Building and Appliance Energy Efficiency Research: Opportunities for EU-Australian Collaboration
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SPIPA (Strategic Partnerships for the Implementation of the Paris Agreement)

The SPIPA programme (Strategic Partnerships for the Implementation of the Paris Agreement) encourages and assists EU and non-European major economies in making their best efforts towards the goals of the Paris Agreement by fostering exchanges and collaboration among national and sub-national administrations, business communities, academia, and civil society stakeholders.

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The research team acknowledges and pays respect to the past, present and future Traditional Custodians and Elders of this nation and the continuation of cultural, spiritual and educational practices of Aboriginal and Torres Strait Islander peoples.
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Executive Summary

European Union (EU) and Australian institutional structures, past policy measures and present policy approaches related to building and appliance energy and climate response have much in common, and important differences. Both the similarities and differences provide fertile ground for increased future research collaboration.

Both the EU and Australia have structures with overarching governance, funding, and influence: The EU has the European Council, European Commission and European Parliament, while Australia has its national government and parliament. The National Cabinet, which replaced the Council of Australian Governments in mid-2020, provides a forum for the Prime Minister to engage with state and territory leaders¹. The EU Member States and Australia’s states and territories have substantial powers and roles to determine detailed design and implementation of policies as well as their own emission targets.

Both the EU and Australia face challenges in dramatically scaling up action to cut carbon emissions associated with appliances and buildings, as well as adapting to more extreme climate conditions and managing equitable transitions. Both have substantial stocks of existing buildings and equipment that will maintain high levels of emissions unless operating efficiency is optimised and/or they are renovated or replaced. Climates and availability of renewable energy vary widely across both regions.

Key differences exist. The EU sets strong climate targets and develops comprehensive Directives with specific expectations of outcomes from Member States. In Australia, state and territory governments have committed to stronger targets than the national government, while community groups, state and local governments and business groups act independently and in coalitions to develop and implement measures.

In broad terms, the EU has more emphasis on ‘top down’ and EU level coordinated policy, though implementation varies widely across Member States. Australia has diversified approaches that are more ‘bottom-up’ and fragmented. In some areas, national policy has evolved based on lessons and pressure from below, for example appliance efficiency policy was initiated by two state governments in the mid-1980s and became national legislation only a decade ago. Renewable energy policy involves a mix of national, state-based, business-driven and community initiatives reflected in, for example, a high level of ‘behind-the-meter’ rooftop solar adoption. Substantial energy retailer obligation schemes exist in some states and territories.

In both the EU and Australia, diversity in approaches at the Member State and state and territory levels provides valuable lessons from ‘pilot projects’ that can be built upon and applied more broadly. However such projects can also create confusion, higher costs, and complexity!

This paper reviews relevant past and represent policies in the EU and Australia within broad categories that were established after initial research. The categories are shown in Table 1 and in more detail in Table 4 and supporting text within the paper.

¹ Effective Commonwealth-State Relations; see https://www.pmc.gov.au/domestic-policy/effective-commonwealth-state-relations
Table 1: Categories for reporting of relevant past and present policies

<table>
<thead>
<tr>
<th>Broad topic</th>
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<tr>
<td>Overarching leadership, institutional and governance structures and resourcing</td>
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<tr>
<td>Regulation and standards</td>
</tr>
<tr>
<td>Financing of investments in building upgrades, expansion of supply chain infrastructure</td>
</tr>
<tr>
<td>Motivating policymakers and decision-makers to factor in long term and whole ‘value chain’ benefits</td>
</tr>
<tr>
<td>Information</td>
</tr>
<tr>
<td>Just, rapid transition</td>
</tr>
<tr>
<td>Development of lifecycle, circular economy models</td>
</tr>
<tr>
<td>Integration of buildings into energy systems</td>
</tr>
</tbody>
</table>

The outcome of the review of policies and evaluations of their outcomes is a table of potential priority areas where collaboration between the EU and Australia seems likely to offer significant benefits to one or both regions.

Table 2: Priority areas for potential collaboration between EU and Australia

<table>
<thead>
<tr>
<th>Opportunity area</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development and justification of streamlined overarching institutional and governance structures and mechanisms to allocate appropriate resources and leadership to building and appliance energy efficiency and lifecycle emission reduction.</td>
<td>Buildings and appliances offer very large and cost-effective potential to deliver multiple benefits (at a societal level, and in comparison with many other carbon emission reduction measures), but progress is well below potential. To deliver rapid and large emission reduction consistent with climate science, both EU and Australia must dramatically increase deep renovation and higher performance of new buildings and appliances.</td>
</tr>
<tr>
<td>Policy packages, policy tools and actions that drive rapid expansion of deep renovation Research into barriers and ways of overcoming them.</td>
<td>In both EU and Australia most building renovation is ‘shallow’, focused on measures with relatively short payback periods and application of narrow criteria, often just energy savings, when they deliver multiple benefits. This will require packages of measures that address issues including financing, reduction of perceptions of risk, energy tariff design, targeting, reduction of costs and labour, streamlining of products and services, expansion of supply chain capacity, local manufacturing and motivation or requirements for compliance and enforcement of key supply chains and consumer groups</td>
</tr>
<tr>
<td>Identification of ways policy areas beyond energy and climate potentially influence energy and climate outcomes, and how they could contribute to positive outcomes.</td>
<td>Many policy areas, such as taxation, social welfare, health, infrastructure, business innovation and urban planning impact on energy efficiency and productivity. These influences are often very powerful, but the links are not recognised, so opportunities to reshape these policies to help achieve energy and climate policy outcomes are missed and perverse outcomes can occur</td>
</tr>
<tr>
<td>High lifecycle performance existing and new public buildings.</td>
<td>Governments must demonstrate that they ‘walk the talk’ to set an example. They are large consumers of buildings, materials, and appliances, so they influence markets and supply chains. In most cases, energy savings and productivity benefits mean measures are cost-effective.</td>
</tr>
<tr>
<td>Development and strategies to drive widespread adoption of comprehensive cost-benefit assessment tools that take into account multiple societal benefits and future carbon costs.</td>
<td>Narrow criteria, high discount rates, layer upon layer of conservative assumptions, reliance on ‘simple payback period’ and other factors such as lack of baseline energy efficiency data undermine effective policy development and decision-making by policy makers and along value chains. Addressing these can also help to overcome split incentives by documenting benefits captured by others so appropriate adjustments can be made and costs/benefits shared.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Development of improved lifecycle impact and costing methods, embodied and end of life emissions and incorporation into voluntary and mandatory policy tools and measures.</td>
<td>Credible, replicable default values are needed, as well as standard methodologies so that individual material and product suppliers and consumers can gain recognition for their choices of materials that rate better than default values, and these issues can be reliably factored into policies.</td>
</tr>
<tr>
<td>Development of improved heat pumps and design techniques and their widespread application, including user-friendly interfaces for information and control.</td>
<td>While there is impressive RD&amp;D aimed at increasing delivery temperatures, use of low Global Warming Potential refrigerants and efficiency improvements, there is scope for further policy and technology development and supply chain capability improvement. Automated detection of clogged filters, refrigerant loss and other types of failures maintains efficiency and output capacity and reduces risk of loss of production or service delivery: smart monitoring and diagnostics that alert operators are much more effective than regular maintenance checks. Use of stored heat or boosting to pre-heat inlet fluids, and optimisation of heat delivery temperatures to reduce the temperature lift required reduces capital cost. Improved monitoring of the actual efficiency of existing gas-fired equipment so that realistic efficiency values are factored into design and sizing of heat pumps will also improve the business case for change.</td>
</tr>
<tr>
<td>Development and application of add-on modules that convert existing ‘dumb’ electricity, gas, and water meters into connected real time monitoring devices that are user-friendly, can support advanced data analytics, and can integrate into existing data systems to use multiple data streams.</td>
<td>The present approach of replacing existing meters with real time, remote readable utility quality meters creates a serious bottleneck that limits the rate of digitalisation, application of data analytics and capture of large energy savings. Utility quality accuracy is not needed for these purposes. If untrained consumers could fit and remove them, it would also allow them to take control of who can access their data: this may encourage faster adoption.</td>
</tr>
<tr>
<td>Research to improve understanding of the underlying energy requirements for services, existing real world’ system efficiencies, energy actually consumed by activity, diversity of energy use for activities and factors influencing demand for services and energy use for them, including changing climate.</td>
<td>Field monitoring, consumer engagement and data analysis are needed to improve understanding of timing and levels of energy use, and to estimate and compare real and ideal energy efficiencies of services provided and demand profiles. Development of models that incorporate the physics and chemistry of service delivery and explain impacts of varying user behaviour, attitudes, maintenance, and other factors.</td>
</tr>
</tbody>
</table>
A key challenge in preparing this paper was the limited evidence base identified regarding the detail of implementation, evaluation of policy outcomes and lessons learned in both the EU and Australia. Given the limited scope and resources of this study, much more information undoubtedly exists, but information is fragmented. An overarching priority should be the collation of information on outcomes of policies, consolidation of the key lessons for policy development and implementation, and identification and action to address significant gaps in the evidence base.
The context of this paper

This paper was funded by the European Union’s SPIPA (Strategic Partnerships for the Implementation of the Paris Agreement) program as part of a broader process managed by the University of Melbourne’s Climate and Energy College that includes:

- A series of webinars on relevant topics
- Preparation of this paper and other papers on energy affordability and health
- Consultation and a launch of this paper
- Development of a basis for future closer links between researchers from the EU and Australia, possibly through an international network.

The paper’s initial overall focus was on lessons Australia can learn from EU experience in building and associated appliance policies. However, this evolved into a broader exploration of potential areas for research collaboration, building on experience from both regions. In order to address this, several issues are considered, including:

- Understanding the scope of EU building and appliance energy and climate policy measures based on the Buildings Performance Institute Europe (BPIE) paper ‘A Guidebook to European Building Policy’ (Fabbri et al. 2020) and recent developments such as the ‘Fit for 55’ measures (European Commission 2021a). Research included attempts to identify independent evaluations of the extent to which they have achieved expectations, and rationales behind recent changes
- Documenting the Australian context and experience in buildings and appliances energy and climate policy, as well as the implications of broader policy approaches that apply across the economy, so the potential relevance of EU policies for Australian circumstances, and vice versa, can be explored
- Comparison of building and appliance policy contexts and performance in Australia and EU
- Identification of areas where future collaboration between EU and Australia offers potential benefit and suggestions for priority areas where collaboration seems to offer maximum potential benefits.

This approach has been taken so that it can offer readers a ‘stand-alone’ document with sufficient background information for discussion and formulation of priorities for collaboration.

The paper initially frames the global context within which future buildings and appliances energy and climate policy must operate. It compares overall policy and governance arrangements in the EU and Australia. It then provides an overview of broad areas where potential for collaboration and sharing of lessons may exist. It provides background by exploring in more detail the approaches the EU and Australia have taken to buildings and appliances policy. This provides a basis for identification of some priority areas for potential collaboration and future discussion between relevant parties. Further background material in appendices provides more detail on the evolution of Australian policy related to building and appliance energy and climate issues.

Given the limited time and resources available for preparation of this paper, it cannot claim to be comprehensive. And this version may not adequately summarise EU work, especially recent developments in a rapidly changing context, as it was prepared by an Australian team from publicly available resources. However, it provides a basis for discussion, policy development and further work.
The broad context

Recent global processes have focused attention on the urgency of carbon emission reduction, with emphasis on substantial reductions by 2030 and zero net emissions by 2050, as well as consideration of carbon budgets. The Intergovernmental Panel on Climate Change (IPCC) has emphasised that climate impacts correlate to cumulative global emissions, not annual emissions. Further, IPCC has presented data on the limited cumulative global carbon budgets available if we are to achieve a range of outcomes within 1.5 to 2 degrees of global heating, including consideration of the probabilities of those outcomes (see Table 3).

Table 3: Limited cumulative global carbon budgets (source: IPPC, 2021, p. 41)

<table>
<thead>
<tr>
<th>Approximate global warming relative to 1850–1900 until temperature limit (°C)*1</th>
<th>Additional global warming relative to 2010–2019 until temperature limit (°C)</th>
<th>Estimated remaining carbon budgets from the beginning of 2020 (GtCO₂)</th>
<th>Variations in reductions in non-CO₂ emissions*3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>0.43</td>
<td>900 650 500 400 300</td>
<td>Higher or lower reductions in accompanying non-CO₂ emissions can increase or decrease the values on the left by 220 GtCO₂ or more</td>
</tr>
<tr>
<td>1.7</td>
<td>0.63</td>
<td>1450 1050 850 700 550</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>0.93</td>
<td>2300 1700 1350 1150 900</td>
<td></td>
</tr>
</tbody>
</table>

On this basis, it seems likely that global emission reduction will need to occur much faster than previous commitments, including those made at the recent Glasgow COP 26. This paper does not propose to engage in discussion of specific targets.

Given this situation, it is clear that policy design should be ambitious, and should incorporate capacity to accelerate emission reduction over time. To support this, timely and comprehensive evaluation of performance of policies and practical options to accelerate emission reduction based on ‘learning by doing’, evidence-based analysis and multi-disciplinary research, development, and demonstration, are all important.

Given the long lives of buildings and the even greater inertia of cities, adaptation and enhanced resilience of existing and new buildings and urban systems to changing climate and technological change are critically important. Effective management of transition, as well as lifecycle perspectives that include the embodied energy and emissions of building materials and end of life issues, are also essential. Incremental improvements risk becoming part of the emission problem in future years: rapid, deep abatement is increasingly important.

Hotter summers create new challenges. For example, highly insulated buildings without suitable shading and other features may overheat. Less reliance can be placed on natural ventilation for cooling on hotter nights. Increasing storm intensity, wildfires and floods will require modification, or even relocation of buildings and communities. Increasing damage from extreme events will increase the risks of failures of essential infrastructure and the need for recovery, rebuilding and relocation of buildings and human activity. Preventive measures and ‘climate-proofing’ will become increasingly important.
The International Energy Agency (IEA) has developed a net zero by 2050 scenario for energy-related emissions. This suggests global emission intensity for energy-related emissions must be reduced (i.e. energy productivity must improve) by 4% per year, much faster than past performance. IEA has also estimated the shares of emission reduction required for each sector, with building operational energy use changes shown in Figure 1 and Figure 2. Figure 1 shows the broad context of energy-related emission reductions and how buildings and appliances contribute to emissions in the scenario. Figure 2 focuses on emissions from on-site activity and assumes electricity supply will be near zero emission intensity by 2050.

Figure 1: Energy-related emissions (source: IEA, 2021, p. 20)
Note that *direct emissions* are from on-site combustion. Emissions from building electricity consumption are additional, and almost all electricity is expected by the IEA to be provided from zero carbon sources by 2050. The scenario also includes large improvements in efficiency of electricity use within the building sector that are not shown in Figure 2.

Upstream ‘embodied’ emissions in materials and other inputs associated with buildings are substantial, and are additional to the emissions shown. End-of-life resource recovery and utilisation not only reduce waste management problems, but also offer additional potential for emission reduction by avoiding the need to produce some virgin materials. A recent Australian study estimated that embodied emissions contribute 6 to 10% of Australia’s present annual emissions of around 500 MtCO₂e (Clean Energy Finance Corporation 2021). Toth, Volt and Steuwer (2022) suggest embodied emissions are 10 to 20% of EU lifecycle building emissions, but there is not a consensus. As operating emissions decline, embodied emissions will become a larger proportion of lifetime emissions.

At a broader level, urban and regional planning policies and actions impact on building-related emissions. These include factors such as travel distances and transport modes, urbanisation, embodied emissions of infrastructure, climatic conditions buildings must cope with (including urban heat island effects), exposure and resilience to extreme climate events, and exposure to impacts from changing climates. These are beyond the scope of this paper.

