Renovation Pathways:

Project update and preliminary findings of cost-benefit analysis

APRIL 2023

ACKNOWLEDGEMENT OF COUNTRY

We acknowledge and pay respect to the Traditional Owners and Elders – past and present – of the lands and waters of the people of the Kulin nation on which the Climateworks Centre office is located, and all of the Elders of lands across which Climateworks operates nationally. We acknowledge that sovereignty was never ceded. More information.

In October 2022, Climateworks Centre initiated the Renovation Pathways project.

This project aims to:

- Define zero carbon homes for Australia
- Identify most common types of homes (archetypes) across Australia and the actions that can improve their energy performance
- Conduct cost-benefit analysis of energy performance upgrades on different archetypes in different climate zones, revealing the costs, savings, energy savings and avoided emissions associated with energy performance upgrades

This document summarises the project’s intention, methodology, early findings and next steps as of mid-April 2023.

ABOUT US

Climateworks Centre bridges the gap between research and climate action. We are climate transition specialists, working in Australia, Southeast Asia and the Pacific with decision-makers who have the power to reduce emissions at scale. Climateworks develops evidence-based solutions to accelerate emissions reduction in line with the global 1.5°C temperature goal and shared climate safety.

Co-founded by philanthropy and Monash University, Climateworks is an independent not-for-profit working within the Monash Sustainable Development Institute. To learn more about this work, visit www.climateworkscentre.org.

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Overview

Early findings

- On average most existing homes can be brought to net zero through a combination of thermal shell, appliance and electrification upgrades, complemented by solar PV.
- Energy performance upgrades yield significant energy bill savings, reduce peak electricity demand and energy consumption and avoid emissions.
- The reduction in peak electricity demand that results from thermal shell upgrades and efficient appliances significantly reduces electricity infrastructure investment costs – this is a key consideration in the transition out of gas.
- Energy performance upgrades are, on average, cost effective at a household level and even more so at a societal level. At household level, the average energy bills savings generally offset the additional cost of energy upgrades over time (including cost of financing if financed through a mortgage), leading to a net saving.

Residential homes are at the forefront of climate change in Australia. With most built before energy performance requirements, residential buildings make up more than 10% of Australia's emissions. Improving the quality and performance of Australia's more than 11 million existing homes is equally as important as increasing the performance of newly built homes.

Climateworks Centre's Renovation Pathways project sets out to understand Australia's residential building stock – what it looks like and what energy performance upgrades homes need to reach a net zero standard.

Australia's net zero future will require both increases in electrification and energy efficiency. The same is true for net zero homes. Electrifying a home by swapping gas for electric cooktops, space heating and hot water is an important part of the energy performance equation.

Preliminary findings from Renovation Pathways show that improving the performance of a home's 'thermal shell' – external walls, roofs and floors – is a very important part of the equation when it comes to energy and financial savings. It is also critical to reducing peak electricity demand in an electrified future.

Roughly 40% of household energy is used for heating and cooling. With climate-appropriate design, however, it could be significantly reduced. That comes down to upgrading a home's thermal shell, which affects peak electricity demand, energy bills, and household health and comfort.

There are also early indications that energy performance upgrades are able to pay for themselves through energy savings. Across the various housing types we've identified as most common for Australia, households could expect to see energy consumption savings in the range of 55–65% on average from thermal shell improvements and efficient and electrified appliances.

HOW WE ARE CONDUCTING THE ANALYSIS

We are working in partnership with Strategy Policy Research, with support from CSIRO, to analyse the largest available housing dataset, containing real energy data from 1.2 million real homes, to conduct a cost-benefit analysis of energy performance upgrades.

We are also able to parse this data by most of the 69 Nationwide House Energy Rating Scheme (NatHERS) climate zones and all eight of the National Construction Code (NCC) climate zones, which will give us a picture of the cost-effectiveness of energy performance upgrades depending on the climate region in which homes are located.

The Renovation Pathways project aims to deliver a representative but granular analysis that can provide actionable information for policy-makers and householders living in a variety of home types and climate zones. To do this, we identified home ‘archetypes’ based on building categories – houses, townhouses and apartments – and 28 varieties of external walls, floors and roofs that influence a home’s energy performance.

We used the 16 most common combinations of building elements to create the archetypes – see Table 1 below.

