



A roadmap to double energy productivity in the Built Environment by **2030**





Background

The Australian Alliance for Energy Productivity (A2EP) is an independent, not-for-profit coalition of business, government and environmental leaders promoting energy efficiency, energy productivity and decentralised energy. A2EP aims to inform, influence and advance the effective use of energy in Australia.

A2EP is supporting a program of business-led research, consultation, collaboration and advocacy called 2xEP (doubling energy productivity). 2xEP aims to double Australia's energy productivity by 2030 (from a 2010 baseline). The 2xEP Roadmap is a collaborative process that will plot a step change in national energy productivity; essential to boost general economic productivity, improve competitiveness and reduce greenhouse gas emissions. The program is led by a steering committee of leaders in business and research. It extends across the national economy and into key sectors: agriculture, manufacturing, mining, freight, passenger transport and the built environment.

This document is a summary of the built environment sector roadmap. The roadmap is finalised to a consultation draft and is available at 2xep.org.au. We welcome comments and contributions. The roadmap will be developed into a platform that leads to 2xEP by 2030 with all of the benefits that promises.

Thanks and a caveat

The roadmap and this summary are published by A2EP. The roadmap was prepared in consultation with the built environment sector. The built environment working group comprises representatives of individual firms, industry associations, research organisations and suppliers of energy services and equipment.

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.

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

Images, cover, this page and next: Lendlease and Living Utilities recently moved to Tower Three at Barangaroo, the new global headquarters for Lendlease. Lendlease plans to make Barangaroo South the most sustainable and advanced large-scale precinct in Australia. The 7.5-hectare site includes three commercial towers, residential, retail and dining zones as well as a landmark hotel. It will be home to around 1,200 residents, 23,000 workers and more than 2.4 hectares of public park space. Underpinning the commercial precinct is a two-level basement that houses the precinct's recycled water plant, centralised chilled water plant for air conditioning and the site's embedded electrical network. Together, they help to make Barangaroo South one of the world's most sustainable precincts – and a significant step forward.

What is energy productivity?

Energy productivity is an indicator of the amount of economic output that is derived from each unit of energy consumed. 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.

$$\text{ENERGY PRODUCTIVITY} = \frac{\text{ECONOMIC OUTPUT}}{\text{ENERGY USED}} = \frac{\text{GDP}}{\text{PJ}}$$

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

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:

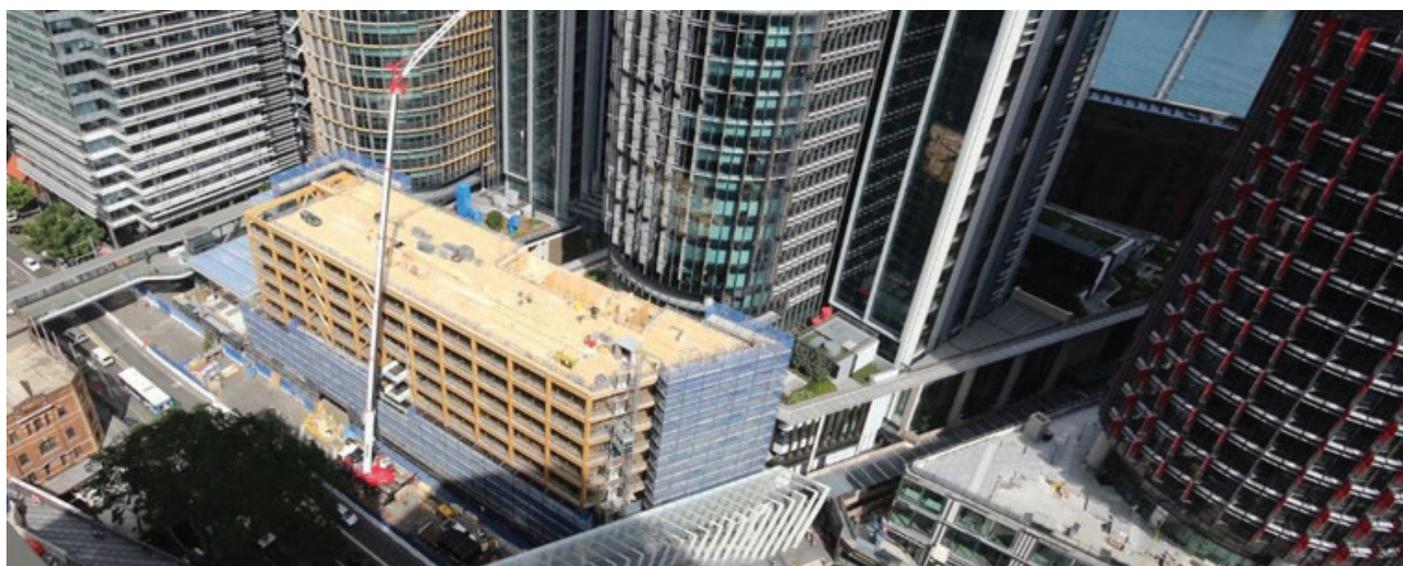
- where we are now, so that we don't regress, or else over-reach on the first steps;
- where we need to get to, specifically in relation to where we are now; and
- what are the best pathways to take us from where we are now to where we need to be.

