ENVIRONMENT DESIGN GUIDE

RESIDENTIAL RETROFITTING: CURRENT PRACTICE AND EMERGING DIRECTIONS – SUMMARY OF A BEIIC REPORT

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This paper provides a summary of the 'Retrofitting Residential Housing and Precincts: Current Practice, New Strategies and Training Responses' report, which was prepared by UNSW Global Pty Ltd for the Commonwealth Department of Innovation, Industry, Science and Research (DIISR). The report was prepared with the guidance of the Built Environment Industry Innovation Council (BEIIC) and aimed to address two main research gaps: First, to identify current practice and new strategies for retrofitting residential housing and precincts in the context of climate change mitigation; Second, to provide a critical review of current upskilling and training programs for the 'green collar' construction workforce.

Keywords:
residential renovations, retrofitting, energy efficiency, water efficiency, climate change mitigation

Australia's housing stock is ripe for a sustainable retrofit.

Source: iStockphoto

1.0 INTRODUCTION

Each year, thousands of residential buildings get retrofitted in Australia. In the context of climate change mitigation, retrofitting represents an opportunity to implement practices that minimise the greenhouse gas contributions of the nation's residential housing sector. This paper provides a summary of the Built Environment Industry Innovation Council's (BEIIC) report *Retrofitting Residential Housing and Precincts: Current Practice, New Strategies and Training Responses* (Prasad, Teo and Dave 2009). The report reviewed the national residential retrofitting market by mapping out current practice and emerging strategies employed in the context of climate change mitigation. This paper identifies various drivers that influence residential retrofitting in Australia. It also provides a general guideline for the selection of various retrofitting measures for a range of budgets, and presents a discussion on various emerging strategies and future directions in residential retrofitting.

Part A of the BEIIC report identifies current practice and innovative strategies used in the residential retrofitting market across the country today. The study sets out to prepare an information resource in the form of a wide-ranging summary and a practical cost guide that can aid individual home-owners, industry groups and precinct managers to identify the available opportunities in residential retrofitting as relevant to their specific situations and requirements.

This paper presents a summary of this research in four parts:

1. An overview of the research project, defining the parameters of its investigation and research method used to address the research objectives
2. Identification of and discussion about a series of regulatory and non-regulatory drivers for retrofitting residential housing and precincts
3. An overview of the common retrofitting measures employed, along with a general guideline for selecting various measures for a range of budgets
4. A discussion about the current and future direction of residential retrofitting at both an individual residence and precinct level.

2.0 RESEARCH APPROACH

2.1 Data Collection and Analysis

The BEIIC project was largely conducted as a desktop study of publicly available information and other relevant documents obtained from both government bodies and private organisations. The research commenced with a comprehensive review of existing literature in the field. A large number of building and construction industry bodies, individual practitioners and tradespeople were then consulted to obtain relevant information and specific data to meet the output requirements. Extensive industry consultation and involvement was sought on an ongoing basis to ensure the report reflected current industry practices. The data was then analysed to produce the findings contained in this paper.

2.2 Limitations and Assumptions

Part A of the BEIIC report was limited to an independent review of current retrofit practices in different parts of the country. A number of exclusions and assumptions were required to be made to create a reasonable list of actions to reflect current state of retrofitting practice at the national level. The study relied upon limited regional sources of information due to the lack of sufficient, current and consistent information at the national level. The report sets out to identify and outline strategies and opportunities, within four different budget levels, to make homes more sustainable. By consolidating information on the diverse and overlapping retrofitting schemes and initiatives into an accessible and meaningful resource, the report aims to provide a foundation for future research initiatives on this topic.

2.3 Retrofitting Residential Buildings

Approximately 1.5 million new dwellings were constructed between 1994/95 and 2003/04 (an average of 146,000 per year), which represents less than 20 per cent of the total number of households in 2003/04 (Horne et al. 2008). Only a small portion of the eight million dwellings that make up the current residential building stock was subject to energy-efficiency regulations at the time of its creation. A large portion of the rest of the building stock remains unadapted for climate change and therefore offers a huge potential for greenhouse gas abatement. There is an urgent need to identify the environmental opportunities that remain within this existing stock through a review of current retrofitting practices and emerging strategies.

