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Energy efficiency in social housing

Literature and program review

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1. Introduction

This report reflects on the findings of an international literature and program review that focuses specifically on the key factors that shape energy efficiency investments and improvements in outcomes in the social housing sector. Preliminary findings suggest similarities across social housing sectors of different geographical contexts, particularly limited financial support, lack of expert knowledge on technology and housing stock, and lack of policy intervention. This review also considers capacity for and barriers to organisational change in this sector. Additionally, these findings informed the drafting of questions asked in the social housing provider senior management interviews conducted as part of a broader project on energy efficiency investments and improvements in the NSW social housing sector, undertaken collaboratively by UNSW Sydney (Dr Edgar Liu and Emeritus Professor Bruce Judd), the University of Wollongong (Professor Paul Cooper, Professor Pauline McGuirk, Professor Gordon Waitt, Dr Daniel Daly, and Ms Jen Halldorsson), and the CSIRO (Dr John Gardner).

1.1 Project background

The sensitivity of low-income households to energy prices and the barriers they face in accessing energy efficiency technologies are well established in Australia and overseas (Walker & Day 2012; ACOSS 2013; Liu & Judd 2016). To this end, the NSW and federal governments deliver several programs that assist social housing providers (SHPs), particularly community housing providers (CHPs), to improve the energy efficiency of their housing stock.

In New South Wales, CHPs currently have access to two main funding sources:

1. low-cost loans arranged by the Clean Energy Finance Corporation's (CEFC) Community Housing Program for constructing highly efficient new housing, and
2. the NSW Department of Planning Industry and Environment (DPIE formerly Office of Environment and Heritage) Home Energy Action Program (HEAP), which co-invests with CHPs to install energy efficiency upgrades to existing community housing stock.

A recent international study surveying Australian CHP executive officers found that 80% of them considered improvements in the environmental efficiency of their housing stock a priority (Milligan et al. 2015).

Despite this prioritisation and the significant funds that are committed to both programs, recent evidence suggests uptake of both programs has been slow and limited to the larger CHPs (DPIE, pers. comm.). Despite having a broad understanding of the specific barriers present when adopting energy efficient technologies in the rental sector (including split incentives, regulatory and financial barriers (Instone et al. 2013; Hope & Booth 2014), insights into specific barriers and opportunities for upgrades in the community housing sector are less developed or understood (Urmee et al. 2012). With the 2016 Draft Climate Change Fund Strategic Plan recommending HEAP be extended (such as to include public housing), it is pertinent to examine barriers that SHPs face in implementing energy efficiency upgrades.

International evidence highlights the issue of split incentives as a major barrier to energy efficiency in the rental sectors. A split incentive occurs when one party is responsible for capital costs of an investment and another is responsible for operating costs, and the costs for the latter party may decrease as a result of the former's capital investment (Gillingham & Sweeney 2012). Gillingham et al. (2009:16) also noted that split incentives may be explained as a principal–agent problem, where the agent (e.g. developer or landlord) sets the level of energy efficiency of the home and the principal (e.g. tenants) lives with the consequences of the agent's decisions, such as high energy costs in inefficient homes. International evidence suggests that the principal–agent problem may be responsible for significant portions of energy use in rental properties: '66% of water heating energy use, [and] 48% of space heating energy use' (Murtishaw & Sathaye 2006 in Gillingham et al. 2009).

The Australian Council of Social Service (ACOSS; 2013) notes that the type of housing that households on low incomes can afford is typically energy inefficient. Low income households are also often unable to afford energy efficient appliances, and energy rationing has become part of these households' daily lives. Australian and international evidence highlights the detrimental impacts energy unaffordability has on households' health and social wellbeing. For example, Evans et al. (2000) note low-quality housing stock, directly and indirectly, contributes approximately £2 billion to the United Kingdom's annual National Health Service spending. Likewise, Liu and Judd (2018) highlight how energy unaffordability has impacted on renters' ability to afford other essentials such as food and medication as well as significantly impacting their mental health and social wellbeing. Energy unaffordability is an increasingly important issue given persistently rising energy costs across Australia (Chester 2015).

Governments can play a very important role in addressing these detrimental impacts of energy unaffordability. Indeed, as ACOSS (2013) notes, 'there is ample scope […] for Governments to facilitate longer term and significant interventions […], including via targeted retrofits of the worst performing social housing where health, climate and hardship risks are greatest.'

While split incentives in the rental sector are typically a well-known barrier to housing providers (both social and private) implementing energy efficient upgrades, other barriers persist. The introduction of the HEAP in New South Wales and the CEFC's Community Housing Program are important steps, but notable financial and regulatory barriers (among others) remain and have thus far limited a wider range of CHPs from participating in these programs. The limited research available in the Australian context suggests that at least the following factors in addition to split incentives also impact on CHP uptake (Urmee et al. 2012):

- perception of efficiency measures as cost-prohibitive and beyond CHP budgets
- inability to make structural changes to stock not owned by the CHP
- time and human resource limitations
- lack of sectoral understanding of cost-effective improvements
- lack of availability of practical advice and information
- lack of tenant understanding of efficiency upgrades coupled with a high energy demand tenant population
- energy inefficient nature of community housing stock
- inability to monitor tenant energy consumption
- lack of tenant access to efficient appliances
- special needs of tenants as inhibiting capacity for efficiency upgrades.

The second point in particular presents significant barriers to CHPs carrying out efficiency upgrades; of the 31,000 dwellings currently in the NSW community housing sector, only 8000+ are owned by CHPs, with the remaining 22,000+ tenancies managed by CHPs on behalf of the state government or private investors such as through the National Rental Affordability Scheme. The lack of ownership often precludes CHPs from carrying out significant upgrades, and coordination is required between state governments and CHPs to arrange for permissions and funding. This issue is likely to be exacerbated by the NSW community housing sector expansion through successive waves of management transfers from the NSW Government under the NSW Social Housing Management Transfer Program. The management transfer will inject another 18,000 tenancies into the sector on a 20-year lease term. This is in contrast to many previous transfer programs, which typically entailed short (3–5 years) rolling leases against which CHPs were often unable to borrow money. The NSW Government is expanding programs like HEAP to include other forms of social housing. In order to devise the most appropriate models of support, it is essential to assess the barriers these other housing providers (public housing and Aboriginal housing) face, which may or may not differ from those faced by CHPs. Thus, establishing how to optimise deployment of energy efficiency technologies in social housing is a priority and one that can yield promising economic and energy reduction results (Bahaj & James 2006).