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.

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.



Why 2xEP? The economy

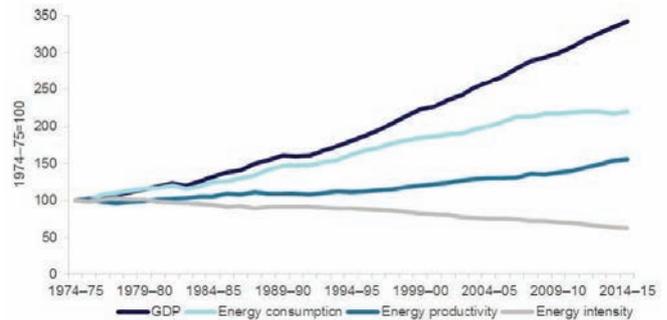
Why the 2xEP target? 2xEP is a voluntary and aspirational target across the economy. It is a stretch target that will require changes in products and services, business models, attitudes and practices. 2xEP can be achieved with existing, cost effective technologies. We can reasonably expect that significant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

Energy productivity is now 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 economic 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). 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.

The 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.

Australia's energy productivity



Australian Energy Statistics

Source: Department of Industry, innovation and Science (2016)

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.

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.



600kW solar array for Amaroo School in the ACT, 1.24MW solar array for Brisbane Markets in Queensland.

Integrated distributed renewable generation and storage can significantly improve energy productivity on-site and upstream by facilitating network optimisation. Solutions can be installed during a new build or retrofitted. More at <http://www.solarchoice.net.au>

The built environment

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.

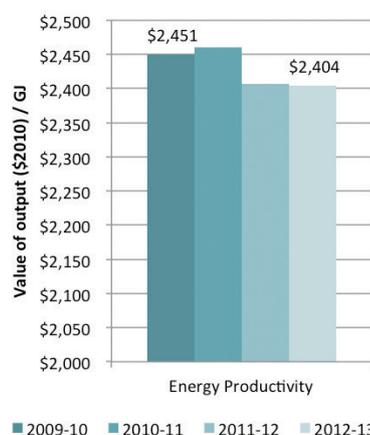
Given that the useful life of assets typically extends over decades, the pace with which initiatives are adopted will have a significant impact on the contribution of the sector towards a goal of doubling Australia’s energy productivity by 2030. Poor decisions can lock in unnecessarily expensive and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

2xEP in the built environment

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 energy 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.