The building sector in Australia is responsible for around 19 per cent of the country's total energy consumption and 23 per cent of the total greenhouse gas emissions (GHG) (ASBEC 2008). With a 'business as usual' approach Australia's total GHG emission is expected to continue to increase rapidly and reach an estimated 915 million tonnes by 2050 in the absence of any additional emission reduction measures (CIE 2007). The Australian Business Roundtable on Climate Change (BRCC) suggests that with early action a 60 per cent reduction from 2000 levels in GHG emissions by 2050 is achievable without compromising strong economic growth (BRCC 2006). The building sector as a whole could reduce 30 to 35 per cent of total emissions with the help of currently available technologies (CIE 2007).

Residential buildings account for around 13 per cent of the total GHG emissions (CIE 2007) with each household contributing around 14 tonnes of carbon emissions each year (DEWHA 2008a). A stock modelling study published by the Department of Environment, Water, Heritage and the Arts (DEWHA 2008b) forecast that between 1990 and 2020 the total number of residential buildings will increase from six million to around 10 million, which is an increase of 61 per cent. The total increase in residential sector energy consumption for the same period is expected to be around 56 per cent.

Wide ranging change activities occur to existing buildings throughout their lifetime. Terms such as renovation, refurbishment, alterations and additions, extension etc. are generally used for changes at relatively larger scales with a focus usually on increasing the capacity or quality of the building. Repair and retrofitting generally refers to relatively smaller scale non-structural work with an objective of fixing specific problems or increasing the efficiency or performance of the building with minimal alterations to the overall bulk, scale and form of the building.

It is estimated that the number of houses that go through major renovation is even greater than the number for new homes that are being built each year (Pears 2007). The estimate for renovations is very uncertain because such work is not well documented and the data are very poor. However it gives a reasonable indication that strategies for residential retrofitting, whether as a part of the already expected renovation or as a separate upgrading activity, offer a significant potential for increasing the efficiency of existing buildings.

Numerous national and international studies such as the Productivity Commission's report *The Private Cost Effectiveness of Improving Energy Efficiency* (2005),

McKinsey and Company's *An Australian Cost Curve for Greenhouse Gas Reduction* (2008) and Boardman et al.'s *40% House* (2005), to name a few, have identified energy efficiency in residential buildings and especially household retrofitting as one of the most vital and cost effective approaches to climate change mitigation. In Australia there is an urgent need to identify the environmental opportunities available within this existing residential building stock.

3.0 DRIVERS

There are multiple drivers that propel and steer the process of retrofitting focused at climate change mitigation; in most cases either through policy tools and regulatory requirements, by the generation and dissemination of information, by increasing general awareness, and by providing required training and certification services.

3.1 Policy and Regulatory Initiatives

Historically, most policies and initiatives relating to the built environment and the climate change have considered reduction in greenhouse gas (GHG) emissions and water and energy demand as the main areas of priority. The report *Possible Design for a National Greenhouse Gas Emissions Trading Scheme: Final Framework Report on Scheme Design* by the National Emissions Trading Taskforce (2007) has identified various Commonwealth and State government policies and initiatives that are already in place. Today there are more than 40 national and state level initiatives that have direct or indirect influence on residential retrofitting for energy and water efficiency.

The Building Code of Australia (BCA) mandates building regulations for all states and territories and provides minimum energy requirements for new buildings and major refurbishments. In 1990, newly built houses had an average rating of 1 star on the NatHERS (DEWHA 2010) scale. By 2003, less than one per cent of Australian houses achieved 5 stars with the introduction of the national energy efficiency regulations for houses. Since then the stringency of energy efficiency provisions have been progressively increased and scope of the provisions has been widened. The BCA 2010 now requires a 6-star energy rating, or equivalent, to be implemented by May 2011 for all new Class-1a and Class-2 buildings. Tighter energy efficiency standards for lighting and hot-water systems have also been introduced for the first time. Each State and Territory has slightly different regulations about when these changes will apply. In New South Wales, new residential buildings are required to comply with the Building Sustainability Index (BASIX) and achieve up to 40 per cent reduction in both energy and water use as well as meet minimum thermal performance requirements.