The project sets out to provide an evidence base to policymakers to assist in devising policy solutions to overcome the various barriers (such as described above) that prevent different SHPs from taking up assistance programs like HEAP. It involves a mixed methodology approach, comprising:

- an international literature and program review
- 25 interviews with senior management of SHPs of various sizes and locations in New South Wales (approximately 20% of the state's SHPs)
- a housing quality questionnaire
- development of a spot measurement protocol for data collection at 100 dwellings for simulation, and
- a qualitative assessment of improvement outcomes.

1.2 Overview of the Australian social housing sector

The social housing sector in Australia has traditionally been small compared to many European and North American contexts. In a recent reflection on the current profile and future potential of the Australian social housing sector, Milligan et al. (2016: Table 1) highlighted that social tenancies comprised around 8% of all households in 2015. In contrast, affordable, public or social housing is typically widespread and represents the dominant form of rental housing in many other countries (Whitehead & Scanlon 2007). Across the European Union (EU), affordable or public housing comprises 17% of the housing stock, with the proportion in the UK, Sweden and Austria being higher (18%, 20% and 25%, respectively; Chegut et al. 2016). It is also the dominant tenure in Singapore (over 80%; Statistics Singapore 2016) where the public agency, Housing and Development Board, builds and manages long-term public leaseholds.

In Australia, social housing has traditionally been provided by state housing authorities through a mix of Commonwealth and state funding and policies (Troy 2012), with local governments playing a much smaller role in housing provision and tenancy management than many other jurisdictions, such as the UK. Over recent decades there have been criticisms of both Commonwealth and state governments for under-funding public housing, both in terms of the construction of new and the maintenance of existing stock, so that the total number of social housing dwellings in Australia has remained relatively steady (Jacobs et al. 2010). The relatively static volume of social housing is in strong contrast to the continued population increases over the same period (Krockenberger 2015), with most of the increase housed in owner-occupied or privately rented dwellings.

The extended divestment in the Australian social housing sector was coupled with tightening eligibility criteria so that only those with the 'highest needs' – such as those who are (or are at risk of being) homeless and those with additional support needs – can now access social housing. Over time, this has created a residualised social housing sector (Morris 2015), with many housing estates now stigmatised as disadvantaged areas (Arthurson 1998; Jacobs et al. 2011).

In recent years, however, a number of programs and initiatives have been introduced by the Commonwealth and state/territory governments to significantly boost public and private investments in the provision of social housing. These programs have taken the forms of:

- direct investments, such as the National Rental Affordability Scheme (DSS n.d.) and the Social Housing Initiative of the Nation Building Economic Stimulus package (Plibersek 2009)
- transfers of public housing to the community housing sector (Pawson et al. 2016), and
- renewal of public housing estates through public and private financing, such as the NSW Communities Plus program (FACS n.d.) and Victoria's Public Housing Renewal Program (DHHS n.d.).

Through these programs and initiatives, along with developments[1] funded by the social housing sector itself (through internal budgets and external private financing), it is expected the community housing sector will continue to play an increasing role in the provision of subsidised housing in Australia.

Across the states and territories, New South Wales has the largest share of social housing dwellings. In 2016, this totalled 123,267, around 35% of the 354,441 total social housing dwellings in Australia (ABS 2017). Of these, 105,554 were public housing, with the remaining 17,713 being community housing managed by 145 providers. This sector is expected to experience significant changes over the coming years under the latest policy directions of further tenancy transfers, development, and recalibration of services (NSW Government n.d.).

2. Barriers to engagement with energy efficiency programs for CHPs

There has been considerable interest in upgrading the energy efficiency of housing stock as part of many governments' approaches to reducing their carbon output, due to the considerable contribution of housing to a country's carbon emissions. Despite broad acceptance of the benefits of retrofit and the presence of federal and state-level policy and funding, the desired outcome in terms of energy savings has in many cases not been achieved. This phenomenon of lower than optimal energy efficiency technology diffusion is known as the 'energy efficiency gap' (Hirst & Brown 1990; Reames 2016; Kowalska-Pyzalska 2017), and the factors that impede it are referred to as *barriers*. This chapter provides an overview of some of the barriers commonly experienced by SHPs in Australia and elsewhere as reflected in academic and grey literature.

2.1 Common barriers to energy efficiency upgrades

There are many reviews on the issues, challenges and approaches for reducing energy demand (Bukarica & Tomšić 2017; Good et al. 2017; Karakaya et al. 2014; Negro et al. 2012; Nygrén et al. 2015; Sorrell 2015). Kowalska-Pyzalska's excellent recent review provides a comprehensive and broad perspective on the incentives and barriers to the adoption of innovative energy services (IES), i.e. renewable energy technologies, green energy tariffs, demand response, smart metering, enabling technologies such as smart appliances (Kowalska-Pyzalska 2017). The disconnect between peoples' attitudes, beliefs and opinions and their actual actions and behaviours, otherwise known as the 'intention–behaviour gap', may be caused by many factors or barriers which the author notes may include:

> unstable consumers' opinions, lack of knowledge of the green power availability, confusion generated by the complexity of tariffs, lack of guidelines and advice, lack of sufficient supply, a hesitancy to switch from one electricity supplier to another, distrust of energy product suppliers and cost concerns, search cost involved in switching and a free rider problem. (Kowalska-Pyzalska 2017:3577)

[1] As per all new housing construction, all new social housing constructions in Australia need to adhere to sustainability standards set out by the National Housing Energy Rating System (NatHERS). Additional standards may also apply depending on funding conditions.

The adoption barriers that exist for households are broadly understood (Hope & Booth 2014; Instone et al. 2013; Kowalska-Pyzalska 2017), and may generally be categorised as economic, organisational, technological and behavioural (Table 1).

Improving the energy performance of the existing housing stock presents many significant challenges. Retrofit activities are shaped by a wide range of fragmented policies, programs and actors, and typical approaches are insufficient to realise meaningful, widespread changes in energy consumption (Karvonen 2013). Overcoming these barriers is not trivial; however, they must be understood before effective approaches for addressing the issues can be implemented.

