A roadmap to double ENERGY PRODUCTIVITY
in the Built Environment
by 2030

AUTHORSHIP OF THIS ROADMAP

This roadmap is published by the Australian Alliance for Energy Productivity (A2EP) and was prepared in collaboration and consultation with the built environment sector. The doubling energy productivity (2xEP) program is led by a steering committee of leaders in business and research. The built environment working group comprises representatives of individual firms, industry associations, research organisations and suppliers of energy services and equipment. A2EP supports the program. This roadmap will continue to be developed into a platform that leads to 2xEP by 2030 with all of the benefits that promises.

A2EP would like to thank the members of the 2xEP built environment working group for their considerable and considered contributions. In particular we would like to acknowledge the Australian Sustainable Built Environment Council (ASBEC) and ClimateWorks Australia. We have drawn extensively on *Low Carbon, High Performance*, the product of their recent partnership, as well as on other material produced by both organisations over recent years. The energy productivity and emissions reduction stories are inextricably linked. We hope that our efforts are complementary and complimentary.

ACKNOWLEDGEMENTS

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The views expressed in this text are those of A2EP and not necessarily those of our supporters and partners. All responsibility for the text as published rests with us.

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Introduction

The Australian Alliance for Energy Productivity (A2EP) is supporting and promoting the 2xEP program. 2xEP aims to double energy productivity in Australia by 2030.

The built environment is a major part of Australia's economy. The Property Council estimates that the sector itself accounts for 11.5% of economic activity. It provides space for industry and commerce, housing, education, health and other services to all areas of the country. The sector consumes 40% of all of Australia's final energy, excluding petroleum-based products. Recent research by ClimateWorks Australia estimates that an investment of $8.2 billion in energy productivity improvement over the period to 2030 could result in net financial savings of nearly $20 billion over the same period, a return on investment of better than two dollars for every dollar spent.

There have been significant positive developments in energy productivity in buildings over recent years, notably for new buildings and for the efficiency of appliances and equipment used in buildings. Steep increases in energy prices have offset these gains to an extent. And there is a great legacy of inefficient stock, residential, commercial and industrial, with enormous potential for improvement using currently available, readily accessible and cost effective technologies.

Energy productivity in the built environment is driven by a range of factors including: the urban form and mix of building types; the design, construction and thermal efficiency of building envelopes; the efficiency of appliances and equipment used within the envelope; and the behaviour of occupants. Related to these variables are others including fuel mix (principally electricity and gas), retail tariffs (structure and pricing), the availability of onsite generation and storage, access to data and the effectiveness of control systems.

Given that the useful life of assets typically extends over decades, the pace with which initiatives are adopted will have a significant impact on the contribution of the sector towards a goal of doubling Australia's energy productivity by 2030. Poor decisions can lock in unnecessarily expensive and energy-intensive outcomes for generations. Smart decisions lay foundations for long-term benefits for building owners and occupants and for the community more generally.

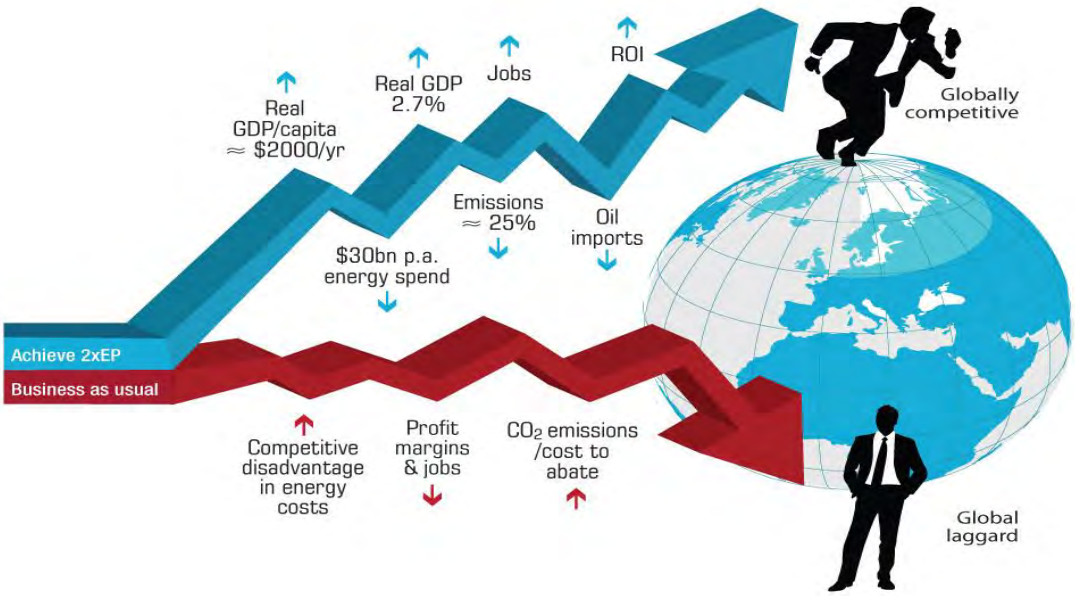
Why 2xEP? It's the economy.

Energy productivity is a clearly identified policy priority for federal, state and territory governments. Improving energy productivity is about increasing the economic value created per physical, as well as monetary, unit of energy consumed. In a period of increasing electricity and gas prices in Australia, in addition to volatility in the global oil market, a holistic approach to energy productivity can make a major contribution to Australia's overall productivity and hence competitiveness.

Energy is a substantial and growing cost to end-users – at $111 billion nationally in 2012, this was equivalent to about 8% of Gross Domestic Product (GDP).[i,ii] The built environment accounts for about 35% of total spend, mostly on electricity. The energy productivity project is directed to ensuring that every dollar spent on energy is effective.

Other major economies are well ahead of Australia in increasing energy productivity. Not only is the mean economic value per unit of energy consumed by the Group of 20 (G20) countries higher than for Australia, so too is the G20 mean *improvement* in energy productivity. Australia must act now to keep pace so that it avoids entrenching competitive disadvantage whilst G20 peers accelerate away (A2SE, 2014a).

Australia is coming from a relatively low productivity base, coupled with relatively high real energy prices, so the potential contribution of energy productivity improvement to Australia's overall economic productivity is now at an historic high. This means that energy, as a production input, now has a more material impact on the profitability of businesses and Australia's economic growth than ever before.

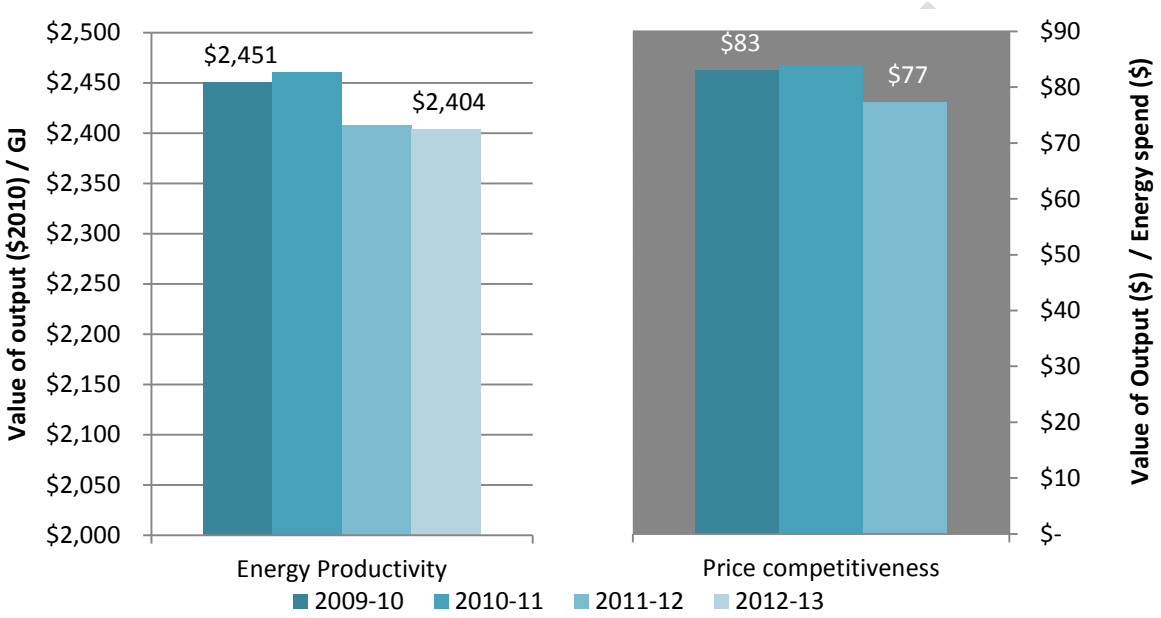


2xEP in the commercial built environment sector would see an increase in value of output relative to the energy input (ie higher revenues and profit relative to energy consumed). 2xEP would result in improved energy competitiveness even with anticipated price rises. In the residential sector the best available measure would see lower per capita consumption and

expenditure. Some of that change will come about through structural changes in the housing market such as, for example, the trend to higher density living in apartments. But measures directed towards 2xEP should benefit all kinds of households, whatever their situation.

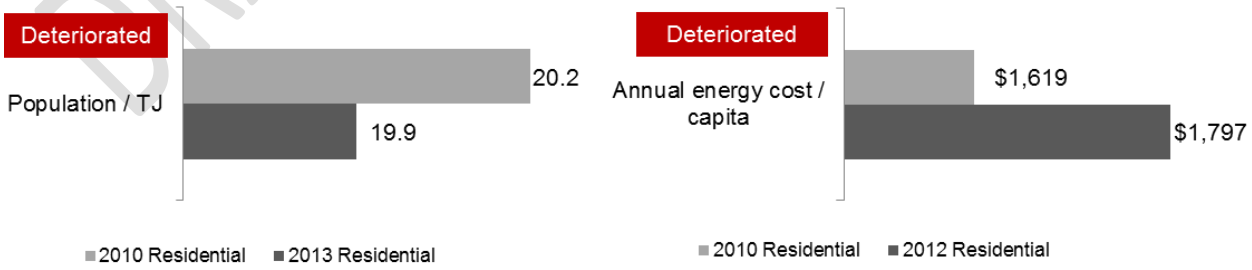
Our preliminary estimate of the 2010 baseline energy productivity of the built environment, excluding the government and residential subsectors, are illustrated in Figure 1 below (Stadler, 2015). The performance level is calculated on a 3-year rolling average basis to reduce the volatility typically associated with energy productivity measures. Nonetheless, performance against both metrics has been trending down wards.

Figure 1: Economic productivity of the built environment – commercial sector (private sector)



We have calculated a baseline for the residential sector on two measures – population served per TJ and annual energy cost per capita in Figure 2. The scope of these measures includes liquid fuel and stationary energy used by this segment, but could be calculated separately for each fuel type. The most recent performance level is calculated on a 3-year rolling average basis to reduce the volatility typically associated with energy productivity measures.

Figure 2: Residential sector proxy measures for the residential sector



2xEP target

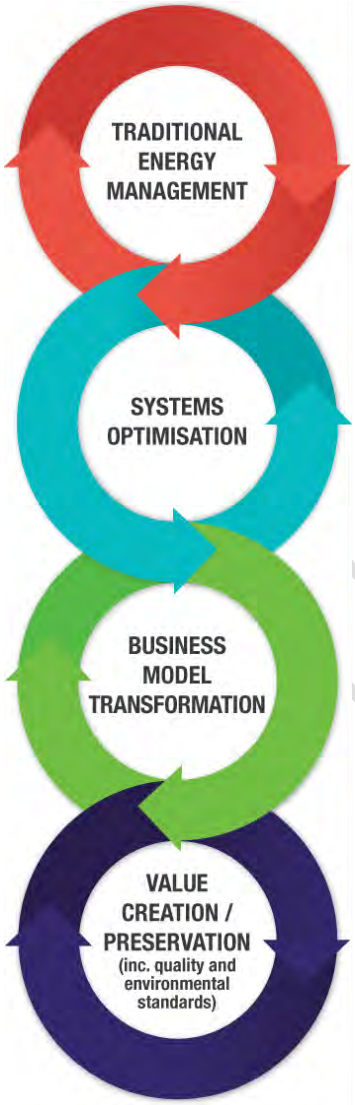
This roadmap provides guidance on the direction required to double energy productivity in the built environment sector by 2030. This is a challenging but achievable target, equivalent to about a 3.5% annual increase in energy productivity, or three times the historical average – but just in line with targeted improvement in competitor economies.

Why the 2xEP target? 2xEP is a voluntary and aspirational target across the economy. It is a stretch target that will require changes in products and services, business models, attitudes and practices. 2xEP can be achieved with existing, cost effective technologies. We can reasonably expect that significant innovation will facilitate change and reduce costs.