IEA expects population growth, economic development, and higher living standards to significantly increase underlying global demand for energy-related services provided by buildings and associated appliances and equipment. Strong measures will be required to offset these trends while also achieving net zero emissions. Efforts to manage indoor air quality in response to the COVID pandemic by increasing ventilation and air filtration also potentially impact on building energy use.
Global initiatives such as the UNFCCC, commitments by G20, G7 and regional groups such as APEC create high-level pressures to drive action to cut building-related emissions while capturing many other economic, social, and environmental benefits. Other initiatives target buildings, for example the UN Environment Program and Global Alliance for Buildings and Construction has mapped out policy directions\(^2\). Cities are also mobilising. For example, the Global Covenant of Mayors for Climate and Energy is supporting policy development and action\(^3\).


\(^3\) See [https://www.globalcovenantofmayors.org/our-initiatives-new/](https://www.globalcovenantofmayors.org/our-initiatives-new/)
Overarching similarities and differences between EU and Australia regarding building and appliance energy and climate issues

The EU and its member states, as well as Australian state and national governments, have pursued energy efficiency and emission reduction measures for many years, driven by a variety of influences. The oil crises of 1974 and 1979, which impacted on building heating and oil-fired electricity generation, not just transport, focused attention on building and appliance efficiency. Over time, local issues such as energy shortages and environmental concerns have provided additional strong incentives to change. Climate change has been an increasingly powerful driver.

Research for this paper has highlighted much common ground and some important differences between EU and Australian situations in relation to building energy and climate issues. The strong message is that we can learn a lot from each other through stronger collaboration on building and appliance energy and climate issues.

The EU has strong ‘top down’ leadership, strong institutional frameworks for development of policies and measures and monitoring of performance. Member States play key roles in detailed policy and program development and implementation, and make many crucial decisions that shape outcomes.

Australia has a more diversified approach. State and territory governments, business groups, academics and community groups often drive innovations. Historically, Australia’s national government has often been a follower in building and appliance energy and climate action. However, agreement by state and federal leaders in recent years to implement work programs for trajectories towards net zero emission-ready buildings has underpinned increased coordination between all governments and led to allocation of more resources.

In a recent article⁴, journalist Laura Tingle quoted a comment by the New South Wales state premier, Dominic Perrottet, that reflects Australia’s federal system:

“He said the Federation had allowed states to tailor their responses and for all to learn from each other. But the pandemic had also identified weaknesses in the system too, he said.

In the health system, in particular, these weaknesses ”are all familiar: lack of clarity around who is responsible for what; buck passing, blame shifting, and sometimes hyper-parochialism”.

“When it comes to COVID, no response has been perfect. No response could be. But we can learn from our mistakes.”

This summarises Australia’s approach to buildings, energy, and climate policy, too.

Both the EU and Australia face a challenge to dramatically accelerate emission reduction, increase resilience through preparation for and adaptation to increasingly intense and frequent extreme climate events, and achieve just transition outcomes. For example, BPIE has published a number of papers in late 2021⁵ that map out measures to accelerate emission reduction from buildings in the EU. While circumstances differ, all countries face many common challenges, as outlined in Table 4.

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⁴ See https://www.abc.net.au/news/2022-01-08/omicron-covid-leaders-not-learning-from-mistakes/100744162
⁵ See https://www.bpie.eu/
A challenge that all building energy and climate policy makers face is that community and business sentiment can shift much faster than businesses and policy makers can respond. Buildings, major appliances, industrial plant, and infrastructure have long lives, but public sentiment responds to immediate realities and many investors look closely at long term risks and returns when making decisions today. When people die because of extreme heat, or wildfires and floods destroy communities, expectations for rapid response and change can be high.

Differing past experiences, differences in consumer and business cultures, and differences in institutional arrangements offer valuable lessons when working with diverse EU Member States or Australian states and territories. In a time of disruptive change, learning from others can open up new ways of thinking and acting, provide evidence to support innovative approaches, and transform perceptions of risk into desire to capture opportunity.

Research for this paper has highlighted the lack of documentation and communication about many exciting experiments in development of policy and implementation of programs in Australia. This paper has really just scratched the surface of the potential for collaboration and capture of lessons from past experience. There is a clear need to bring together relevant information and draw out lessons for broad application in many different jurisdictions.

Institutional and governance frameworks
Both the EU and Australia have similar three-level governance structures which include:

- An overarching level: in the EU, the European Council, European Commission and Parliament and, in Australia, the national government. The EU’s role involves high level leadership, monitoring of progress and development and enforcement of measures that have been agreed at the EU level. Australia’s national government also has limited powers. In broad terms, Australia’s national government focuses on international issues and activities where consistent national approaches are considered to be necessary. Both EU and Australian governments influence actions of member states and territories through financial and other mechanisms.
- A ‘state’ level: in the EU the Member States, which are separate countries with their own agendas and cultural approaches to policy. In Australia, state and territory governments are similar. Australia’s states combined to form a federation in 1901, while the territories (Australian Capital Territory and Northern Territory) are subject to direct control of the federal government. The Australian parliament has powers to legislate for territories while it cannot legislate for states on many issues\(^6\).
- Provincial and local governments including cities and regional governments, which have varying powers and resources. Major cities have strong global networks that allow them to leverage influence.

With regard to building energy and climate policy, all three levels of government have responsibilities, policies, legislative and implementation roles, and must respond to the expectations of their own electorates, business groups and civil society.

The EU has a clear institutional framework under the European Council\(^7\), its parliament and the European Commission, that plays a leadership role regarding building energy and climate issues, for example via the Energy Efficiency Directive and strong climate targets. The overarching theme of ‘energy efficiency first’ and EU-wide mechanisms set strong agendas and facilitate harmonised approaches and funding for building and appliance-related carbon emissions and energy. The BPIE report\(^8\) that led to preparation of this paper summarises initiatives by the EU and its member states. Since its publication, further initiatives and stronger measures have been adopted under the EU ‘Green Deal’ and ‘Fit for 55’ frameworks. These are discussed later in this paper, where we outline EU actions for readers who are not familiar with this rapidly changing landscape.

The EU must work closely with Member States in developing a case for action, facilitating harmonisation and learning, monitoring, and building accountability and transparency.

As will be discussed later in this paper, the Australian approach is much more diversified and ‘bottom up’. National politics can differ greatly from states, and states can differ from each other. The national government tends to build on and follow state, territory, business and community experience, and coordinate processes. Other agents from business, unions and community often fill the vacuum. In many cases, market participants or communities implement measures that drive government policy development as a ‘catch-up’, or because they are recognised as worthwhile. This innovation often occurs outside national policy.

Given this situation, international reviews of policies often overlook substantial policy research, development and implementation that occurs in Australia. Later sections of this paper and appendices provide a preliminary overview of Australia’s diverse buildings and appliances energy and climate policy research, development, and implementation to outline Australian experience to support discussion of potential for broader collaboration with the EU.


\(^8\) See [A Guidebook to European Building Policy: Key Legislation and initiatives > BPIE - Buildings Performance Institute Europe](https://www.consilium.europa.eu/en/european-council/)

Overview of topics for potential collaboration

Table 1 and the following text summarise the major themes in the buildings and appliances areas where research for this project has highlighted potential for productive collaboration between the EU and Australia. This section provides a basis for Table 5, which proposes a preliminary list of priority topics for potential future EU-Australian collaboration.

Table 4: Major areas for potential collaboration on buildings and appliances policy research, development and implementation and selected examples

<table>
<thead>
<tr>
<th>Broad topic</th>
<th>Examples of specific issues/opportunities for collaboration</th>
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</table>
| Overarching leadership, institutional and governance structures and resourcing | Clear institutional structures, relationships, governance mechanisms (reporting, accountability, targets)  
Appropriate (and stable) resourcing - funding, staff, R&D capability etc  
Effective networking  
Streamlined processes, removal of historical regulatory barriers/distortions/structural inefficiencies, inertia                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Regulation and standards                                                   | Design to facilitate change, adapt to changing circumstances, contribute to ‘packages’ of policies  
Identify and overcome barriers to acceptance, improve compliance                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Financing of investments in building upgrades, expansion of supply chain infrastructure | Facilitating ‘deep’ upgrades, avoiding ‘lock-in’ of future emissions, costs, and impacts  
Facilitating innovation in materials, products, and services to underpin ongoing cost reduction, performance improvement, motivation of supply chains and consumers  
Facilitating investment in production capacity and skilled workers  
Facilitating improved maintenance and optimal operation  
Also see ‘transition’ below                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Motivating policymakers and decision-makers to factor in long term and whole ‘value chain’ benefits | Addressing split incentives and short-term thinking by reducing perceived risk and enhancing perceptions of benefits, standards, accountability/quality control, compliance/enforcement, appropriate information/analytical tools  
Clear methods of estimating multiple benefits (including energy supply infrastructure, health, equity, quality of service, productivity, long term implications)                                                                                                                                                                                                                                                                                                                                                   |
| Information                                                                 | Ensure provision of ‘right information at right time, in right form, to right place/person’ – to provide ‘actionable insights’  
Data acquisition and management, monitoring technologies/techniques, data security/privacy, data analytics, consumer rights to data  
Integration of multiple data streams to maximise value and action  
Understand user/operator/consumer experience, perspectives, values, priorities, and ways of reshaping them to support net zero/sustainable buildings and appliances and their operation  
Capture lessons from experience (policy and program development, user experience, supply chain issues, priorities, and roles of key stakeholder groups etc) and apply them  
Development and deployment of rating tools and techniques  
Effective, appropriately resourced communication  
Information often involves regulation and standards |
<table>
<thead>
<tr>
<th>Broad topic</th>
<th>Examples of specific issues/opportunities for collaboration</th>
</tr>
</thead>
</table>
| Just, rapid transition                               | Transformation of energy systems and sectors, e.g. distributed energy solutions, efficient electrification, pricing structures, techniques to motivate consumer action  
Equity for vulnerable consumers and impacted regions, access to capital, assistance and opportunity for workers and communities impacted  
Ensuring health, safety and quality of life, productivity  
Adaptation to changing climate, including improving resilience, planning for and response to extreme events and capacity to rebuild and recover  
Targeting of measures, e.g. high consumers, fringe of grid, consumers in stressed parts of networks, piggy-back projects being implemented for other reasons |
| Development of lifecycle, circular economy models    | Improve data quality, confidence  
Build secure, reliable data systems across value chains so that impacts and benefits can be fairly allocated and there is transparency  
Develop mechanisms to finance activities that offer benefits to other parts of a value chain  
Encourage consideration of Scope 3 emissions in carbon footprints and strategies |
| Integration of buildings into energy systems         | On-site electricity generation and storage, distributed intelligence  
Demand response, demand management  
Interactions with electricity and gas grids  
Business models and consumer issues |
Lessons from past and present activities

This section of the paper uses the categories proposed in Table 4 as a framework to present the outcomes of our research into past and existing policies. It draws upon later sections that include more detailed descriptions of the historical evolution of policy on energy efficiency, particularly with regard to buildings, appliances, and equipment.

Overarching leadership, institutional and governance structures and resourcing – EU

Building energy policy at the EU level sets the basis for well-structured and organised national policies across the EU Member States which in turn facilitates policies at different government levels. The EU policy mechanisms are based on solidarity mechanisms such as the Cohesion Fund and Just Transition Fund that play a crucial role when it comes to achieving the goals set at the EU level. In the past, the EU has set ambitious targets relating to building energy which many members could not reach without relying on these funds that in turn rely on the richest EU Member States (Tijanic and Korent 2019).

In terms of energy efficiency, targets at the EU level have also reflected optimistic estimates of energy policy outcomes such as the 2012 Energy Efficiency Directive (EED) target. Under this regulation, the EU sought to generate national energy savings of 1.5% each year which was found to be unrealistic over time (European Union 2012). In recognition of actual experience, this target was adjusted in the 2018 revised EED to 0.8% energy savings per year (European Union 2018). However, under the current revision process of the EED it has been proposed to return to the target of 1.5% energy savings each year using a revised approach (European Commission 2021b). Nevertheless, there are concerns about this target being rigid and the practical probability that some EU member states may not reach it (European Commission 2021d).

Rigid existing regulation at the national level, driven by factors other than climate, also has proven to be a great challenge for EU countries when it comes to meeting their energy savings targets through high rates of deep renovation, which is a major EU focus. EU countries such as Poland, Belgium, Spain, Portugal, and Denmark have historical regulations for multifamily buildings that protect tenants’ rights. These regulations have become barriers to reaching ambitious energy efficiency targets. Among the key factors holding back renovations on multifamily buildings are rental contracts without any provision to pass on the cost of renovations to tenants, long duration of contracts and unanimity requirements for consensus among tenants to allow a landlord to do renovations (Economidou et al. 2018).

Under the Clean Energy for all Europeans package, EU countries are required to create National Energy and Climate Plans (NECPs), Long-Term Strategy (LTS) and a Long-Term Renovation Strategy (LTRS) which aim to ensure that national building energy policies align with EU goals and targets. Although deep energy building renovation has been one of the main focus areas of the EU regulation and funding, most renovation has been shallow, mainly measures with short-pay back periods, in contrast to deep renovations with long payback periods but much bigger emission reductions (European Court of Auditors 2020). Under the Renovation Wave Strategy, the EU is tackling this issue by providing targeted funding while making it more accessible (European Commission 2020a). The Recovery and Resilience Facility (RRF), the Cohesion Policy Funds and InvestEU currently fund building renovations of both residential and commercial buildings under the EU Multiannual Financial Framework for 2021-2027, and NextGenerationEU (United Nations Environment Programme (UNEP) 2021).
In line with the Renovation Wave for Europe, the 2021 proposal for the revised Energy Performance Buildings Directive (EPBD) addresses non-economic barriers to building renovations such as the organisational structure of multifamily buildings by removing unanimity requirements (European Commission 2021c). This proposal also increases the target rate of building renovation and introduces EU-wide minimum energy performance standards for worst-performing buildings. Definitions of zero-emission buildings and deep renovations are also introduced along with renovation passports that consider lifecycle carbon emissions. The revision of the EPBD is aligned with the recent Fit for 55 package that introduces a new emissions trading system (ETS) for buildings which aims to create incentives for decarbonising buildings while establishing a stable source of funding for building renovations and energy efficiency programs (European Commission 2021a).

Along with the new ETS, the Fit for 55 package introduces other important measures such as the Social Climate Fund to achieve a reduction of at least 55% of emissions by 2030 recognising the different capacities and resources among EU countries. The package sets higher targets for renewable energy, energy efficiency and building renovations which are reflected in the current proposals for revision of the EED, EPBD, and the Renewable Energy Directive (RED).

Energy programs at the city level have been supported and funded from different fronts such as the EU Horizon 2020 which funded the Build Upon project. This helps cities to decarbonise the existing building stock by 2050 by creating a ‘multi-level renovation impact framework’ which considers hidden social benefits of building renovations at the local level, aiming to influence decision-making processes at a national level (REN21 2021). Another project is #BuildingLife, led by local councils across Europe and the World Green Building Council (WGBC). This project seeks to decarbonise the whole life cycle of buildings to help achieve the goal of a climate-neutral Europe by 2050 set by the European Green Deal (WGBC n.d.).

Along with strong leadership at the EU level in the building energy sector, Member State governments in the EU have also taken the lead in accelerating the transition to an energy-efficient built environment powered by clean energy. Germany is always on the list of these countries leading change in the EU. Germany has implemented a multi-level governance framework that supports cities in financing and implementing low-carbon projects such as the case of Hamburg which is backed by national regulation and funding to achieve 100% renewables by 2035 (REN21 2021).