Table 1 Economic, organisational, technological and behavioural barriers to adoption

Type of barrier	Features
Economic	• The market fails to operate properly due to: imperfect information, incomplete markets (lack of knowledge, awareness, information) • Imperfect competition and uncertainty • Limited access to capital and hidden cost of negotiating and enforcing contracts (lack of appropriate long-lasting financial and legal support) • Lack of appropriate market structure • Difficulty in the proper pricing of the services • Financial cost (e.g. investment, service and maintenance costs)
Organisational	• Lack of agreement how, e.g. demand response should be measured and remunerated • Political and regulatory barriers • Limited availability (e.g. program unavailability, inaccessibility) • Misconceptions between consumers and energy service designers or suppliers • Lack of supporting social structures • Lack of supply chains, services and conventions
Technological	• Limited supply of energy • Technological ‘lock-in’ • Integration of IES with the power grid • Need for standardisation (also in terms of metering) and computing the large amount of data • Communication and private data security

Behavioural	• Cognitive biases and heuristics in the decision-making process:
	  ○ bounded rationality
	  ○ resistance to change
	  ○ confusion of choice (lack of professional advice)
	• Negative perceptions (negative values, not understanding)
	• Negative word-of-mouth (i.e. negative information about the innovation shared within a social network)
	• Credibility and trust (e.g. disbelief in climate change)
	• No perceived responsibility (no moral obligation to subscribe or participate, or already doing another energy efficiency behaviour)
	• Discomfort of usage

Source: Kowalska-Pyzalska (2017:Table 1)

2.2 Barriers to energy efficient technologies experienced by low-income households

The specific barriers to people on low incomes accessing energy efficiency retrofits are well understood. The 2013 Australian Council of Social Service (ACOSS) report on energy efficiency and people on low incomes identifies three main barriers to investment in energy efficiency measures, namely:

1. lack of access to the capital required to pay for new energy efficient appliances
2. split incentives, whereby those investing in energy efficiency measures are not directly receiving the benefit of a lower energy bill, and
3. information barriers that prevent people experiencing disadvantage from accessing energy efficiency, including literacy and language barriers, particularly for those with recent migrant or refugee status; illness and disability; information on products and programs often being conflicting and complex; and understanding the most effective ways to save energy.

The problem of split incentives is a particularly pertinent issue in the affordable housing rental market as it is difficult for CHPs to recoup their investment costs through higher rent due to regulations around rent protection (Chegut et al. 2016).

Regulations, incentive programs and information provision are all important and necessary tools in bringing about upgrades to the housing stock. These have, however, often failed to achieve widespread reduction of carbon emissions from housing (Eames et al. 2013). As Karvonen (2017) notes:

> The problem with regulations, incentive programmes, and information provision is that they focus on the individual as the agent of change. […] The result has been an overemphasis on the individual, particularly homeowners, to realise systemic change to the housing stock while neglecting the various stakeholders that can either facilitate or hinder change. This is particularly the case with energy upgrades to housing.

Karvonen (2017) contends that housing stock can be considered a 'cultural asset that is embedded in the fabric of everyday lifestyles, communities and livelihoods'. Such an understanding shifts the onus of retrofit away from the individual or property owner but instead recognises that domestic life is part of a larger system of social, cultural and political drivers. It is within this context that we seek to consider a broad range of potential barriers facing the social housing sector.

Community housing providers play an important role in overcoming barriers as they often best understand their tenants' needs, their history, assets, interests, how to communicate with them, and how to best engage them in energy upgrades. As Reames (2016) highlights, the complex decision-making processes that guide energy choices and the subtleties and complexity of human behaviour much be acknowledged and taken into account. The need for a tenant-focused approach is especially important given that social housing tenants, particularly within the Australian context, are often vulnerable individuals and households with needs[2] that require additional support that is provided or referred to them by their social landlords. This adds a different level of complexity when designing and implementing programs and processes aimed at benefitting vulnerable households, including social tenants. To date, however, there is limited evidence in the Australian context on how such decision-making processes operate when social tenants are involved.

[2] Eligibility criteria for social housing across Australia have become increasingly strict. Once a common tenure for workers and their families, extended retraction of funding means it is now a residualised tenure (e.g. Jacobs et al. 2010; Morris 2015) that typically houses vulnerable individuals and households with multiple and complex issues such as those on very low incomes, and those with physical and/or mental disabilities that require additional support services for their daily living.

2.3 International studies on barriers facing the social housing sector

This section presents evidence from our international literature review on barriers faced by social tenants and their housing providers in different overseas contexts.

A common theme in the international literature is a pressing need to upgrade the energy efficiency of existing housing stock to reduce its carbon emissions (e.g. Karvonen 2017). Multiple studies have emerged over the past decade that focus on community housing retrofit programs. The following section describes the main barriers faced by SHPs in improving the energy efficiency of their stock.

Major studies

Much of the international literature on social housing and energy efficiency centres on the United Kingdom (UK). Housing associations, also known as Registered Social Landlords (RSLs) or Private Registered Providers of Social Housing, are the independent, not-for-profit organisations that provide homes for people experiencing housing needs. The UK Government has a commitment to reducing carbon emissions by 80% by the year 2050, and this commitment has resulted in a large number of initiatives to reduce the carbon emissions from its housing stock, such as the Green Deal (see Section 3.2).

Table 2 below summarises the findings of a recent report by Fusion21 (2011) on the primary barriers social housing organisations in the UK face regarding the uptake of energy efficiency measures.

Table 2 Main barriers UK social housing providers face in implementing energy efficiency measures

Barrier	Description
High transaction costs and limited understanding	• RSL and occupiers are **ill-informed** and lack awareness of energy efficiency and its whole-life benefits • RSL and occupiers sensitive to **disruption**, **time and money** needed to achieve energy efficiency improvements • Low levels of government intervention and policy; retrofits perceived as **high risk** and by some as **low priority**
Split incentives	• Little **incentive** to invest in energy efficiency upgrades when the benefits are enjoyed by someone else
Technological immaturity and barriers to mass rollout	• Lack of technical knowledge and supply chain issues. **Price** and **availability** of many low carbon technologies still prohibitive

Source: Fusion21 (2011)

The Retrofit State of the Nation Survey (Swan et al. 2013), conducted in conjunction with the aforementioned report by Fusion21 (2011) and the social enterprise Procurement for Housing, aimed to provide a more in-depth understanding of the perceived barriers highlighted in Table 2, as well as the drivers for adopting energy efficient retrofit measures in the sustainable housing sector. Additionally, it looked at how SHPs perceived the issue of sustainable retrofit for the sector as a whole. The survey was sent out to 704 RSLs with 130 valid responses (18%) returned. Respondents were allowed to identify a maximum of four barriers, with the results shown in Table 3.