At the state level there are different energy efficiency requirements for existing homes in different states. South Australia and Victoria require all existing homes that undergo major renovation or extension and require a building permit from council or a private certifier to achieve a 5-star energy rating. In Victoria, building extensions are required to comply with these standards depending on the size of the floor area of extension. Renovation work that represent more than 50 per cent of original building volume need the entire building to comply with the 5-star energy efficiency requirement. BASIX in New South Wales applies to major building renovations where the renovation cost is $50,000 or more, or includes a new swimming pool of 40,000 litres or more. While many of the measures required by these State regulations are voluntarily employed as retrofitting measures, the regulations only apply to major renovations or alterations and additions. Hence, they do not trigger the retrofitting activity in itself. On the other hand, most of the retrofitting measures can be undertaken under exempt development without requiring building permits and therefore do not need to comply with State based regulatory requirements.

There are other State-level initiatives that are able to achieve broad based participation from both commercial and residential sectors and influence large-scale residential retrofitting activity. The Greenhouse Gas Abatement Scheme (GGAS) is a white certificate scheme that has been operating in New South Wales since 2003. White certificates certify reductions in energy use. The scheme requires energy retailers to reduce energy consumption by either:

- Improving their own energy efficiency by facilitating demand-side abatement
- Generating electricity in a way that reduces GHG emission
- Capturing carbon from the atmosphere with forests
- Or by purchasing certificates, in this case NSW Greenhouse Abatement Certificates (NGACs), from other energy retailers in the scheme.

The residential retrofitting market in New South Wales observed a lot of activity influenced by GGAS (IPART 2008). One of the examples of a large-scale retrofit driven by GGAS is Sydney Water's WaterFix program which, in just one year, saved 9747 million litres of water by retrofitting more than 35,000 residential homes and more than 3000 Department of Housing homes with water-saving devices and distributed over 60,000 Do-It-Yourself Water Saving Kits (Sydney Water 2008).

The energy-efficiency component of GGAS was transferred to a new scheme in June 2009, the Energy Savings Scheme (ESS) formerly known as NSW Energy Efficiency Trading Scheme (NEET). The retrofitting measures approved under ESS include retrofitting and upgrades of showerheads, floor and wall insulation, downlights, fridges/freezers, washing machines, clothes dryers and dishwashers (NSW Government 2009).

The Victorian Energy Efficiency Target Scheme (VEET) is a white certificate scheme that commenced in January 2009. This scheme sets targets for energy savings in the residential sector, and requires energy retailers to meet their own targets through energy-

efficiency activities such as draught-proofing, retrofitting and upgrading the efficiency of light bulbs, showerheads, ceiling and floor insulation, hot-water systems, heating systems, and upgrade of windows (DPI 2008).

The Residential Energy Efficiency Scheme (REES) commenced in South Australia in January 2009. REES is not a trading scheme but sets mandatory minimum energy-efficiency targets for energy retailers operating in South Australia. The energy retailers are required to deliver energy audits and energy-efficiency improvement measures to low-income households. As noted in the Residential Energy Efficiency Scheme (REES) *Energy Efficiency Activities* (2008) report, the measures include draught-proofing, retrofitting and upgrading the efficiency of light bulbs, showerheads, ceiling insulation, fridge/freezer, hot-water systems, and heating and cooling systems.

The result of the GGAS suggests that these State-based schemes are likely to provide a very positive stimulus to the residential retrofitting market.

3.2 Non-Regulatory Initiatives

There are numerous governmental and non-governmental voluntary initiatives that influence residential retrofitting at multiple levels. The Commonwealth Government introduced a Green Loans program in July 2009, which offered free Household Sustainability Assessments (HSAs) to 360,000 homes with interest-free loans of up to $10,000. In March 2010, overwhelming demand for HSAs forced the government to discontinue the loans component; in July, as a result of administrative problems and highly critical independent reports, the government discontinued the remainder of the program.