For each of these archetypes, we then modelled the cost, savings, energy savings and avoided emissions resulting from a sliding scale of energy performance upgrades. What would the economics look like to upgrade a house with weatherboard-clad walls, concrete slab floors and a framed tile roof? For an apartment with brick veneer walls, suspended concrete floors and a concrete roof, what are the most cost-effective upgrades? See the improvements needed across four levels of energy performance upgrades Table 3.

The model investigates the cost-effectiveness of thermal shell upgrades, and to round out the energy performance picture, we also look at ‘whole-of-home’ upgrades (e.g. electrifying space conditioning equipment, domestic hot water and electrifying cooktops) and the addition of solar PV. The combination of thermal shell upgrades, efficient electric appliances and solar PV allows us to investigate the cost-effectiveness of getting homes to net zero.

WHAT WE EXPECT TO FIND

Depending on the type of home (archetype) and depending on the level of energy performance upgrades undertaken, we will be able to show the cost-effectiveness of different renovation pathways for nearly 80% of Australia’s housing stock.

The results will be a robust and highly practical database on home energy performance. We expect the data to show possible financial, energy and emissions savings for each type of home across all climate zones.

Introduction

What is this project about?

The Renovation Pathways project was designed to provide evidence-based information and advice to decision-makers and consumers on the opportunities, costs and savings associated with energy performance upgrades of homes.

The current understanding of key energy performance characteristics of homes and of the opportunities to upgrade a home, in different climate zones and for different kinds of homes (single detached dwellings, townhouses and apartments) is limited. This missing piece of knowledge prevents better support for different communities – for busy homeowners, landlords and renters, social housing providers and vulnerable households alike.

What defines a zero carbon home? What interventions can improve the energy performance and comfort of a home? How much does it cost and how much will it save? How do the economics vary in different types of homes and in different climates? These are the questions that the Renovation Pathways project aims to answer by developing a strong evidence base.

Why is it needed?

The problem

Climateworks Centre and the International Energy Agency's modelling show zero carbon buildings need to be the norm by 2030s – currently the existing building stock is very far from that and Australia does not have a net zero aligned building code. Increasing frequency and severity of extreme weather events (heat waves, floods, etc.) and spiking energy prices also call for urgent future-proofing and improvement of existing homes.

The solutions

To deliver on Australia's climate targets and reduce cost of living, improving the quality and performance of most of Australia's nearly 11 million homes will be equally as important as increasing the performance of newly built homes. Most homes making up Australia's existing building stock were built before any energy performance standards existed. In Victoria, for example, existing homes are rated well-below current building standards, rated just above 2 NatHERS stars on average (CSIRO 2023). For existing residential building stock to become zero carbon aligned, energy performance upgrades will be essential.

The current state of new homes

For new homes, the energy performance standards in the NCC were increased in 2022 from 6 to 7 stars, using the NatHERS and whole-of-home energy budget (kWh). But even a 7-star home might not be net zero emissions, and is far from achieving year-round energy efficiency and lower energy bills. With further improved building standards, homes could reach low or zero carbon emissions, produce no emissions on site, and deliver higher levels of comfort during hot summers and cold winters. Updating the NCC to include a zero carbon building standard (voluntary in 2025 and mandatory in 2028) will be critical to achieving Australia's climate target. First, we need to define what a zero carbon home is.

The current state of existing homes

Urgent action is needed to upgrade existing homes, but there is a lack of understanding of how to go about it, with limited enabling policy and finance conditions to support it. Well planned renovations can contribute to upgrading energy performance and deliver financial, thermal comfort and health benefits, as well as mitigate climate change. To support large scale energy performance upgrades across Australia, for everyone, we need effective supportive government policy in place, as well as finance support and a skilled workforce in industry to upgrade homes. We also need consumers to be well informed about what interventions can improve the energy performance and comfort of their home, and for what cost. This however requires understanding key energy performance characteristics of existing homes and the possible upgrade interventions to improve their energy performance, as well as understanding the key costs, savings and benefits associated with it.

Thermal shell upgrades key to energy transition

Thermal shell upgrades are critical to achieving a safe energy transition and optimum societal outcomes and should be an integral part of energy performance upgrades alongside appliance switching and electrification.

The project takes a holistic approach to energy performance: we look at home upgrades that improve energy performance by combining thermal shell energy efficiency improvements, appliance energy efficiency, and full electrification.