The clear framework implemented by the EU helps to align climate and energy policies implemented at different government levels across Europe. The clear path of the EU building energy policy shapes activity in the private sector, stimulates the market and creates opportunities for investment. National government policies that ban the use of fossil fuels for heating buildings or introduce renewable energy requirements in building codes create new opportunities while enabling local governments to set more ambitious targets.

Recent and proposed revisions of EU policies reflect lessons from past experience and ongoing research. Monitoring, data collection and analysis is being improved: this will underpin ongoing evidence-based policy review. Other countries such as Australia could certainly benefit from the resulting lessons, and through collaboration that allows the EU to build on the experience of other nations.
Overarching leadership, institutional and governance structures and resourcing - Australia

Australia’s overall institutional and governance structures related to building energy and climate issues are diffused and changeable, as reflected in Figure 3 which shows the situation in 2010. Governance of energy efficiency issues is complex, with reliance on agencies that may have limited interest and expertise in this area, or even potentially conflicting agendas. The building sector is just one of many areas where there are significant differences between jurisdictions, though progress towards harmonisation on building energy, appliances and climate issues is accelerating, as discussed below.

Australia has a history of preparation of national energy efficiency policy and strategy development processes and reports that have languished due to changes of government, failure to allocate sufficient resources and other factors, as discussed later in this paper. Within this difficult environment, there are some examples of effective models, including:

- Organisations at arms-length from government with significant and stable funding and clear terms of reference, such as the Clean Energy Finance Corporation and Australian Renewable Energy Agency (ARENA)\(^9\) (though ARENA’s scope constrains its ability to fund energy efficiency). These agencies draw upon broad cross-disciplinary expertise for their Boards and staff, build strong networks and operate processes with high standards of probity. They have remained largely intact despite efforts by some national governments to shut them down, cut budgets and targets, and revise their terms of reference.
- The NSW Sustainable Energy Development Authority operated for a relatively short period around the turn of the century, and drove significant innovations such as development and implementation of what is now NABERS, the certified GreenPower scheme, local government level building efficiency policies and an innovative business efficiency scheme. Key elements underpinning its effectiveness were a young, talented multi-disciplinary team working with experienced staff and advisers, led by CEOs that supported innovation.
- The Australian Government coordinated *Trajectories* work program has facilitated cooperation and increased resourcing for building policy since 2019.
- Energy Retailer obligation schemes in several states have worked fairly well, within the limits of their scope
- Several states have recently committed significantly increased funding to develop and implement energy efficiency policies as in the case of New South Wales\(^10\) and Victoria\(^11\). A recent report by Climateworks Australia (2021) summarises the broad approaches adopted by Australian states and territories, including building and appliance policies.

Nevertheless, the scale of resources still falls far short of societally cost-effective levels and the rate of change needed to meet climate objectives.

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\(^9\) See [https://arena.gov.au/](https://arena.gov.au/)


Trends within governments such as creation of ‘mega-departments’, increasing mobility of staff with more focus on generalist backgrounds and increasing outsourcing of specialist work have meant that energy efficiency has often lacked a strong focus and direction, and in-house expertise has declined.

Australia’s ‘supply side’ culture has focused resources and funding on other areas. For example, the wording of the National Electricity Objective (and related objectives) states\(^\text{12}\):

> “to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity with respect to:

- price, quality, safety and reliability and security of supply of electricity
- the reliability, safety and security of the national electricity system.”

The use of the word ‘price’ instead of ‘cost’ focuses attention on actions that reduce unit prices of energy, and ignores actions that may reduce overall energy costs while failing to reduce unit prices. The Objective has no reference to environment. This is just one example of a pervasive ‘supply side’ focus in Australian energy policy debate. For example, major clean energy industry organisations such as the Clean Energy Council and Smart Energy Council rarely refer to energy efficiency. Many environmental groups focus on ‘renewable energy’ in their advocacy.

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When prompted, almost everyone acknowledges the importance of energy efficiency, but this is not generally reflected in policy development, outcomes and allocation of resources. This situation is gradually changing as variable, distributed energy solutions emerge. However the demand-side focus of energy market policy tends to be on short term demand response, energy storage and distributed energy production, not underlying energy efficiency that drives long-term trends. Energy efficiency could well be described as Australia’s ‘forgotten fuel’. This contrasts with the EU’s ‘energy efficiency first’ mantra.

Renewable energy policy has attracted much greater policy focus than energy efficiency. National renewable energy targets were introduced in 2001, along with financial incentives based on Large Generation Certificates and, later, Small Technology Certificates. At state and territory levels, feed-in tariffs and incentives have been offered. Although renewable energy policy has been volatile, it has been effective.

**Building energy and climate policy**

Heavy reliance on building regulation to drive change in Australia has meant progress in this area has been slow, as discussed later in this paper. This approach requires development of consensus across a wide range of interest groups and institutions with disparate agendas. While commercial building policy has engaged with both supply and consumer-side groups (building owners and managers, designers, and technical specialists), residential consumers have had limited representation in residential building industry organisations and regulatory/standards development. This is changing as sustainability-focused business groups (e.g. Australian Sustainable Built Environment Council and Green Building Council of Australia) have emerged, Energy Consumers Australia (funded through energy markets) has built capacity and a range of community groups such as Renew and Beyond Zero Emissions have mobilised. Grassroots activity such as the *myefficientelectrichome* Facebook page (with 50,000 members), Friends of the Earth, Sydney-based Total Environment Centre and Environment Victoria are driving advocacy and local empowerment. The increasing profile of social justice and community groups has broadened agendas and built broader engagement. The large number and diversity of submissions to recent consultation on the proposed 2022 National Construction Code has highlighted the tensions and the institutional and process barriers that slow change.

Broader issues such as fire hazards and structural failures in buildings have recently increased the focus on construction quality assurance and accountability (Shergold and Weir 2018). Institutional frameworks responding to these issues generally support improved energy efficiency outcomes.

Recent increasingly extreme bushfires, floods and windstorms have led to an increasing policy focus on resilience of energy and other infrastructure and buildings, as well as management of recovery and rebuilding.

The emerging interest in Circular Economy and value chain thinking (e.g. Materials & Embodied Carbon Leaders’ Alliance, A2EP reports such as *Next Wave- Innovation*, and RACE for 2030 Cooperative Research Centre B1 scoping reports also potentially support existing lifecycle analysis, energy and resource efficiency and waste management initiatives.

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13 Australian Building Codes Board; see [www.abcb.gov.au](http://www.abcb.gov.au)


Appliance and equipment policy

Australian appliance efficiency policy development was initially driven in the 1980s by two state governments with strong ministerial commitment. Their publicly owned electricity utilities allocated significant promotional budgets, partly to improve their public images and despite internal concerns that improving efficiency would create a ‘death spiral’ by reducing electricity demand and revenue.

Strong promotion of a well-designed ‘star rating’ energy label built public support for complementary performance standards as ‘laggard products’ were publicly exposed, and consumers asked why governments allowed ‘clearly inferior’ products to be sold. Though Australia’s appliance efficiency schemes have been very cost-effective, with estimates of carbon costs of minus $200/tonne of CO2e avoided (Commonwealth of Australia 2019, p.16), momentum has been lost for a number of reasons. Given the extremely high cost-effectiveness of appliance emission reduction it seems to deserve higher priority. Recent activity\(^{16}\) reflects some recovery, but action still falls far short of economic optimum.

Regulation and standards - EU

The EU regulatory framework is an important driver for policy implementation among the EU Member States. At the EU level, there are several examples of policies that have enabled synergies among its members such as the introduction of a carbon tax, Environmental Performance Certificates (EPC), and methodologies to quantify the embodied carbon in buildings. EU regulations have also promoted the exchange of good practices among the EU Member States such as energy poverty measures and innovative financing tools (Steuwer et al. 2020). A recent example of this is the ongoing assessment of the introduction of building renovation passports (BRP) at the EU level which is already a successful policy practice in some EU countries such as Germany, Portugal, Denmark, Belgium, and France (Staniaszek, Kockat and Vitali 2020).

BRP’s main objective is to stimulate building renovations through a “long-term, step-by-step deep renovation roadmap for a specific building based on quality criteria, following an energy audit, and outlining relevant measures and renovations that could improve the energy performance,” (European Union 2018). The German federal renovation roadmap (iSFP) and BetterHome Denmark program are examples of the effective use of BRP (Steuwer et al. 2020). BetterHome is a one-stop-shop and service-oriented model where the building renovation process is simplified through partnerships with different players within the construction value chain and by providing homeowners with tailor-made solutions based on their preferences (European Construction Sector Observatory 2018).

The EPBD along with the EED, RED, and Governance Regulation (GR) frameworks set targets, obligations, and guidelines on the building energy sector among EU Member States. Those regulatory frameworks have proven to have a major impact on policy development in the EU Member States, particularly the EPBD which is the primary legislation guiding building renovation and construction (Fabbri et al. 2020). One of the main provisions of the EPBD is Energy Performance Certificates (EPC) which have been implemented across Europe since 2002. EPCs have the main goal of informing owners and tenants of the energy performance of a building relative to a reference value at the time of selling or renting while contributing to improving the energy performance of buildings (Arcipowska et al. 2014).

At the core of the regulatory framework on building energy at both the EU and EU Member States levels is phasing out inefficient buildings. Although EPCs were introduced to increase energy efficiency in buildings they are increasingly viewed as insufficient to stimulate renovations, which are the key measure for improving energy performance. EU Member States such as Germany, France, Belgium, and Denmark have adopted BRP policies as complementary measures to the EPC (Staniaszek, Kockat and Vitali 2020). According to the report from Steuwer et al. (2020) while some EU countries provide only technical solutions, other EU countries have made concerted efforts to fully engage end-users in building renovation processes, such as providing tailored advice through one-stop-shops or building renovation passports. These provide guidance on step-by-step actions required to achieve the long-term net zero emissions objective.

In terms of renewable energy, several EU Member States have renewable energy targets embedded within their regulatory frameworks. This is reflected in the provision of various economic incentives such as soft loans, tax rebates and grants to install charging infrastructure in buildings across Europe. Cooperation agreements between the private sector and local governments are also used to make Electric Vehicle charging infrastructure more accessible. At the national level, many EU countries also promote this process by providing clear regulations on the roles of different authorities and actors involved, technical issues, safety, etc. (International Renewable Energy Agency (IRENA), IEA and OECD 2018).

At the EU level, there is substantial recognition that major changes and higher targets need to be achieved to limit global warming to 1.5 degrees over the next decade. However, many efforts are yet to be implemented or fully implemented, which creates an uncertain future for policymakers who seek to follow European examples.

**Regulation and standards - Australia**

Regulation and standards play important roles in implementation of policy in Australia. However, over the past few decades, policy makers and leaders have often stereotyped regulation as a blunt and inefficient tool. Many regulations do fit this description. This often reflects poor design and/or implementation, and a policy focus on ‘market solutions’, privatisation and deregulation.

In practice, all markets rely on rules, so that a ‘race to the bottom’ is avoided and decisions that are of value to society but undervalued by individual decision makers are made. Effective markets also rely on rewarding innovators, reducing risk for those that comply, and supporting development of profitable business models and investment in supply chain capacity.

Australia has built significant experience in ‘market based’ regulation that aims to provide an appropriate regulatory underpinning to markets, and may involve creation of new markets. For example, energy retailer obligation schemes operate in several states. These create markets for energy savings or emission reductions by requiring energy retailers to surrender specified numbers of certificates, and by facilitating development of supply chains to create those certificates through building and appliance-related measures. Indeed, the NSW Energy Saving Scheme has evolved from a ‘baseline and credit’ emission trading scheme introduced two decades ago.17

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Australia’s two attempts at national emission trading schemes and the existing industry focused ‘safeguard’ mechanism that sets industry targets and creates potential for trading of credits (Clean Energy Regulator 2021) have provided many lessons for policy makers. The Business Council of Australia (BCA) now supports adaptation of the present Safeguards mechanism and carbon trading (BCA 2021).

Australia’s successful appliance energy labelling and Mandatory Energy Performance Standards and National House Energy Rating Scheme (NatHERS) have also provided experience in integrating regulation, information mechanisms, standards, and markets.

Recent work programs in the national building ‘trajectories’ program\(^\text{18}\) reflect recognition of the need for regulation to be integrated into comprehensive packages of measures, thorough research to understand the attitudes and behaviours of all decision makers, the need for engagement with a wide range of stakeholders, and development of supply chains and training (Commonwealth of Australia 2018).

The now closed Low Carbon Living Cooperative Research Centre\(^\text{19}\) has sponsored policy analysis, research, and pilot projects across a range of building and appliance-related areas. The recently established RACE for 2030 CRC\(^\text{20}\) is conducting a number of scoping projects that frame topics for potential projects that will involve academics and business and feed into policy development and implementation related to buildings, flexible equipment and demand, data collection and analysis, etc. RACE has direct and in-kind funding of over AU$250 million over its 10-year life.

Financing of investments in building upgrades, expansion of supply chains - EU

At the EU level, there are significant financing initiatives to support the decarbonisation of the building stock while facilitating innovation and energy performance improvements in buildings. Horizon Europe is the key funding programme for innovation and research in Europe with a budget of 95.5 billion euros. As its predecessor Horizon 2020 did, this fund supports, among other projects, the research and development of clean energy programs across Europe for the period 2021-2027\(^\text{21}\). Horizon Europe along with Invest EU, Modernisation Fund, Just Transition Fund, React EU, Recovery and Resilience Facility, Multi-Annual Financial Framework and LIFE are the main funds available to the EU Member States for expenditure on energy renovation\(^\text{22}\).

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\(^{19}\) See http://www.lowcarbonlivingcrc.com.au/

\(^{20}\) See https://www.racefor2030.com.au/

\(^{21}\) Horizon Europe fund; see https://ec.europa.eu/info/sites/default/files/research_and_innovation/strategy_on_research_and_innovation/presentations/horizon_europe/ec_rtd_he-investing-to-shape-our-future.pdf

\(^{22}\) EU Funding for Energy Renovation of Buildings 2021-2027; see https://www.renovate-europe.eu/funding-for-energy-renovation/
Under the Clean Energy Package, the Cohesion Fund (part of the European Structural and Investment Fund) and the European Regional Development Fund were expected to invest 17 billion euros in energy efficiency in buildings. These funds had the potential to achieve an investment of 27 billion euros through public and private co-financing over the period 2014-2020 (European Commission 2016). According to Esser et al. (2019) more than 200 billion euros were invested in energy renovations in residential buildings over the period 2012-2016.

The Smart Finance for Smart Buildings (SFSB) initiative was also introduced under this package. SFSB has a main goal to make investments in energy efficiency projects in residential buildings more appealing to private investors by using EU grants as a guarantee (European Commission n.d.). SFSB facilitates EU policy provisions such as Energy Performance Contracts (EPCs) in the public sector, and investment in energy efficiency projects by providing technical assistance and aggregating projects using one-stop-shop models. This initiative also focuses on de-risking energy efficiency information by providing a thorough analysis of risks and benefits of projects to investors (European Commission n.d.)

In terms of national financing initiatives, EU Member States have implemented a variety of programs to improve the energy performance of buildings such as grants, subsidies, taxes, or loans. Most programs in the EU aim to provide appropriate incentives across the different market actors within the construction supply chain. For example, on-bill financing targets renters, low-interest loans and grants target building owners, and market transformation programs target manufacturers (Harrington and Toller 2017). Across Europe there are several available financing options in place to promote building renovation as the graph shows below.