Green Loans is to be replaced with Green Start, a new $130 million Commonwealth initiative expected to commence in early 2011. The government also replaced the Home Insulation Program and Solar Hot Water Rebate with a new household Renewable Energy Bonus Scheme. The new scheme offers $1000 rebates for solar hot water systems and $600 rebates for heat pump systems. This programme is aimed at providing low-income and disadvantaged households with free home energy and water assessments, free supply and installation of energy and water-efficiency products, personalised help to access government rebates and programs, and advocacy and support to deal with landlords, real estate agencies and tradespeople to implement energy and water efficiency measures.

Commonwealth and State Government joint initiatives such as the Equipment Energy Efficiency Program (E3), the Energy Star program, the Water Efficiency Labelling and Standards (WELS) scheme, the Smart Approved WaterMark and the Windows Energy Rating Scheme (WERS) provide nationally consistent frameworks and standards for minimum energy and water efficiency for various appliances, equipment and window assemblies. There are industry groups and organisations that either voluntarily or in partnership with government bodies provide information, training and accreditation services. These include the Association of Building Sustainability Assessors (ABSA), the Building Designers Association of Australia (BDAA), the Australian Council of Building Design Professions (BDP), the Housing Industry Association's (HIA) GreenSmart program, and the Master Builders Australia's (MBA) Greenliving Training Course. There are also State Government organisations such as Sustainability Victoria's Resource Smart and the ACT's Home Energy Advice Team (HEAT), and national environmental organisations such as the Australian Conservation Foundation (ACF) and the Alternative Technology Association (ATA) that are active in providing advice and information to households to increase resource awareness and responsiveness towards environmental issues. Finally there are numerous other initiatives and programs delivered by over 230 councils representing 84 per cent of Australia's population as part of the Cities for Climate Protection (CCP) initiative.

4.0 CURRENT PRACTICE

According to the Department of Environment, Water, Heritage and the Arts' 2008 Baseline Energy Estimates (DEWHA 2008a), hot-water systems, space heating and cooling systems and household appliances together consume almost 79 per cent of the total household energy and produce 67 per cent of their GHG emissions. This means that these three things should be considered as the priority areas for retrofitting measures.

There is a lot of information available on low-cost and no-cost measures that a household could take up in order to maximise energy and water efficiency and minimise GHG emissions. However in most instances, the information resources that are publicly available are specific to a region or climate and focus on a particular area of retrofitting. The provenance, independence and verification of claims or predicted benefits also vary.

See Appendix A for a summary of various current and new retrofitting measures. Not all the measures will be relevant or appropriate for each situation. It is therefore suggested that this compilation be considered as a general guideline, and further investigation be undertaken by studying provided references or by consulting relevant government or industry bodies to gain climate and situation-specific understanding.

4.1 A practical cost guide

It is important to recognize that many retrofitting measures do not perform separately but in fact act in combination with each other. In particular, the measures that affect thermal performance of the building may have a different level of effectiveness than their singular predicted performance when they are employed in combination with other measures. For example, double glazing of windows may offer more thermal improvement once draught proofing and insulation have been applied to a house than when it is

Figure 1 – Building-integrated photovoltaic application in Kogarah, NSW

Source: Kogarah City Council

employed without consideration to any other measures. Similarly it would be a quite an inefficient approach to install a photovoltaic system to supply additional electricity without employing energy consumption reduction measures first. This means that the sequence of upgrade should be taken into consideration while selecting measures to improve overall energy and water efficiency.

Residential retrofitting situations vary, so not all measures listed would be relevant or appropriate for each situation and budget. A practical cost guide, as presented in Appendix B, is intended to give an indication of the priorities and general sequence of retrofitting that would provide maximum environmental benefits at minimum cost. The cost guide was prepared with consideration of the then-applicable ceiling insulation rebates which were discontinued by the Commonwealth Government in February 2010.