Energy efficiency through thermal shell improvement and appliance switching is a core part of achieving net zero homes alongside electrification with renewable energy sources:

+ As Australia transitions out of gas and electrifies to achieve its climate targets, electricity demand is projected to skyrocket, putting pressure on existing networks. Reducing energy consumption from households through highly efficient thermal shells and appliances is a critical solution to reduce peak electricity demand, the overall pressure on electricity production capacity and ultimately energy supply and distribution costs.
+ Reducing energy consumption from households also increases Australia's energy security and reduces household vulnerability to energy price spikes.
+ Thermal shell improvements are critical to improving household comfort and health and reducing energy consumption to a minimum, avoiding unnecessary energy bill costs to households.

In the transition to net zero households, optimum societal outcomes will be achieved if we go hard and early on thermal shell and appliance energy efficiency and electrification.

What are we doing and how

The first phase (October 2022 – July 2023) of the Renovation Pathways project focuses on producing an evidence base about the opportunities associated with zero carbon homes and energy performance upgrades.

The second phase (July 2023 onwards) will focus on supporting key stakeholders in utilising the evidence base to inform policy, financial products and consumer information.

Phase 1 includes the production of four key knowledge assets:

1. A detailed definition of zero carbon homes
2. Cost-benefit analysis of four energy performance upgrade levels on 16 types of homes representative of 80% of Australia's building stock
3. A building stock model to understand the scale of the opportunity (cost, savings, energy savings and avoided emissions) to roll out energy performance upgrades in each state and territory and for the whole of Australia
4. Recommendations (policy, technical and financial) for energy performance priorities across Australia

These knowledge assets are being developed through a combination of desktop research and literature review, data modelling and analysis and inputs and feedback from experts including in the project's Expert Advisory Group.

The project is conducted in a research partnership with Philip Harrington (Strategy Policy Research) for the economic analysis and the building stock model, and with data and expert advice contribution from Michael Ambrose (CSIRO).

The project is supported by an Expert Advisory Group (EAG) that provides inputs and feedback into research methodologies, data collection, and findings. Current members of the EAG include representatives from the following organisations:

+ Industry and sector peak bodies and associations: Australian Sustainable Built Environment Council, Community Housing Industry Association, Energy Efficiency Council, Green Building Council of Australia, Property Council of Australia, Royal Institution of Chartered Surveyors
+ Banks: Bank Australia, Commonwealth Bank of Australia, Westpac Bank
+ Not-for-profit organisations and research organisations: Better Renting, Brotherhood of St Laurence, Climate-KIC Australia, Climate Council, Energy Consumers Australia, Merri-bek City Council, Renew, Resilient Building Council, Victorian Council of Social Service.

The project has also been informed by discussions with representatives from the NSW OECC, NSW DPE, VIC DEECA and Commonwealth DCCEEW departments.

The project is funded by philanthropic sources.

This project update focuses on updates regarding the two first knowledge assets.

Asset 1: Defining zero carbon homes

What we did

A literature review was undertaken to examine existing definitions for zero carbon buildings. A range of academic and grey literature was reviewed. This information was then collated and qualitatively examined to uncover key themes across the literature.

The Renovation Pathways EAG were then invited to a workshop to provide their insight and expertise on a zero carbon home definition. During the workshop, existing definitions were presented to the EAG for review and we collated feedback from experts on the key elements of the definition.

Information from the literature review and workshop were reviewed to determine the key elements of a zero carbon building. Based on this, Climateworks developed a detailed definition of a zero carbon building.

Note: This definition is primarily intended to inform standards for new built homes and major renovations. It was also used to inform modelling work under Asset 2 (see next section) – although our analysis of energy performance upgrades in Asset 2 focuses on operational emissions.

Defining zero carbon homes

Zero carbon buildings produce no net emissions over their entire lifecycle. To achieve this, all decisions made at each design phase reduce energy demand and carbon emissions. There is no single solution. Zero carbon homes are the product of many choices based on local climate conditions.