- 2xEP is the minimum level of energy productivity improvement that will, at the least, maintain Australia's *relative* energy productivity.
- The doubling target ensures that we don't focus on incremental improvement and skip tougher step changes (including major infrastructure investments) required to restore competitiveness. It provides a common goal, guiding the alignment of policies, strategies and, ultimately, resources to execute plans.
- Innovation and advances in technology will make a significant contribution to energy productivity. Our strategy should facilitate development and transfer of these technologies into the Australian market. A separate 2xEP innovation roadmap forms a component of the program.
- A 15-year target period to 2030 allows implementation of best practice technology during the business as usual cycle of renewal (maintenance, replacement, refurbishment).
- An energy productivity target provides greater scope for improvement than an energy efficiency target. Some improvement will be driven by growth in the value of output over time. Modelling by the International Energy Agency indicates that energy productivity projects generate total benefits typically two and a half times the energy savings.
- 2xEP aligns with the target that has been adopted in the USA through the Accelerate Energy Productivity 2030 initiative.
- The Global Alliance for Energy Productivity (GAEP) was established in June 2015 with a remit to extend aspirations to double energy productivity, initially to India, China and Europe. GAEP has a focus on economic growth, energy security, monetary savings and greenhouse gas reductions.

Productivity vis efficiency

In this context, 'efficiency' is generally understood to mean a reduction in consumption, 'conservation' or 'savings'. Productivity, however, looks to yield, to the economic outputs generated by energy as an input. Our approach canvasses established practice and emerging opportunities that, if more broadly adopted, could have a significant impact on energy productivity. We consider these opportunities within four broad strategy areas supporting an energy productivity agenda: traditional energy management (efficiency), system optimisation, business-model transformation and value creation/preservation as illustrated below. The strategic areas are complementary. Examples of these strategies in the built environment sector include:



- Energy efficient equipment and passive building design
- Distributed generation and storage
- Power factor correction
- Waste heat recovery
- Data and energy management
- Advanced building management systems

- Precinct scale designs for new developments or urban renewal projects incorporating, for example:
  - transport centric urban design
  - shared infrastructure – e.g. district heating, cooling
- Precinct scale retrofits to address heat-island effects

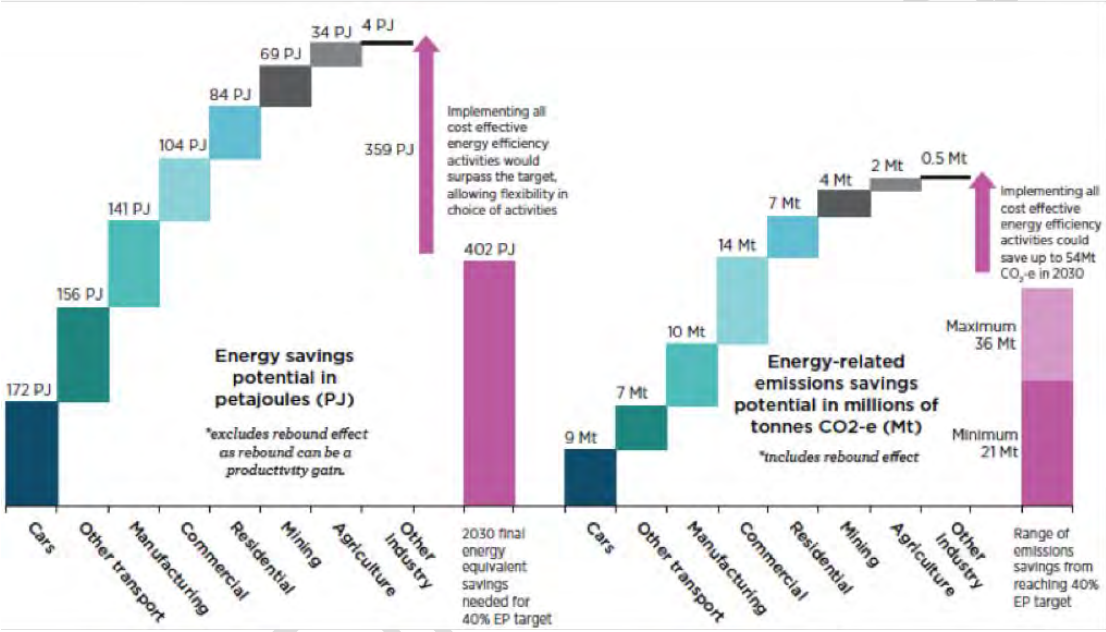
Break traditional relationship between capital, labour, energy and asset or amenity value of the built environment e.g.

- Zero emissions buildings and advanced construction materials that reduce the cost / time of construction, whilst improving thermal efficiency
- Collaborative development models to support the development of eco districts
- Smart hubs / teleworking

- Adoption of rating schemes (e.g. Green Star and NABERS) that secure rental / investor premiums
- Use of sustainable building materials, rather than steel and concrete, and associated verification

Energy productivity and emissions reduction

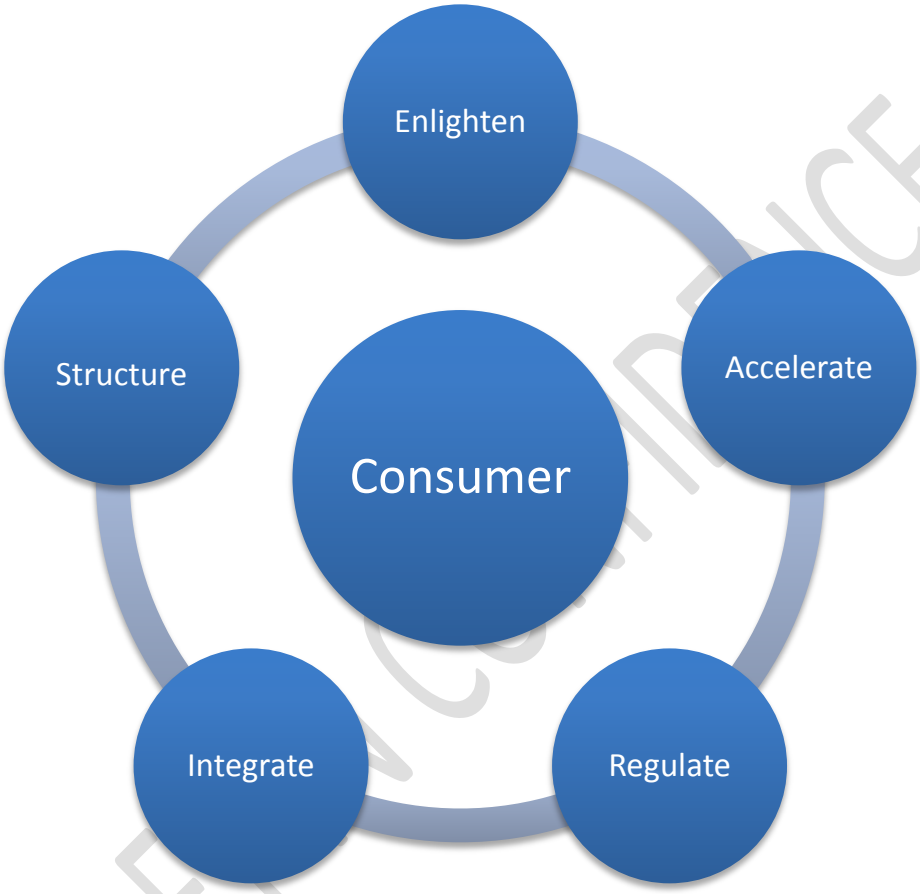
The Australian Government has set a target of a minimum 26% reduction in greenhouse gas emissions from 2005 levels by 2030. The forthcoming review of climate policy may revisit and revise that target. Energy productivity improvement can make a significant, low cost and unobtrusive contribution to the emissions reduction task. The National Energy Productivity Plan (NEPP), produced by the COAG Energy Council and released in late 2015, observed the correlation between energy productivity improvement and emissions reduction and the potential contributions of commercial and residential buildings. As illustrated in the figure below, drawn from the NEPP, efforts to improve energy productivity in commercial and residential buildings result in parallel energy savings and emissions reductions.



Source: ClimateWorks Australia estimates for the Department of Industry, Innovation and Science, 2015.

Getting to 2xEP

We identify a suite of measures as the necessary elements of a roadmap. They represent an *integrated* strategy – not a menu of options. These opportunities can be considered within the four strategy indicated above (traditional energy management, system optimisation, business-model transformation and value creation/preservation). And they can be grouped thematically as below.



A list of the measures we propose:

Put the consumer first - Reframe the conversation: centralise the consumer and citizen

Enlighten - Develop the market, demonstrate the possible

- Develop and implement an engagement strategy
- Improve the knowledge base: quantity, quality, access
- Set baselines and benchmarks metrics and reporting
- Define data needs: collection, analysis, access
- Modernise metering, align datasets, publish data
- Plan and resource research, development, demonstration
- Engage business through associations
- Re/train workforces of the future across the supply chain

Accelerate - Build confidence, stimulate change

- Progress financial incentives: provide resources for action
- Remove systemic barriers to innovation: address failings in energy markets
- Establish 2xEP Challenge: voluntary commitment and recognition for organisations

Regulate - Address market failure, ensure consumer protection

- Modernise building regulation with strong minimum standards
- Improve compliance with standards and codes
- Develop a nationally harmonised residential rating framework
- Promote ratings and disclosure for all buildings
- Consider mandatory disclosure for all buildings
- Strengthen and harmonise energy performance standards

Integrate - Buildings are networked, a rich opportunity

- Plan better: existing and new precincts
- Activate district energy precincts; greenfield and brownfield
- Facilitate distributed renewable energy
- Deploy smarts: buildings, cities, infrastructure
- Prioritise transport-oriented development

Structure - Set the goals, facilitate the transformation

- Build and maintain a stable, long-term policy platform
- Coordinate policy and programs between all levels of government
- Manage through government procurement
- Support low-income households through the transition
- Raise the standard in social housing

2xEP: Who drives?

The likely benefits and costs of energy productivity improvement should be shared reasonably by the community and across the economy. A diverse range of actors will be required for the transformation. As consumers of energy and energy services and the functions they enable, the power rests with us all. The task and the challenge will fall to:

- End-use consumers
- Purchasing and procurement people
- Architects, designers and specifiers
- Town planners and urban designers
- Developers
- Builders and trades at all scales
- Real estate agents
- Energy retailers
- Energy service providers
- Engineers: energy, water and waste
- Policy makers
- Regulators
- Educators and institutions

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1. The purpose of this roadmap

This roadmap sets an agenda for action to double energy productivity in the built environment by 2030. It intends to make the case for action in the interests of building owners, occupants and the community more generally. Measures to 2xEP will save money, make money, optimise investment and rectify markets.

The strong relationship between energy productivity and emissions reduction has now been made clear. We aim to ensure that the roadmap integrates with other programs, for emissions reduction, economic development, innovation and investment. Later versions of the roadmap will more explicitly identify the points of integration with these other initiatives.

A feature of the 2xEP program is the fostering of non-partisan support to allow the delivery of a long term, stable policy framework for change. Business investment in energy productivity improvement has been adversely affected by years of volatility; the rapid introduction, modification, contraction and removal of measures to support energy productivity. Having a 15-year target and direction for change is crucial at this point to build business confidence and drive continuous improvement.

This roadmap canvasses measures for industry to undertake of its own initiative, measures that would involve joint action by industry and government, and policy initiatives for action by government to overcome market barriers, to facilitate and accelerate change. The roadmap is intended as a living document that will evolve with developments in technologies and markets and accounting for the success - or otherwise - of measures as they are implemented. Some initiatives recommended in this report can be commenced in the short term, whereas others require further investigation and testing.

We expect that the measures proposed will show strong benefit-cost outcomes. Further benefit-cost analysis is required to test the viability of recommended measures, to forecast the contribution of these measures toward the 2xEP 2030 targets and to delimit any gap that will have to be addressed with supplementary measures.

2. Scope and limitations of this roadmap

The Australian Alliance for Energy Productivity (A2EP) is supporting and promoting the 2xEP program. 2xEP aims to double energy productivity improvement in the Australian economy by 2030.

The built environment is a major part of Australia's economy. It provides space for housing, employment, education, business and services to all areas of the country. It consumes 40% of all of Australia's final energy, excluding petroleum-based products.

This roadmap has a focus on the energy utilised during the operational life of buildings, residential and non-residential, and also touches on integrated planning and urban design. We do not focus here on energy *embodied* in the built environment (for example in construction materials or the construction process) or on transport associated with building use or infrastructure planning. Similarly, energy supply is generally considered a sector in its own right. However, as building-attached and building-integrated generation systems become

ubiquitous, this distinction becomes blurred. Regardless, there are linkages between the built environment and other sectors of the economy and an integrated policy approach will be most effective and most cost-effective.

