone apps, particularly for households. While direct access to energy consumption data for energy consumers is important, far more important is the process for third parties to access this data (subject to privacy considerations), in order that they can package it into useful information that is comprehensible and actionable by consumers, as part of an energy upgrade offering or as part of an energy management service such as a cloud-based energy management app.

[122] See www.liveability.com.au/about/

Examples of these services are beginning to emerge, such as the Google Nest device, a smart thermostat which allows users to control their heating and cooling appliances remotely via their phone[123].

Energy consumption data is currently collected via electricity and gas metering[124]. The quality and granularity of data collected varies significantly in different jurisdictions and across different building types. The most granular and real time data is available via advanced meters (or 'smart meters') which do not need to be read manually and measure energy use at regular intervals (e.g. every 5 minutes). While data is not available on penetration of advanced meters in the commercial sector, industry experts suggest that large commercial buildings almost all have smart meters installed, while the remainder are slowing upgrading and penetration may be in the region of one half of the building stock. In the residential sector, penetration of advanced meters outside Victoria is limited. The Australian Energy Market Commission has recently finalised a rule change to facilitate the market-led rollout of smart metering from 2017.[125]

Data is collected by metering service providers in a form that, according to industry experts, is standardised[126] and suitable for use by third party service providers. However, the current process for accessing energy consumption data is not streamlined and varies depending on the geographic location and electricity distribution network service provider. This presents a strong barrier to the development of energy efficiency service offerings by increasing transaction costs involved in data access. It also increases the cost for consumers to undertake building energy ratings (see below). The need for open data was a strong focus of discussions at Buildings Day at the Paris Climate Summit, including strong calls from financial institutions such as Standard & Poor's for better data collection and accessibility.[127]

An inquiry should be undertaken to investigate ways to facilitate better access to energy data. One option may be the development of a single central publicly administered platform for the collection of energy consumption data, with a single, standardised process for access to this data by consumers and by third parties (subject to privacy considerations, and with consumer approval). For this platform to be most useful, consideration should be given to making the upload of data automatic, in order to enable consumers to access real-time data. An alternative may be the development of standards for collection of and access to data. Initiatives like this are being undertaken in places like California through the Caltrack initiative[128], and in other US states through Building Performance Institute Data Standards.[129]

Any such platform should also be capable of accepting data from new energy monitoring products that emerge in the future.

[123] See https://nest.com/blog/2016/03/03/nest-and-alexa-working-together/
[124] The focus of this section is on electricity metering considering the high (and growing) share of buildings' energy consumption associated with electricity consumption
[125] See www.aemc.gov.au/Rule-Changes/Expanding-competition-in-metering-and-related-serv#.
[126] NEM 12-13 protocols
[127] Lieblich, 2015
[128] See www.caltrack.org/caltrack.html
[129] See hpxmlonline.com/Data_Standards.html

The platform should also facilitate public access to aggregated and de-identified data to enable researchers to easily access the data required to fill major gaps in knowledge about energy consumption by different market segments and to better inform industry efforts and policy development. This platform could also potentially function as a central repository for existing information from reporting programs such as GRESB, CDP, NABERS and Green Star[130].

Timing

The NEPP includes a measure[131] to 'improve the exchange of market data'. In 2016, this measure will include engagement with market institutions to understand barriers to the exchange of market data. This review should include consideration of the development of an open energy data and information platform, for potential implementation in 2017.

Improving and expanding mandatory disclosure of energy performance

Recommendation 5.3: Expand mandatory disclosure to smaller offices and investigate the possibility of requiring disclosure for other building types

Recommendation 5.4: Implement mandatory disclosure of energy performance to residential buildings, beginning with pilots in one or more jurisdictions

Rationale

Even where energy rating tools exist, a lack of motivation can result in low engagement and a low number of buildings getting ratings, particularly where a strong competitive dynamic amongst purchasers and prospective tenants does not exist (largely the case outside the large office sector).

The Commercial Building Disclosure (CBD) scheme requires large commercial office buildings (above 2,000 m^2) to disclose their NABERS energy rating at the point of sale or lease. In combination with government and large corporate tenant leasing requirements, this scheme has been instrumental in driving improvements in the large office sector. The Commercial Building Disclosure review recommended extending this scheme to all commercial offices above 1,000m^2, and ASBEC supports this recommendation. The needs of other building types outside the office sector may be different, however the potential expansion of disclosure policies to other building types should be investigated.

In the residential sector, disclosure is already required for homes at the point of sale or lease in the ACT, with good results[132]. There is a strong case to extend residential disclosure to other jurisdictions, beginning with a pilot in one or more states over the next two years, while developing the framework for implementation of a nationally consistent scheme in 2018. This

[130] This could be done through a partnership with the US-based Green Building Information Gateway See http://www.gbig.org/
[131] NEPP Measure 24
[132] Australian Government, 2008.

will also allow time to investigate potential improvements in and harmonisation of residential rating schemes.

Timing
The Commonwealth is planning to respond to the CBD review recommendation to extend the scheme to smaller offices in early 2016. In the second half of 2016, a further inquiry should be undertaken to review the possibility of extending disclosure to other commercial building types.

Residential disclosure could be piloted in one or more states in 2016-2018, for potential implementation of a nationally consistent scheme in 2018.

Supporting research, education and training

Recommendation 5.5: Develop a national built environment energy efficiency and emissions research agenda, and establish a permanent energy efficiency and distributed energy research institution, for example by expanding ARENA's mandate to include energy efficiency

Recommendation 5.6: Develop a national built environment energy efficiency and emissions education and training agenda to coordinate actions to improve energy efficiency and distributed energy awareness and skills across a wide range of industry, public and government stakeholders

Rationale
Australia has a very well-developed set of research and innovation entities, including in particular the CRC for Low Carbon Living working on primary research relating to energy and emissions in the built environment amongst other areas, ARENA which provides funding for early stage renewable energy technologies and the Clean Energy Finance Corporation to support commercialisation.