5.0 EMERGING DIRECTIONS

In addition to the measures listed in Appendix A, there are also emerging techniques and technologies which may become more widespread in dealing with climate change adaptation and mitigation issues. Some of these are already in the market place, such as Building Integrated Photovoltaic (BiPV) systems (Figure 1).

There are emerging practices which demonstrate high level integration of technology and design both at individual and precinct level. A range of initiatives can be made to act together to address multiple issues at once. With increasing knowledge of zero energy (zero net energy or zero operation energy) developments there is a growing body of literature on how to achieve this. Design and technological innovations such as BiPV and cogeneration (see below) are increasingly being employed in mixed-use and residential precincts to achieve such performance.

To encourage the development and uptake of these techniques and technologies, it is critical that government get the policy settings right. ACT, NSW and NT now offer gross feed-in tariffs for small-scale energy producers, while Victoria, Queensland, South Australia and Western Australia offer net tariffs. There is an argument for a nationally consistent gross feed-in tariff, which could significantly reduce the pay-back period for such systems and hence stimulate the market for distributed electricity generation.

Distributed generation technologies such as Combined Heat and Power (CHP) or cogeneration (Figure 2) or even trigeneration can achieve up to 85 per cent overall energy conversion efficiency of suitable fuels compared to around 30 per cent for the conventional grids and coal-fired power stations (CFCL 2009). Woking Town Centre in UK (Woking Borough Council 2007) and The Vision Estate Glenfield in Australia (Integral Energy 2007) are two examples that use cogeneration and trigeneration for their electricity, heating and cooling requirements. Although these technologies are getting increasingly popular at large-scale developments due to their high efficiency in energy supply, the systems are expensive and have required policy intervention to make them more affordable. The UK and a few other European countries have successfully driven greater uptake of these technologies thorough policy initiatives (BERR 2008). There are highly efficient fuel cell technologies also under