3. What is energy productivity?

Energy productivity is an indicator of the amount of economic output that is derived from each unit of energy consumed[1]. Economy-wide energy productivity is generally measured as national gross domestic product (GDP, in millions of dollars) divided by petajoules (PJ) of primary energy consumed. While other definitions are possible, this is a common international measure that will make it easy to compare our progress with other countries.

$$\text{energy productivity} = \frac{\text{economic output}}{\text{energy used}} = \frac{\text{GDP}}{\text{PJ}_{\text{primary}}}$$

Source: COAG Energy Council, 2015, National Energy Productivity Plan 2015–2030, December 2015

Another useful indicator is the *rate of change* in energy productivity through time, expressed as a percentage change. This is particularly useful for making comparisons, as the absolute level of energy productivity varies from sector to sector and from country to country, reflecting differences in economic structures and resource endowments amongst many other factors. Focusing on the rate of improvement through time is therefore a great leveller, and rates of change can readily be compared between sectors and even between countries.

A focus on energy productivity has sharpened in recent years and organisations and countries have begun developing targets. Examples include the United States with a goal of doubling energy productivity by 2030 relative to 2010, and Germany's goal of doubling energy productivity by 2020 relative to 1990. Australia's National Energy Productivity Plan (NEPP) aims for 40% improvement by 2030, relative to 2015. According to ClimateWorks[2], however, Australia has enough potential across multiple sectors of the economy to double its productivity by 2030. Achieving such ambitious targets requires a clear set of actions based on a thorough understanding of the key factors impacting energy productivity. These are: the sectoral energy productivity and the structural energy productivity. Change in sectoral productivity can arise from technological improvements, behavioural changes or changes in product mix; whereas structural productivity occurs due to change in economy mix, e.g. shift from less to more energy productive sectors of economy[3].

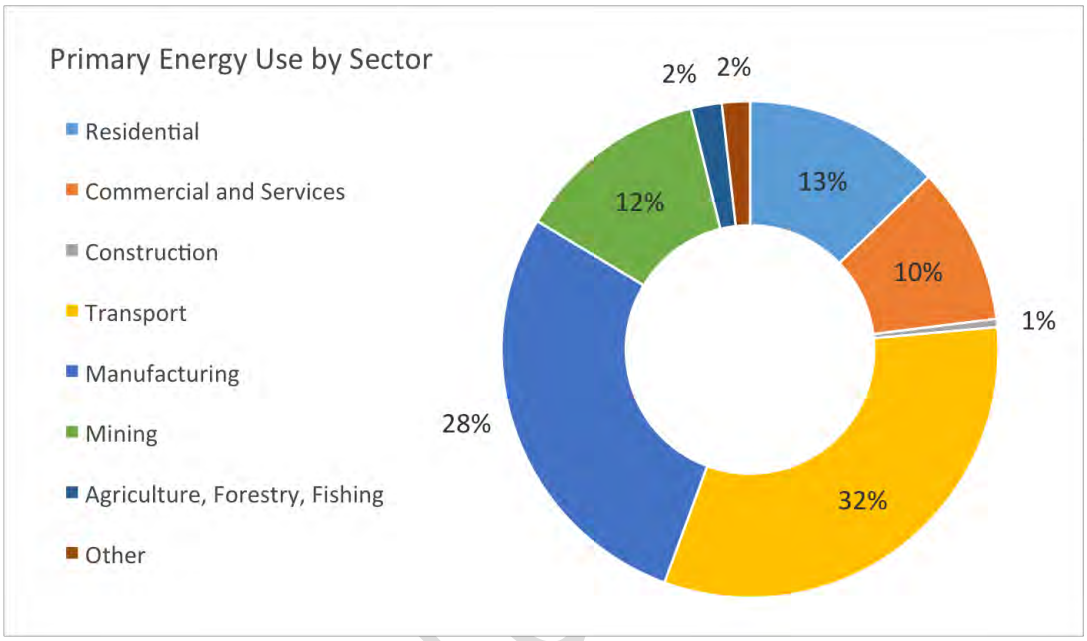
Energy use by the built environment

When buildings are energy efficient, their occupants are better off – they have lower energy bills and higher levels of comfort and wellbeing. Energy efficient buildings are better for the

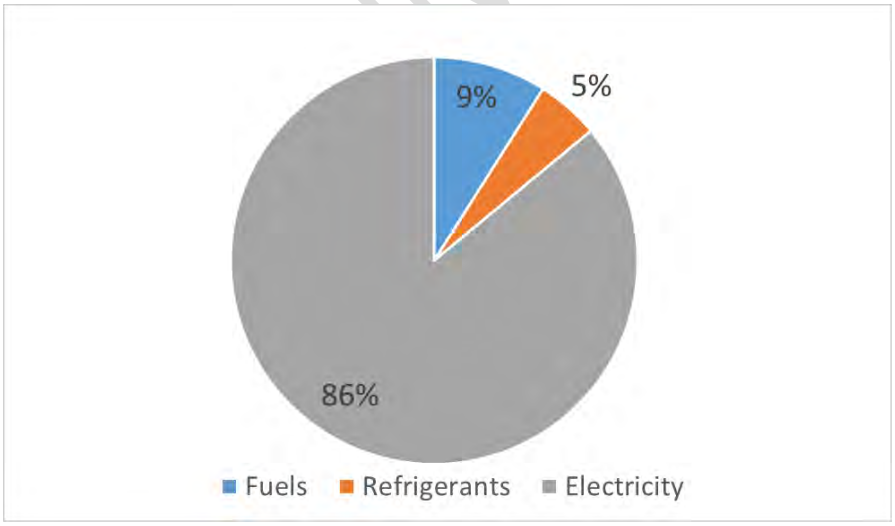
[1] COAG Energy Council, 2015, *National Energy Productivity Plan 2015–2030*, December 2015
[2] Climateworks, Australia's Energy Productivity Potential Report, March 2015
[3] Multiple international studies have demonstrated that sectoral (or also commonly known as 'energy efficiency') effect is much more significant when it comes to influencing total energy productivity improvement.

economy and better for the environment. Reducing energy use allows the money saved to be invested elsewhere. Australian households spend an average of about $380 million every week on electricity and gas. An average energy efficiency improvement of less than 3% would free up $10 million a week to be invested in other parts of the economy. Energy efficiency improvement also reduces the negative environmental impacts of energy use – such as greenhouse gas emissions.

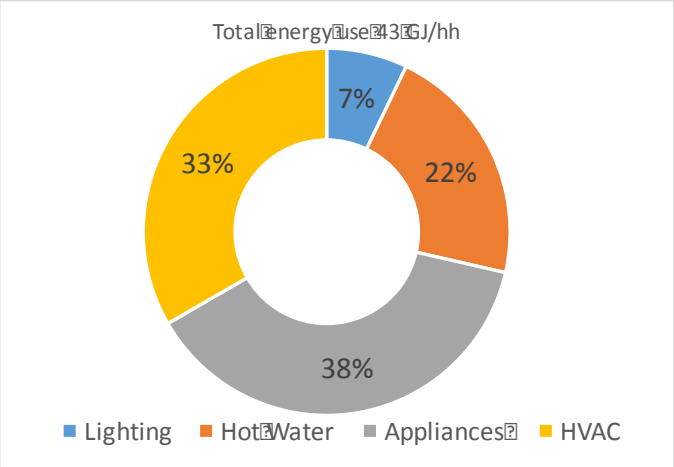
Primary energy use by sector

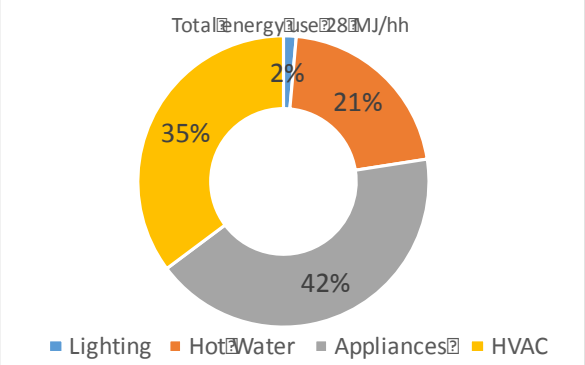


Primary energy use by the building sector

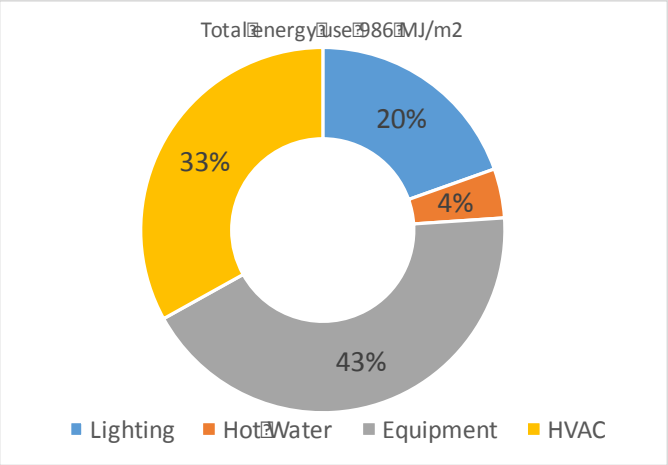


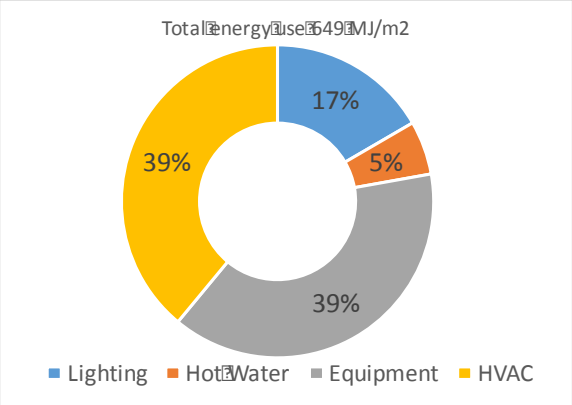
Residential energy efficiency potential 2015 to 2030:





Commercial energy efficiency potential 2015 to 2030:

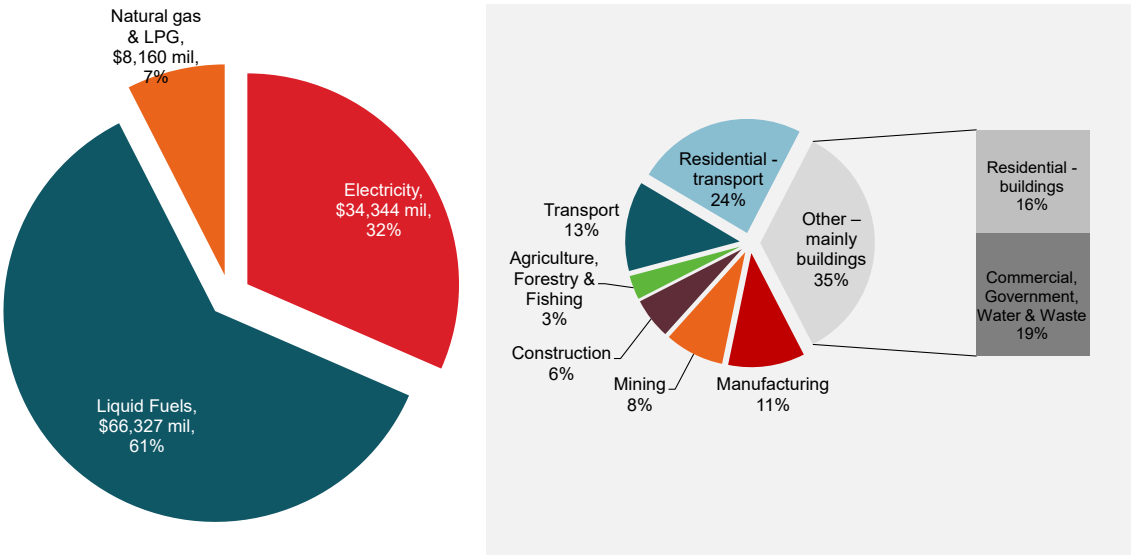




Energy spend by the built environment 2012

Energy is a substantial and growing cost to end-users – at $111 billion in 2012, this was equivalent to about 8% of Gross Domestic Product (GDP).[iii,iv] As illustrated below, more than 60% of this cost is associated with liquid fuels. Major users of liquid fuel are the transport, mining and agricultural sectors. The built environment accounts for about 35% of total spend, mostly on electricity.