![Figure 4: Percentage of consumers of energy renovations positively influenced by available subsidies, grants, low, interest loans, or tax rebates for energy renovation by country (Esser et al, 2019, p. 65)](image)

In this report, a correlation was found between a high number of financing incentives and a high average of building renovations in Eastern European countries. However, this high average was mainly driven by shallow renovations. This highlights the need for improving quality and depth of renovations across Europe, which has recently triggered new policies such as the Renovation Wave. This program, financed via NextGenerationEU, EU’s Multiannual Financial Framework, and private funds aims to renovate 35 million inefficient buildings by 2030 (European Commission 2020).
Along with current financing initiatives, the EU has introduced the new Social Climate fund under the Fit for 55 package, which aims to support energy poverty and building renovation projects across the EU Member States. This fund will provide 72.2 billion euros for the period 2025-2031 from the new ETS (European Commission 2021a). However, all these financing initiatives are still insufficient to achieve the necessary 3% renovation rate per year as required by the EED (Fabbri et al. 2020). According to the 2019 EC report, the EU would need 800 billion euros per year to achieve the 3% renovation rate which in turn would require attracting more private funding and creating new innovative funding schemes.
Germany – KfW Energy Efficiency Programme

Since 2006, KfW has promoted and funded energy efficient construction and renovation of residential and commercial buildings through low-interest loans and grants (KfW 2016). As a result of this program, Germany has a well-established market for energy efficiency finance that made possible the funding of over 500,000 individual loans and grants per year for both construction and renovation of housing units that comply with the minimum energy performance standards (Dorendorf 2018). The KfW has its own rating system for its home loans (Effizienzhaus or Efficiency House in English) which assess both thermal insulation and energy requirement of a house. The system has different standards based on the different level of energy efficiency that can be reached through renovations or new constructions compared to a reference house. The programme has triggered 300 billion euros of investments over 12 years by 2018 and help to reduce carbon emissions by about 9 million tonnes per year (Dorendorf 2018).

Croatia – Energy renovation of buildings in Croatia

The energy renovation policies in Croatia comprise different programmes targeting energy efficiency in public, multi-family, and single-family buildings. Croatia has established the implementation of financial and regulatory mechanisms to de-risk energy efficiency investments and make renovation projects more attractive to private investors (Republic of Croatia Ministry of Construction and Planning 2014). Among these mechanisms are the establishment of a long-term funding source for energy service providers through a national revolving fund (funded by the ESI (European Structural and Investment Funds)) and the introduction of guarantee instruments to reduce the risk of private funding (Križ 2018). Croatia’s policies also enable banks to finance energy renovations by subsidising interest rates on loans. Along with these measures, Croatia has created standard energy performance contracts and implemented standards methods for verifying energy savings in order to build trust among financial institutions and end-users (Steuwer et al. 2020).

Financing of investments in building upgrades, expansion of supply chains - Australia

Building owners, landlords and tenants often face barriers and perceived risks when considering investments in building and equipment upgrades.

A fifth of Australian households own at least one additional property and over 70% of landlords own only one rental property (Australian Bureau of Statistics (ABS 2019). House owners on average relocate every 11.3 years and apartment owners every 9.6 years, and the turnover has increased in recent years (Horan 2022). Renters are much more mobile.

So Australians are relatively mobile, and the rate of new home construction is relatively high. Many landlords are small investors (ABS 2016): these characteristics seem likely to work against homeowners investing in measures that offer low rates of return, unless they are perceived to be valued by potential buyers or tenants.

A number of Australian policies, frameworks, and programs have been developed to address these issues.
At a national level, the AU$10 billion Clean Energy Finance Corporation (described in detail later in this report) makes substantial investments in energy efficiency, renewable energy and improved management in buildings and equipment. Clean Energy Finance Corporation leverages substantial private investment and educates the financial sector. It has a decade of experience in this role. It provides a financial return to government.

Some state and local governments operate financial mechanisms to offer long term low interest loans for building upgrades that improve energy or water efficiency or enhance climate resilience. For example, Victoria’s Environmental Upgrade Finance scheme was recently extended to include residential upgrades as well as commercial buildings. The scheme is legislated at the state level and works through local governments. It shifts the repayment of loans to council charges on property, rather than creating risk for the owner. Since council charges have high priority for recovery in the case of inability to repay debt, this is seen as lower risk by financiers, so lower interest rates over long periods can be offered. For rental properties, the landlord repays the loan through council rates. Commercial and industrial tenants can elect to contribute to repayment from their savings on utility bills.

The Sustainable Australia Fund is a ‘for purpose’ company with a AU$200 million loan facility that offers financing to businesses with packages designed to overcome split incentives and cash flow challenges. It works with local and state governments across three states.

The Victorian government’s Greener Government Buildings approach to financing upgrades of existing government buildings has achieved some success. The Department of Treasury and Finance facilitates financing, usually through Energy Performance Contracts. Projects must meet an overall 5-year simple payback criterion. The Victorian Government Purchasing Board’s energy performance contracting website provides more information, including guidelines, standard contracts/templates, and a list of current and past projects.

Research could document lessons from the offerings of these schemes, to underpin improvement and expansion. Lessons from EU financing mechanisms could also contribute.

Expansion of supply chains and adoption is often reliant on perceptions of investment risk and limited access to capital. So finance for supply chain expansion and to support consumer demand is a key factor.

One aspect of risk raised by some energy consuming businesses is their fear that failure to meet payments on an energy efficiency loan could tip them into business failure, even though energy is a small component of their business costs. Scope to adjust repayment periods in response to such situations could address this.

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25 Sustainable Australia Fund; see https://sustainableaustraliafund.com.au/
Education and training require substantial investment, both by education and training entities, and also investment of time by professionals and tradespeople. Crowded curricula, high workloads for staff and rationalisation of programs in education limit progress. Nevertheless, tertiary education programs related to sustainability and clean energy exist in many Australian universities. As in the broad policy area, a lack of high profile, well-resourced centres focused on energy and resource efficiency means activity is dispersed and limited relative to more tangible fields such as energy supply and waste ‘management’. Potential students also need to be confident that courses will lead to employment and career paths (Pears 2020).

In Australian supply chains, time is often a scarce commodity, with ‘lean’ business models, high workloads, and large numbers of small businesses with limited capacity to upskill and keep up with high rates of change. Nevertheless, Australian professional bodies have worked with training organisations to establish training and certification programs for building assessment28, energy efficiency29, trades30 and specialist areas such as heating and air conditioning31. Private vocational training providers such as PointsBuild32 also offer training.

Another important driver of supply chain expansion is consumer ‘pull’. Australia’s energy retailer obligation schemes and incentive programs, and associated certification and quality management measures support skill development and consumer confidence. Recent policy and program development processes are focusing more attention on these areas33.

There is substantial scope to learn from experience within energy efficiency, and from other fields, to guide development and expansion of building and appliance efficiency training and education.

Motivating decision-makers to factor in long term and whole ‘value chain’ benefits - EU

Among the EU Member States, one of the main challenges of meeting their building renovation goals is the split-incentive dilemma between the building owner who makes the investment and the tenant who gets the benefits from it. A number of policies across Europe have successfully helped to overcome this barrier. They include implementation of mandatory energy performance requirements, energy service contracting, on-bill schemes, and others. For example, Germany and Denmark allows building owners to transfer a share of the costs for energy renovations to their tenants34. This regulatory framework provides incentives to landlords who otherwise would have not been interested in undertaking extra costs for renovations that they are not benefiting from.

28 See https://www.absa.net.au/find-an-assessor
29 See https://www.eec.org.au/events/training-2/training#/training
30 See https://www.picac.edu.au/
34 See German Civil Code, 559 section; see 2020 Denmark Long-Term Renovation Strategy, Ref. No 2019 – 93913.
Under the ongoing revision process of the EPBD, mandatory minimum energy performance standards (MEPS) have been proposed to accelerate the phasing out of inefficient buildings while overcoming barriers such as the split-incentives dilemma (European Commission 2021c). According to Steuwer et al. 2020 the MEPS is one of the most effective instruments to avoid this dilemma as it compels the owners to invest in building renovations. The same report mentions that MEPS exponentially increases dedicated funding for deep renovations, EPCs and building renovation passports. However, only a few countries have implemented this measure within their regulatory frameworks.

A different policy greatly used in Europe is energy service contracting. This instrument involves a third-party (ESCOs) who provides specific energy renovations which are repaid by energy costs saved. Examples include the Energy Efficient Fund of Ireland35 and the National Energy Efficiency Fund of Italy36.

Under the 2018 revised EPBD, the concept of considering wider benefits in relation to energy efficiency projects in buildings was introduced and required to be part of the long-term renovation strategies of every EU Member State (European Union 2018b). Those wider benefits involve environmental, social, and economic benefits such as air quality, safety, and improved health which goes beyond the traditional cost-benefit analysis that considers only energy savings. Nevertheless, neither the 2018 revised EPBD nor the proposal for the revision of EPBD establishes a methodology for calculating those multiple benefits.

Motivating decision-makers to factor in long term and whole ‘value chain’ benefits - Australia

Expectations of short payback (high implied discount rate) on energy efficiency measures, and split incentives are widely recognised barriers to adoption of energy efficiency measures in Australia. The reasons for their impact are also fairly well understood. But, to date, Australian measures to overcome them have often had limited success or have involved politically unacceptable interventions, and have not progressed.

As noted earlier, the high rates of housing mobility, relatively short-term duration of rental leases and large number of landlords with only one property do not encourage long-term investment.

Research (Strengers et al 2021) suggests that this is not just an energy-specific ‘rational economic’ problem as defined by energy policy makers, but involves complex social and systemic issues and differing interpretations of ‘rationality’ that may include many factors. This requires well-designed packages of policies. Outcomes can be very sensitive to subtle program design and implementation factors and require substantial interventions, at least in early days. Cross-disciplinary research and field trials are likely to be required, as well as analysis of previous policy outcomes.

We need to understand why policy makers have focused on particular approaches, as well as effectiveness of measures in changing behaviour of supply chains and consumers.

The emerging fields of circular economy and value chains, discussed later, seem likely to help by increasing perceived value and strengthening the motivation of policy makers and leaders to take stronger action. Within business, increasing connection, access to data and sophisticated data analytics and security systems will support optimisation at a system and value chain level. These features may support preparation of more convincing business cases, reduce perceptions of risk, and increase accountability.

Motivating Small-Medium Enterprises to invest in energy efficiency is particularly challenging due to time and cashflow constraints, narrow business objectives and limited management and strategic capacity.\(^\text{37}\)

**Information - EU**

Energy Performance Certificates (EPCs) across Europe are important instruments for data collection which help policymakers to set ambitious targets and facilitate policy implementation on energy building performance. They also provide a valuable resource for buyers, owners, and tenants. While developing a database for registering EPCs is not a compulsory measure at the EU policy level, by 2020 24 out of 27 EU Member States had created a system to voluntarily collect EPC data (Fabbri et al. 2020). There is recognition of the high potential of this instrument to collect and communicate data on energy building performance across Europe. EPCs also provide basic information for consumers.

Most EU Member States have implemented information measures to inform on the benefits of deep renovations. However, there is a scarcity of well-targeted information available about the multiple benefits of renovations. Some examples of information policy measures other than EPCs are the one-stop-shop models and building renovation roadmaps. These tools seek to trigger behaviour change among homeowners by informing them about energy demand (Esser et al. 2019). Furthermore, across Europe there are a significant number of public information and awareness-raising campaigns to promote behavioural change.

Building renovation passports and digital building logbooks are also used to foster behavioural change related to renovation among building owners as well as occupants. For example, under the Flemish Renovation Pact program, Belgium has implemented the logbook Woningpas and the EPC+ program to provide building owners with comprehensive and accessible information on building performance and quality as well as with long-term guidance and advice on energy renovations (Fabbri et al. 2020). Since 2009, Belgium has made EPCs available for rental and housing units which have been used to assess economic incentive programmes.

How accessible information on energy building performance is to not only policymakers and researchers but also to building and homeowners can determine the success of a renovation programme. Following this logic, EU Member States such as Denmark, the Netherlands, Belgium, Sweden, and Portugal have made EPC information publicly available at different levels. For example, in Denmark a range of stakeholders can access EPC information about energy performance that is then used to make purchasing/renting decisions in relation to energy efficiency, the share of renewable energy used, etc. (Brand, Manteuffel and Hermelink 2018).

\(^{37}\) Pears (2016a) outlines Australian research and program experience in this area; see https://pceerd.dost.gov.ph/images/pdf/information-resources/APEC_2016/4_Pears_EE_Policies_and_Practices_in_MSMEs_APEC.pdf
In terms of renewable energy, Nordic countries have implemented an innovative system to inform on existing EV charging points in both residential and public buildings through the database NOBIL (Steuwert et al. 2020).

An impactful initiative that has facilitated the exchange of information on best practices among EU countries is the platform Concerted Action EPBD38. This platform has become an essential space for EU Member States to share and learn about energy efficiency and energy saving best practices while facilitating and improving the implementation of the EPBD across Europe.

Information - Australia

Information is a necessary but not sufficient basis for action that has many dimensions. Australia has many examples of failures to communicate energy efficiency, from building and equipment monitoring systems that produce enormous amounts of data that is incomprehensible to users and may be quickly deleted before it can be properly utilised, to energy consumer engagement measures predicated on a numerate, empowered consumer with infinite amounts of time and high motivation.

Digitalisation and communications technologies are transforming the area. But many Australian initiatives focus more on benefits to the energy supply system or technology issues, than on the consumer or decision maker.

Where smart meters are installed, a range of clip-on data analytics products are emerging: for example the Powerpal sensor and data analytics app are subsidised by the Victorian government.39 Many rooftop solar systems also incorporate useful data monitoring and analytics.

In Australia, few recent building or appliance energy efficiency measures have been supported by large communication budgets, in contrast to the early days of appliance efficiency labelling.

Significant government building and appliance information programs include the appliance efficiency program and the very comprehensive Your Home resources40. The Australian Building Codes Board has significantly expanded its information and training resources in relation to building codes and practices41.

Community groups, energy retailers and industry organisations also focus resources on provision of energy efficiency information for their target groups42. So there is a lot of information around, some of it conflicting. The challenges are to gain a higher profile, and to motivate action.

We have a lot to learn in this field if we are to mobilise change at the necessary scale. Some projects will require carefully constructed, well-funded trials and implementation based on sophisticated social and technical research. We need to work out how to motivate funding agents to fund and resource them, as well as motivating decision-makers and consumers to act.

38 Concerted Action EPBD; see https://epbd-ca.eu/about-us
39 See https://www.powerpal.net/free-in-victoria/
41 See https://abcb.gov.au/resources
42 See for example www.renew.org.au
Just, rapid transition - EU

The energy transition in the EU reflects the urgent need for action that climate change demands. New changes in building energy policy and the current implementation of the EU’s ambitious targets show the increasing commitment of most EU Member States to make a just and rapid energy transition in the built environment. The EU’s principle of *energy efficiency first* has guided national strategies, regulations, funding, incentives, and information on building energy performance resulting in best practices that non-EU countries can learn from. Energy efficiency measures not only cut energy costs and emissions, but also offer other social, economic, and environmental benefits. In contrast with other policies worldwide that see renewable energy as the main solution to achieving net-zero emissions, the EU has recognised that in relation to the built environment strong energy efficiency needs to be prioritised. This approach makes it possible to not only achieve net-zero buildings but also to support the renewable energy transition by maximising impact.

One of the most important changes that supports the EU energy transition is the proposed extension of the EU Emissions Trading Scheme (ETS) to the building and transport sectors. This new ETS seeks to transform the building energy sector by putting a price on emissions that sends clear signals on ambitious energy targets across the relevant supply chains (European Commission 2021e). This new system is expected to commence from 2026 to allow time for the implementation of provisions that prevent vulnerable households from being adversely affected by it. The main provision is the activation of the Social Climate Fund. This fund will aim to address social challenges that vulnerable communities may face as a result of the new ETS (European Commission 2021a).