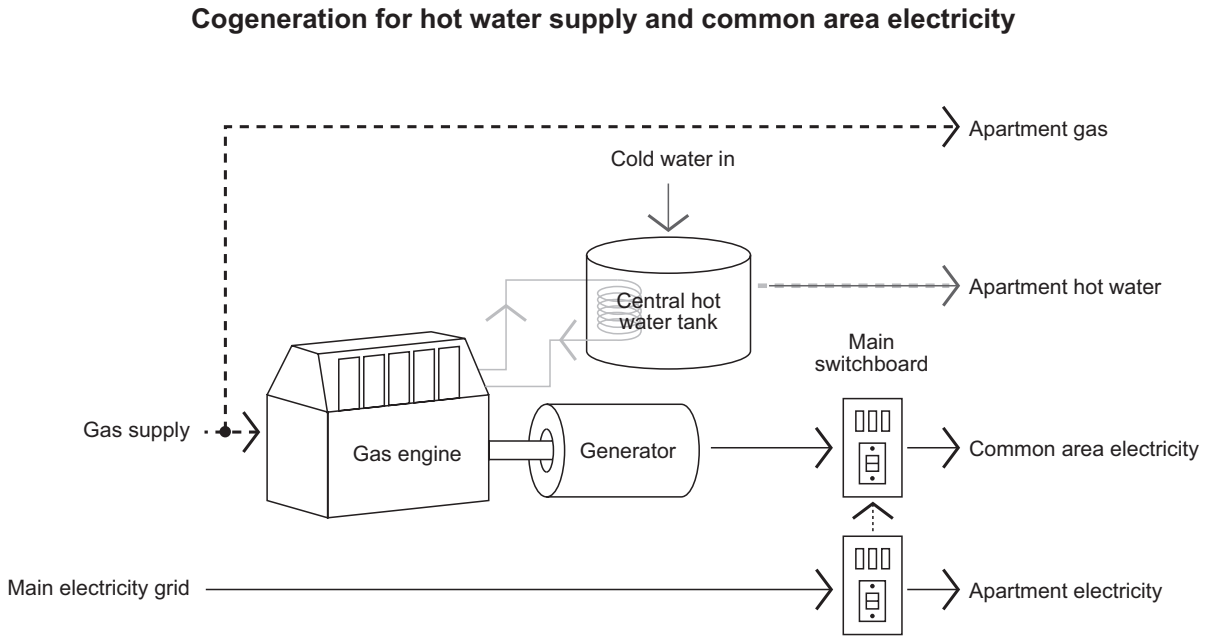

Figure 2 – Cogeneration system diagram

Source: NSW Department of Planning 2008

development for production of small, barfridge sized micro-generation units for domestic scale applications. Commercial availability of this technology in Australia is still believed to be three to four years away. Future large-scale production and commercial availability will bring their costs down and would provide great opportunities for high energy efficiency technologies to get retrofitted in Australian houses.

When comparing predicted performance with actual performance there are number of behavioural issues which can cause variations. There are also construction-related issues which, because of the nature of building construction, are concealed from normal inspections. There are advanced diagnostic techniques such as the blower door for infiltration tests (how leaky is your building?) and thermal cameras which identify thermal bridging or leak points such as gaps in insulation or torn reflective insulation, which can cause significant heat leakage (Figure 3). In countries with colder climates, such as North America and Europe, diagnostics tools such as infrared cameras are readily available. However in Australian buildings this is a much more recent methodology for understanding inefficiencies of the building envelope. There is a need for post-occupancy certification for building construction as well as retrofits to identify such problems or inconsistency between predicted and actual thermal performance of the buildings. With national level mandatory disclosure of energy efficiency for residential buildings to be phased in from May 2011, it is very likely that such post-occupancy assessment and certification of residential buildings will receive further attention.

Another emerging area is precinct-scale retrofitting. Retrofitting at a larger precinct scale (i.e. above the building level scale) has generally been a neglected area in both research and practice. There is a lack of documented information on such developments in Australia. Because of the economies of scale, retrofitting at precinct, urban block or city level, can offer more effective ways of providing social and environmental infrastructure while addressing issues and technologies that may be otherwise more difficult to address at a smaller level. There are examples of new mixed-use precinct developments in inner-city areas, both in Australia and elsewhere, that have shown ways of successfully addressing issues of waste, water management, distributed energy generation, bio-diversity improvement, urban farming as well as density and transport – to list a few. The potential for adapting such technologies and design innovations in retrofitting suburban Australia needs further research and development.

The Melbourne City Council's Sustainable Living in the City project is a noteworthy initiative that aims to raise environmental awareness and reduce the everyday environmental impact of high-rise residential living by retrofitting selected residential precincts to reduce water and energy use and improve waste management. Such projects, though scarce today, are likely to become a mainstream approach to large-scale sustainability initiatives. The Solar Cities program, in each of the seven Solar Cities – Adelaide, Townsville, Blacktown, Alice Springs, Central Victoria, Moreland and Perth – aims to demonstrate how solar power, smart meters, energy efficiency and new approaches to electricity pricing can combine to provide a sustainable energy future in urban locations through Australia. The program will provide a wide range of valuable information that will inform future energy efficiency policies.