End use sector energy spend by source (FY 2012)



Beyond energy efficiency: Productivity

Energy productivity in the built environment is driven by a range of factors including: the urban form and mix of building types; the design, construction and thermal efficiency of building envelopes; the efficiency of appliances and equipment used within the envelope; and the behaviour of occupants. Related to these variables are others including fuel mix (principally electricity and gas), retail tariffs (structure and pricing), the availability of onsite generation and storage, access to data and the effectiveness of control systems.

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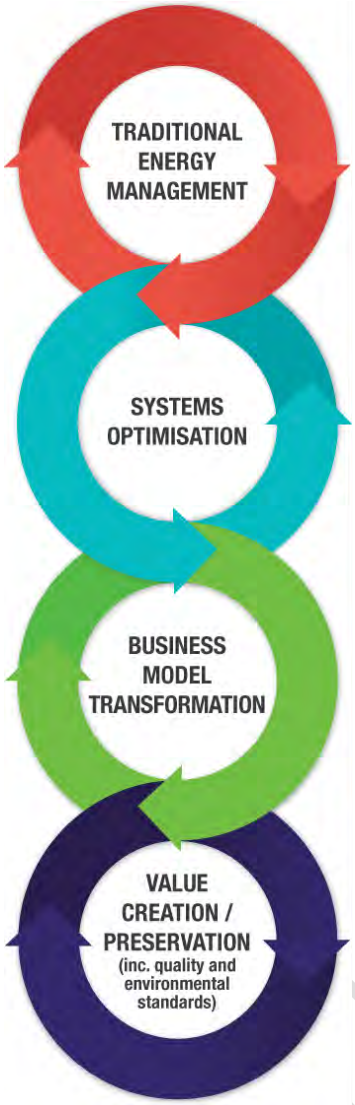
Our proposed measures include both established practice and emerging opportunities that, if more broadly adopted, could have a significant impact on energy productivity in the sector. These opportunities are considered within four broad strategy areas supporting an energy productivity agenda: traditional energy management, system optimisation, business-model transformation and value creation/preservation as illustrated below.

The strategic areas are complementary. Opportunities are associated with the strategy area deemed most relevant, but most opportunities are not limited to one area.

Figure 2: Summary of opportunities per energy productivity strategy area



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- Adoption of rating schemes (e.g. Green Star and NABERS) that secure rental / investor premiums
- Use of sustainable building materials, rather than steel and concrete, and associated verification

Where buildings are: The importance of location, planning and integration

Our discussion paper "Doubling energy productivity of the built environment by 2030" highlights the importance of system optimisation to energy productivity improvements. While the focus of the discussion paper is on internal benefits of precinct design it should be noted that such areas will need to function as parts of a bigger landscape. This section addresses the benefits of integrated infrastructure planning and design and the productivity gains from smart systems across the built environment, transport and manufacturing sectors.

Among other benefits, well planned precincts can function as specified 'innovation zones' to showcase new policies (EEC, 2016), optimise supply chains by enabling industry to work close to residential areas (Design Trust for Public Space, 2012) and reduce commuting times and road congestion by adopting innovative employment models such as SmartHubs (A2EP, 2016a). District heating and cooling solutions can reduce energy consumption by up to 50% and could simultaneously operate as storage for renewable energy generation (UNEP, 2015).

Furthermore, precinct-scale retrofits can go as far as altering the temperature landscape of the urban environment and thereby not only reduce energy consumption but raise liveability (Hatvani-Kovacs & Boland, 2015).

Integrated infrastructure planning enables the development of transport, energy and other infrastructure around future service needs, creating sustainable value chain precincts. By working with industry and agricultural stakeholders, transport pathways and manufacturing processes can be optimised and the competitiveness of the Australian agricultural and manufacturing sectors raised (A2EP, 2016b). Measure 10 of the Agriculture roadmap suggests that precinct initiatives also have the potential to "help overcome information barriers by identifying the energy productivity risks and opportunities in the supply chain and assist companies make informed investment decisions".

A comprehensive integrated planning strategy can then facilitate the creation of smart infrastructure and smart cities. A smart city is "a city based upon the foundations of good urban planning, economic competitiveness, environmental engineering and sustainable practices that use information and communication technologies to enhance liveability, sustainability and workability" (PCC, 2016). Implementing the civil and data infrastructure needed to enable efficient industrial ecology is crucial to unlocking the benefits of smart systems (IPA, 2012a), including increased opportunities for economic exchange through i.e. the sharing economy. Information integration will permit consumers to find the most economic and time-efficient transport routes, facilitate localised energy trading between small-scale electricity generators and provide data for an increase utilisation of Internet of Things applications to name only a few benefits.

4. How much productivity is enough?

There are two ways to answer this question: top-down and bottom-up. The top-down perspective asks 'how much do we need?' From the perspective of the national economy this question cane be framed as 'what are our competitors achieving?' If other countries, particularly in our region, are improving their energy productivity more rapidly than Australia, then the competitiveness of their goods and services will also be improving more rapidly than ours. Benchmarking our performance internationally makes a great deal of sense – and particularly benchmarking the rate of improvement through time, not only the absolute level of energy productivity, as this will vary depending on the structures of the economies in question[4]. Overall, our report card would appear to read, 'could try harder'

From the perspective of greenhouse gas emissions, the Paris Climate Change Agreement acknowledged that the world must transition to zero net emissions by around the middle of this century. Australia's relatively high emissions intensity and limited carbon budget means that we need to reduce emissions rapidly in all sectors. Noting that there will be some sectors where reaching zero emissions will be more challenging than others[5], those sectors that have cost effective abatement opportunities may need to move further and faster to provide the

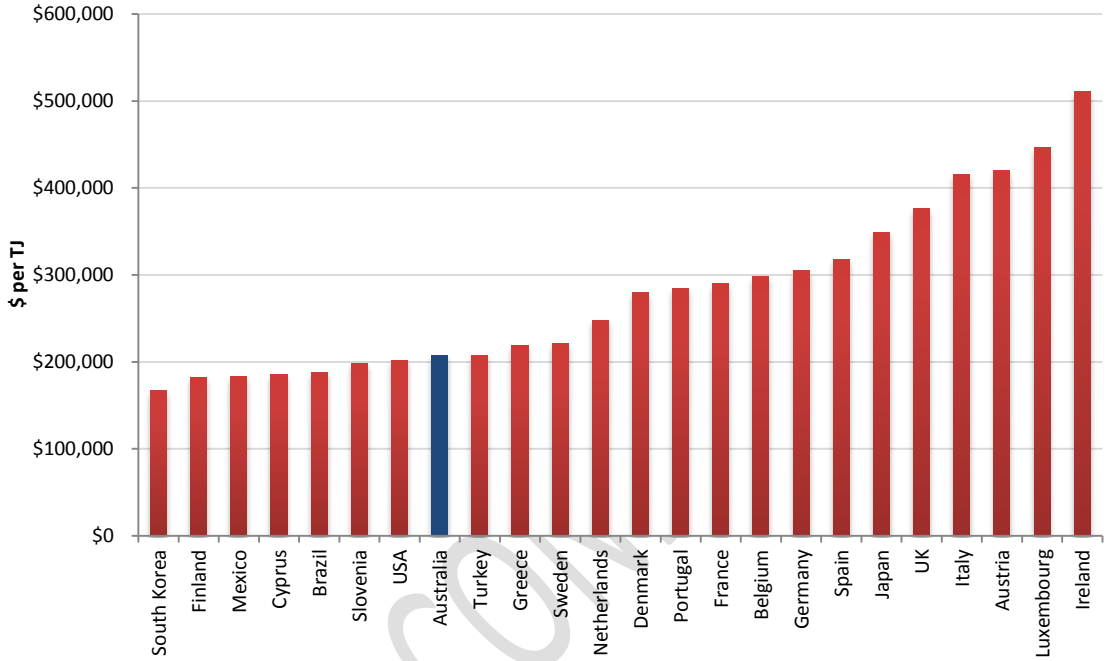
[4] Attallah et al., Determinants of energy productivity: A comparison of 39 countries, KS-1518-DP012A, March 2015

[5] For example aircraft, heavy road vehicles, some aspects of agriculture, and chemical processes such as aluminium smelting and cement production.

breathing space for those more difficult challenges to be solved, for example through research and development of entirely new technologies.

While there are numerous strategies to reduce emissions, improving the energy productivity of key sectors, such as the built environment, is one of the best available. This is because of the 'co-benefits' that it can deliver for the economy and for society more generally.

Figure 2. Weighted Average Energy Productivity 1995-2012



Source: pitt&sherry, adapted from KAPSARC, 2015

There is a second, bottom-up perspective to the question of how much energy productivity is enough. That is, how much would make Australia better off, regardless of what other countries do or don't do? This is an economic question, where the ideal rate of energy productivity improvement through time is the one that maximises real economic value now and in every period going forward. The aspiration should be to go just as fast as this economic boundary allows, rather than setting safe, 'business as usual' goals that neither maximise welfare and competitiveness domestically, nor position us to meet our international goals.

How fast is that rate? It would require economic modelling to answer that question, but is clear that we can and must do better than we have to date. Setting a goal to double the rate of energy productivity improvement in the built environment will drive innovation, enabling us to identify and roll-out the least cost solutions in each sub-sector.

This will demand a comprehensive and evidence-based mix of measures, to deliver the outcome at least cost.

5. Why a roadmap?

A roadmap provides an excellent analogy for the long term process of doubling energy productivity in the built environment. For any long and complex journey, we need to know:

- *where we are now*, so that we don't regress, or else over-reach on the first steps;
- *where we need to get to*, specifically in relation to where we are now; and
- *what are the best pathways* to take us from where we are now to where we need to be.

In this context, a roadmap is also a journey through time. The aim of the 2xEP strategy is to double energy productivity in Australia by 2030, and the dimension of time is critical to a successful strategy.

First, we can recognise that the key to improving energy productivity through time is to identify the opportunities or leverage points that occur as a natural function of the turnover of capital equipment, buildings and plant at the end of their economic lives. While it may be cost-effective in some circumstances to accelerate the replacement of capital in the economy – for example, when a significant technological break-through makes older equipment non-competitive – generally it will be more cost effective to work with natural investment cycles. Much plant and equipment has an effective life of between 5 – 15 years, and even longer lived buildings will tend to undergo a major refurbishment at around 15 year intervals, depending on market circumstances. Therefore, policies that encourage the most efficient investment choices possible – that is, within the boundary of cost effectiveness (discussed further below) – will lead to a rapid but also cost effective trajectory of improvement in energy productivity through time.

Second, improving productivity requires innovation, investment and therefore the confidence that comes from clear and long-term policy strategies. Providing an early indication of future policy changes can enable the research community, businesses, regulators, policy makers, planners and many others to anticipate and plan for these changes in a timely and cost-effective manner. By contrast, precipitous changes, commenced too late, with insufficient research and consultation, risk to destabilise markets and to close off the very investment needed to progress energy productivity rapidly.

Finally, noting that new building construction is estimated to add only around 1% to the existing stock each year, there is a need for a roadmap to encompass both new and existing buildings. As touched on above, it is generally much more cost effective to make new buildings highly energy efficient than it is to retrofit older buildings for the same level of performance. However, we must recognise the legacy effect of the existing building stock, and seek to improve its efficiency to the greatest extent feasible. Therefore the strategy must be comprehensive of all buildings, new and existing, in all locations and markets. Differentiated strategies are called for to reach all of the diverse situations.

This paper sets out an initial roadmap to 2030. We expect that the process of engaging with stakeholders in particular sub-sectors will lead to the refinement of individual measures, or even the identification of new ones altogether. Also, within a consistent long-term roadmap, we must expect that there will be deviations along the way, as new opportunities or challenges

emerge. Solving these as a joint process between stakeholders will deliver the mix of flexibility and determination required to reach the goal.