Table 3 Main barriers facing the social housing sector for the adoption of sustainable retrofit

Barrier	Responses
Lack of funding support	112 (86%)
Commercial difficulties, e.g. failure to establish business case	53 (41%)
Lack of policy and government intervention	47 (36%)
Lack of technical knowledge	44 (34%)
Too much long-term risk, e.g. defects or non-performance	43 (33%)
Other organisational priorities, e.g. development	43 (33%)
Lack of installation skills supply chain	26 (20%)
Lack of equipment supply chain	23 (18%)
Lack of repairs and maintenance supply chain	21 (16%)
Resident resistance	18 (14%)

Source: Fusion21 (2011)

Limited funding support was noted as the biggest barrier. This includes both direct full subsidies from the public sector, such as grants for installing photovoltaic panels, and co-funding opportunities where there is a perception by housing providers of their inability to recover the capital investment. Fusion21 (2011) notes that government subsidy of more expensive carbon abatement measures may be a potential approach to overcome this.

Commercial difficulties such as failure to establish a business case for sustainable retrofit, lack of policy and government intervention, high long-term risk, and competing organisational priorities, were also identified as key barriers; internal and external capacity to deliver sustainable retrofit in terms of skills, knowledge and supply chain readiness were also noted to be of importance. A perception that the supply chain (in terms of sustainable materials and retrofit technologies) has yet to reach maturity is also noted as an industry concern.

Additionally, the study identified the issue of sustainable retrofit as the second biggest challenge faced by the sector, with the main challenge being the general economic downturn, indicating that while the sector views sustainable retrofit as important, there are wider economic, political and social factors influencing outcomes in this sector. It is important to note that these barriers are interrelated and cannot be considered in isolation from each other. Some factors, e.g. government policy and organisational priorities, may indeed be both a barrier and a driver (Fusion21 2011; Kempton 2014).

Similarly, Kempton (2014) conducted a study of senior asset management practitioners working within social housing organisations to understand the drivers for and barriers to low-zero carbon technologies (LZCTs). The practitioners were in RSLs managing between 8000 and 50,000 dwellings located in London as well as the South, South-East and Midlands of England. The main barriers were found to fit into the main themes and subthemes listed in Table 4.

Of the subthemes, interdepartmental conflicts (e.g. between development and asset management departments) and occupier responsibility for maintenance are of particular note, as they had not been reported previously in other similar literature.

The lack of asset management involvement in the specification of energy efficient technologies during the development phase, and the major disconnect between development's short-term and funding-driven performance targets were seen to be major barriers to the efficient long-term maintenance of assets. A consideration of the full lifetime

costs of LZCTs (namely maintenance, refurbishment, eventual removal, disposal and replacement) was suggested as an approach to achieve more cost-effective decision-making.

Table 4 Main barriers to low-zero carbon technologies among UK social housing organisations

Main themes	Subthemes
Asset management planning	• Legal issues, e.g. access to dwellings • Planning issues, e.g. surveys not adequately capturing LZCT data • Competing asset management priorities, e.g. LZCTs a drain/distraction on the primary role of maintaining the structure of buildings • Change in asset management strategy focus • Lack of management knowledge and training • Infancy and fragility of supply chains • High capital costs of equipment and spare parts • Interdepartmental conflicts between those in development and future maintenance roles
Maintenance skills	• A culture of traditional maintenance practices and resistance to change to maintain LZCTs
Occupier issues	• Occupier aesthetic preferences outweighing energy efficiency needs • Lack of occupier skills, understanding and commitment to using LZCTs • Distribution of income streams between the RSL and occupiers, e.g. a perception that RSLs would incur additional maintenance costs • Occupier responsibility for maintenance

Source: Kempton (2014)

To overcome the barrier of occupier assistance with routine maintenance, training could be provided to the relevant occupier(s) to undertake basic maintenance to the shared benefit of both the occupier and the RSL, such as a reduction in rent for the occupier in return for lower maintenance costs for the RSL. Adjustments to current legal, insurance and other practical issues would be needed to facilitate this potential change in practice.

Recently, McCabe and colleagues conducted a systematic review and narrative analysis exploring the key themes behind why and how SHPs have chosen to implement renewable energy technologies (McCabe et al. 2018). A final list of 67 references were included in the analysis. Note that grey literature and government reports were not included, which the authors acknowledge as potentially reducing the number of empirical, or case-based, assessments captured. The majority of the studies included were based in the UK (n = 35) and Brazil (n = 6).

Three key themes for the systematic review were given priority. These were: (a) motivations, (b) success factors in past adoptions, and (c) barriers to implementation and adoption. Six further subthemes emerged through the systematic analysis:

1. Lack of resident engagement
    - social barriers including user interaction; not engaging users with the process or empowering them with education and involvement
    - over-complication of control mechanisms or information provided
    - visibility of device (e.g. biomass as opposed to wind or solar)
    - overselling the benefits of retrofit/renewable energy installation.

2. Unclear understanding of users (N.B. Only three studies specifically focused on residents of social housing)
    - users categorised into four groups, namely ‘The interested user’, ‘The non-user’, ‘The conscious user’ and ‘The opportunistic user’
    - three typical usage patterns were identified, namely low demand electricity consumption, peaky/high demand electricity consumption and high base load/high demand electricity consumption
    - demography of users, in particular social housing with a high proportion of elderly residents, should be taken into account.
3. Financial risks
    - lack of financial capital or ongoing capacity to fund and maintain projects
    - split incentives due to a disparity in motivation and gains between housing provider and user
    - tension where financial risk is taken on by intermediary organisations or local authorities due to conflicting goals and outcomes. May also lead to a form of split incentive where the housing provider is left with the burden and the intermediary gains benefit, such as political capital.
4. The novelty factor
    - organisational barriers related to the relative novelty of renewable energy to SHPs; unfamiliarity means providers are less likely to consider application in the first place or have access to knowledge and support once installed
    - disruption during implementation and ongoing structural changes
    - allocation of time and funding for maintenance including contracting of specialist services not always available locally
    - ineffective installation due to inadequate staffing and managerial systems and protocols
    - lack of inter-organisational cooperation, related to competing motivations between for-profit contractors and non-profit SHPs
    - lack of enthusiasm for ongoing maintenance when perceived to be outside the remit of contractor or external organisation.
5. Inadequate policy support
    - lack of institutional support, incentives or requirements at a national scale
    - restrictive or lacking funding requirements, unsuitable competing policies or organisational barriers listed above.
6. Technological complexities
    - innovation – disruption to organisational regimes due to the novelty of the innovation (both the technology and its usage) may be a hindrance to innovation; carving of new roles requires CHP to be adaptive
    - innovation may be a barrier to implementation as it is usually at a higher cost
    - innovative measures may be put aside in favour of conventional ones due to perceived financial risk or complexity.