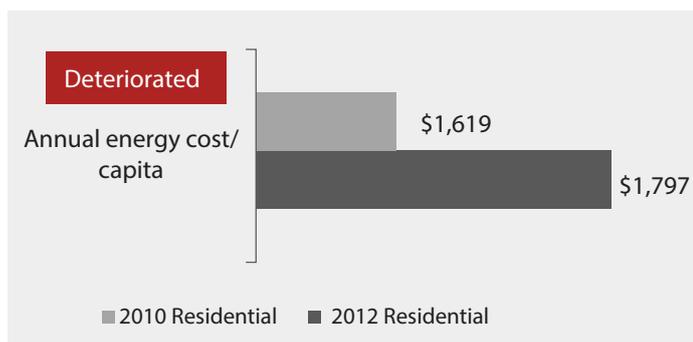
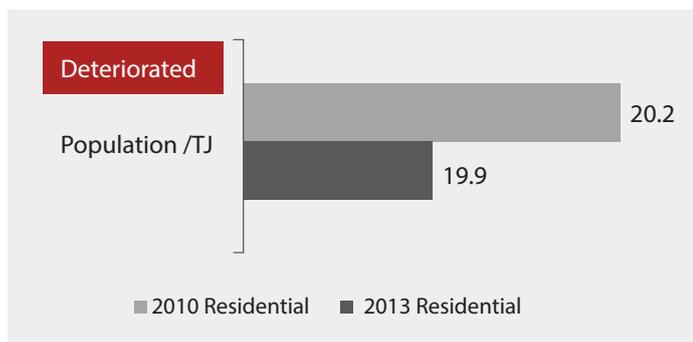
Our preliminary estimate of the 2010 baseline energy productivity of the built environment, excluding the government and residential subsectors, is illustrated below. The performance level is calculated on a three-year rolling average basis to reduce the volatility typically associated with energy productivity measures. Nonetheless, performance against both metrics has been trending downwards.

Economic productivity of the built environment – Commercial sector (private sector)



Economic productivity of the built environment – Residential sector (proxy measure)

We have calculated a baseline for the residential sector on two measures – population served per TJ and annual energy cost per capita. 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 three-year rolling average basis to reduce the volatility typically associated with energy productivity measures.



Built Environment Sector Overview

Source: Australian Alliance to Save Energy (2014) 2xEP

Beyond energy efficiency: Productivity

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The five Habitat 21 show homes sit by side by side at the Dandenong site, as models for affordable architecturally designed housing.

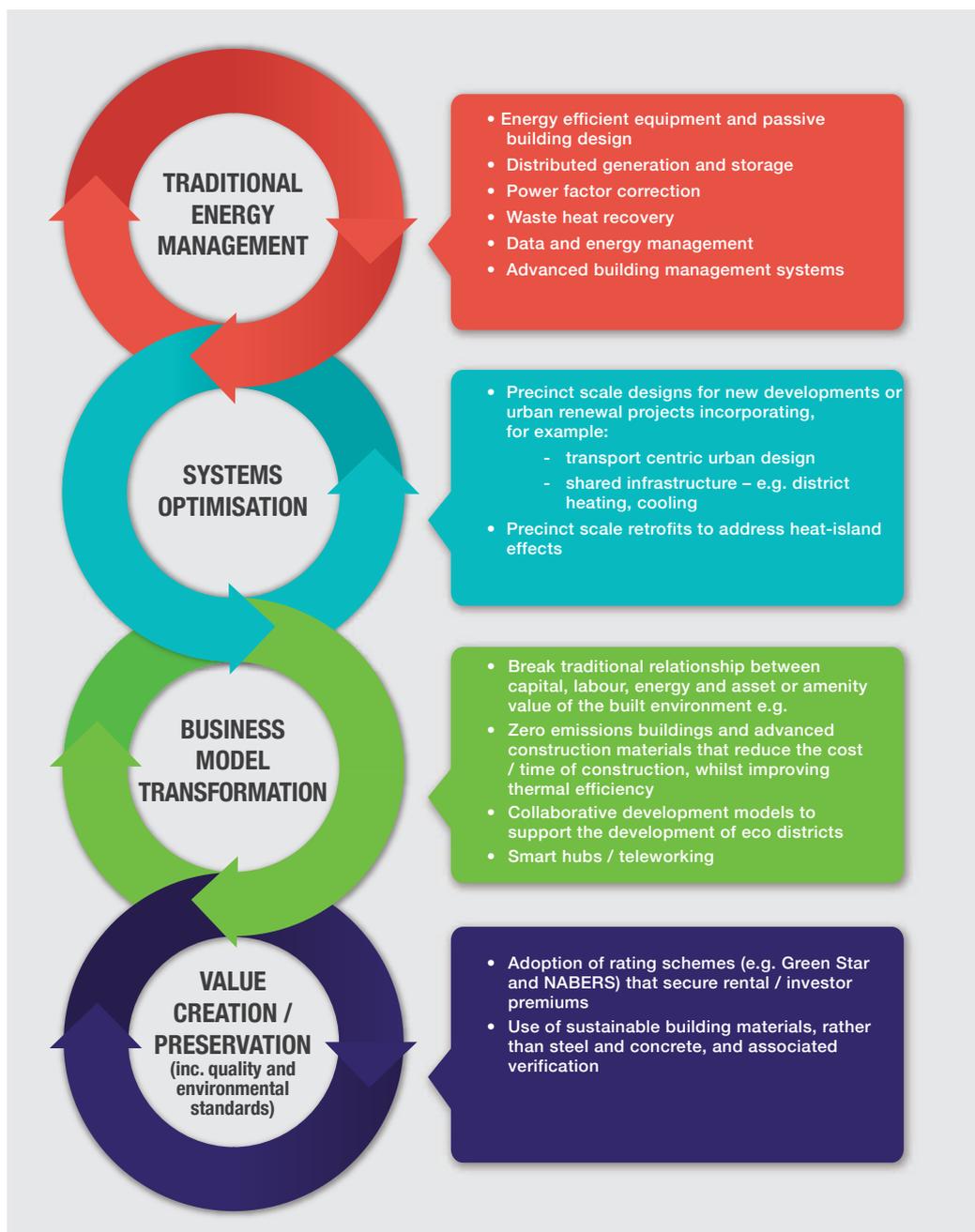
Image: Peter Clarke , <http://architectureau.com/articles/habitat-21/>