6. Why improve energy productivity?

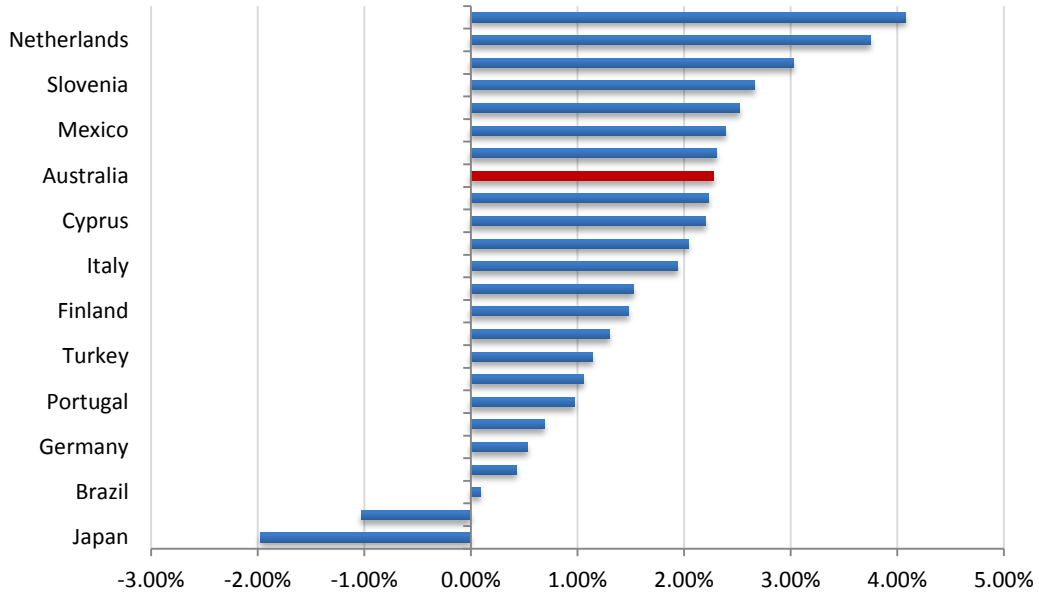
By improving the productivity of energy use in the built environment, Australia can achieve greater competitiveness, higher growth and a better quality of life for all, while at the same time reducing the demand for purchased energy services, infrastructure investment and related greenhouse gas emissions.

A feature of the built environment is that many assets are long-lived. Buildings, for example, may have economic lives of 50 years or more. Fundamental design decisions – that might be based on short term incentives – can have very long-term consequences for the overall productivity and emissions intensity of the economy. It is generally much more cost-effective to design and construct efficient buildings in the first place than it is to retrofit them once built. That said, with the vast majority of buildings that will be standing in 2030 having already been built, there is both a need and an opportunity to improve the performance of this existing building stock.

There have been energy productivity gains in the built environment sector of the economy in recent years; construction productivity growth of 0.3% annually and a growth in GDP of $6.5 billion[6]. This improvement reflects higher prices for electricity and gas, the availability of new technologies and the effectiveness of some energy efficiency policies, amongst other factors.

[6] Sustainable Built Environment National Research Centre, Innovation underpinning Australia's built environment industry

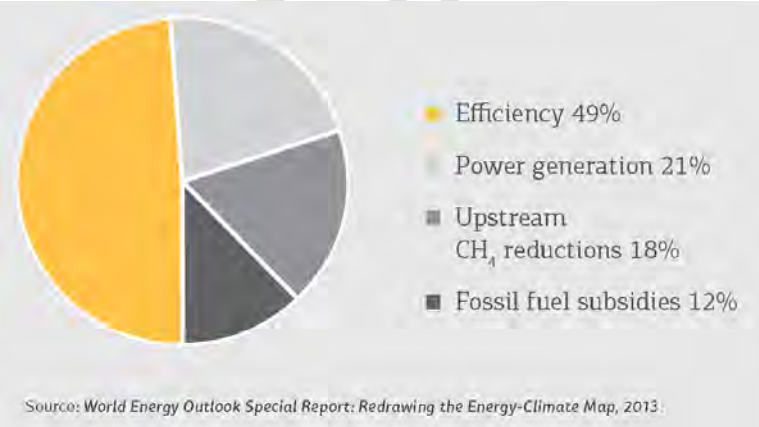
Figure 3. Energy Productivity Mean Growth Rate 1995-2012



Source: pitt&sherry, based on ClimateWorks and KAPSARC

However, around the world, improving the efficiency and productivity of energy use in the built environment is recognised as the largest and most cost effective source of greenhouse gas abatement. For example, in the International Energy Agency's *World Energy Outlook* 450 ppm Scenario, almost 50% of the estimated global abatement potential for 2050 (from actions that can be taken before 2020) comes from improving energy efficiency. The IEA notes that these efficiency measures would have a net zero cost to GDP – that is, all incremental investment costs would be fully offset by energy savings.[7]

Figure 4: International Energy Agency's 'Four Key Actions'



Of course, reducing greenhouse gas emissions is not the only reason to target a doubling of energy productivity in the built environment. Achieving energy cost savings is a first-round effect, leading to improvements in competitiveness for businesses and welfare for households. There is also evidence that 'green' or high performance buildings, both residential and commercial, are more valuable – bringing long-term benefits for their owners in terms of

[7] International Energy Agency, The Way Forward: five key actions to achieve a low-carbon energy sector, 2014, p.3.

capital gain and the ability to leverage their building portfolio for economic and business growth. An Australian Bureau of Statistics study of the ACT's residential mandatory disclosure scheme showed that every half-star under NatHERS (the National House Energy Rating Scheme) added some $3,500 to house values [reference], while research commissioned by the Australian Property Institute and Property Funds Association found evidence of a 'green premium' of 9% in building value for 5 star NABERS rated buildings, on average, but reaching up to 21% in certain markets. Similarly, it found that Green Star ratings are associated with a 12% additional building value on average.[8]

While economic values are important, we should recognise that the built environment is not just another economic sector: it is literally where we live and work. The quality of these places – how they make us feel, how healthy they are, how they inspire us and liberate our dreams – these too are elements of productivity. Buildings and houses that have access to natural daylight, that are well-ventilated – including with passive or hybrid systems – that have exposed thermal mass that provides radiant heating and cooling for comfort, that have controls that enable tailoring of individual workplace conditions – these are examples of strategies that can deliver a built environment with 'human' attributes, or liveability, *and* highly efficient use of energy.

Going forward, we will need to plan and construct our built environment to deliver resilience to the anticipated effects not only of climate change, but also the urban heat island effect. The combined effect of these two phenomena has, for example, been projected to raise average ambient temperatures in Sydney by more than four degree Celsius by 2050[9]. Building design, construction and cooling and ventilation strategies will all need be designed to cope with such conditions, without excessive energy consumption. In particular, the anticipated increased frequency and intensity of heat-waves will pose a severe threat to health and well-being, notably for our ageing population. The 2003 heatwave in Paris, known as 'la canicule', directly caused an additional 15,000 deaths in just two weeks, with older persons primarily affected. We will therefore need to place greater focus on the summer performance of buildings. Strategies such as shading, high-performance glazing, insulation, greater attention to air-tightness, mechanical ventilation with heat/coolth recovery, appropriate use of exposed thermal mass, different forms of energy storage, can all be deployed to improve the summer performance of buildings, improving their liveability and resilience while potentially reducing total energy use.

We also need to recognise that people are using buildings differently now when compared to just a decade or two ago. Houses are increasing playing the role of office but also entertainment complex, while offices and retail centres are increasing moving to extended hours of operation – potentially 24/7 – reflecting the changing living and working patterns of our population. Multiple use buildings are becoming the norm, particularly in our cities, blending residential towers with offices, retail, a childcare centre, medical centre, gym and sports complex. The challenge is to deliver the services that people want while minimising the

[8] Building Better Returns: a study of the financial performance of green office buildings in Australia, The Australian Property Institute and Property Funds Association, 2013, p. 13.
[9] City of Sydney Energy Efficiency Master Plan – Foundation Report: http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0003/241437/Energy-Efficiency-Master-Plan-Foundation-Report.pdf

resource use associated with those services – and ensuring that the energy consumed is generated from renewable sources.

7. Where are we now?

There is evidence that leading developers and property trusts, but also some home owners, are delivering buildings that are exemplars of the kind of built environment we can all aspire to live in. Eight and nine star houses – often delivered without a significant cost premium – are becoming more and more prevalent. CSIRO recently noted that of the 24,000 NatHERS ratings compiled around Australia since 2014, 15% or around 3,600 of those houses rated 7 stars or more, when 6 star is the legal requirement in most states (less in some). In the commercial building world, both the NABERS and Green Star rating schemes show a clear progression through time towards higher star rated buildings, and that because they are delivering substantial energy savings results, *inter alia*. NABERS reports that a NABERS accredited rating delivers not only financial benefits – such as reduced operating costs, increased value, increased rental income and reduced vacancy rates – but also provides market recognition and a competitive advantage for building owners and tenants, and helps to create a better work environment for employees.[10] Similarly, the Green Star program reports that, on average, Green Star certified buildings use 66% less electricity and produce 62% less greenhouse gas emissions than average Australian buildings, and that they use 50% less electricity and produce 45% less emissions than buildings built to minimum Code requirements.[11]

With such results, can we say that 'it's happening already' and perhaps there is no need for a strategy to accelerate uptake? It is true that we know how to design and build high performance buildings in Australia, and we also know that there are significant economic, environmental and social rewards for doing so. We have noted that it *is* happening, but at a limited scale and not fast enough to deal with the challenges facing the country. High energy performance and productivity remains a niche offering, attractive to those with the opportunity to leverage brand or other benefits, and willing and able to pay the necessary cost premium. In the CBDs of our major cities, for the buildings owned by major property groups, and for a small but rising number of house owners, we are increasingly seeing 'beyond minimum standard' buildings.

However, outside the CBDs, and in many building types, building to minimum standards remains the norm. This is particularly concerning because current energy performance standards in Australia are relatively low by global standards, and – particularly for commercial and also apartment buildings – very low relative to the levels of energy performance that would be cost effective. Research by pitt&sherry in 2012 showed that it would then have been cost effective to lift minimum energy performance standards for commercial buildings in Australia by between 58% and 68% on average by 2020[12]. Stronger than expected rises in energy prices in Australia would be very likely to increase these figures today, and yet there

[10] http://www.nabers.gov.au/public/WebPages/ContentStandard.aspx?module=10&template=3&include=Benefits.htm&side=CommitmentAgrTertiary.htm, viewed 25/5/2016.

[11] *The Value of Green Star: a decade of environment benefits*, Green Building Council of Australia, 2013, p. 3.

[12] *Pathway to 2020 for Increased Stringency in New Building Standards: Benefit Cost Analysis*, pitt&sherry, 2012.

have been no new energy performance requirements in the National Construction Code since 2009, and no changes are now expected until 2019. This lack of attention to the regulation of building energy performance is unprecedented in OECD and indeed advanced developing countries and should be urgently rectified. Every year of delay means another cohort of inefficient and unproductive buildings are added to Australia's stock – with the exceptions noted above – leaving a legacy that will be expensive to remedy in future, while in the meantime, building occupants pay more than necessary for energy services, leading to increased emissions in low productivity workplaces and homes.

8. Towards a roadmap

Doubling the energy productivity of Australia's built environment will require at least three key ingredients:

- The *joint leadership* of governments and industry with other stakeholders, collaborating to craft and implement a winning strategy
- The *technical strategies*, designs, technologies and know-how to deliver more productive and energy efficient buildings cost effectively; and
- The *policy strategies* that have a proven track record, in Australia and elsewhere, to deliver the market transformations required.

Reflecting on the gap between the market leaders and the rest, and the gap between best regulatory and policy practices and those prevalent in Australia, it is apparent that a key ingredient in any successful strategy will be leadership. Leadership includes the ability to 'call out' poor practices and to acknowledge that we can and should do better. But leadership also includes facilitating change – holding a space that *legitimises* change – which can mean nothing more than tapping into the demonstrated goodwill and capabilities of the leading players in the buildings market, to their understanding of the opportunities as well as the challenges, and to their experiences of solving those challenges. Governments have a clear role to play, and must step up to those roles, but they should not seek to impose strategies that are poorly supported by stakeholders. Rather, bringing together the enabling power of governments with the market and technical knowledge of building owners and developers, and also the critical perspective of building occupants and users, will be the winning approach.

If joint and shared leadership can be achieved, does the technical potential exist to double energy productivity in the built environment and, if it does, is that potential cost effective? While there will be challenges, and new learnings to be made by rising to those challenges, there is also evidence to say that yes, we can double energy productivity cost effectively.

We have touched on some of the key technical solutions already. They include:

- Improving *planning schemes* to encourage well-conceived urban form and precincts, through strategies like master planning, setting high but achievable standards, and facilitating learning by developers, building companies, building owners and users, and all the related building professions;

- Improving building *design*, embracing solar passive and related design philosophies like Passivhaus, enabling access to natural light and passive ventilation wherever possible, with appropriate use of thermal mass;
- Encouraging *integrated design and construction* approaches, where building owners, occupants, designers, builders and all others involved in a building project work together and communicate clearly their needs and aspirations;
- Encouraging *building integrated modelling* and the use of advanced diagnostic software tools as strategies to improve design, construction, compliance and the operational phase of building use;
- Improving *construction systems*, including innovation to achieve integration of high performance components without adding – or even while reducing – construction cost and minimising waste;
- Improving building *facades*, or thermal shells, with external shading, high performance glazing, high performance building materials, insulation and better attention to air-tightness and controlled ventilation, integrating solar or other renewable energy technologies;
- Improving building *services and controls*, from daylighting and other advanced lighting strategies, to advanced and user-responsive controls, recovering waste heat and coolth, energy storage, and high-efficiency plant and equipment, and effective and continuous commissioning and maintenance;
- Engaging with building *occupants* to seek outcomes such as energy efficient fit-outs, use of energy efficient appliances, energy conserving practices and appropriate use of user-responsive controls.