A zero carbon building has all of the below:

+ **Planning and design decisions** for new buildings, future maintenance and renovations maximise a building's longevity and long-term safety for occupants including prioritising resilience (i.e. ability to withstand or quickly recover from power outages and extreme weather events such as prolonged heatwaves, bushfire, cyclones, droughts, floods) **AND**
+ **Form** (i.e. building's orientation to the sun, overall shape, and arrangement of internal rooms) designed to suit local climate temperatures and harness renewable energy, sized to be an efficient use of space and materials, and can be maintained safely **AND**
+ **Thermal shell** (i.e. external walls, ground floor and roof) designed, constructed and upgraded using a fabric-first approach to reduce the amount of energy needed to heat, cool and operate the home and therefore to reduce the size of appliances to maintain safe indoor temperatures and air quality **AND**
+ **Materials** (i.e. all components used in a building plus its external spaces and structures on site) have low overall embodied energy and carbon emissions (i.e. the energy used and emissions released to produce or dispose of building materials, and construct upgrade, or demolish a building, calculated over their lifecycle, or are reclaimed materials, and are durable **AND**
+ **Electrified appliances and services** (i.e. fixed appliances) which are:
    - fully powered by renewable energy generated/stored on-site or purchased from a renewable energy source, and
    - optimised for a renewable energy grid (i.e. minimise energy demand and operable at times of peak solar generation) **AND**
+ **Operation** (i.e. control of building's features and fixed appliances) is simple and user-friendly on a day-to-day basis and for maintenance or repair by occupants or tradespeople.

Asset 2: Cost-benefit analysis of energy performance upgrades

What we are doing

STEP 1. Identify data from real homes to use as a starting point

With research partners, Climateworks identified CSIRO's managed Australian Housing Data (AHD) portal as the best possible dataset, as it contains energy efficiency data from NatHERS assessments of 1.2 million homes from 2016 onwards. It is the largest available dataset containing real energy data from real homes.

This dataset includes data on:

- energy consumption
- construction technologies and techniques
- materials used including glazing and insulation specifications
- other features relevant to energy performance, such as floor area.

The housing sample is from 2016–2022, but homes have been regressed to simulate the energy performance at the pre-energy efficiency standards level (i.e. pre-2003). Thus modelling simulates the energy performance of a much larger share of the total stock.

The dataset includes identification of data relevant for most of the 69 NatHERS climate zones and all of the 8 NCC climate zones across Australia. Data from several sources – including the Australian Bureau of Statistics, industry reports, and energy data – was incorporated to undertake the cost-benefit analysis.

STEP 2. Identify types of homes representative from Australia's building stock

To inform decision-makers and consumers in a variety of contexts (various home types and climate zones) the analysis needs to be both comprehensive and granular. Thus, we identified the smallest number of meaningfully-different types of homes that are representative of Australia's building stock.

The economics of energy performance upgrades vary depending on the main characteristics of the home (external walls, floor type and roof type) and on the climate zone. So, we defined representative types of homes (or archetypes) as combinations of construction technologies for the main building elements that influence the energy performance of a home:

- external walls
- floors
- roof type.

For each of these building elements, we categorised all possible technologies to identify the fewest categories possible that still represent the building stock.

As shown in Table 1, building element types (left column) were therefore grouped into categories (right column) based on how similarly they impact energy performance of the home.

TABLE 1: CATEGORISING BUILDING ELEMENTS BASED ON ENERGY PERFORMANCE.

Building element technology	Categorised in this project as
External Wall	
Brick veneer Clad autoclaved aerated concrete (AAC) Clad fibre cement Clad insulated panel system Clad metal Clad other Clad timber Clad weatherboard Masonry other Masonry single brick Reverse brick veneer Structural insulated panel system	Lightweight (LW)
Concrete block Concrete other Concrete panel Insulated concrete formwork	Concrete (C)
Cavity brick	Cavity brick (CB)
Floors	
Concrete slab on ground Waffle pod	Concrete slab on ground (CSOG)
Autoclaved Aerated Concrete (AAC) Concrete Concrete slab Suspended concrete	Suspended concrete (SC)
Suspended timber	Suspended timber (ST)
Roof	
Concrete	Concrete (C)
Metal Tiles Mixed	Framed (F)

Using the three NCC building classes (houses, townhouses and apartments), we selected the 16 most prevalent combinations of categories, with each combination called an archetype (see Table 2). For example, a house with weatherboard clad walls, suspended timber floors and a metal roof would be categorised as Class 1ai and archetype H2 defined by its lightweight walls, suspended timber floor and framed roof (LW_ST_F) for the purposes of modelling the most cost-effective energy efficiency updates.