Productivity vis efficiency

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.

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:



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

“...precincts are key to the dense, diverse, varied cities we need. They house the labour force needed for cities and provide the type of amenity people want. If planned properly they provide the opportunity to export energy and recycled water and remove some of the burden from existing centralise water and energy networks.”

Monica Barone, Chief Executive Officer, City of Sydney

Strategies and policies to improve the energy performance of the built environment are typically focused on equipment scale and at best building scale improvements in energy performance. However, optimising individual buildings is only part of the solution as economic productivity is intrinsically tied to the transformation of Australian cities.

Precincts lend themselves to transform the energy profile in urban environments as they are small enough to innovate, but large enough to have a meaningful impact due to their size.

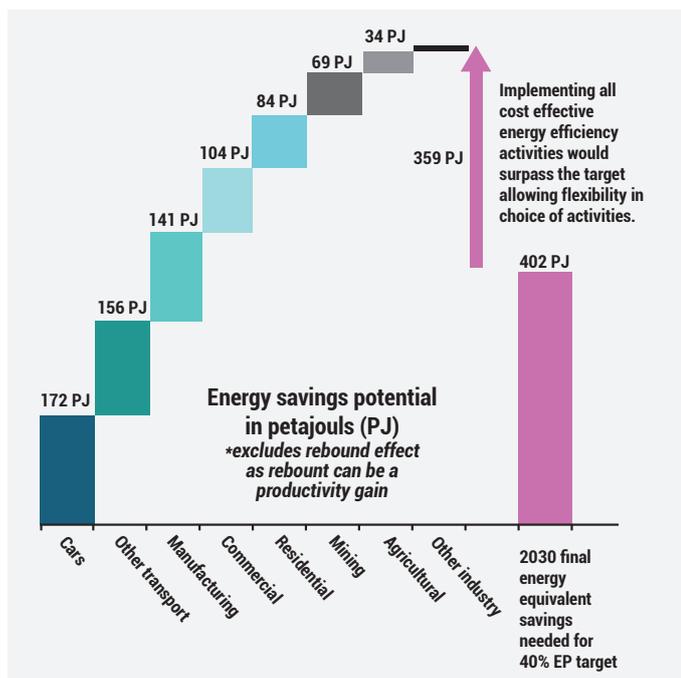
Integrated infrastructure planning enables the development of transport, energy and other infrastructure around future service needs, creating sustainable value chain precincts.