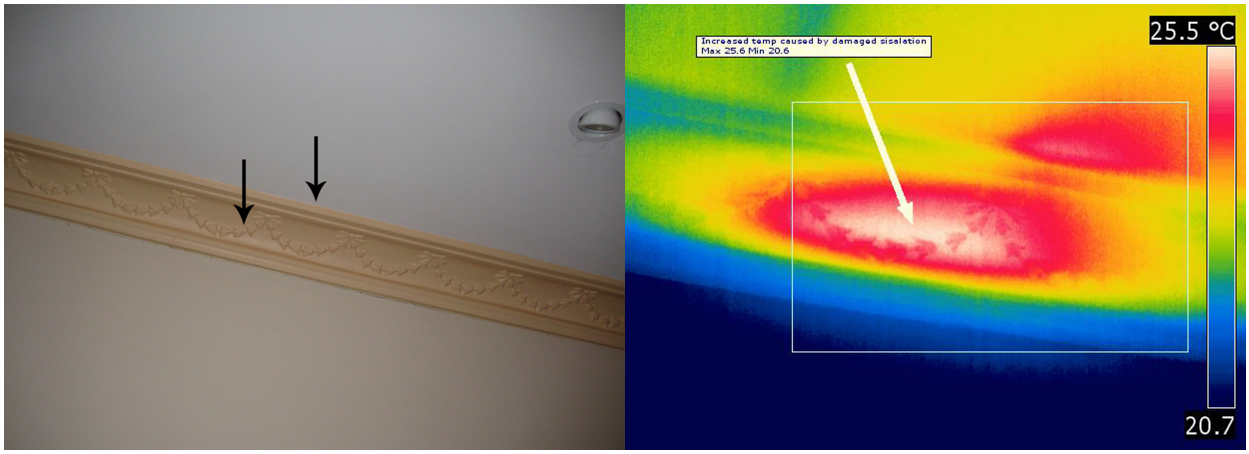

Figure 3 – Infrared camera locating a hidden leak behind a cornice

Source: Krishna Munsami

6.0 CONCLUSION

Retrofitting residential homes and precincts has the potential to make a significant contribution to reducing energy and water use and resultant GHG emissions, making Australian homes more environmentally sustainable. However retrofitting for energy and water efficiency is therefore only a part of the picture. Operational GHG emissions are a result of the GHG intensity of household energy and water, the efficiency of energy use in the household, and the demand for different energy services., and if the consumption of energy services continues to rise in households then energy efficiency gains from retrofitting will be offset.

The study has identified continued government and household support for efforts to improve homes and address GHG emissions. There are diverse and overlapping numbers of retrofit schemes that make it difficult for the public to successfully navigate the information and make informed and robust decisions. There is a need to consolidate initiatives into an accessible and meaningful resource which also accounts for changing standards and demand for energy services. Initiatives such as a new Living Greener website (www.livinggreener.gov.au) may assist in this regard.

There remains a lack of sufficient and current information on climate-specific retrofitting strategies, their costs and environmental benefits, to address larger issues of sustainability beyond energy and water. There is also a need to conduct a study of adaptation strategies for existing housing and precincts to improve resilience to the impacts of the changing climate, and to capture current and future local and international policy and regulatory initiatives.

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APPENDIX A – SUMMARY OF CURRENT AND NEW RETROFITTING MEASURES

A.1 Energy Efficiency and Thermal Comfort

- **Draught Proofing:** Seal the gaps and cracks around the doors, windows, skirtings, mouldings, cornices; install weather-strips to doors and windows; and remove vented downlights and permanent ceiling and wall vents. Install self-sealing casing to the existing ceiling exhaust fans.
- **Thermal Insulation:** Insulate the external envelope of a house by insulating the roof, ceiling, external walls and floors.
- **Glazing:** Replace existing standard single glazing (glass doors, windows, skylights or glass roofs) with new thermally better-performing glazing assemblies. Alternatively employ less expensive retrofit measure by adding one more layer of glass or removable clear polycarbonate or even thin film plastic membrane to an existing single glazing. These options offer variable degrees of flexibility in use as well as durability over a period of time. Provide correct external shading and internal covering to improve thermal performance of the existing glazing.
- **Showerhead:** Replace existing standard showerheads with low flow 3-star rated showerheads to reduce the water heating requirement.
- **Light Bulbs and Downlights:** Replace old inefficient light bulbs and downlights with energy-efficient ones. Consider using timers, motion detectors and/or daylight sensors.
- **Space Heating:** Replace existing electrical heating system with gas or solar space-heating system. Choose a system with a higher energy star rating.
- **Space Cooling – Air-Conditioner:** Select an air-conditioning system with the highest possible energy efficiency rating (EER) and coefficient of performance (COP)
- **Space Cooling – Fans:** Use ceiling fans to cool the house instead of an air-conditioner. Use fans to increase the effectiveness of the cooling in air-conditioned spaces.
- **Hot-Water System:** Replace your existing inefficient hot-water system with a more efficient one. Or retrofit an existing electric hot water system with a solar system rather than having to install a whole new system. Insulate hot water pipes and install insulation cover for external electric or gas storage hot water tanks.
- **Whitegoods and Appliances:** Replace old inefficient appliances, such as fridges and freezers, clothes washers, dishwashers and clothes driers, at the end of their life with new ones with a higher energy star rating.
- **Renewable Energy Supply:** Install a photovoltaic system on the roof to generate electricity. Or buy accredited GreenPower.
- **Standby Power:** Switch off appliances at the power point. Install readily available devices to reduce standby power for a group of appliances.
- **General:** Install a pool blanket to the swimming pool; use passive solar strategies such as light colours on walls and roofs, strategic internal thermal mass elements; use external fixed or operable shading elements; use outdoor landscape elements to create suitable micro-climatic condition around the house.