What is missing in Australia is a mechanism to coordinate research on built environment energy efficiency and emissions. To fill this gap, it is recommended that government consider the development of a permanent national built environment energy efficiency and emissions research agenda and the establishment of a permanent national built environment research body such as the BRE in the UK or BRANZ in New Zealand[133]. This body could build on the substantial achievements of the CRC for Low Carbon Living, which is due to

complete its work in 2019 - indeed, the body could be a continuation of the CRC. This entity could also take responsibility for facilitating the sharing of international research and learnings relating to the built environment, building on the substantial achievements of the CSIRO and CRC for Low Carbon Living, which is due to complete its work in 2019. In

[133] See, for example, the New Zealand BRANZ or UK BRE.

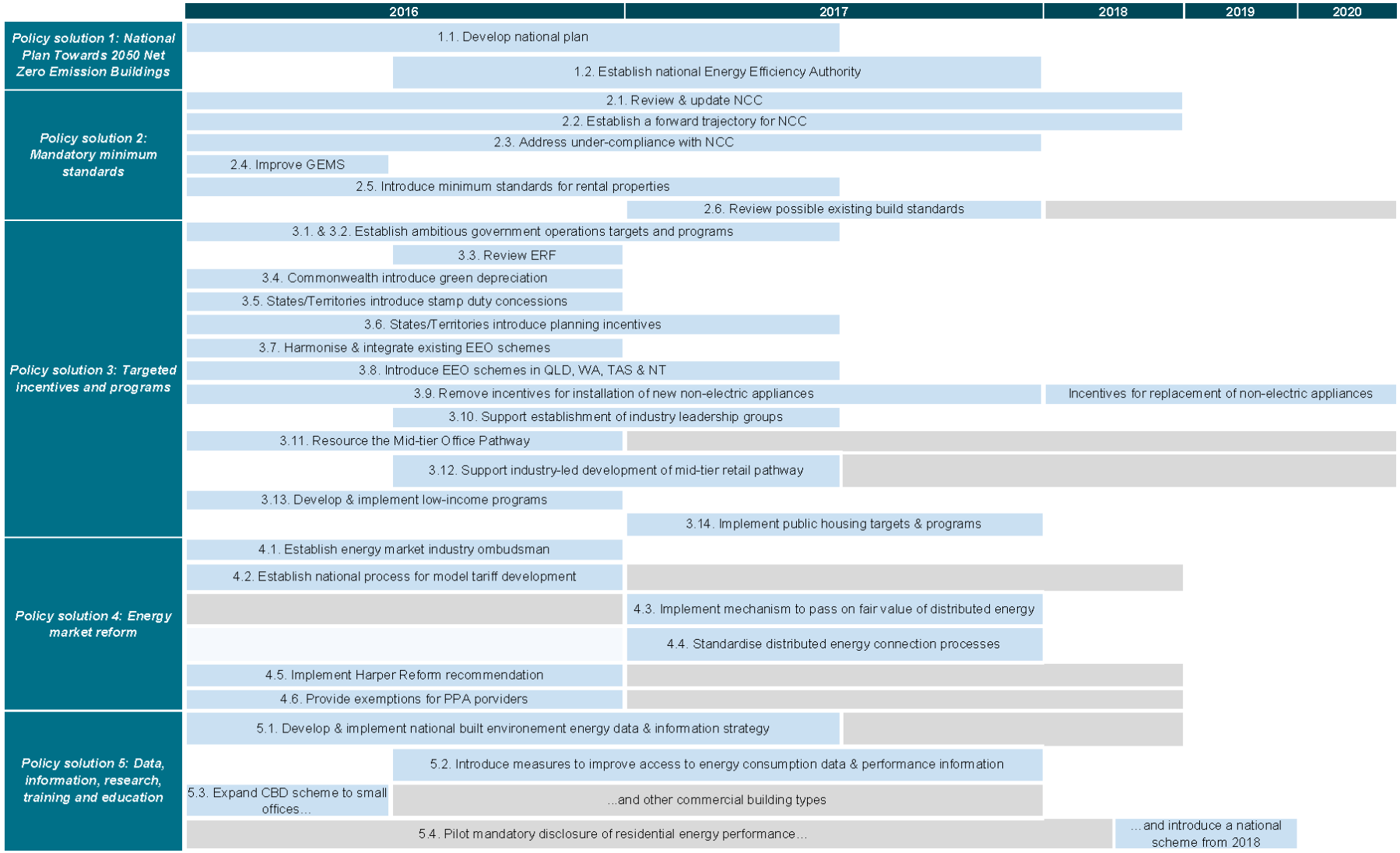
addition, ARENA's mandate should be expanded to include energy efficiency and the forthcoming establishment of Innovation and Science Australia.

In recognition of the broad need for upskilling amongst many different industry sectors, the national zero emission buildings plan should include the development of a national built environment energy efficiency and emissions education and training agenda and co-ordination with existing industry bodies such as the Energy Efficiency Council and Clean Energy Council, and education and training institutions such as the Industry Skills Council and AQSA. This strategy should build on a number of NEPP measures that are currently investigating energy efficiency skills gaps.

Timing
A national built environment research strategy and education and training strategy should be developed in 2016-17, in consultation with the CRC for Low Carbon Living and ARENA. In 2017-18, ARENA's mandate could be expanded to include energy efficiency while at the same time the form and scope of a potential permanent research institution could be investigated.

The development of a national education and training agenda could be included in the scope of work of the NEPP in 2016, for implementation in 2017.

5.4. Indicative implementation timeline



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