The authors highlighted that the literature was ‘overwhelmingly dominated by the importance of understanding residents, engaging them appropriately and maintaining that engagement’ (McCabe et al. 2018). The review describes the motivations for SHPs to adopt energy efficiency technologies, the success factors uncovered within, as well as the authors’ recommendations to practitioners working in this sector for effective application of renewable energy technologies to social housing.

United Kingdom

A number of additional studies have focused on the challenges the UK social housing sector faces in improving the energy efficiency of their stock.

- Alencastro et al. (2017) found in order to develop quality assurance plans that encompass energy efficiency in social housing, energy performance targets must be included as a fundamental objective from the outset of projects, necessitating a collaborative approach to procurement by SHPs.
- Brown et al. (2014) looked at the barriers to adoption, and the impacts of living with retrofits in social housing tenants. It was found that the technology and interfaces were often a mystery to the user, leading them to rely on those they trusted to help them navigate the systems, pointing to the need for a robust handover process from the installer and landlord. The issue of trust was central to the retrofit process, particularly around distrust of the quality of installation that could be expected from contractors appointed by social landlords, indicating more needs to be done to develop and maintain trust within the supply chain, particularly the tenant–installer–landlord relationship. The authors comment that 'If we are to succeed in the mass deployment of retrofit across the UK, we will need to support the narration of positive stories about the technologies that will be re-told from home to home'.
- Provan and Brady (2015) looked at how some social landlords are addressing energy saving and fuel poverty in their organisations, what factors contribute to retrofitting the current stock and how tenants' energy bills and wellbeing are impacted, with the aim of producing a 'how to' for social landlords in energy-saving techniques.
- A 2007 survey of SHPs found that only a minority of organisations had a sustainable development policy and that environmental, economic and societal aspects of sustainability were not being given equal weighting, indicating a gap between policy and practice such that sustainability was not being fully addressed in the procurement of social housing projects (Carter & Fortune 2007).
- Ben and Steemers (2014) demonstrated the importance of behaviour change on energy savings in a large social housing complex retrofit, finding it had the highest energy-saving potential, far exceeding that from physical improvements.
- Dewick and Miozzo (2004) discuss the challenges that exist in implementing sustainable technologies in the Scottish social housing sector despite governmental policy initiatives, highlighting the competing aims and interests of the various organisations in the construction chain (including contractors, government, clients, designers, sub-contractors and suppliers) as a hindering factor that conspired against innovation.

Rest of Europe

The following selected studies address challenges experienced by social housing organisations in Europe in carrying out energy efficiency upgrades.

- Hoppe (2012) looked at case studies of eight large-scale social housing renovation projects in the Netherlands, finding many barriers exist to the adoption of energy efficient technologies, namely 'lack of trust between project partners, delay in project progress, financial feasibility considerations, lack of support from tenants, lengthy legal permit procedures, over-ambitious project goals, poor experiences in previous projects, and IES [innovative energy systems] ambitions that are not taken serious[ly] by key decision-makers'. The study calls for careful attention in dealing with the various stakeholders to contend with complexity that may derail the project.
- Egmond et al. (2006) note most housing associations in the Netherlands are typically change-averse when it comes to adopting new behaviours and are neither innovators nor early adopters of energy efficient technologies, and that their focus is primarily on

core business. Therefore, energy solutions are implemented at a later development stage rather than incorporated early. The authors also note, however, that a portion of housing associations do innovate early.

- Similar to the above study from the Netherlands (Egmond et al. 2006), the late involvement of stakeholders to do with construction and management (i.e. landowners, designers, construction firms, lending institutions, public bodies granting building permits, end users, etc.) expressing greater interest in building energy efficiency was noted to be a key factor in the slow adoption of energy-saving technologies in the Italian building sector (Berardi 2013).
- Copiello (2016) provides a review of the literature regarding the willingness to adopt energy efficiency measures during construction or retrofit of buildings, with a particular focus on social housing settlements. The authors noted the late involvement of stakeholders and their conflicting purposes, as well as the adoption of a short-term perspective and the split incentive issue, as key barriers to the widespread deployment of energy efficiency measures. They discussed the main feasibility drivers within the current Italian context, namely the increasing involvement of a new kind of developer (i.e. bank foundations adopting a venture philanthropy approach), the role of public–private partnerships, and the monetary benefits of wide adoption of energy efficiency solutions that let the tenants benefit from savings on energy bills so they are neutral in regard to possible rent increases, and in turn allows the developers to expect higher investment returns due to the increased rent. In the author's 2015 case study analysis a contractual approach was developed to structure relationships among all stakeholders (the municipality, the landlord, the tenants), whereby the developer incurred capital improvement costs and was repaid by higher rents than those in protected/regulated tenancies; however, the tenants were partly kept neutral to the rent increase thanks to energy bill savings through the adoption of energy efficient solutions (Copiello 2015).

North America

The two selected studies below discuss issues facing social housing organisations in North America in addressing the energy efficiency of their stock.

- Pitt (2007) explores the link between the theory of affordable energy efficient housing, policy and programs, and the actual practice using case studies of three social housing projects in Ottawa, Ontario, Canada. Barriers to developing social housing are identified as follows:
    - lack of a national housing program
    - lack of education or training for housing developers
    - preliminary costs of development and renovation often being higher in energy efficient buildings
    - complex funding programs
    - cost of land due to high demand for higher density, mixed-use locations
    - planning and regulatory barriers
    - planning processes, such as the length of the development process increasing costs.

  Suggestions for overcoming barriers and policy recommendations based on the results of the case studies are also presented.

- A case study of five urban, low income, majority African-American neighbourhoods in Kansas City, Missouri explores a community-based approach to energy efficiency retrofits funded by the Weatherization Assistance Program (WAP) discussed further in Section 3.4. (Reames 2016). Although not specifically social housing, the findings have relevance for social housing organisations. Even in the absence of financial

impediments to energy efficiency the study found many other barriers to participation existed that stakeholders had to overcome, namely 'two social barriers (public priorities and public distrust); two market barriers (information gap and split incentive); and two regulatory barriers (pre-weatherisation repairs and previous weatherisation ineligibility)'. The author also notes that 'a community-based approach to low-income energy efficiency provided the institutional capabilities to recognise the magnitude of the effect of these barriers, and to respond appropriately with innovative strategies to overcome the barriers'.