This selection of archetypes represents over 80% of the total houses and townhouses building stock, and almost 50% of the total apartment building stock. This means that the cost-benefit analysis we later conduct in the project on these 16 archetypes can inform energy performance upgrades for most of Australia's building stock.

TABLE 2: 16 ARCHETYPES ACROSS THE THREE CLASSES OF HOMES.

Class	Archetype	External wall	Floor	Roof	Combination
House (Class 1ai)	**H1**	LW	CSOG	F	LW_CSOG_F
	H2	LW	ST	F	LW_ST_F
	H3	CB	CSOG	F	CB_CSOG_F
	H4	LW	SC	F	LW_SC_F
	H5	CB	ST	F	CB_ST_F
Townhouse (Class 1aii)	**T1**	LW	CSOG	F	LW_CSOG_F
	T2	LW	ST	F	LW_ST_F
	T3	LW	SC	F	LW_SC_F
	T4	CB	CSOG	F	CB_CSOG_F
	T5	C	CSOG	F	C_CSOG_F
	T6	CB	ST	F	CB_ST_F
Apartment (Class 2)	**A1**	LW	SC	F	LW_SC_F
	A2	LW	CSOG	F	LW_CSOG_F
	A3	LW	SC	C	LW_SC_C
	A4	C	SC	F	C_SC_F
	A5	C	SC	C	C_SC_C

STEP 3. Identify energy performance upgrades and determine upgrade levels

As discussed in the introduction, this project takes a holistic view of energy performance upgrades, including:

+ thermal shell upgrades
+ whole-of-home upgrades, specifically switching to efficient and electrified appliances for space conditioning, hot water and cooking.

It also looks at solar PV installed capacity necessary to get the home to a net zero level (on-site PV capacity being used to offset remaining energy consumption).

Note: This modelling focuses on operational emissions and does not include embodied emissions.

The energy performance upgrade measures are detailed below.

THERMAL SHELL UPGRADES

Thermal shell upgrades focus on energy efficiency upgrades to the thermal shell of the home.

Insulation

Material to reduce the transfer of heat through a building, applied to the roof/ceiling, walls and floor

Curtains

Internal window hangings – this analysis uses 'heavy drapes'

Infiltration

Unintended air flowing from outdoors into the building, through doors or cracks in a building

Window system

Windows with an additional layer of glass insulation or double-glazed windows

Window shade

External window coverings – this analysis uses 'roller shutters'

Heat recovery ventilation

System to allow air into a building without letting the cooler air from outside decrease the indoor temperature

A 'Base' case was designed to simulate a typical pre-energy-efficiency regulation dwelling (2003 or earlier), and then three levels of thermal shell upgrades were analysed, based on CSIRO's initial dataset. The levels were set according to earlier research conducted as part of Race 2030 program (Rajagopalan et.al, 2022).

TABLE 3: IMPROVEMENTS ACROSS FOUR LEVELS OF ENERGY PERFORMANCE UPGRADES

Upgrade level	Items improved	Improvements
Base	Insulation	Ceiling R0.25
	Infiltration	1.0 ACH
Rehab ***Basic***	Insulation	Ceiling R3.0
	Infiltration	0.5 ACH
	Curtain	Heavy drapes
	Window shade	Roller shutters
Refurb ***Intermediate***	Insulation	Ceiling R3.0, Floor R2.0
	Infiltration	0.5 ACH
	Curtain	Heavy drapes
	Window shade	Roller shutters
	Window system	Additional layer of glass or film
Renov ***Advanced***	Insulation	Roof/Ceiling R3.0, Floor R2.0, Wall R2.0
	Infiltration	0.2 ACH
	Curtain	Heavy drapes
	Window shade	Roller shutters
	Window system	Energy efficient double glazing
	Heat recovery ventilation	0.4 ACH, 85% heat recovery efficiency

Note: R-value: used to determine how well insulation material resists heat flow (i.e. the higher the R-value, the better); ACH: Air changes per hour, which indicates the rate of unintentional flow of outdoor air into a building (i.e. lower infiltration rate reduces energy consumption).