While these and many other strategies are available, and known to and practiced by industry leaders, still these approaches are rarely implemented in Australia. This roadmap is intended to provide the strategy to see leading practices become standard practices, while the leaders move on still further, developing and trialling the next wave of solutions that can later become the next industry standard.

Are such advanced practices cost effective, and to what extent? There has been considerable research into this question in Australia and elsewhere. The Australian Sustainable Built Environment Council (ASBEC)[13], for example, has concluded that over 50% improvement in energy productivity in our built environment could be achieved (based on net energy cost savings and emissions reductions) between 2015 and 2030; equivalent to $20 billion in savings. It is estimated that these potential savings could be achieved through new builds (15%), appliances and equipment (40%) and existing building retrofits (45%). These outcomes do not capture the opportunities presented to also decarbonise electricity supply at the same time as improving energy efficiency. The ASBEC paper notes that when this opportunity is considered, net emissions from the built environment could be negative – that is, helping to offset emissions from other parts of the economy.

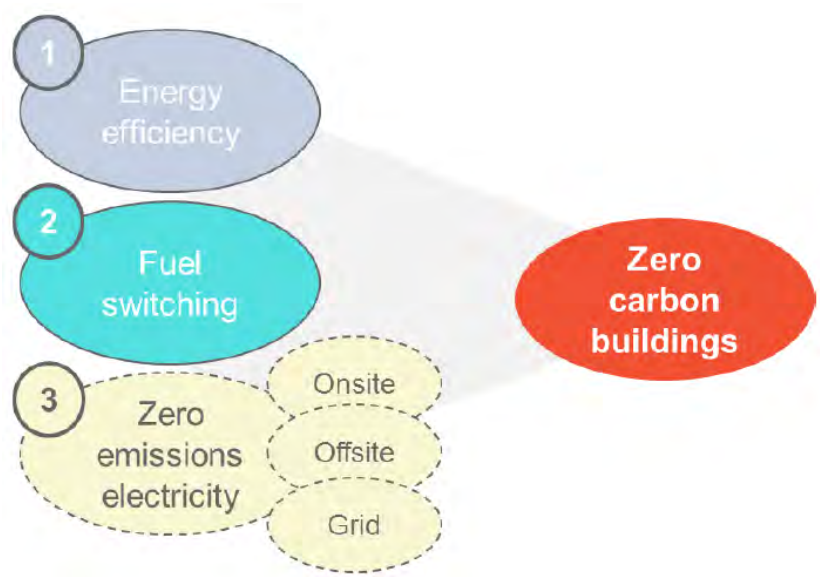
[13] Australian Sustainable Built Environment Council (ASBEC), *Low Carbon, High Performance, How buildings can make a major contribution to Australia's emissions and productivity goals*. Summary report May 2016

ASBEC[14] identified, increasing in energy productivity through:

- Energy efficiency
- Fuel switching
- Zero emissions electricity; onsite, offsite and grid.

Refer to 5 below.

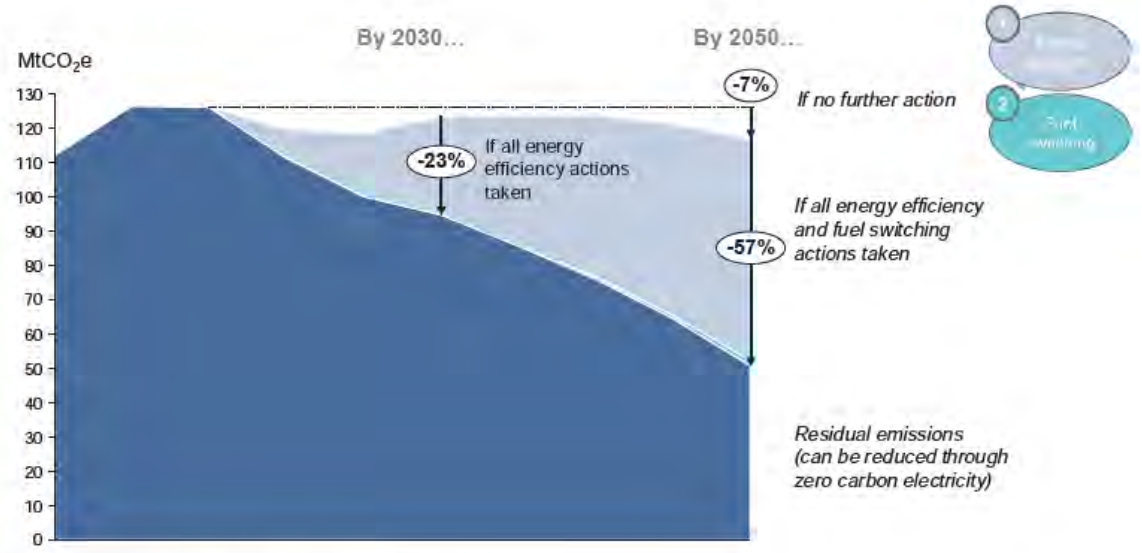
Figure 5: Opportunities to reduce emissions in the built environment



Even without technological breakthroughs, ASBEC reports on modelling that suggests cost-effective energy efficiency and fuel switching can reduce projected 2050 emissions from buildings by more than half. Further, ASBEC maintains that there is sufficient opportunity for distributed solar PV to eliminate remaining emissions, resulting in net zero carbon buildings by 2050, provided barriers can be overcome. Refer to Figures 6 and 7 below.

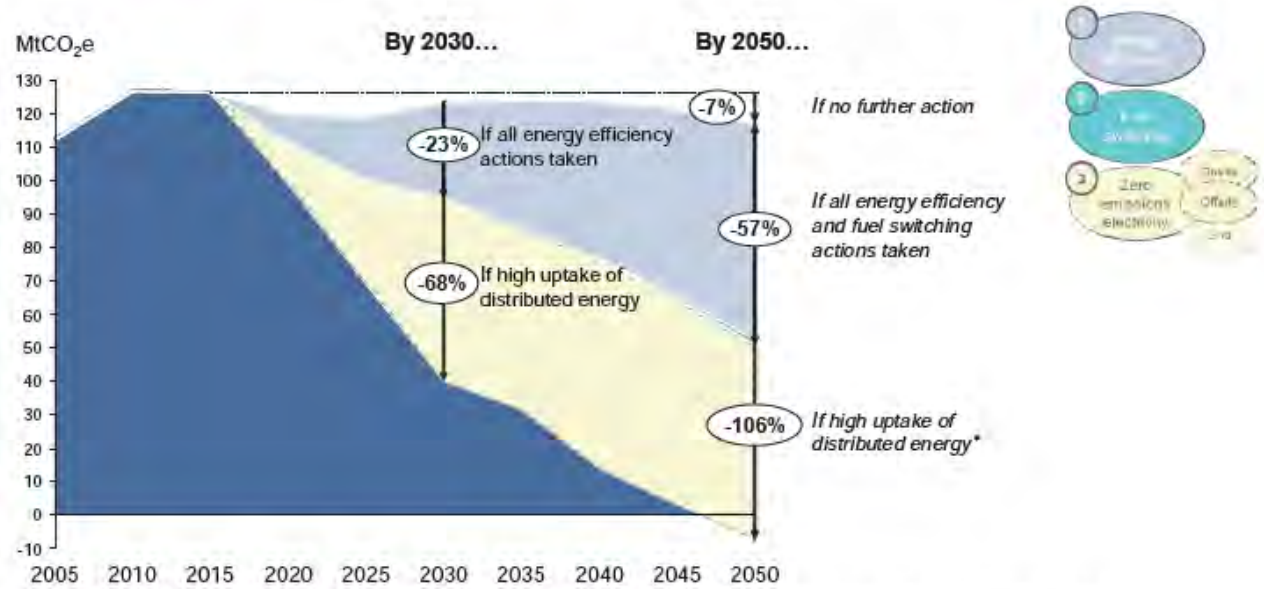
[14] Australian Sustainable Built Environment Council (asbec), *Low Carbon, High Performance, How buildings can make a major contribution to Australia's emissions and productivity goals*. Summary report May 2016

Figure 6: Built environment emissions and energy efficiency and fuel switching opportunities to 2050 ($MtCO_2e$)[15]



Source: ClimateWorks team analysis

Figure 7: Built environment emissions and opportunities to achieve zero carbon buildings ($MtCO_2e$)[16]



* 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).

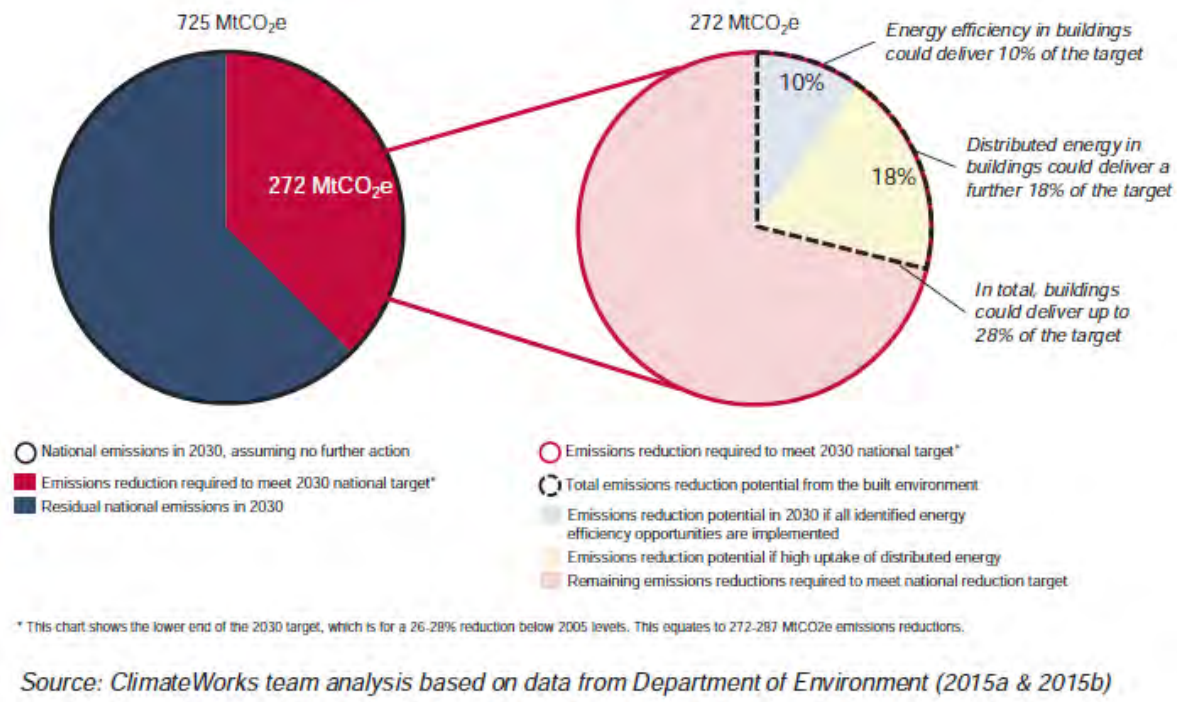
Source: ClimateWorks team analysis

ASBEC notes that implementing all energy efficiency opportunities, that buildings could meet over half of the current national energy productivity target, and more than a quarter of the current national emissions target.

[15] Australian Sustainable Built Environment Council (asbec), *Low Carbon, High Performance, How buildings can make a major contribution to Australia's emissions and productivity goals*. Summary report May 2016.

[16] Australian Sustainable Built Environment Council (asbec), *Low Carbon, High Performance, How buildings can make a major contribution to Australia's emissions and productivity goals*. Summary report May 2016.