However, among EU Member States there are still major concerns regarding fuel suppliers transferring additional costs to consumers, and households facing short-term constraints not being able to pay the higher bills (Liboreiro 2021). According to Stenning, Bui & Pavelka (2020), the implementation of the new ETS will involve several challenges that may lead to its failure, such as the inelasticity of heating fuel demand, lack of financial support to low-income households to replace their low energy efficiency appliances, the high price of cleaner technologies, and the impact of split incentives on low-income households who are most likely to be tenants.

In terms of equity for vulnerable consumers and climate resilience, energy poverty policies have increasingly been implemented across Europe primarily due to regulations on housing energy efficiency under the Clean Energy for all Europeans Package (Rodriguez-Alvarez, Llorca and Jamasb 2021). Although most of the NECPs include measures to address energy poverty, policy action is still limited and highly uneven among EU State Members. On the one side, there are notable examples of EU Member States that have implemented or committed to implementing ambitious and integrated policies along with relevant indicators on energy poverty and housing renovation. This is the case with Spain, Croatia, Estonia, and Greece. However, there are states that have a lot of room for improvement. For example, some EU State Members that contain the highest levels of energy poverty such as Bulgaria treat this matter superficially. For instance, Bulgaria has implemented measures such as providing financial assistance to households to pay energy bills but lacks policies that effectively integrate energy poverty into energy efficiency programmes (Bouzarovsku, Thomson & Cornelis 2021).
**Sweden - carbon tax**

At the national level, an important policy that has helped to cut emissions substantially in Sweden is the carbon tax implemented since 1991. This carbon price has gradually increased from 23 euros to 110/tCO2 euros in 2020 covering the building sector which has resulted in significant emissions reductions. Heating emissions have decreased by 80% since the program started. This policy has achieved a dramatic increase in the use of sustainable biomass in district heating while reducing fuel oil demand from 25% to less than 5% (Ackva and Hoppe 2018). The clear price signals delivery through this program has increased the implementation of sustainable infrastructure and innovative energy solutions in buildings while engaging the rapid decarbonisation in this sector. Some of the success factors of this policy are the simple design of the program, low administrative costs, the introduction of strategic exemptions and lowered tax rates, and the compensation of other tax reductions when tax increases were implemented (Martin et al. 2014). This carbon tax has proven to be an effective policy instrument to drive significant emissions reductions in Sweden which can lead other countries such as Australia to similar results.

**Just, rapid transition - Australia**

The companion SPIPA paper to this one focuses on these issues.

Australia has substantial experience of transitions across many geographical and economic areas, driven by different forces. Many researchers have evaluated them. Several groups, including University of Melbourne social researchers, are working on just transitions in the energy sector, where disruption and transformation are occurring at world-leading pace – with little emphasis on energy efficiency. Energy Consumers Australia\(^\text{43}\), funded through energy markets, social justice groups such as ACOSS (Australian Council of Social Service) and community groups like Beyond Zero Emissions are conducting action research projects focusing on building aspects of transition across Australia.

With regard to buildings and appliances, tenants and financially stressed households may not be able to replace faulty appliances or shift energy sources as relative energy prices change. Some may not be eligible for subsidies. Workers may require retraining, and traditional business models may need to change. As noted earlier, small businesses may struggle to adapt. Consumers may struggle to understand how to operate new technologies or respond to new business models such as microgrids, Virtual Power Plant agreements, etc. One consumer may interact with multiple service providers, which introduces potential for confusion and blame shifting, while emerging businesses may fail or change the services they provide. Changing energy market rules add to challenges. Accreditation, quality control and enforcement become increasingly important in rapidly changing marketplaces, though compliance issues can impede innovation and new market entrants. Changing climate or extreme events may require modification, rebuilding or relocation in stressful circumstances.

Commercial building tenants often occupy thermally poor buildings, as commercial building energy regulations for new construction were only introduced in Australia in 2006. Tenant fit outs may affect building energy efficiency. The introduction of the mandatory Commercial Buildings Disclosure at time of resale or lease in 2010, based on actual performance using the existing voluntary NABERS rating scheme, has begun to influence base building performance, as discussed later in this paper. Its threshold has been reduced from the original 2,000 square metres to 1,000 square metres. NABERS is being extended to cover a wider range of building categories.

\(^{43}\) See [https://energyconsumersaustralia.com.au/](https://energyconsumersaustralia.com.au/)
Commercial tenant behaviour and selection and operation of equipment can also impact significantly on energy use and emissions. State level energy retailer obligation schemes in some states offer incentives for adoption of efficient equipment. Mandatory Appliance Efficiency Standards exist for some non-residential equipment, but there is substantial scope for expansion of both information and performance standards. Provision of information for buyers is limited, partly because a lot of commercial sector equipment is assembled, fabricated, or designed using components from multiple sources.

Digitalisation is opening up new opportunities to accelerate transition, equitably and securely allocate benefits and costs and capture benefits from optimisation. Energy productivity improvement and capture of multiple benefits are critical for rapid transition: groups such as the Australian Alliance for Energy Productivity (A2EP) (with funding from governments and ARENA) and the RACE for 2030 CRC are working to raise the profile of energy-related issues in development of Industry 4.0. For example, A2EP has a strong focus on commercial/industrial heat pumps, building awareness and supporting demonstrations, increasing supply chain capacity and knowledge sharing. iHUB is driving data sharing across researchers and industry.

Building climate and energy measures operate within a complex market. Market trends such as rapid increases in housing prices, high and volatile energy prices, and building industry responses to these issues can influence outcomes. A recent development in Australia (already strong in EU) is the emergence of ‘build for rent’ housing. This means the building owner has an interest in long term costs and ‘perceived value’ for potential renters.

The growth in construction of high-rise apartments with very large numbers of units, owners and tenants creates challenges for operation of Owners Corporations and building management.

**Development of lifecycle, circular economy models – EU**

The construction sector is one of the most resource-intensive sectors in Europe, accounting for approximately half of the total energy demand and of all extracted materials, and one third of water consumption. In terms of waste generation, while construction and demolition waste make up between 25-30% of the total waste across Europe, recycling and material recovery is highly inconsistent among EU Member States (Eurostat 2021).

The main policy at the EU level addressing circular economy is the Circular Economy Action Plan (CEAP) introduced in 2015. The CEAP considers the construction and demolition sector as one of the five priority sectors, along with biomass and bio-based products, food waste, plastics, and critical raw materials. The CEAP establishes voluntary and regulatory measures to address the effective use and management of resources through the whole construction and building value chain (European Commission 2020b).

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45 iHUB; see [https://www.ihub.org.au/](https://www.ihub.org.au/).

In terms of measurement of circularity principles across the building sector, the European Commission has created a tool called Level(s). Level(s) is a free, open-source tool that seeks to promote consistency regarding the assessment of sustainability including circularity principles across the life cycle of buildings in Europe (European Union 2021). This tool also creates an informative platform for future policies and initiatives in this sector.

Among EU Member States, circular economy is progressively gaining importance and increasing recognition as one of the critical areas to support energy building programs across Europe. An example of one such program is the deep energy renovations program. This is reflected in the recent Renovation Wave wherein the EU has put in place a series of actions to introduce circularity principles in the construction and building sectors to boost deep energy renovations (European Commission 2020a). However, there remains room for improvement in important issues concerning the life cycle of buildings, such as the assessment of the embodied carbon of buildings (Fabbri et al. 2020).

Circular economy in the EU’s construction and building sectors has great potential. Implementing ambitious and targeted actions at present can result in a decrease of up to 60% in the materials-related greenhouse gases generated throughout the life cycles of buildings (European Environment Agency 2020).

Denmark: Circle House Lab

At the national level, EU Members States such as The Netherlands and Denmark have implemented policies and programmes to promote exchange platforms for capacity building regarding circular economy. Circular House Lab in Denmark brings together multi-stakeholders across the building value chain to experiment and discuss circular building solutions. Similarly, the Transition Agenda Circular Construction Economy in The Netherlands promotes sharing knowledge and experimentation on circular solutions in the construction sector. This programme aims to achieve a circular construction economy in 2050 through a joint transition agenda that includes the introduction of circularity principles in building codes, the use of materials passports, and the incorporation of circular construction as an essential part of the education of building professionals (BLOXHUB 2020).

Development of lifecycle, circular economy models - Australia

There is increasing recognition that embodied energy and emissions of buildings, and end-of-life management of building materials comprise a significant and increasing proportion of overall building energy use and emissions in Australia47. Australian researchers have been active in Life Cycle Analysis and its application since the early 1990s and there is an active professional association called Australian Life Cycle Assessment Society (ALCAS)48. More recently researchers such as Usha Iyer-Raniga at RMIT have worked in global networks exploring circular economy issues49.

48 ALCAS; see https://www.alcas.asn.au/
State governments have been researching and beginning to implement circular economy approaches. The Australian government’s approach is a more traditional waste management model (Australian Government Department of Agriculture, Water, and the Environment n.d.). Business also tends towards seeing CE as about waste management and recycling (Inside Small Business 2021).

The Raw Materials to Shelter Value Chain applies simplified lifecycle, ‘Systems and Services’ thinking (from Aust Alliance for Energy Productivity major report)

‘Circular economy’ perspective, blockchain, BIM are gaining momentum

Decisions made at each stage influence and ‘lock-in’ upstream and downstream impacts

Figure 5: An example of the ‘value chain’ approach for ‘farm to plate’ (adapted from Australian Alliance for Energy Productivity, 2017)

The Australian Alliance for Energy Productivity has explored application of Value Chain thinking, which complements circular economy approaches. This focuses on the fundamental services delivered and the inefficiencies that occur at interfaces between participants, as well as those within participating businesses. An example of the ‘raw materials to shelter’ value chain is shown in Figure 5. This work highlights the potential value of information sharing and enhanced accountability at a system level.

Widespread adoption of life cycle and circular economy approaches will rely heavily on communication, accountability and fair allocation of resources and money across value chains. So digitalisation, communication and secure, standardised data will play important roles.

Despite decades of Australian work, embodied energy/emission data are still far from satisfactory in quality. The University of Melbourne hosts a useful resource, the EPiC database.50

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Some state governments in Australia are actively encouraging CE approaches and relevant research. For example, the Victorian government issued a discussion paper and consulted widely in 2019. It has published a policy document and is rolling out a strategy.

The NSW government recently funded consultation and a paper for a WWF-led project that focused on cutting embodied carbon emissions from building materials. This has led to establishment of the Materials and Carbon Leaders Alliance (MECLA), a buyers’ alliance that will develop model specifications and commit to volume purchases (WWF n.d.).

A recent report from the Clean Energy Finance Corporation, described earlier in this paper, reflects increasing interest in addressing embodied emissions.

Integration of buildings and appliances into energy systems – EU

According to the European Commission (2021a), to ensure the EU becomes a climate-neutral economy by 2050, renewable energy must be mainstreamed in heating and cooling as well in electricity. Under the RRD, individuals in the EU have the right to self-generate, consume, store, and sell excess renewable electricity to the grid (European Union 2018c). Along with this, the EU has also introduced the legal person: ‘renewable energy community’, who are entitled to consume, produce, store, and sell renewable energy. These legal provisions play an essential role in facilitating the participation of citizens in the energy system and the organization among individuals to promote self-consumption. These provisions have also contributed to facilitating a social license for renewable energy projects across Europe (Biresselioglu et al. 2021). However, not all EU Member States have yet introduced ‘renewable energy communities’ under their regulatory frameworks. This is a result of several factors such as bureaucracy, legal and administrative uncertainties regarding infrastructure, insufficient technical capacity and skills, and low-maturity electricity market and tariff schemes (Biresselioglu et al. 2021).

As it was mentioned before in this paper, most EU Member States have implemented the EPBD’s provisions related to the installation of electric vehicle charging infrastructure in public areas and buildings. The regulatory and technical clarity provided for the EU Member States in this regard has enabled energy operators to manage the impacts of the electricity used by electric vehicles (Esser et al. 2019).

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The 2020 EU Strategy for Energy System Integration seeks the “coordinated planning and operation of the energy system as a whole, across multiple energy carriers, infrastructures, and consumption sectors”. This EU Strategy proposes using digitalisation of the energy systems to interconnect energy carriers, maximise self-consumption of energy, and match consumption and production at a smaller scale. At the national level, provisions concerning digital technology in the built environment are uneven across Europe, with Germany and Spain leading the way. Some of the main provisions found across Europe are related to fostering local consumption of decentralised energy sources, to supporting the energy system with flexible energy consumption patterns, to mainstreaming optimal energy uses via digitalised energy-consuming appliances and services, and to digitalising the building renovation supply chain (European Commission 2020c).

Germany - Digitisation of the Energy Transition Act

The Digitalisation of the Energy Transition Act (DET Act) seeks the optimisation of energy use by implementing automation and self-regulation. This policy started in 2016 and established smart meters to be mandatory for households with a consumption above 6,000 kWh per year by 2020. The program has been gradually implemented by first tackling households with a consumption over 10,000 kWh in 2017. Germany has invested a considerable amount of money in this program which is between 10-20 billion euros. This investment has made possible that retail companies receive funding of up to 2 million euros for helping end customers to reduce their electricity demand through the implementation of innovative solutions (German Federal Ministry for Economic Affairs and Climate Action n.d.). The objective of doing so is to evaluate different types of technology with different users while creating the foundations for a new market of technology solutions on energy efficiency (Steuwer et al. 2020).

Integration of buildings and appliances into energy systems - Australia

Australia’s electricity industry is being transformed very quickly. A complex mix of factors is responsible. Volatile energy prices, complex and rapidly evolving markets and regulations, excellent renewable energy resources, policy ‘competition’ between states and territories to be seen to support renewables, some effective and popular national renewable energy policies that conservative governments have been unable to shut down, an energy market with limited consumer trust and innovative disrupting businesses have all contributed. It has been a wild ride. Ongoing policy and regulatory changes and emerging disruptive business models drive intensive policy debate and analysis.

Because of limited interconnection capacity, there are significant differences between regions. South Australia, with no coal-fired generation, relatively expensive gas-fired generation, limited interconnection and excellent renewable energy resources located in areas where there are not many people to object, has seen renewables provide all of its electricity at times, and periods of negative wholesale prices. The Australian Capital Territory has combined behind-the meter generation with Power Purchase Agreements supplied by renewable generators in other states to achieve zero net emission electricity. States with coal-fired electricity are accelerating transition, partly because the mostly old coal generators are becoming less reliable and are struggling to ramp output up and down as net electricity demand varies in response to growing wind and solar generation.

Around 30% of Australian homes have rooftop solar systems and an increasing proportion of commercial buildings are installing systems. Rapid growth is occurring, though the Covid pandemic has slowed it. In regions with high solar adoption, excess solar energy generation on sunny, cool days is driving negative market prices and creating challenges for grid operators to maintain stable operation.
Energy price volatility, declining export prices and the need to stabilise voltage and frequency has opened doors for rapid growth in battery storage. Most batteries are installed in transmission or distribution networks, although behind-the-meter storage is growing. Micro-grids, virtual power plants (VPPs) and community batteries are emerging. While there is interest in demand response, and some major industrial sites participate, it has proved difficult to engage large numbers of smaller consumers, though many trials and extensive research are being pursued.

Domestic demand for gas is fairly flat, apart from increasing gas consumption for LNG production for export. The recent construction of three LNG export plants on the heavily populated east coast has led to volatile and often high gas prices, which have impacted on industry and jobs. Increasing production from Coal Seam Gas fields is controversial with farmers and environmentalists. The emergence of low-cost renewable electricity at the same time has shifted community attitudes away from gas. Further, the large gas fields in Bass Strait that have been major sources since 1969 are in decline, with winter shortfalls predicted in a few years in cooler southern states.

Distributed energy solutions and smart, connected technologies necessarily involve buildings and appliances, as discussed in Pears & Moore (2019). They are evolving rapidly, and many disruptive and potentially incompatible options are being promoted. Effective consumer protection policies that can adapt to rapid change are needed. Research groups such as Victoria University’s Energy Policy Centre55, the Monash Digital Energy Futures group56 and Energy Consumers Australia57 are examples of the independent researchers active in this area.