WHOLE-OF-HOME UPGRADE

Whole-of-home (WOH) refers to upgrading appliances considered fixed (e.g. heating and cooling equipment, hot water heaters and lighting) and also adding on-site renewable energy generating systems, such as rooftop solar panels. Analysis was conducted to examine the incremental costs and benefits of several WOH upgrades, in addition to the thermal shell upgrades. These were:

- Electrification of domestic hot water – from natural gas hot water technology (Base) to heat pump hot water units (applied in all other upgrade levels)
- Electrification of cooktops – from gas cooking hobs (Base) to electric induction hobs (applied in all other upgrade levels).

+ Upgrade and electrification of space conditioning equipment.
+ Installation of photovoltaic (PV) systems. The total electricity consumption for each archetype in each climate zone was determined from previous research. From this, we estimated the capacity of rooftop PV needed to offset this consumption over a typical year – that is, for each archetype to reach net zero emissions.

STEP 4. Cost-benefit analysis of energy performance upgrades

For each energy performance upgrade level, on each archetype, in all climate zones, we calculated several economic and energy indicators and different levels. They are detailed below.

ECONOMIC INDICATORS

+ Benefit cost ratio (BCR) and net present value (NPV) of the upgrade. Calculated at
  - Household/private level, including future energy bill reductions, greater comfort conditions, reduced noise, improved health outcomes and higher home values
  - Societal level, including annual grid consumption, greenhouse gas emissions, network infrastructure needs
+ Estimated annual energy bills and energy bill savings
+ Private payback period and annualised net savings (energy bill cost savings *minus* additional mortgage cost including interest)

ENERGY INDICATORS

+ Capacity, consumption, cost and savings (expressed in GJ and dollars)
+ Reduction in peak electrical demand
+ Solar PV capacity and costs

CARBON INDICATOR

+ Annual greenhouse gas (GHG) emissions

At this stage of the project, these metrics have been calculated for each single archetype, but not for the total aggregate stock of archetypes. In the next stage of the project, we will build up this analysis at building stock level to produce 'whole of economy' analysis.

KEY ANALYSIS LIMITATIONS

At the time of this project update, the early quantitative results of the data modelling are undergoing review and quality assurance. Any findings presented to date are therefore preliminary and subject to change.

The preliminary findings in this early stage of the project are based on average performance of specific archetypes in specific locations for specific upgrade scenarios. These unweighted averages do not capture the nuances associated with the prevalence of a specific archetype in a given state or across Australia. They can also mask outlier results and non-existent data. The next stage of the project, in which we will develop a building stock model to capture the actual composition of the building stock more accurately and allow for weighted averages, will better account for this nuance. This will also provide further information to characterise the evolution of Australia's housing stock over a much longer period of time and in the future.

Preliminary high-level findings of cost-benefit analysis of energy performance upgrades

Preliminary results show that a large portion of existing homes in Australia can be renovated cost effectively to net zero through a combination of thermal shell, appliance and electrification upgrades, complemented by solar energy. Looking at the 16 main home types in Australia, early findings suggest that the most-common types of houses – making up approximately two-thirds of all houses – have the biggest savings.

Energy consumption savings per dwelling average between 55% and 65% when analysing whole-of-home efficiency improvements and electrification. The reduction in peak electricity demand that results from thermal shell upgrades and efficient appliances significantly reduces electricity infrastructure investment costs – this is a key consideration in the transition out of gas.

At the household level, the average up-front cost of upgrades – including the cost of the upgrades (generally between $15,000 and $40,000) and the cost of financing (via a standard residential mortgage) – is generally less than the annual energy bill savings. This means the average home is better off, even from the first year of the upgrade. The average home would save more in energy bills than the additional mortgage cost, leading to a net saving.

The societal benefit cost ratio is consistently and significantly higher than the household benefit cost ratio. This is because these renovations bring societal level benefits beyond each household, such as reducing electricity peak demand supply and network investment costs and avoiding carbon emissions. The analysis does not factor in savings resulting from improved health and resilience to extreme weather events - these would only make the upgrades more cost-effective.

Next steps and timeline

The Climateworks team and its research partners are working to refine and finalise quality assurance of the quantitative findings associated with this research, prior to publication. We expect to complete this process by the end of May.

In the next stage of the project, we will be building up these results at the building stock level, with a view to quantify the potential costs, savings, energy savings (including reduction in peak electricity demand) and avoided emissions at whole-of-economy level and at state and territory level.

In addition, the Climateworks team has issued policy recommendations as part of its submission to the National Energy Performance Strategy consultation.

If you have any questions about this project or to contribute any data, please contact:

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