Brazil

A study examining the social housing sector in Brazil and Rio de Janeiro (Bodach & Hamhaber 2010) identified the following barriers to energy efficiency in social housing:

- high initial costs were considered to be the major barrier to energy efficiency in social housing by most interviewed experts, particularly given the very limited initial capital in housing for the poorest segment of the community
- limited awareness of energy conservation opportunities by stakeholders
- knowledge among architects about sustainability is still typically low
- lack of consistent policy action and legislation – there is a need for energy efficiency regulations and standards
- fragmentation of responsibilities in project development practices.

Recommendations for overcoming these barriers were suggested. The authors note that the 'economic analysis of this study has shown that more energy efficiency in social housing would improve the income situation of the poorest strata of the population due to the reduction of their energy expenses'.

2.4 Australian studies on barriers facing the community housing sector

There is little evidence within the Australian context about the implementation of energy efficiency measures by SHPs. While several transfer programs such as South Australia's Better Places, Stronger Communities (BPSC) initiative include energy efficiency improvements as key performance indicators (Blunden et al. 2017), these have typically involved minor upgrades. As part of BPSC, for example, tenants were given options such as ceiling fan installation and external awnings for west-facing windows. Most of these programs, however, are in too early stages to impact assessments. Such information on program outcomes is also not captured in comprehensive national surveys such as the National Social Housing Survey.

The latest report on the National Social Housing Survey (AIHW 2017), however, revealed that energy efficiency rated as the second highest amenity in terms of importance for community housing tenants, behind safety and security in the home. This is especially important as a recent KPMG report (2017) noted that large families on low incomes, with those in the public housing estates of south-western Sydney (Fairfield and Liverpool), and in Melbourne's north (Hume) and south-east (Dandenong), along with almost all Indigenous communities, were the most exposed to experiences of energy poverty. The report estimates that 1% of the Australian population (42,000 households, or 240,000 people, including 200,000 children) are impacted by energy poverty and have reprioritised household spending. Given that large portions of these households may be living in social housing, the inability of providers to improve the quality of their stock can have significant impacts on these vulnerable households.

There have been a number of studies looking into the issues that prevent CHPs from implementing energy efficiency measures in the Australian context. A key study by Urmee et al. (2012) looked at the demographics of the Australian community housing sector and approaches needed to engage it in reducing carbon emissions through energy efficiency upgrades. A total of 38 of Australia's approximately 1800 community housing providers responded to a questionnaire. For the 13 providers that responded to a Building Information Matrix component, representing approximately 3500 dwellings, the following factors in addition to split incentives are indicative of the spectrum of issues that impact CHPs introducing energy efficiency upgrades (Urmee et al. 2012):

- perception of efficiency measures as cost-prohibitive and beyond CHP budgets
- inability to make structural changes to stock not owned by the CHP
- time and human resource limitations
- lack of sectoral understanding of cost-effective improvements
- lack of availability of practical advice and information
- lack of tenant understanding of efficiency upgrades coupled with high energy demand tenant population
- energy inefficient nature of community housing stock
- inability to monitor tenant energy consumption
- lack of tenant access to efficient appliances
- special needs of tenants as inhibiting capacity for efficiency upgrades.

The lack of incentives to upgrade stock they do not own is also emphasised in ACOSS (2013) and Liu, Judd and Mataraarachchi (2017).

3. Australian and international approaches

This chapter provides an overview of a number of Australian and international programs aimed at assisting SHPs to improve the energy efficiency of their existing stock or to build new and highly efficient stock. These comprise a mix of those that are funded by government and non-government organisations, and reflect a range of approaches, including direct financial assistance, co-funding schemes, loans and brokerage, and information and guidance. These also range in scale, with a number of small and short-term pilot programs and, less frequently, sector-wide implementation. The ones that are noted to have yielded the most widespread and longest lasting impacts were those that included a suite of approaches, such as the UK's Decent Homes program that provided financial funding and incentives as well as changes in legislation to mandate upgrades. These programs are summarised below.

3.1 Australia

National programs

In Australia in 2016, the CEFC introduced a Community Housing Program, a brokerage service for CHPs to access affordable loans for the construction of energy efficient new dwellings and for upgrading existing community housing. This program was introduced in light of an industry reflection that levels of private finance in Australia for social housing developments more generally are typically low, with many CHPs being treated as private businesses and as such only able to access loans at full market rates. This is reflective of the lack of an ongoing framework for the sector nationwide, particularly for the construction of new social and affordable housing (Milligan et al. 2015). The borrowing capacity of most CHPs is also restricted due to their relatively small scale (compared to housing associations in the UK and Europe; see introductory chapter for sector overview); they also do not own

(but manage on behalf of other owners) large proportions of these tenancies. As an outcome, any loans they were able to access have typically been short-term. All these factors have led to inhibitive outcomes for the sector so that:

- only larger housing providers have had the capacity to access bank loans, and the amounts they have borrowed are relatively small compared to their net assets
- community housing providers have relatively little control over rent revenue due to regulation and government policy
- despite housing stock transfers, there are often strict conditions imposed on CHPS. In most cases, only management of the tenancies on relatively short timeframes (3–5 years) are transferred, with state housing authorities retaining the title of the properties. As such, most CHPs are not able to use this asset as security.

Approaches such as contracts between the government and CHPs that enable long-term leases can provide security for lenders and therefore lower perceived risks. This can greatly increase the number of financing products that CHPs are able to access for stock upgrade and for new property developments.

The CEFC's Community Housing Program is relatively new and to date only one loan has been brokered for a CHP (SGCH Ltd). This $170 million loan will allow SGCH to construct 500 7-star NatHERS rated social and affordable homes in suburban Sydney.

In addition to the CEFC program, the Commonwealth Government has also funded a number of short-term trial programs, the most significant of which was the Low Income Energy Efficiency Program (LIEEP). From July 2011, the program provided $55 million in grant funding to 20 government, business and community organisations as part of the government's climate change strategy, with the aim of conducting projects focused on improving the energy efficiency of low income households. The program concluded in June 2016.

During its lifetime, two LIEEP projects focused on community housing: Home Energy Efficiency Upgrade Program (HEEUP; Brotherhood of St Laurence (BSL)) and Beat the Heat! (Uniting Communities of South Australia). Of these, the HEEUP study reported useful findings regarding engagement with CHPs (Sullivan 2016).