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

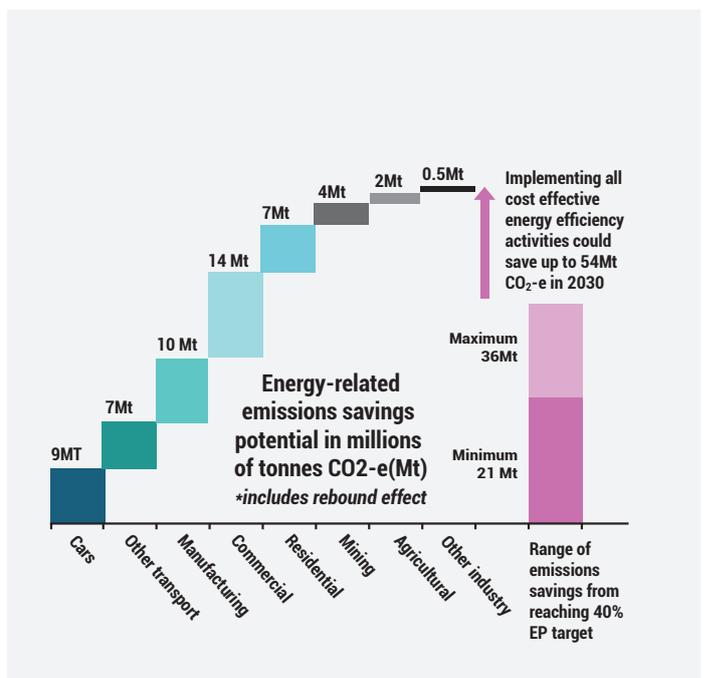
urban planning, economic competitiveness, environmental engineering and sustainable practices that use information and communication technologies to enhance liveability, sustainability and workability”. Implementing the civil and data infrastructure needed to enable efficient industrial ecology is crucial to unlocking the benefits of smart systems, 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.

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.



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



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.

Proposed measures:

Put the consumer first

Reframe the conversation: centralise the consumer

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

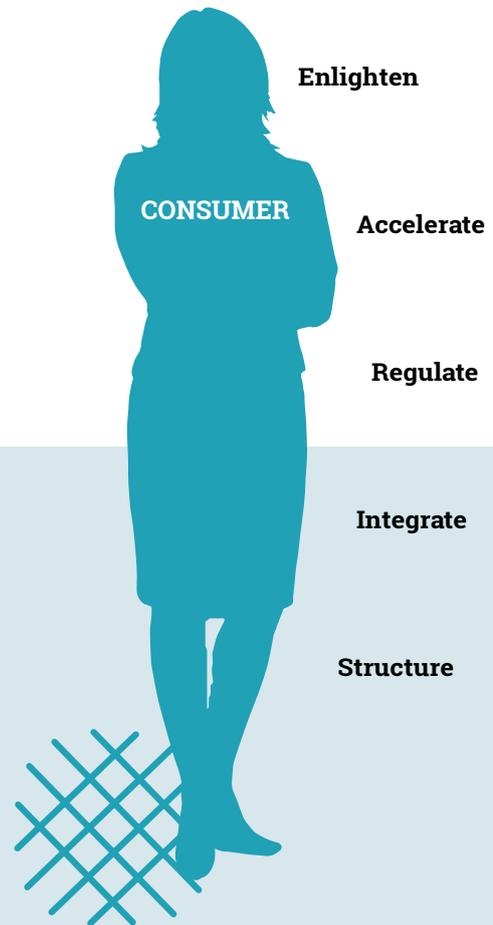
Build confidence, stimulate change

- 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

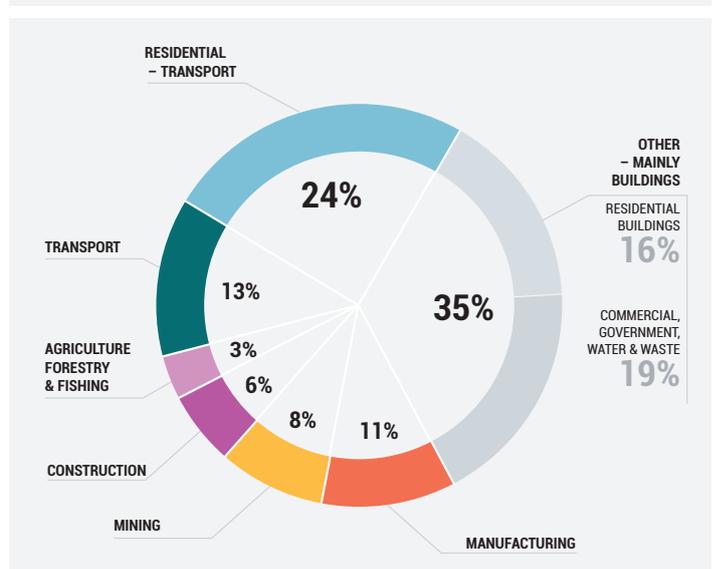
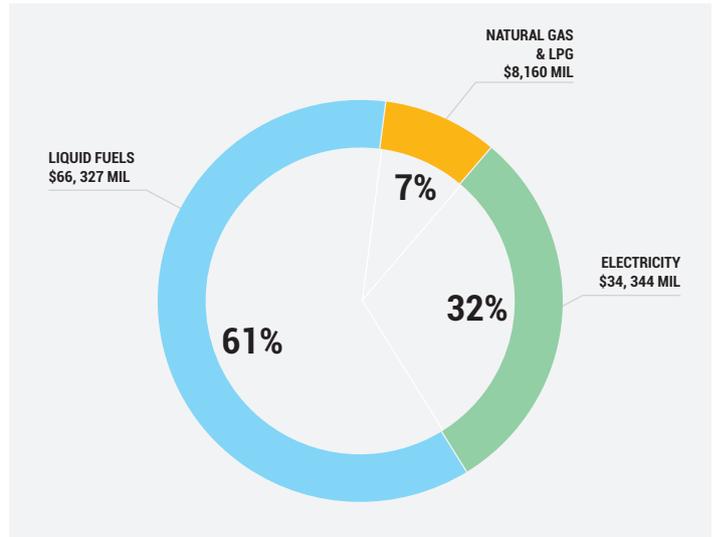
Set the goals, facilitate the transformation

- 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

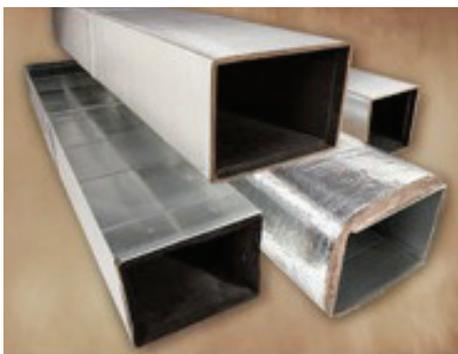
Energy consumption and expenditure in the built environment

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 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.

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). 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)



Insulation can significantly improve amenity, efficiency and productivity. Recent research by pitt+sherry for Knauf Insulation reviews optimal levels of insulation for homes. <http://www.knaufinsulation.com.au/en/content/new-research-reveals-australians-could-save-over-300m-through-better-insulation>



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

Barriers to achieving 2xEP

Some barriers to energy productivity are those encountered when investigating and implementing energy efficiency. However, as energy productivity is broader than energy efficiency, there may be additional barriers to 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.

- Prevailing investment paradigms
- Split incentives
- Unsupportive regulatory environment
- Lack of information and knowledge
- Lack of skills

Applying an energy productivity focus on overall productivity improvement should go some way towards addressing some of these barriers. 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.



The central thermal plant at Central Park in Chippendale, Sydney reduces the space required for hot water, air conditioning and energy supply by 60%. For example, instead of 13 individual back up energy systems, only two are required. Space savings translate to an improved rate of return for developers and a smaller carbon footprint. This self-sufficient neighbourhood meets regulatory requirements for operational redundancy.
<http://flowsystems.com.au/communities/central-park-water/>



Energy solution providers taking advantage of the Internet of Things to create solutions for businesses and consumers.

[http://www.schneider-electric.com.au/en/work/campaign/improve-your-facility/facility-insights.jsp#xtor=CS4-44-\[Print\]](http://www.schneider-electric.com.au/en/work/campaign/improve-your-facility/facility-insights.jsp#xtor=CS4-44-[Print])

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. 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

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, Lendlease

Kane Thornton, Chief Executive Officer, Clean Energy Council

Suzanne Toubmourou, 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 communications, innovation, finance and metrics.

2xEP Built Environment Working Group

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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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A2EP Board of Directors

Scott Taylor, Head of Living Utilities, Lendlease (Chair)

Jonathan Jutsen, Deputy Chairman, Australian Alliance for Energy Productivity

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Travis Hughes, Head of Energy Services, AGL Energy

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Brian Morris, Vice-President Energy and Sustainability Services, Schneider Electric

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