A.2 Water Efficiency

- **Fix Leaks:** Fix leaking taps, showerheads and toilets.
- **Flow Regulators:** Install 3-star rated flow regulators to the water system.
- **Showerhead:** Replace existing standard showerhead with a 3-star rated showerhead.
- **Toilet:** Switch or retrofit to a dual-flush or low-flush toilet. Or install a flush regulator to existing single-flush toilet cistern.
- **Washing Machine:** Replace existing inefficient washing machine at the end of its life with new washing machine with high water-efficiency rating.
- **Rainwater:** Install a rainwater tank for water use around the house.
- **Greywater:** Install a greywater treatment system for water use in the laundry, toilets and garden.
- **Hot water recirculation:** Install a hot water recirculation system to divert cold water in the pipes back to the hot water system or cold water plumbing.
- **Pool Blanket:** Install a pool blanket to the swimming pool.
- **General:** Reduce the area of lawn and replace it with water-wise garden or mulch; use drip irrigation or subsurface irrigation systems in the garden; use rain sensors and tap timers; use rainwater diverter devices to divert rainwater from the downpipes to the garden or to a swimming pool.

APPENDIX B – PRACTICAL COST GUIDE

Optimum Retrofitting Sequence for Maximising Environmental Benefits

Measures for $5000 budget:

- Weather proofing
- Lighting upgrade
- Ceiling insulation
- Fixing leaks
- Low-flow showerheads and flow regulators
- Flush regulator to existing single-flush toilet
- Hot water system upgrade to 5-star gas instantaneous

Measures for $10,000 budget:

- Weather proofing
- Lighting upgrade
- Ceiling insulation
- Fixing leaks
- Low-flow showerheads and flow regulators
- Flush regulator to existing single-flush toilet
- Hot water system upgrade three-panel solar (gas boosted) hot-water system
- Rainwater tank (2000L)
- Pool cover
- Secondary glazing and internal covering to selected windows

Measures for $15,000 budget:

- Weather proofing
- Lighting and downlights upgrade
- Ceiling insulation
- Under-floor insulation
- Fixing leaks
- Low-flow showerheads and flow regulators
- Flush regulator to existing single flush toilet
- Hot water system upgrade three-panel solar (gas boosted) hot-water system
- Rainwater tank (5000L)
- Pool cover
- Secondary glazing to selected windows with internal covering and required external protection
- Fridge and freezer upgrade

Measures for $20,000 budget:

- Weather proofing
- Lighting and downlights upgrade
- Ceiling insulation
- Under floor insulation
- Fixing leaks
- Low-flow showerheads and flow regulators
- Flush regulator to existing single-flush toilet
- Hot water system upgrade three-panel solar (gas boosted) hot-water system
- Rainwater tank (10,000L)
- Pool cover
- Double glazing to selected windows with internal covering and required external protection
- Fridge and freezer upgrade
- Washing machine upgrade
- Solar space heating and cooling
- Photovoltaic system (1 kW)
- Hot water re-circulation system