The primary aim of the HEEUP was to enable households in Melbourne and regional Victoria to upgrade to more efficient hot water systems. The upgrades were delivered in two streams: low income owner-occupier households, where 71% (550) of the upgrades occurred, and community housing, where 22% (176) of the upgrades occurred. The community housing stream involved direct engagement with property managers, with a focus on logistics rather than detailed energy efficiency advice, and the provision of a flat rate subsidy of $1100 per upgrade to the housing provider. The program was found to be highly successful in engaging with community housing providers, with the BSL able to leverage the maintenance function of each CHP to achieve logistical efficiencies in implementing the upgrades as well as effectively managing communication with and payments to each provider. The major challenge for the CHPs was noted by BSL to be 'the rejigging of planned hot water system upgrades and, in some cases, the identification of funding that could be brought forward to take advantage of the offer' (Sullivan 2016). The report noted that the success of CHP engagement was overwhelmingly due to the trust that existed between the CHP and tenants.

A summary report of the LIEEP was prepared by the Group of Energy Efficiency Researchers (Russell-Bennett et al. 2017) with the top five barriers that participants faced in adopting energy efficiency practices noted as:

1. high perceived cost
2. knowledge gaps
3. lack of trust
4. poor split incentives
5. low literacy.

Note that these are across all projects and not specific to those focused on CHPs only. The authors noted that an opportunity exists for the government to provide leadership in regulation reform such that all social housing homes are retrofitted to a high energy efficiency level, thereby setting the standard and providing quality affordable housing to those most in need.

State-based programs

The Home Energy Action Program (HEAP) is a multi-stream co-funding program led by DPIE to assist CHPs, low income households and business to improving the energy efficiency of their homes, offices and daily living (NSW OEH 2013). One stream provides discounts to eligible low income households on energy efficient whitegoods purchases; another stream works via a co-funding mechanism to assist CHPs to provide energy efficiency upgrades and retrofits to their stock; it also funds innovative behaviour change programs aimed at educating tenants to adopt energy efficient practices.

In Victoria, the Department of Health and Human Services introduced an EnergySmart Public Housing Project through its Sustainability Fund. Between 2017 and 2019, it provided funding for the replacement of energy efficient hot water and heating systems as well as upgrading the thermal shell (through draught sealing and insulation) of 1500 public housing dwellings in the state. This program works in conjunction with a wider renewal program in Victoria where over 11,000 public housing homes will be redeveloped to higher energy efficient and living standards (DHHS 2017).

This move is similar to the approach taken by other state governments in Australia in significantly upgrading public and social housing stock through extensive estate-wide renewal programs. In addition to the abovementioned BPSC program in South Australia, where tenants were offered energy efficiency upgrade options, its successor, Renewing Our Streets and Suburbs (Renewal SA n.d.), will offer similar upgrades as well as work with CHPs to deliver new social housing through renewed stock and bringing inefficient stock to modern, NatHERS standards. The Communities Plus program in New South Wales will also bring social housing up to more efficient standards through a similar approach (FACS n.d.).

The introduction of the HEAP in New South Wales and the EnergySmart Public Housing Project in Victoria have been important steps in overcoming some barriers. Along with wider estate renewal programs, the CEFC's Community Housing Program is also assisting in the introduction of more energy efficient social housing. As introduced in the previous chapter, however, many other barriers remain that these programs are not able to address, so widespread uptake of these and other similarly assistive programs by CHPs has been limited. The next section looks at some overseas case studies on how some of these other barriers may be overcome.

3.2 United Kingdom

The UK offers a number of successful case studies regarding the upgrading of social housing to higher energy efficiency standards. A notable example is the Decent Homes program that ran from 2000 to 2010, which, through legislative mandates, facilitated the upgrading of social housing dwellings through a mix of public and private funding as well as broader structural changes that improved the operability of housing providers. The program had four objectives (DETR 2000), to:

- deliver on significant repair and maintenance backlog
- improve efficiency in stock management and value for money
- improve living outcomes of tenants and reduce incidence of fuel poverty
- construct new, efficient affordable housing, increasing tenant choice and outcomes.

It achieved this by facilitating mass stock transfer to the community housing sector and local authorities, including the transfer of property titles to CHPs and local authorities, and providing significant public funds for the upgrading of both transferred stock and the remaining public housing, and the levels of 'decent' standards were increased during the program's lifetime. It also introduced mechanisms for the construction of new affordable housing such as the Social Housing Grant and Approved Development Programme. At its conclusion in 2010, it was estimated that over one million homes benefitted from the program (NAO 2010), significantly boosting the internal capacity of the sector by facilitating the growth of many housing associations and affiliated businesses.

Its successor, Green Deals, was introduced by the Department of Energy and Climate Change (DECC) in October 2012 (UK Government n.d.). While not aimed specifically at social housing upgrades, it allowed for (social and private) tenants and landlords to jointly make decisions about improving the quality of their homes (including energy efficiency) through a standardised Green Deal assessment procedure. This significantly shifted the provider-based approach of Decent Homes to a more individualised approach, where occupants were able to access loans to perform the recommended upgrades. The loans were tied to the upgraded properties, therefore if there were any changes to their occupancy the loans would also be transferred to the new occupants. During its lifetime, Green Deals received a number of criticisms relating to its funding mechanisms and low uptake. It was eventually discontinued in 2015 after just 15,000 deals. Prior to Green Deals' scraping, a new National Energy Efficiency Action Plan (DECC 2014) was introduced by the DECC in April 2014. This national action plan took a similar approach and did not include any strategies specific to the social housing sector.

Outside of the public sector, philanthropic funding has also enabled the upgrading of social housing stock in the UK, though on a more case-by-case basis. A recent example is the Solarplicity Community Energy Scheme (BBC 2017). Funded by a Dutch investment company focusing on the resource and shipping sectors, Maas Capital, the investment of £160 million will enable the upgrading of social housing of over 40 providers across the southern UK through the installation of solar panels. It will also recruit military veterans as skilled installers, benefitting another vulnerable community.

At a sub-national level, there are different programs and regulatory mechanisms that target SHPs in specific regions within the UK. The Ready for Retrofit program, run between 2012 and 2015 by the independent Energy Saving Trust provided funding to social landlords in the south-west of England through the stimulation of local low carbon building retrofit demands (EST n.d.). The program worked in conjunction with partners to create local, sustainable domestic energy sectors. Throughout its lifetime, £2.3 million of direct funding was allocated, and together with external co-funding achieved a total investment of £10 million into the region for more than 1400 energy efficiency measures. The Energy Saving Trust also offers region-specific advice, such as through its Scottish offices, on how social landlords can best take advantage of local, regional and central assistance programs. For example, they offer free expert advice on:

- public funding schemes such as the Home Energy Efficiency Programme Scotland loans scheme for Registered Social Landlords and the Direct Heating Local scheme, which offers loans of up to £1 million for energy saving improvements to social housing stock, the latter specifically on heating
- how to best meet the Energy Efficiency Standard for Social Housing as set out by the Scottish Housing Regulator
- linking with the Green Network for Social Housing, connecting with other social landlords in Scotland on how to approach energy efficiency and saving upgrades.