Figure 8: Potential contribution of built environment opportunities to 2030 national emissions target (MtCO2e)



Source: ClimateWorks team analysis based on data from Department of Environment (2015a & 2015b)

Similar findings have been made in other studies. In pitt&sherry's *Energy Efficiency Master Plan – Foundation Report* for the City of Sydney, for example, we noted that emissions savings of at least 43% (based on energy savings of around 32%) could be realised by 2030 through energy efficiency improvements to the city's buildings, while realising a net economic *gain* of over $500 million in present value terms. These results were realised despite an expected 29% growth in Sydney's floor area by 2030. Higher savings of up to 70% could be achieved if the full technical potential were captured – although at very high levels of abatement, eventually net abatement costs would turn positive. For the savings levels reported above, the average cost of abatement of all measures considered for Sydney was -$35/tonne for commercial buildings and -$69/tonne for residential buildings.[17] The City of Sydney calculated that implementation of its Energy Efficiency Master Plan[18] would double energy productivity from 5.31 to 13.14 $GDP per MJ by 2030.

Similarly, in work undertaken for the Australian Government, we found that it would be cost effective for new commercial buildings to save between 58% and 68% of the energy currently allowed under the National Construction Code's energy performance requirements by 2020.[19]

[17] http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CB0QFjAA&url=http%3A%2F%2Fsydneyyoursay.com.au%2Fenergy-efficiency-master-plan%2Fdocuments%2F19823%2Fdownload&ei=V01hVdXILcbc8AWSzYCACw&usg=AFQjCNHnRNS7OdUYPBvM5r2Tv-h84zwoNw&sig2=y6f5q-pLjnCyAquet15PSw&bvm=bv.93990622,d.dGc

[18] City of Sydney, Energy Efficiency Master Plan; http://www.cityofsydney.nsw.gov.au/__data/assets/pdf_file/0020/241436/Energy-Efficiency-Master-Plan-low-res.pdf

[19] http://www.industry.gov.au/Energy/Energy-information/Documents/pathwayto2020newbuildingenergyefficiencystandards.pdf

9. Barriers to achieving 2xEP

This section summarises the barriers analysis in the 2xEP Built Environment Sector Overview. Some barriers to energy productivity are those encountered when investigating and implementing energy efficiency. However, as energy productivity is broader than energy efficiency, there are additional barriers to some energy productivity improvement. These include the lack of knowledge of how improvements or investments in energy often provide broader, and more important benefits including increased output and product quality. The following outlines the key barriers identified to energy productivity improvement in industry. Applying an energy productivity focus on overall productivity improvement should go some way towards addressing some of these barriers.

Table 2. Barriers to doubling energy productivity

Barrier	Overview
Prevailing investment paradigms	▪ The investment-decision making framework used by 90% of Australian firms appears to ignore cash flows beyond 5-years which penalises long term transformational projects. This short term orientation is placing Australia's future growth and prosperity at risk (Delloite, 2014; Lane & Rosewall, 2015).
Split incentives	▪ Developers and builders have different costs and interests to building occupiers, and building owners have different incentives to tenants
Unsupportive regulatory environment	▪ Key concerns include. ○ *poor enforcement of standards* ○ *regulation of energy and water networks* ○ *retail pricing structures for energy*
Lack of information and knowledge	▪ Building owners and managers frequently hold on to old paradigms/habits/behaviours which are not conducive to optimising energy productivity ▪ There is a genuine lack of information and knowledge across all sub-sectors in the built environment. For example: ○ a lack of performance and stock data limits regulatory efforts and has an impact on performance benchmarking. ○ in the residential sector, there is a general lack of understanding and awareness of benefits vis costs

Lack of skills	▪ Skills gaps in the building sector have been noted as one of the key barriers to lifting energy productivity (The Department of Resources Energy and Tourism, 2010).

Source(s): Stadler, A., Smith, M. and Atherton, A. (2015). *The energy productivity roadmap – Doubling energy productivity of the built environment by 2030*, Draft Version 1.0. Sydney: Australian Alliance to Save Energy.

Note that some of these barriers represent market failures. Others simply represent features of the market and resource limitations that make energy productivity investment more difficult. In either case, well-judged policy support and business consideration directed at the barriers can potentially ease them.

10. Measures to 2xEP in the built environment

The National Energy Productivity Plan (NEPP) was launched in December 2015. The NEPP has a modest target for energy productivity improvement of 40% improvement by 2030 from the 2015 baseline. Business believes that a more aggressive target is required to restore some level of competitiveness. The NEPP included reference to several of the built environment and broader recommendations put forward by 2xEP in November 2015 (see www.2xep.org.au – 2xEP and the National Energy Productivity Plan). Further support and guidance is required in order to double energy productivity.

The following section sets out a range of program and policy recommendations developed with the objective of driving a doubling in energy productivity by 2030 in the built environment sector. The recommendations include business leadership in this area supported by consistent long term non-partisan government policy support.

In formulating these recommendations, it should be recognised that 2xEP is a necessary, aggressive target, which will require a substantial acceleration of the rate of improvement of energy productivity. This can only be achieved with government intervention to support business-led actions, and will require significant measures to lift the priority for business investment in this area. Both business and government need to recognise that we are proposing a step change from business as usual activity.

The 2xEP built environment working group puts the following proposition to all political parties:

> ***Business seeks a consistent non-partisan approach to energy productivity, with stable, long-term policy platforms and, where required, reliable funding commitments at least across the forward estimates, and ideally through to 2030. Business confidence to act in this area has been damaged by policy modifications and reversals. Governments need to restore confidence through immediate and lasting action.***

The proposed recommendations are designed to meet all of the following principles:

- Measures should be supported by industry.
- Action is targeted where there are market failures and/or a demonstrated need to accelerate energy productivity improvement to improve our competitive position; that a pragmatic approach should be taken to select the best measures to address the specific market barrier, with no type of measure excluded in principle.
- An integrated package of measures is required to deliver sustainable change, with the imperative that all elements be in place.
- National harmonisation of policies and programs.
- Regulation is proposed where it is demonstrably cost effective and supported by business.
- Provides strong linkage to the National Innovation and Science Agenda.
- A solid fact base is used to support a positive benefit/cost analysis.
- Thoroughgoing stakeholder consultation occurs before implementation.

- Achieve business commitment to do its fair share to achieve commitments under the Paris Climate Agreement while maintaining and increasing prosperity. Improving energy productivity can reduce emissions while boosting the economy. Doubling energy productivity across the economy as a whole would deliver over 60% of the reduction required to meet Australia's current 2030 target.

High level benefit/costs analysis

A2EP has conducted a high level qualitative assessment of the costs and benefits for each of the proposed initiatives to help determine whether a project should be pursued. The analysis also includes reference to other assessments previously conducted where relevant and applicable. A more robust approach is required for assessing the initiatives prior to implementation.

Summary of potential benefits

Boosting productivity and competitiveness	Likely to result in improved output and a reduction in energy intensity as well as reduced costs and improved competitiveness
Improving company value and brand	High performance companies are more profitable, attract investment and customers, attract and retain staff
Reduced government outlays	Once implemented a reduced number of government staff required to administer the initiative. Additional savings are also achieved through a reduction in infrastructure and on-costs.
Reduced company resources	Reduced company resources required to access support and assistance as a result of streamlined and consistent processes
Red tape reduction (by industry)	Consistent and streamlined processes resulting in reduced regulatory burden
Improved investment certainty	Potential for increased investment as a result of increased certainty about the policy and regulatory environment and in the performance of plant and equipment
Contributing towards Australia's emissions reduction	Assisting Australia meet its emissions reduction goals through improved energy productivity
Reducing the cost of energy	Potential to reduce the amount of company expenditure on energy
Protecting energy security	Reducing reliance on imported liquid fuels as well as coal-based generation and networked electricity infrastructure

Summary of potential costs

Additional government outlays	Additional staff may be required to develop, administer or deliver the initiative taking into account additional salaries, infrastructure (i.e. office space and equipment) and on-costs.
Increased company resources	Increased company resources required to access support and assistance
Increased energy prices	Potential to increase energy prices. For example a nationally consistent white certificate scheme might increase retail energy prices in jurisdictions that currently don't have schemes.

Increased red tape	The potential for increased government involvement leading to delays in development and implementation
Government funding/support	Financial costs associated with providing either direct or indirect funding, incentives and support

11. Policy strategies - Towards a roadmap

We have established that the technical potential exists in Australia to dramatically enhance the energy productivity of Australian buildings, and also that this improvement can be achieved cost effectively. Yet while industry leaders are willing and able to implement these strategies in market segments where a return on investment can be expected, this leaves the majority of buildings languishing with minimum compliance – at best[20] – and with low energy performance standards.

As noted above, the joint leadership of governments and the building community, working together to an agreed plan, is required to deliver the transformation of all building practice in Australia and to double the energy productivity of the built environment. This section therefore turns to the policy strategies that can and must be deployed to lead and enable the change.

In considering policy measures, we can draw on both local and international experience of successful practices and programs. As noted above, we have considerable evidence in Australia about the effectiveness of key strategies, including building codes; rating, labelling and disclosure measures and others. However, we are less familiar with other policy models – widely used in OECD countries – that are collectively designed to achieve *market transformation*.

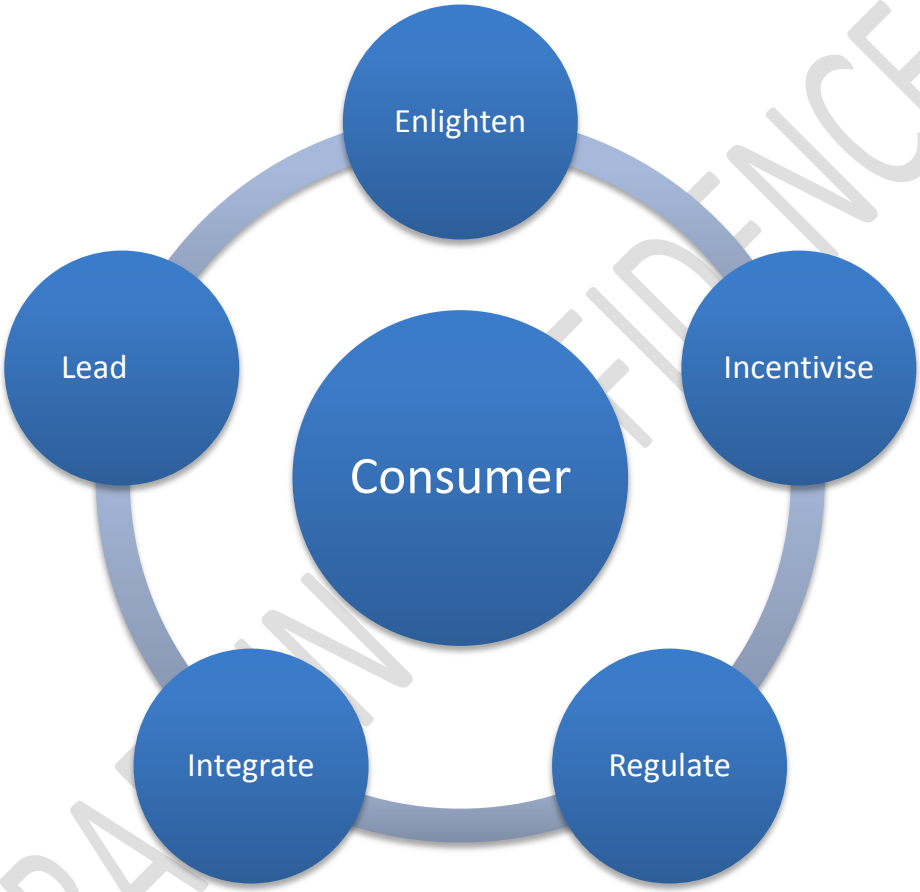
The American Council for an Energy Efficient Economy (ACEEE) defines market transformation as "...the strategic process of intervening in a market to create lasting change in market behaviour by removing identified barriers or exploiting opportunities to accelerate the adoption of all cost-effective energy efficiency as a matter of standard practice." It describes market transformation as the process of getting new, high performance products or designs to be taken up in the mainstream, without ongoing support or cost. A wide range of policy strategies can be used to achieve market transformation, from mandatory codes and performance based standards, to financial incentives, information measures and more. Commonly cited examples include the commercialisation of compact fluorescent lamps as replacement for incandescent lamps[21], and also the commercialisation of high-performance glazing. In California, the UK and Europe, mandatory standards for high-performance glazing have led to the virtual elimination of glazing strategies that are ubiquitous in Australia (single glazing, uninsulated frames), while economies of scale led to significant cost reductions[22].