For buildings and appliances, some studies have shown that most households will save money and cut carbon emissions by ‘going off gas’ and adopting efficient electric technologies with rooftop PV (Alternative Technology Association 2018; Wood and Dundas 2020). The Australian Capital Territory government is actively promoting new housing developments without gas infrastructure. The gas industry is arguing that the costs of upgrading electricity infrastructure will be high, especially in colder climates, and that hydrogen offers an option for reticulation to consumers. This is an ongoing debate with major implications, for example the Victorian government is developing a comprehensive gas substitution roadmap (The State of Victoria Department of Environment, Land, Water and Planning n.d.)58.

State governments, who regulate energy network operators and retailers, are conscious that voters expect them to manage energy supply, so they are actively developing and implementing transition policies, despite views that vary between states. The present national government, which promotes a technology-based approach with emphasis on gas as a transition fuel with development of hydrogen production (Australian Government Department of Industry, Science, Energy and Resources 2021a) has been largely bypassed by state and territory governments. Many lessons are being learned.

55 See https://www.vepc.org.au/
56 See https://www.monash.edu/emerging-tech-research-lab/research/research-programmes/energy-futures/digital-energy-futures
57 See https://energyconsumersaustralia.com.au/
Within Australian energy market policy development there has been little emphasis on energy efficiency. This is a significant but rarely acknowledged risk factor for supply-side investors and, as recognised by the EU, has substantial economic, social, and environmental benefits. The electricity scenarios prepared annually by the Australian Energy Market Operator (AEMO) consider several scenarios, with demand in the highest one in 2021 being over 50% above that of the low scenario in 2030 (AEMO 2021). This wide range reflects the demand-side uncertainties and highlights the scale of risk for energy supply investors. Energy models are limited by lack of quality data on end use activities and the underlying energy required for the services that require energy. Figure 6 shows an energy system model presented to the 2015 APEC energy ministers’ meeting. This attempts to reflect the significance and complexity of the demand side. Australia is at an early stage in understanding the interactions between energy efficiency and the energy system.
Priority areas for potential EU-Australian collaboration

There is substantial Australian literature on energy and climate policy that includes policy recommendations relevant to buildings, appliances, and equipment. Resources include many studies such as reports and papers by ClimateWorks Australia\(^{59}\), the Low Carbon Living Cooperative Research Centre and a recently published 700-page book coordinated by the Australian National University’s energy and climate group\(^{60}\).

Based on reviews of policies, characteristics and other factors discussed in earlier and later sections of this report, the following areas seem to offer high potential for mutual benefit through collaboration.

Table 5: Priority areas for potential collaboration between EU and Australia. These have been drawn from the reviews in the previous section of the paper.

<table>
<thead>
<tr>
<th>Opportunity area</th>
<th>Rationale</th>
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<tr>
<td>Development and justification of streamlined overarching institutional and governance structures and mechanisms to allocate appropriate resources and leadership to building and appliance energy efficiency and lifecycle emission reduction.</td>
<td>Buildings and appliances offer very large and cost-effective potential to deliver multiple benefits (at a societal level, and in comparison with many other carbon emission reduction measures), but progress is well below potential. To deliver rapid and large emission reduction consistent with climate science, both EU and Australia must dramatically increase deep renovation and higher performance of new buildings and appliances.</td>
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<tr>
<td>Policy packages, policy tools and actions that drive rapid expansion of deep renovation Research into barriers and ways of overcoming them.</td>
<td>In both EU and Australia most building renovation is ‘shallow’, focused on measures with relatively short payback periods and application of narrow criteria, often just energy savings, when they deliver multiple benefits. This will require packages of measures that address issues including financing, reduction of perceptions of risk, energy tariff design, targeting, reduction of costs and labour, streamlining of products and services, expansion of supply chain capacity, local manufacturing and motivation or requirements for compliance and enforcement of key supply chains and consumer groups</td>
</tr>
<tr>
<td>Identification of ways policy areas beyond energy and climate potentially influence energy and climate outcomes, and how they could contribute to positive outcomes.</td>
<td>Many policy areas, such as taxation, social welfare, health, infrastructure, business innovation and urban planning impact on energy efficiency and productivity. These influences are often very powerful, but the links are not recognised, so opportunities to reshape these policies to help achieve energy and climate policy outcomes are missed and perverse outcomes can occur</td>
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<tr>
<td>High lifecycle performance existing and new public buildings.</td>
<td>Governments must demonstrate that they ‘walk the talk’ to set an example. They are large consumers of buildings, materials, and appliances, so they influence markets and supply chains. In most cases, energy savings and productivity benefits mean measures are cost-effective.</td>
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\(^{60}\) Transitioning to a Prosperous, Resilient and Carbon-free Economy by Baldwin et al (eds).
<table>
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<tr>
<th>Development and strategies to drive widespread adoption of comprehensive cost-benefit assessment tools that take into account multiple societal benefits and future carbon costs.</th>
<th>Narrow criteria, high discount rates, layer upon layer of conservative assumptions, reliance on ‘simple payback period’ and other factors such as lack of baseline energy efficiency data undermine effective policy development and decision-making by policy makers and along value chains. Addressing these can also help to overcome split incentives by documenting benefits captured by others so appropriate adjustments can be made and costs/benefits shared.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of improved lifecycle impact and costing methods, embodied and end of life emissions and incorporation into voluntary and mandatory policy tools and measures.</td>
<td>Credible, replicable default values are needed, as well as standard methodologies so that individual material and product suppliers and consumers can gain recognition for their choices of materials that rate better than default values, and these issues can be reliably factored into policies.</td>
</tr>
<tr>
<td>Development of improved heat pumps and design techniques and their widespread application, including user-friendly interfaces for information and control.</td>
<td>While there is impressive RD&amp;D aimed at increasing delivery temperatures, use of low Global Warming Potential refrigerants and efficiency improvements, there is scope for further policy and technology development and supply chain capability improvement. Automated detection of clogged filters, refrigerant loss and other types of failures maintains efficiency and output capacity and reduces risk of loss of production or service delivery: smart monitoring and diagnostics that alert operators are much more effective than regular maintenance checks. Use of stored heat or boosting to pre-heat inlet fluids, and optimisation of heat delivery temperatures to reduce the temperature lift required reduces capital cost. Improved monitoring of the actual efficiency of existing gas-fired equipment so that realistic efficiency values are factored into design and sizing of heat pumps will also improve the business case for change.</td>
</tr>
<tr>
<td>Development and application of add-on modules that convert existing ‘dumb’ electricity, gas, and water meters into connected real time monitoring devices that are user-friendly, can support advanced data analytics, and can integrate into existing data systems to use multiple data streams.</td>
<td>The present approach of replacing existing meters with real time, remote readable utility quality meters creates a serious bottleneck that limits the rate of digitalisation, application of data analytics and capture of large energy savings. Utility quality accuracy is not needed for these purposes. If untrained consumers could fit and remove them, it would also allow them to take control of who can access their data: this may encourage faster adoption.</td>
</tr>
<tr>
<td>Research to improve understanding of the underlying energy requirements for services, existing real world system efficiencies, energy actually consumed by activity, diversity of energy use for activities and factors influencing demand for services and energy use for them, including changing climate.</td>
<td>Field monitoring, consumer engagement and data analysis are needed to improve understanding of timing and levels of energy use, and to estimate and compare real and ideal energy efficiencies of services provided and demand profiles. Development of models that incorporate the physics and chemistry of service delivery and explain impacts of varying user behaviour, attitudes, maintenance, and other factors.</td>
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Conclusion

This paper reflects an attempt to provide background information on EU and Australian policy and related research on energy use and climate impacts of buildings and appliances. Given the limited resources and time available, it has really just scratched the surface of many issues. Nevertheless, this outcome highlights the value of building ongoing research and policy collaboration between the EU and Australia, as it is clear that both their similarities and differences provide fertile ground for learning from each other and generating innovative approaches. There is substantial knowledge and experience, but limited communication, networking and engagement means it is under-utilised.

The appendices to this paper provide additional useful detail that, if incorporated in the body of the paper, would potentially distract from its focus on identifying priority areas for collaboration.
Appendix 1: Energy and emissions data – EU and Australia

Recent trends in Australian building final energy use are shown in Figure 7. Electricity is the dominant energy source in both residential and commercial buildings, though gas is widely used for space and water heating. Buildings consume about half of Australian grid-sourced electricity (47.5% in 2019-20 – commercial buildings 235.7 PJ and residential 217.8 PJ out of total Australian electricity grid supply of 954.6 PJ). Residential electricity demand is a major contributor to morning and late afternoon-evening peak demand and is significant in both summer and winter. Commercial demand is variable.

Australia has around 10.5 million dwellings, of which 30% are rented. A significant number (around 5%) of dwellings are holiday homes: in some tourism areas around half of all homes fit this category. New home construction rate is 150,00 to over 200,000 annually, of which half to two-thirds are separate dwellings. In recent years, the proportion of large apartment developments has grown.

Gas is widely used in Australian homes, with space heating in cooler climates dominated by gas ducted air central heating systems. Gas water heating is also common. Heat pump HWS units comprise less than 3% of the residential stock. Electricity dominates the commercial building sector because cooling is a major factor, and refrigeration, office and other equipment rely on electricity.


Around 30% of Australian homes have rooftop solar systems and an increasing proportion of commercial buildings are installing systems. According to the Australian PV Institute (2021) in 2019-20 rooftop solar generated 14.7 TWh (53 PJ) of electricity compared with 454 PJ consumed by buildings from the grid. Annual increase in PV generation that year was 3.8 TWh/year or 13.6 PJ/year, around 30% increase on the previous year. This is creating challenges for the electricity industry, energy market operators and governments, as well as opportunities for the rapidly growing PV and energy services industries.

61 See https://www.housingdata.gov.au/
The high level of PV generation is reducing demand around the middle of sunny days, and is creating ‘reverse flows’ in some parts of electricity grids, while driving wholesale electricity prices negative at times. However, PV output declines significantly in winter peak periods, when building heating is a major driver of demand for both electricity and gas.

Buildings consumed around 15% of total 1692 PJ of Australian gas (and LPG) usage in 2019-20, with the residential sector consuming 190.4 PJ, 11.3% of total Australian gas and LPG consumption. Winter gas demand by buildings, particularly homes in cooler climates, is much higher than in the rest of the year, reflecting its major role in building heating – and the poor thermal efficiency of most buildings as well as inefficient appliances and equipment.

There is intense analysis and debate about the implications of building electrification on both electricity and gas industries\(^\text{62}\).

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Figure 8 compares final energy use by activity in the Australian and EU residential sectors. Climatic differences and age of buildings are reflected in the higher heating energy use in the EU. Australian dwellings are larger in floor area, but often only part is heated, and heating is used intermittently due to relatively mild and variable climates. Particularly in warmer climates and apartments, plug-in portable resistive electric heaters are widely used. In colder regions, there has been a trend towards ducted air gas central heating instead of space heating, and larger dwellings, which may explain the increase in gas consumption. Australia’s higher water heating energy use may reflect wider use of gas water heaters, which have lower final energy efficiency than electric units, as well as cultural differences regarding bathing and the slightly higher size of Australian households, which average over 2.5 people compared with 2.3 in the EU.

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Limited data from Pears (2021) using Victorian 2001 government survey data suggests that the 5% highest electricity and gas consumers in Victoria consumer around 15% of residential electricity and gas. This implies that targeting high consumers for efficiency measures could deliver disproportionate savings.

Electricity intensity of Australian commercial buildings is shown in Figure 9. This shows a steady decline in intensity, but also shows that retail and healthcare have high electricity intensity relative to other categories. If gas and oil consumption are factored in, this would rise from around 430 MJ/m² to approximately 585 MJ/m². Odyssee-Mure (2021) suggests average energy intensity of EU non-residential stock is 273.6 kWh/m² (985 MJ/m²), significantly higher than the Australian value. This may reflect differences in climate, construction and/or mix of activities within the sector. Australia, commercial buildings are more electricity intensive, potentially reflecting higher cooling energy use and lower heating activity. District heating provides about 7% of EU non-residential energy: this technology is rare in Australia.

![Figure 9: Electricity of Australian commercial buildings (source: EY, 2019)](image)

Figure 10 and Figure 11 provide Australian data on non-residential building energy use – the authors could not find similar end use category data for EU and energy use by fuel is 2013 – EU 28 includes UK which is no longer a member of the EU.
Figure 10: Australian commercial sector final energy consumption (source: EY, 2019)

Australian building-related policy directions

Despite, and in some cases because of, the tensions around building energy efficiency and climate policy, Australia has made significant progress. The successes and failures have delivered many useful lessons of global relevance.

In the commercial sector, energy and climate policy has included:

- Strengthening of the National Construction Code for all new on-residential buildings: the 2019 NCC increased stringency by around 30% (Harrington and Toller 2017). However, this is not particularly stringent relative to many other countries.
- Expansion of the NABERS scheme for existing buildings to a wider range of building categories, and modification to recognise the rapid rate of decarbonisation of electricity supply and the logic for a transition away from fossil gas. The Green Building Council of Australia’s Green Star scheme continues to evolve, with increasing focus on performance outcomes and streamlining and refining. The proposed 2022 National Construction Code is expected to allow use of NABERS and Green Star ratings as partial compliance methods within the NCC. This streamlines design and legitimises these rating schemes.
- Analysis that has shown that the retail, health care and public building categories (especially aquatic centres) are energy-intensive, and deserve a stronger focus [see Fig 8].
- In the Victoria, New South Wales and the Australian Capital Territory, energy retailer obligation schemes offer incentives for a range of upgrade measures, and ongoing program development is occurring, including factoring in the rapidly declining carbon intensity of electricity. In NSW, a safeguard incentive framework is being developed to incentivise reduction in peak demand and enhanced flexibility of electricity demand.

These developments have been underpinned by committed professionals and their industry associations. For example, in 1994 the Victorian Division of the Building Owners and Managers Association (later integrated into the Property Council of Australia) published its 1994 Energy Guidelines which included ambitious performance targets and practical guidelines. AIRAH (Australian Institute of Refrigeration Air-conditioning and Heating) has actively promoted sustainable practices through its Ecolibrium magazine, events and programs, training, and resources such as the FairAir residential heating and cooling load calculator.

Indeed, there has been much less opposition to energy efficiency and sustainability policy in the Australian commercial sector than in the residential building sector, although most leadership and progress has occurred in large office buildings and public buildings. In addition to the strong technical base, the reality that the main industry body, the Property Council of Australia, has both builders/developers and consumers (building managers and owners) as members has meant that both building supply side and consumer perspectives have been represented. In contrast, residential consumers have been poorly represented in residential building industry organisations and in public policy development processes.

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63 NABERS scheme; see [https://www.nabers.gov.au/](https://www.nabers.gov.au/)
64 Australia’s Green Start scheme; see [https://new.gbca.org.au/](https://new.gbca.org.au/)
In the residential sector, policy makers have relied heavily on regulatory approaches to drive change, and have failed to engage effectively with consumers. This has been, to some extent, an outcome of failure to invest resources and funds in community engagement. This has been reinforced by often unconscious cultural factors: both the building industry and policy makers have felt comfortable with a focus on regulation. This has led to slow progress due to chronic serious conflict between interest groups.

Australian national and state governments have not been prepared to commit the large resources and funding required to drive change in this sector. Politicians have strong incentives to support the existing distorted markets as the construction sector is a powerful lobby group. The reality is that most home buyers are not skilled or expert: they buy one or two homes in their lifetimes. They face skilled marketing and salespeople in a context where they face complex decisions. Key advisers and influencers (such as tradespeople) have agendas that are not focused on consumer benefit, let alone long-term societal benefit.