A non-profit energy supply company, Our Power Energy, was also recently set up by 35 organisations (including SHPs) to provide affordable energy to disadvantaged households, including social tenants.

3.3 Rest of Europe

A number of different approaches are undertaken throughout the rest of Europe to improving the energy efficiency of social housing stock:

- In the Netherlands, through its social housing peak body Aedes, a benchmark is established for quality assurance and improving social housing stock. The benchmark allows member-providers to compare and work on strategies to improving the quality and performance of their stock, including under the benchmark of sustainability, which reports on the 'energetic performance of the homes and CO_2 emissions' (Aedes 2019).
- A number of social housing projects in the Netherlands, France and the UK participated in Power House's Nearly Zero Energy Challenge, which was funded by the European Commission's Intelligent Energy Europe Program (Power House n.d.). Under the challenge, social housing was upgraded through the installation of insulation, improved ventilation, water saving equipment among others. In Nantes, France, for example, 194 social dwellings were refurbished, leading to annual energy savings of €59,000.
- The collaborative housing model was tried in Grand Lyon, France, where a group of people eligible for social housing with similar ecological and social values worked with a local housing provider and the mayoral office to construct 24 low-impact social housing dwellings (Czischke 2018).
- In Emilia Romagna, Italy, the LEMON Project utilised a mix of European Regional Development Fund and Italian national funds to make €15 million of energy investments in retrofitting the existing stock and, in conjunction with the Regional Social Housing Programme, invested in a new financing model for energy to vulnerable communities.
- In Malaga, Spain, another participant in the Nearly Zero Energy Challenge and beneficiary of the European Commission's European Regional Development Fund, and city council investments totalling €486,800, implemented a range of retrofitting interventions to 140 dwellings (less than €30,000 per unit investment) including external insulation, internal blinds and solar hot water systems, to deliver an annual energy saving of around 40%.
- Across the European Union more broadly, the seven-year Horizon2020 Programme was launched by the European Commission in 2014 to inject €80 billion and additional private investments aimed at delivering smart, sustainable and inclusive growth and jobs throughout the region, nearly €200 million of which is earmarked for improving energy efficiency. Part of this earmarked fund includes engaging with social housing developers to deliver extensive energy refurbishments for existing stock to improve energy performance such as through the abovementioned LEMON Project.

3.4 North America

One of the longest running energy efficiency upgrade programs in the world, the Weatherization Assistance Program (WAP) was first introduced by the US Department of Energy in 1976. While not targeting social housing tenants specifically, WAP provides funding and advice to vulnerable households, including social tenants, for home-based upgrades to improve energy efficiency and to reduce energy expenditure. To date, it has benefitted over seven million households and is noted to have high social return on investments, particularly when improvements in occupants' health and safety are taken into account.

Elsewhere, the US Environmental Protection Agency's State and Local Climate and Energy Program provides important guidance on the development and retrofitting of energy efficiency measures to affordable housing (including social housing) products. Its 2011 report (US EPA 2011), for example, provides detailed guidance on the steps needed to reduce greenhouse gas emissions and improve energy efficiency in affordable housing. This

includes guidance on how best to evaluate the energy performance of a home, such as using their ENERYGY STAR Yardstick online tool and ENERGY STAR Home Advisor services, and developing an action plan, including details of the Department of Housing and Urban Development's energy programs. Advice on building new energy efficient affordable housing such as in choosing effective insulation and high-performance glazing is also available. Case studies of program participants are also included, such as the installation of motion sensors by a community corporation to reduce electricity wastage.

There are also many state-based programs. In Colorado, the Affordable Housing Energy Efficiency Grants, which include the Weatherization Program and Energy Rebate Program, provides co-funding to SHPs to upgrade their stock (Energy Outreach Colorado n.d.). In Delaware, a similar Energize Delaware Affordable Multifamily Housing Program has also been developed by private and non-profit organisations to provide technical assistance, financial incentives and low interest loans to perform energy efficiency upgrades (Energize Delaware n.d.).

In the Canadian Province of Ontario, the non-profit conservation website Save on Energy offers useful advice to individuals and organisations on ways to take advantage of assistance programs currently available from government and industry sources. Of specific relevance to this literature review, a number of programs for social and assisted housing providers are promoted, including co-funding opportunities, incentive programs as well as training courses for building operators to enhance the operations of their buildings' heating, mechanical and electrical systems (Save on Energy n.d.)

3.5 South Africa

In South Africa, there are a number of programs aimed at assisting SHPs to upgrade and retrofit their stock. These include the Greening of Social Housing pilot project, funded by WWF South Africa and implemented in partnership with the Social Housing Regulatory Authority and an SHP, to retrofit a small social housing complex with ceiling insulation, double-glazed windows, solar hot water and water-efficient shower heads, taps and toilets (WWF n.d.). The housing provider also benefitted from this pilot project, realising a 95% saving on their water bills, while the City of Cape Town also reduced its outlay of electricity subsidy over the winter periods.

Another SHP, Johannesburg Housing Company, has recently introduced an energy efficiency program aimed at reducing the energy consumption of social housing complexes' common areas. Upgrades have included the installation of motion sensors and LED light fittings. Tenants have also benefitted from a pilot project in Smitshof that installed solar energy systems, hot water system insulation, load-shedding devices, and ripple relay services that reduced tenants' need to access the electricity grid, particularly during the peak demand periods (JHC 2017).

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Appendix A: Shortened forms used in this report

ACOSS	Australian Council of Social Service
BPSC	Better Places, Stronger Communities
BSL	Brotherhood of St Laurence
CEFC	Clean Energy Finance Corporation
CHP	community housing provider
DECC	Department of Energy and Climate Change [UK]
DPIE	Department of Planning Industry and Environment, formerly OEH
EU	European Union
FACS	Department of Family and Community Services (NSW), former
HEAP	Home Energy Action Program
HEEUP	Home Energy Efficiency Upgrade Program
IES	innovative energy services
LIEEP	Low Income Energy Efficiency Program
LZCT	low-zero carbon technology
NatHERS	National Housing Energy Rating System
NSW	New South Wales
RSL	Registered Social Landlord [UK]
SHP	social housing provider
US EPA	United States Environment Protection Agency
WAP	Weatherization Assistance Program [US]