What the market transformation approach highlights is the need for a comprehensive and fully integrated approach to policy design; informed by industry and market perspectives, potentials and cost/benefit considerations; but also aware of the differing incentive structures created by specific policy instruments. This approach underpins this roadmap, as it offers the opportunity to transform building practice and productivity in Australia, working with rather than against markets, to achieve self-sustaining outcomes. It demands a 'continuous

[20] pitt&sherry's 2014 *National Energy Efficient Buildings Project* report indicated that compliance with current building energy performance requirements is widely understood in the industry to be poor, but it also noted that the actual degree of compliance is not known due to a lack of compliance auditing and verification.
[21] An early overview of the approach is contained in *Creating Markets for Energy Technologies*, International Energy Agency, 2003.
[22] Zero carbon Hub, Cost Analysis of Meeting Zero Carbon Standard, 2014, http://www.zerocarbonhub.org/sites/default/files/resources/reports/Cost_Analysis-Meeting_the_Zero_Carbon_Standard.pdf

improvement' – based on evidence, research and market feedback – rather than a 'set and forget' approach to policy.

We identify a suite of measures as the necessary elements of a roadmap. They represent an *integrated* strategy – not a menu of options. These measures include both established practice and emerging opportunities that, if more broadly adopted, could have a significant impact on energy productivity in the sector. These opportunities can be considered within the four broad strategy areas supporting an energy productivity agenda, namely: traditional energy management, system optimisation, business-model transformation and value creation/preservation as illustrated above. And they can be grouped thematically as below.



Put the consumer first

Reframe the conversation: centralise the consumer and citizen	

Enlighten

Develop and implement an engagement strategy	Communicate and inform: affect choices, decisions, and behaviours. The passive provision of information is insufficient to engage effectively with consumers. An approach is required that changes the culture around energy and assists at decision-making moments.
Improve the knowledge base: quantity, quality, access	There is a dearth of available information about existing building stock, potential for improvement, the arrangement of precincts and networks. A coordinated approach to collection, mapping, analysis and publication is required.
Set baselines and benchmarks metrics and reporting	Define starting points and track progress at the level of the economy, sectors, firms and sites. Baselines should refer to a common base year.
Define data needs: collection, analysis, access	Energy productivity data should be collected and collated so as to align with the reporting of other productivity-related data including capital and labour productivity. Data should be collected at national, state and territory, sector and, where appropriate, sub-sector levels. An approach to data collection at the firm or operation level should be developed and made available for use by entities on a voluntary basis. Data should be collected, collated and published having regard to the value of data relative to the costs of collection and processing and, where possible, should draw on established systems.
Modernise metering, align datasets, publish data	Incentivise the uptake of modern metering systems that provide real time information and support demand side engagement, demonstrate value and return for investment in energy productivity improvement, support sharing and analysis of data.
Plan and resource research, development, demonstration	A national built environment research agenda would improve coordination between research institutions and industry needs. Care must be taken to acknowledge existing resources and work in train to avoid duplication, identify gaps, respect and build on strong foundations.
Engage business through associations	Industry associations can provide cost effective, peer-based channels of communication to constituents.
Re/train workforces of the future across the supply chain	The energy productivity agenda promises significant opportunities for investment and employment in design, construction, installation, operation and maintenance as well as in related fields including consulting, monitoring and verification. The agenda suggests significant developments in fields ranging from architecture to real estate, air conditioning to landscaping. The tertiary education sectors - vocational and university - must be engaged in the transition at an early stage to ensure that the workforce is prepared and sustained

Accelerate

Progress financial incentives: provide resources for action	Judicious incentives - tax incentives, obligation schemes, grants, low cost skills development and the like – that encourage the commercialisation and wide-spread uptake of solutions are required to kick start and maintain investment in energy productivity improvements. Given the competition for capital, in both commercial and residential settings, cost effective inducements may help to accelerate investments and transform markets. In the absence of standards for existing buildings (ie rather than new buildings) financing mechanisms specifically for retrofits should be a priority.
Remove barriers to innovation: address failings in energy markets	The availability and penetration of a range of 'emerging' energy products and services could be hampered by regulatory arrangements that do not anticipate or actively prevent change. Current energy market conditions actively discourage buildings to maximise on-site generation of renewable energy. The ongoing use of 'dumb' metering and fixed cost billing practices actively

	discourages good energy management practices. Some planning law and regulation can hamper innovation in the siting, design and operation of individual buildings and developments, both new and retrofit/rebuild.
Establish 2xEP Challenge: commitment and recognition	Establish a voluntary commitment and recognition program, incentivise action, encourage reporting, reward leadership, build community.

Regulate

Modernise building regulation with strong minimum standards	Energy performance requirements in the national code are fundamental to lifting energy productivity in the built environment sector. They affect performance outcomes for all new work. The current standards should be strengthened in line with best practice. A forward trajectory for regulation should be set in line with plans for energy productivity improvement and targets for emissions reduction.
Improve compliance with standards and codes	Requirements under building codes can only be fully effective when they are enforced. The current regulatory system does not ensure that the energy performance provisions of the code are met. Consequently, building owners and users – as well as the many industry participants that do meet or exceed requirements – are being short-changed by the system. Regulators must be properly funded and the compliance process should be fine-tuned. An effective system will see planners, designers, builders, inspectors and users all playing a cohesive and active role in quality assurance practices that deliver or exceed requirements.
Develop a nationally harmonised residential rating framework	All jurisdictions should collaborate on the development of a nationally harmonised residential rating framework that follows a three-layered approach of setting minimum standards, benchmarking building performance, and communicating value; and work towards an implementation strategy that ensures rating integrity, accessibility to market information, and low cost delivery
Promote ratings and disclosure for all buildings	Ratings tools can and do play an important role in driving energy productive outcomes. Ratings tools translate code requirements into a form that can be communicated to prospective purchasers and tenants of buildings and space within buildings. The tools play a vital role in establishing market conditions that allow a value to be placed on higher levels of energy productivity. This must occur to incentivise the supply of buildings - of all classes - that exceed minimum requirements. However, the relationship between standards and ratings is not currently seamless and there is a proliferation of ratings tools. Standards and ratings should be aligned and harmonised.
Consider mandatory disclosure for all buildings	Information is a vital ingredient of a well-functioning market. When information about the energy performance of a building is unavailable the market can only fail to factor energy productivity into price considerations. The Commercial Building Disclosure program ensures that all players understand the energy productivity of a large office space – and the market applies premiums and discounts accordingly. Extending mandatory disclosure to other building types that are regularly traded, including residential buildings, will introduce a market-based incentive (a premium) for higher performance and penalise (discount) poor performance.
Consider the introduction of 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.
Strengthen and harmonise energy performance standards	Minimum energy performance standards have proven effective in driving cost effective improvement in the efficiency of appliances and equipment used in buildings. The Greenhouse and Energy Minimum Standards (GEMS) Act of 2012 establishes a framework for standards. The Equipment Energy Efficiency (E3) Program is intended to align and integrate standards and labelling following the 2015 review of GEMS. While prioritisation of efforts towards products with higher levels of potential is welcome, resources should be

	devoted to ensuring that standards for all GEMS-regulated products closely align with best practice.

Integrate

Plan better: existing and new precincts	Infrastructure planning and investment are among the most complex areas of government policy and decision-making. They require a long-term strategic framework. Due to the long lifespan of most infrastructure projects and the deterministic impact transport systems have on urban form, spatial development and, ultimately, economic activity in Australian cities, more collaboration is needed between different levels of government, regulatory bodies and industry.
Activate district energy precincts; greenfield and brownfield	Recent research identifies district energy systems as a best practice approach to providing local, affordable, low-carbon energy supply. The integration of high performance buildings and equipment with renewable energy supply, real time data and intelligent systems offers great promise for energy productivity improvement.
Facilitate deployment of distributed renewable energy	Energy productivity can be improved on the supply side: optimising network investment, minimising transportation and line losses, maximising yield from input fuels. Distributed renewable generation can be co-located with or distant from a building, facility or precinct. It can be attached or integrated into structures, new and existing. Automated control systems can account for factors including actual real time generation, current and forecast weather, internal temperature and humidity levels, energy tariffs, the availability of storage. In some circumstances (factories, warehouses retail complexes) there is potential to generate and sell energy surplus to need.
Deploy smarts: buildings, cities, infrastructure	Smart city strategies generally rely on real-time data about factors such as weather, energy consumption and production and people traffic to control systems such as parking availability, battery charging, transport management. This integration of smart systems allows for the optimised use of infrastructure across sectors, for example with demand shifting in electricity grid use or with dynamic, congestion-dependent pricing in transport. Short-term gains can include improved amenity for service users and cost reduction for service providers. Long-term gains can include minimised capital investments in infrastructure and improved productivity from operating expenditures including on labour and energy.
Prioritise transport-oriented development	Transport oriented development can contribute significantly to energy productivity and emissions reduction. Greenfields and brownfields development in urban areas, both large and small, high- and mid-density, can benefit from a focus on planning geared closely to transport, particularly public and active transport.

Structure

Build and maintain a stable long-term policy platform	Align the energy productivity and emissions reduction agendas in a long-term plan towards optimum productivity and net zero emissions
Coordinate policy and programs between all levels of government	The alignment and allocation of responsibility for policy and programs between levels of government is essential for success.
Lead through government procurement	Government owned, tenanted and operated space: Offices, hospitals, schools all have significant potential for high levels of efficiency
Support low-income households through the transition	Ensure the fair operation of energy markets and equitable access to the benefits of increased use-efficiency and distributed renewable generation.
Raise the standard in social housing	State and territory governments continue to own and operate social housing. Acknowledging that affordability is a factor of the cost to occupy (ie rent) and the cost to operate (heating, coo ling, lighting), stock in these portfolios should, over time, be brought to best practice building standards.

2xEP Steering committee and working group members

2xEP Steering Committee

The 2xEP Steering Committee was inaugurated in July of 2015 and is tasked with guiding the program through development and completion. The Committee meets quarterly to review progress, refine strategy, and provide leadership. Most Steering Group members are involved in one or more of the sector working groups.

Kenneth Baldwin, Director, Energy Change Institute, Australian National University
Graham Bryant, Deputy Chair, Energy Users Association of Australia
Tony Cooper, Chief Executive Officer, Energetics
Bo Christensen, Manager Sustainability, Linfox
David Eyre, General Manager, Research & Development, NSW Farmers
Chris Greig, Fellow, Australian Academy of Technology, Sciences and Engineering
Tim Hicks, Senior Manager, Economic Policy, Australian Chamber of Commerce and Industry
Travis Hughes, Head of Energy Services, AGL Energy
Jonathan Jutsen, Deputy Chairman, Australian Alliance for Energy Productivity
Andrew Lamble, Co-Founder and Chief Operating Officer, Envizi
Adam Lovell, Executive Director, Water Supply Association of Australia
Sid Marris, Director – Industry Policy, Minerals Council of Australia
Luke Menzel, Chief Executive Officer, Energy Efficiency Council
Brian Morris, Vice President, Energy & Sustainability Services, Schneider Electric
Gordon Noble, Managing Director, Inflection Point Capital
Andrew Peterson, Chief Executive Officer, Sustainable Business Australia
Glenn Platt, Group Leader, Energy Technology, CSIRO
Tennant Reed, Principal National Adviser – Public Policy, AiGroup
Duncan Sheppard, Director Communications and Policy, Australian Logistics Council
Anna Skarbek, Executive Director, ClimateWorks Australia
Scott Taylor, Head of Living Utilities, Lend Lease
Kane Thornton, Chief Executive Officer, Clean Energy Council
Suzanne Toumbourou, Executive Officer, Australian Sustainable Built Environment Council
Laura Van Wie McGrory, Vice President, International Policy, US Alliance to Save Energy
Stephen White, Energy for Buildings Manager, CSIRO
Stuart White, Director, Institute for Sustainable Futures
Bruce Wilson, Syndicate Chair, CEO Institute, Transport specialist
Oliver Yates, Chief Executive Officer, Clean Energy Finance Corporation
2xEP is supported by 10 working groups; for each key end use sector of the economy plus finance, innovation, metrics and communications.

Built environment
Suzanne Toumbourou, Executive Officer, Australian Sustainable Built Environment Council
Scott Taylor, Head of Living Utilities, Lend Lease
Brian Morris, Vice President, Energy & Sustainability Services, Schneider Electric
Andrew Lamble, Co-Founder and Chief Operating Officer, Envizi
Jonathan Wood, Group Manager Sustainability, Crown Resorts
Josh Machin, Policy Adviser, Business Council of Australia
Stephen White, Energy for Buildings Manager, CSIRO
Tony Westmore, General Manager, Australian Alliance for Energy Productivity

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[ii] excluding cost of energy used by the energy supply and oil and gas extractive sectors

[iii] Stadler A, 2015. *A review of available data to establish national and NSW energy productivity baselines*, (Version 1). Sydney: A2SE (Analysis based on a range of primarily Australian government sources and adjustments in consultation with the Australian Bureau of Statistics)

[iv] excluding cost of energy used by the energy supply and oil and gas extractive sectors