EU building-related building policy
The EU has a strong ‘top-down’ policy commitment to climate action and building energy issues relative to the Australian national government, as outlined earlier in this paper. This seems to be an outcome of a broad agenda to build a comprehensive Europe-wide economic, political, and social framework. It also reflects a political and economic reality that the EU is a net importer of energy and resources, while Australia is an exporter with relatively cheap energy, and major population centres have relatively moderate climates.

European population is relatively stable, with an aging population and some inter-country migration (Eurostat 2020). Building energy use is dominated by existing buildings and the residential sector, and by heating energy use. District heating, multi-family buildings and rental properties are major elements of building energy use and emissions. They create split incentives and institutional barriers. Many EU countries have cold climates, so winter comfort and health are key issues. Fuel poverty, where building occupants cut back on energy use because of inability to pay energy bills, is a major issue from social justice, health, and political perspectives.
Appendix 2 Building energy policy and action in Australia: a brief history

The path of building energy policy in Australia has been windy. Governments and policy makers have trailed far behind researchers, community, and leading practitioners. Powerful conservative forces have retarded progress, aided by failures in government leadership and weak market signals. This has led to a complex evolutionary process, where many players have influenced outcomes and consumer preferences, research, energy markets, building markets, politics and ideology have all played important roles.

Australia’s culture means that simple regulation will not drive optimal change. Voluntary programs, community groups, media, tensions between state and federal governments, luck and other forces have driven or blocked past progress. This complexity means that Australian building energy policy makers have explored many options and, of necessity, have had to build an understanding of the complexities of markets, cultures, communication, institutional change, and politics. This experience is potentially useful for European policy makers. Reflection on this experience is also valuable for Australian policy makers.

1940s to 1980s

This period involved a range of diverse participants. It reflected the reality that significant numbers of Australians lived in relatively extreme climates far from electricity and gas grids. From the late 1940s, researchers such as the Experimental Building Station carried out theoretical and practical research to develop and communicate key principles and examples of appropriate building design for Australian climates. CSIRO continued this work, and explored solar heating solutions, at its building research centre in Highett, Victoria. Some universities conducted leading research.

The Australian New Zealand Solar Energy Society provided a focus for researchers from academia and CSIRO, and enthusiasts, to share knowledge and experience. Its annual conferences included a diverse range of information.

In the 1960s and 1970s, several factors drove increased interest. Alternative lifestyle advocates explored passive solar design, solar water heating, natural building materials and off-grid living. Increasing focus on environmental issues increased the emphasis on energy issues in buildings. The 1973 OPEC oil embargo focused attention on the impacts of fossil fuels, and the fragility of global energy supply systems. Australia was largely shielded from the impacts of this crisis, because of its high production of oil and its heavy reliance on locally sourced coal-fired electricity. But the seeds for concern were sown, and lessons were learned from other countries.

In Australia, debate about environmental impacts of large-scale hydroelectricity projects and nuclear energy led from conflict to a search for practical solutions. The emergence of computers and the modelling of building thermal performance, led by researchers at CSIRO and universities, underpinned development of guidelines for solar-efficient buildings from the late 1970s.
Some state governments focused on environmental issues: for example Victoria promoted the slogan ‘The Garden State’, and established a solar energy agency in 1978. Victoria’s Gas and Fuel Corporation saw an opportunity to position gas as a ‘clean’ alternative to electricity after the discovery of enormous gas resources in the Bass Strait. In 1977, GFC offered households the opportunity to install ceiling insulation and ‘pay it off on their gas bill’. It established an Energy Information Centre to advise households and educate school children, and an industrial Energy Management Centre to provide technical advice about energy efficiency and renewable energy. It built and aggressively promoted low energy display homes – with gas appliances.

Community groups such as Friends of the Earth and the Alternative Technology Association as well as alternative lifestyle groups promoted clean energy solutions.

The 1979 Iranian revolution, and associated oil shortages also focused attention on broader energy issues. Concerns about electricity shortages and enormous public investments in polluting coal-fired electricity generation focused public attention on energy alternatives. State level election policies included proposals for mandatory insulation and appliance labelling.

The early 1980s saw an explosion of interest in renewable energy and energy efficiency, with strong emphasis on building issues. The New South Wales and Victorian governments worked together to introduce appliance energy labelling in 1986. Several unsuccessful attempts to introduce building insulation and efficiency regulations were pursued.

In the mid-1980s, the voluntary industry-led Glass-Mass-Insulation 5-star building rating was introduced, using a rating approach developed at the University of New South Wales based on application of CSIRO’s building simulation model. This was launched by then Australian Prime Minister Bob Hawke.

In the commercial building sector, interest in energy efficiency grew. In Victoria, the Building Owners and Managers Association published ambitious guidelines and benchmarks for office buildings.

The late 1980s saw a rapid increase in concern about climate change, with Australia playing a constructive role in global research and advocacy.

The 1990s


The Australian government ran a comprehensive consultation process, the Ecologically Sustainable Development process. This led to recommendations for introduction of building energy regulations and other measures, and proposals for expansion of appliance labelling and mandatory standards in 1992 [pp.166-7 Greenhouse Report Ecologically Sustainable Development Working Group Chairs, 1992, AGPS]. The Energy Use Working Group proposed a range of measures including incentives, disclosure, regulation, and education on energy efficiency related to buildings and appliances.

A change of Prime Minister in December 1991 with different priorities meant that these proposals were dropped, and Australia backed away from its progressive position on climate change. Community action on building energy efficiency continued. For example, the Australian Conservation Foundation, a major national environmental group, published its *Green Home Guidelines* in 1992.

Progress on building and appliance energy efficiency then ground to a halt. Energy market reform and deregulatory governments at state and national levels cut funding and rejected regulation across all sectors, including buildings and appliances. Nevertheless, in 1994 the Australian Capital Territory introduced a 4-star rating performance requirement for new homes, using a computerised rating tool, VicHERS, developed in Victoria for a voluntary building program involving leading edge builders. The Australian government published information resources such as the 1992 *Energy Efficient Australian Housing*.

Research funding for building energy efficiency also withered in this period. Promises that energy market reform would drive energy prices down also undermined public and business interest in building and appliance energy efficiency.

An important shift occurred in the lead-up to the Kyoto Climate Conference in 1997. John Howard, Australia’s then Prime Minister, in his *Safeguarding the Future* speech (Howard 1997) stated:

> The Government will also work with the States, Territories, and industry to develop energy efficiency codes and standards for housing and commercial buildings, appliances, and equipment.

> For industrial and commercial appliances and equipment we will implement an improved labelling programme and minimum energy performance standards.

> We will expand the Nationwide House Energy Rating Scheme by including a minimum energy performance requirement for new houses and major extensions and we will work with the States, Territories, and industry to develop voluntary minimum energy performance standards for new and substantially refurbished commercial buildings.

> These initiatives will take us to best practice standards in these important areas. If this voluntary approach does not achieve acceptable progress within 12 months, we will work to implement mandatory standards.

In this speech, the Prime Minister also proposed to develop a support mechanism for renewable energy: this became the Renewable Energy Target.

These commitments underpinned a major shift in Australian building and appliance energy policy.

The New South Wales government’s Sustainable Energy Development Authority was also active in building energy efficiency in the late 1990s. It worked with NSW local councils to roll out residential building policies. SEDA also developed and launched a voluntary program targeting office buildings, the Australian Building Greenhouse Rating scheme. This evolved into the widely acclaimed NABERS rating scheme (Mallaburn et al. 2021), which is discussed elsewhere in this paper. This scheme pioneered the use of performance-based rating using actual energy data.

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The Australian Capital Territory government introduced a residential energy disclosure scheme in 1999 that applies at time of sale. This uses a simplified star rating scheme to rate the thermal performance of the building envelope. This has been shown to increase the sale price of higher rating dwellings.

The 2000s
Attempts by building industry leaders to develop a voluntary building energy code in response to the government’s Kyoto commitment failed. So the Australian government established a process in 2000 to develop national building energy regulations. The Australian Building Codes Board, which was responsible for development of national building codes, was instructed to develop building energy regulations and a steering committee was established under the chair of the ABCB, Peter Laver. One of the authors of this paper, Alan Pears, was a member of this committee until 2006.

This process led to introduction of a basic residential insulation code in 2003 and, in December 2005, comprehensive codes for non-residential buildings and residential ‘five stars’ requirements that focused on overall building envelope thermal performance were agreed.

The national process was far from smooth, so individual state jurisdictions pursued their own paths in parallel with the national process. In 2004, the state of Victoria announced its 5-star building regulations, while the New south Wales government introduced its BASIX energy and water regulations, which it still uses. BASIX included separate summer and winter thermal performance criteria and set standards for major fixed appliances and equipment.

Due to Australia’s federal system, the national building code is not applied nationally: it is a ‘model’ code. Each state and territory legislates its building regulations, and each reserves the right to vary the national code to take into account local conditions. This leads to significant variations in stringency and scope across jurisdictions, as well as delays in adoption. On one hand, this introduces complexities and inefficiencies but, on the other hand, it means that progressive state governments can implement tougher standards. This provides a mechanism for a state to effectively run ‘pilot’ projects that may be adopted by others over time.

In parallel with the regulatory approach other developments have occurred.

In the early 2000s, progressive building industry participants established the Green Building Council of Australia (GBCA) based on a US model. GBCA has developed a suite of Green Star rating tools for commercial buildings that are now widely used on a voluntary basis, though mainly for larger buildings, and in the premium sector.

As noted earlier, the commercial building NABERS rating scheme emerged. Some governments required buildings they occupy to meet high NABERS ratings. In 2010, the mandatory Commercial Building Disclosure (CBD) scheme was introduced nationally, and applies to office buildings at time of sale or lease: this is discussed elsewhere in this paper.

Both NABERS and the Green Star scheme are being extended to a wider range of building categories.

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[68] GBCA; see https://new.gbca.org.au/
These developments highlight an important issue: different forces operate in the residential and non-residential sectors, and in sub-sectors. These influence what measures are adopted and their stringency. Different factors also influence outcomes for premium and ‘mid-tier’ commercial buildings, different types of commercial buildings, and existing and new buildings. Development of policies and programs must factor in these differences to policy design if they are to be successful.

The Australian and several state and territory governments have introduced energy performance requirements for buildings they occupy. For example, the Commonwealth government announced a program in 2006 that still operates\(^\text{70}\). It makes use of the NABERS rating scheme and includes a green lease schedule.

In 2009, the National Strategy on Energy Efficiency was launched by the Council of Australian Governments\(^\text{71}\). This included proposals for comprehensive measures related to buildings and appliances.

In the following year, a Prime Minister’s taskforce conducted consultation and prepared another strategy document on energy efficiency policy: Report of the Prime Minister’s Task Group on Energy Efficiency (Australian Government Department of Climate Change and Energy Efficiency, 2010). On page 1, it notes:

“To date, Australia has not consciously or explicitly targeted world best practice in energy efficiency and, by comparison with other countries, has significant gaps in its energy efficiency policy armoury [...] It seems clear that the level and the rate of improvement of improvement of energy efficiency in Australia lag behind much of the rest of the world.”

Neither of these efforts delivered significant expansion of energy efficiency policy.

In December 2015, the National Energy Productivity Plan was prepared – the weak progress on this was mentioned earlier.


While these international studies may not fully consider state and territory level policies and action, it is clear that, at a national level, Australia has not been a world leader in energy efficiency.


Recent years

Over the past decade, substantial research and analysis by a number of groups including ClimateWorks Australia\(^\text{72}\) (affiliated with Monash University) community groups such as ReNew\(^\text{73}\), academics (for example the Low Carbon Living Cooperative Research Centre), the Green Building Council and progressive industry bodies including the Australian Sustainable Built Environment Council (ASBEC)\(^\text{74}\) and Energy Efficiency Council\(^\text{75}\) have built a case for stronger policy on building energy efficiency. This work led to agreements in 2018 and 2019 by commonwealth, state and territory energy ministers to commit to pursuit of ‘trajectories’ for ongoing increasing stringency in regulation and voluntary measures on new and existing building energy performance\(^\text{76}\). The target is for ‘net zero energy ready’ buildings to be required, though no specific date for achievement has been set.

Nevertheless, this agreement has led to development and implementation of a substantial work program\(^\text{77}\). Progress across the range of measures has varied, due to resource limitations, impacts of the Covid pandemic, and other factors including opposition from some groups. State and territory governments have led much of the work and, in some cases, have implemented measures ahead of other jurisdictions.

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\(^{72}\) ClimateWorks Australia; see https://www.climateworksaustralia.org/

\(^{73}\) ReNew; see https://renew.org.au/

\(^{74}\) ASBEC; see https://www.asbec.asn.au/

\(^{75}\) Energy Efficiency Council; see https://www.eec.org.au/


Appendix 3 Australian appliance and equipment energy efficiency – context and a brief history

Context of Australian appliance policy and other related activities

The focus of formal government policy has been on high volume appliances with significant energy consumption, with a focus on energy (and water) labelling and mandatory performance standards. Substantial data collection, technology analysis, publications and consultation processes are involved. Regular residential and commercial sector Baseline Studies are published: new editions are close to publication, with the previous residential report dated 2015 and commercial report 2012. These analyse building and equipment stocks, energy use by activity, carbon emissions, peak demand impacts, etc.

In recent years, research and policy development related to behind-the-meter renewable electricity generation and storage, demand response and interactions with electricity grids have grown rapidly. This reflects the rapid growth in adoption of distributed energy technologies in Australia. However, most of the focus has been on actions that would assist the energy supply system to optimise its utilisation of energy and infrastructure. So most focus has been on short term demand response, not underlying energy efficiency.

In parallel, consumer focused policy and research have grown from a low base, with community energy, social justice, consumer groups and academics raising their involvement. Energy Consumers Australia has been a major funding source.

Since most appliances and energy consuming equipment is imported, Australian policy development tends to focus on consumer markets and end-user aspects as well as harmonisation with international Standards. Australian governments are actively engaged in a number of international processes, while Australian consultants and researchers have contributed to international work.

Early days

Energy utilities and the appliance industry in Australia carried out research, while policy relating mainly to health and safety has been pursued for many decades. Interest in energy efficiency emerged in the late 1970s, after the OPEC oil embargo (1973) and Iranian revolution (1979), driving research and policy development in appliance efficiency. For example, in 1978, Victoria’s publicly owned energy utilities established industrial and household energy information centres, while the state government established a solar energy research council. The Australian gas industry had a substantial RD&D program to support local manufacturers of gas appliances and its strategy to create a positive environmental public image.

The New South Wales government adopted a policy to introduce energy labelling in 1979 and focused more attention on appliances during an electricity shortage soon after. In 1982, the newly elected Victorian government committed to ‘a simple system of energy efficiency labelling... to guide consumers, such as that already used in the USA’. Victoria’s Gas and Fuel Corporation introduced a voluntary gas efficiency tag to promote more efficient hot water heaters and heating equipment.

78 Energy Rating website; see www.energyrating.gov.au
Community groups began to focus on energy efficiency as a positive path forward instead of fossil fuels and nuclear power. For example, in 1981 the Conservation Council of Victoria published a comprehensive household guide *Energy to Burn* that included detailed appliance energy saving hints and lists of running costs of appliances, sourced from the consumer magazine *Choice*.

A national process for development of appliance labelling was established, in which the NSW government was very active. The Victorian government proposed a ‘5-star’ label, and market research showed it was very effective in a showroom environment. By 1986, after the national process lost momentum, the NSW and Victorian governments jointly introduced a 6-star refrigerator label, with one star awarded for meeting electrical safety standards and up to 5 stars for energy performance. The label was heavily promoted, and transformed consumer interest in appliance efficiency. By the early 1990s, dishwashers, clothes washers and dryers carried energy labels.

The gas industry adopted an industry-managed star rating label. This is still industry managed today.

Through the 1990s other states mandated labelling but it was 2012 before national regulation was introduced in the Greenhouse and Energy Minimum Standards (GEMS) scheme. This reflects a common theme in Australian energy efficiency policy: state governments have led, often with voluntary schemes that evolve into mandatory schemes. Eventually they are adopted nationally.

The appliance efficiency label paved the way for development and adoption of Mandatory Energy Performance Standards through the 1990s and beyond. The overall approach in Australia has combined energy labelling for products that have a high profile with consumers, extensive consumer information, and mandatory performance standards as a complement to labels and for products that are less influenced by consumer choice, such as electric motors and lamps.


The scheme has also faced challenges in addressing rapid improvements in best practice appliance efficiencies. For some products, such as refrigerators, the rating scale has been revised several times, so that 5 stars on the original 1980s label would only rate about 1.5 stars on today’s label. For other appliances such as clothes dryers and TVs, the 6-star label has been modified so that products achieving ratings better than 6 stars can display an optional ‘coronet’ that presents an additional 4 stars, so that ratings of up to 10 stars can be displayed.

A recent development for reverse cycle air conditioners is the ‘zoned’ rating which displays star ratings for three climate zones, so that consumers can select climate-appropriate products.

These adaptations bring various challenges. Adjusting the rating scales means that old appliances that still have their labels – because many people are proud that they have chosen a high star rating product, mislead people into thinking their existing appliances are more energy efficient than they actually are. Extending the scale to 10 stars can also mislead, as consumer attitudes to star ratings are still dominated by their experience with hotel star ratings, where 5 stars is reflects best practice.

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The problem is compounded by the optional application of the coronet of extra stars, which only appears on products that rate higher than 6 stars. If an appliance retailer does not display any 7+ star products, a buyer may think that a 5-star product is excellent when it is actually a relatively poor performer. This can also negatively distort perceptions of the performance of products where 5 to 6 stars is still ‘best practice’, often because the rating scale has been adjusted over time.

Lack of spending on public education and promotion by governments allows these confusing issues to undermine understanding of energy labels. The situation is further complicated by the adoption of star ratings for building performance and even health rating of food.

The use of mandated performance standards in Australia also faces issues. Many forces work to block introduction of standards and to set weak stringencies. Some sections of industry oppose mandated standards on principle, while others work to reduce stringency. In Australia, new mandatory regulations are subject to public consultation, including preparation of a Regulatory Impact Statement (RIS). An RIS must be approved by the Office of Best Practice Regulation (OBPR). The OBPR applies restrictive requirements to estimation of benefits of energy efficiency measures, such as a high discount rate and narrow range of benefits that can be considered (Australian Government Department of Prime Minister and Cabinet 2020; Australian Government Department of Prime Minister and Cabinet n.d.). Submissions to recent consultation on the National Construction Code have highlighted some of the concerns about the OBPR’s approach.

The present Australian government also applies a challenging criterion to new regulations that may increase the ‘burden’ on business, as noted earlier. Any additional burden must be ‘offset’ by an equivalent reduction in burden at a departmental level. For an environment department or an emerging area where increasing regulation is necessary, this creates serious internal tensions.

These problems, and others, are noted by Harrington & Toller (2017 p.81) as he refers to findings of a 2015 review of the program:

- Federal and state government concerns about ‘red tape’ and the actions of the Office of Best Practice Regulation stalling progress with RIS [Regulatory Impact Statement] development and decision-making
- The Australian Government’s introduction of a regulatory offsets program, requiring those proposing new regulations to be offset, including by removing other regulations – the 2015 Review notes that “…no new regulations have been put to the [COAG] Energy Council for decision since this policy came into effect” [Note: some new regulations have been introduced since this review, but progress has remained slow]

Harrington & Toller (2017, p.41) on 2014 guidelines states:

*Offsets may be from any area of your portfolio, though ideally, they should assist those directly affected by any new regulation you introduce. They should be achievable and coincide as much as possible with your new regulation. Remember to identify where the new burden and offset impacts will overlap.*

Reviews of the appliance efficiency program have been carried out in 2015 and 2019. Both found the program was worthwhile. The 2019 review found that, in 2018, the net savings of GEMS regulations to the Australian economy ranged between $1.13 and $2.15 billion with greenhouse gas emissions savings of 2,000,000 tonnes.

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emissions savings of between 4.8 and 7.6 million tonnes. It was providing emissions abatement at a negative cost of around $200/tonne.

The 2019 review supported expansion of the program and flagged areas for improvement including:

- Development of a long-term strategic plan
- Incorporation of demand management capability in appliances
- Expansion of coverage and alignment with international standards

International appliance-related programs with Australian involvement include membership of 5 of 17 current international initiatives and campaigns (Australian Government Department of Industry, Science, Energy and Resources n.d.b):

1. Super-Efficiency Equipment and Appliance Deployment (SEAD)
2. International Smart Grid Action Network (ISGAN)
3. Clean Energy Solutions Centre (CESC)
5. Clean Energy Education and Empowerment (C3E)

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Appendix 4 Policy tensions between many key players

In Australia, state and territory governments often set stronger targets than the national government and, individually or in partnerships, develop and implement policies relating to buildings and energy supply in response to local factors. For example, at present, states and territories have more ambitious climate targets than the national government: state and territory climate targets would cut Australian emissions by 35-42% by 2030 (ClimateWorks Australia 2021), while the national government’s target is only a 26-28% reduction, though it has acknowledged that a reduction of around 35% is likely to be achieved.

Some Australian states and territories have historically led the national government on energy efficiency and building energy policy. Australian appliance energy labelling was introduced by two states (New South Wales and Victoria) in 1986, and only became a national scheme in 2012 under the GEMS legislation. Building energy regulations were introduced in some jurisdictions from the early 1990s, and were integrated into the Building Code of Australia (now National Construction Code) in 2006, despite objections from the national government at the time. Each state and territory still legislates building activity, including energy related measures, though strong efforts are made to encourage consistent adoption of the model National Construction Code developed by the Australian Building Codes Board.

In 2015, a National Energy Productivity Plan (NEPP) was released, with a comprehensive work program. However, this has stalled, with the most recent document on the government NEPP web page being a 2018 progress report85. Some of the initiatives in the NEPP have been pursued through energy market agencies and the Trajectories activities in the building sector.

Australia’s Building Ministers Forum has formal responsibility for all national building-related policy, so energy and climate-related measures must be negotiated via complex processes, involving participants with varying priorities. Australia’s energy ministers agreed a broad overarching national approach to trajectories for progress towards ‘net zero emission ready’ buildings in 201986. This agreement has been the main driver of recent national building energy and emission policy, and has led to increased coordination and cooperation between state, territory, and national governments with regard to policy development and implementation. Resource limitations, legislative barriers and the Covid pandemic have limited progress in some areas.

Until 1998, when the National Electricity Market (which includes all jurisdictions except Western Australia and the Northern Territory) was created, states and territories were responsible for most stationary energy policy, and energy grids had limited interconnection across state boundaries. Electricity and gas supply is still legislated at a state/territory level, although substantial policy development and management of energy markets occurs in the ‘National’ Electricity and Gas Markets through agencies such as the Australian Energy Market Commission, Australian Energy Regulator and Australian Energy Market Operator.

Energy efficiency and climate issues have not been comprehensively addressed within energy market policy in Australia. Indeed, instead of being Australia’s ‘first fuel’, as in the EU, energy efficiency is, in most cases, Australia’s ‘forgotten fuel’. Most energy industry associations and environmental groups focus on renewable energy, and rarely mention energy efficiency in their public statements. Funding for energy efficiency measures has been very modest in comparison with renewable energy. Key

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funding organisations such as the Australian Renewable Energy Agency (ARENA) have been constrained by narrow terms of reference that focus on supply options.

Recent national plans and roadmaps have placed little emphasis on energy efficiency measures. For example, Australia’s Long Term Emissions Reduction Plan mentions energy efficiency a number of times but (on pages 116-118) allocates only $115 million to specific energy efficiency initiatives, most of which are already under way (Australian Government Department of Industry, Science, Energy and Resources 2021a). The national government’s Low Emissions Technology Roadmap (Australian Government Department of Industry, Science, Energy and Resources 2021b) mentions end use efficiency a few times in relation to cement and steel production and the potential role of heat pumps.

National electricity and gas market objectives focus on low energy prices, rather than overall consumer costs, so there is a bias towards supply-side options that impact on prices, and no reference is made to environmental impacts (Australian Energy Market Commission n.d.)

Intense national level political disagreement over climate policy and energy issues has meant that state and territory governments have largely pursued their own agendas. This has led to a situation where the Australian government has a modest commitment to a 26-28% reduction in emissions from the 2005 level by 2030 while states and territories mostly have stronger commitments, assessed in one study as achieving 37-42% emission reduction relative to 2005 (ClimateWorks Australia 2021). This situation has impacted on the behaviour of the building industry and building owners and occupants, as well as the broader energy sector. On one hand, it has sent the message that energy efficiency and emission reduction in buildings are not important and will not be rewarded but, on the other hand, it has mobilised state governments, communities, and forward-looking businesses to take stronger action.

In Australia, governance of energy efficiency issues is complex, as shown in Figure 3 in the body of this report, with reliance on agencies that may have limited interest and expertise, and conflicting agendas, as outlined earlier in this paper. The building sector is just one of many areas where there are significant differences between jurisdictions, though progress towards harmonisation on building energy and climate issues is accelerating.

Given the historically less than ideal institutional arrangements related to building energy/environment and energy supply in Australia, many community, academic/research/think tank’ and business groups have emerged. They actively drive policy and practices. This means that attempts to evaluate progress on building energy and environmental issues through evaluation of national government activity will not recognise the high levels of activity and innovation that are occurring at a state level, and through non-government mechanisms. For example, Australia is a world leader in ‘behind the meter’ rooftop solar, and South Australia is a leader in management of an electricity grid with little fossil fuel generation capacity.

Building-related programs, research and advocacy by states (e.g. NABERS, originally developed in New South Wales), industry groups (ego Green Building Council of Australia Green Star rating schemes, Energy Efficiency Council, Australian Sustainable Built Environment Council, etc) local government (e.g. Victorian CASBE’s Building Environment Sustainability Scorecard), thinktanks (ego ClimateWorks Australia, Grattan Institute) and community groups (e.g. ReNew, Australian Council of Social Services, C4CE (Coalition for Community Energy), Cities Power Partnership, Community Power etc) are also driving innovation in buildings. Progressive architects and building designers are embracing environmental rating systems (e.g. Australian Institute of Architects, WELL and passivhaus) and addressing issues such as bushfire resistance and innovative apartment development models.
Energy Consumers Australia, an agency funded through the energy market, advocates on behalf of consumers and funds substantial leading-edge research. Specialised non-government groups such as the Australian Alliance for Energy Productivity, AIReH and the Energy Efficiency Council are driving adoption of heat pumps and broader policy at state and national levels. Australian academics are also active in research and advocacy on building-related issues, as reflected in the work and publications of the Cooperative Research Centre on Low Carbon Living and through the recently established RACE for 2030 Cooperative Research Centre.

Australian perspectives on regulation and government intervention are complex. The default position is that governments should minimise their interference in people’s lives. But many recognise that regulation and government interventions are important to protect the ‘public interest’. So Australia has an extensive public health system that co-exists with a private system. We have ‘competitive’ electricity and gas markets, but they have significant regulatory mechanisms for ‘regional monopoly aspects such as transmission and distribution’, and to protect the poor and vulnerable.

The ongoing tensions between ‘free’ markets, protection of the public interest and an active community (driven to some extent by compulsory voting, media and rapid societal change), as well as the tensions between national, state, and local government agendas, mean that Australia provides useful ‘experiments’. Indeed, while the tensions between levels of government create inefficiencies, they also create the opportunities for ‘pilot projects’ and disruptive innovations driven by different governments, industries, businesses and community groups.

In the buildings, energy, and climate areas, this chaotic but ‘learning’ environment has led to many important innovations. Australia’s ‘promotional’ appliance energy label, developed in the mid-1980s, highlighted the need for energy labels to work in a retail environment. The NABERS building rating scheme has driven a focus on ‘delivered performance’ instead of ‘design intent’ (Mallaburn et al. 2021). Australia’s rooftop solar deployment experiments have led a global revolution.

Australia is a ‘young’ country (despite the ancient nature of our land and a very old and rich indigenous culture) with relatively high population growth (and a high share of population born, or with parents born, overseas) and an enormous endowment of natural resources. Australian energy and resources policy is dominated by the mining and fossil fuel industries, and there is an underlying cultural focus on supply-side solutions over demand-side, efficient solutions. This goes far beyond energy. For example, urban sprawl, increasing exploitation of land and water, and production of mineral resources for export dominate policy development. Our present Prime Minister’s office is dominated by staff with fossil fuel and resource industry backgrounds (Wood, Griffiths and Chivers 2018).

At a state, business and community level, priorities are very different. Australia’s economy and employment is dominated by the services sector, and by ‘light’ manufacturing, yet most perceive the economy to be heavily dependent on the fossil fuel industry (Huntley 2022). Australians care about the elderly and disabled. Increasing numbers of young Australians cannot imagine buying a home: they face lifetime renting, often in large apartment developments unlike anything built before 2000. Major business organisations including the Business Council of Australia and the Australian Industry

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87 For example, the collaborative work contained in the book *Decarbonising in the Built Environment*; see https://link.springer.com/book/10.1007/978-981-13-7940-6
88 RACE for 2030; see https://www.racefor2030.com.au/
Group\textsuperscript{90} have publicly supported more aggressive climate action than that proposed by the Australian government.

The lived experience of many Australians impacted by increasingly extreme wildfires, coastal erosion and floods is shifting public opinion. And those affected are focusing more on resilience and independence from centralised utilities.

State governments have to recognise this reality: they are expected to ‘keep the lights on’ with practical policy. So conservative state governments such as the New South Wales\textsuperscript{91} and South Australian governments, are leaders in climate and clean energy action. The more Australia’s national government props up the fossil fuel sector and tries to blame state governments for problems, the greater the pressure on state governments to act more aggressively to drive clean innovation. While this model can be economically inefficient, the checks and balances and shared lessons often lead to better outcomes and disruptive innovation.

The Australian building industry is an important but complex beast. It is a major employer and a major economic driver. But it is also a major climate liability. The focus of many new home builders is on a low ‘sticker price’, regardless of long-term costs and social problems. The industry is fragmented, with many small businesses and contractors, and has serious problems with quality control and accountability (Shergold and Weir 2018) which is driving significant interventions.

Governments have failed to educate new home buyers on energy efficiency and sustainability, while builders have exploited flaws in our energy star rating scheme\textsuperscript{92}.

In the commercial building sector, Australia’s NABERS rating scheme is a global leader. But smaller office buildings, the retail and health care sectors are slow movers (Mallaburn et al. 2021)

The existence of many tensions over climate and energy policy, which impact on building and appliance policies, clearly creates delays and distortions in Australian policy. Nevertheless, lessons can be learned from how these issues have played out and, in many cases, been overcome. Many other countries, including some EU Member States, face similar challenges. So there is opportunity for learning through collaborative research in this area.


\textsuperscript{92} See https://theconversation.com/spruiking-the-stars-some-home-builders-are-misleading-consumers-about-energy-ratings-136402
References


Australian Government Department of Industry, Science, Energy and Resources (2021a): Australia’s Long-Term Emissions Reduction Plan: A whole-of-economy Plan to achieve net zero emissions...


Shergold, P.; Weir, B. (2018): Building Confidence: Improving the effectiveness of compliance and enforcement systems for the building and construction industry across Australia. Building...


