Final report

Glebe Energy Transitions: A place-based upgrade model for social housing

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Glebe Energy Transitions: A place-based upgrade model for social housing

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Project partners

UTS NSW GOVERNMENT bridge

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- Homes NSW
- Justice and Equity Centre
- NSW Community Housing Industry Association (CHIA NSW)
- Pingala Community Renewables

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What is RACE for 2030?

The Reliable Affordable Clean Energy for 2030 Cooperative Research Centre (RACE for 2030) is a 10-year, $350 million Australian research collaboration involving industry, research, government and other stakeholders. Its mission is to drive innovation for a secure, affordable, clean energy future.

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Context

National and state governments are committed to achieving net zero emissions by 2050, with NSW targeting a 50% reduction by 2030. Alongside greening the electricity grid, the energy performance of existing housing will need to improve by nearly 50% to achieve net zero emissions. Improving many of 150,000+ social housing dwellings in NSW is not only critical for achieving targets, but also as these often house vulnerable residents who struggle to maintain comfortable, healthy living conditions. Achieving this target must involve a mix of improving the building fabric of homes, as well as facilitating access to the benefits of Consumer Energy Resources (CER) such as rooftop solar.

Motivating challenge

The technology for shared solar for apartments is now available and has been tested in social housing. However, these shared solar applications cannot be readily replicated by social housing providers, as the housing provider does not capture sufficient benefit to overcome reliance on grant funding to apply shared solar across their portfolios. At the same time, housing providers struggle to access funds for other home energy upgrades outside dedicated government grants, which seldom cover the breadth of the housing stock. This project thus sought to research and design a financially self-sustaining and replicable model for shared solar and thermal upgrades of social housing apartments.

Approach

The research involved understanding the stakeholder benefit split from shared solar, optimising the business case through load-shifting focussed efficiency upgrades, exploring policy mechanisms and alternative business models for benefit sharing between stakeholders, and identifying a financing source and structure suited to the nature and scale of the challenge.

The project took a case-study approach for two sites: a 1970s all electric apartment block in Glebe and a 1980s two-storey apartment block with gas in Brookvale. Detailed energy audits were conducted in a sample of representative units. These audits assessed current energy use, thermal performance, and tenant experiences of comfort and discomfort. Key findings include:

- Total electricity use varied substantially, ranging from 5-12 kWh/day in these 1-bedroom apartments. This excludes gas used by a small number of Brookvale units for water heating.
- Low energy use did not necessarily indicate comfort, as many tenants withstood summer or winter discomfort without using substantial heating or cooling.
- Excess or lack of solar access was the biggest determinant of thermal comfort. Units with the identical layout varied from a (relatively comfortable) 3.7-star NatHERS rating, to a (very uncomfortable) 2.3-star NatHERS rating, with temperatures below recommended healthy temperature guidelines more than 20% of the time.
- Uniform upgrades across a building will not be appropriate and need to be tailored to each unit.

Business Case for Shared Solar (without upgrades)

Shared solar equivalent to 1-1.5kW per unit was deemed to have a potentially attractive – albeit longer – payback period (9-12 years simple/discounted)[1] than is typical for stand-alone dwellings, primarily due to additional capital costs associated with sharing power between units. Solar access, switchboard upgrades and the total number of units per block are important factors for viability. With the right site conditions, the preliminary analysis indicated that if a long-term, low-cost financing arrangement of up to 15 years was available, a surplus financial benefit could plausibly be used to fund additional energy upgrades. Upgrades would be modest (<$1000/dwelling) if these measures merely represent additional costs. However, if in addition to driving thermal comfort improvement, these measures can also drive energy savings or shift demand to daytime hours, they could further improve the cost-effectiveness of shared solar.

Proposed Complementary Energy Upgrades

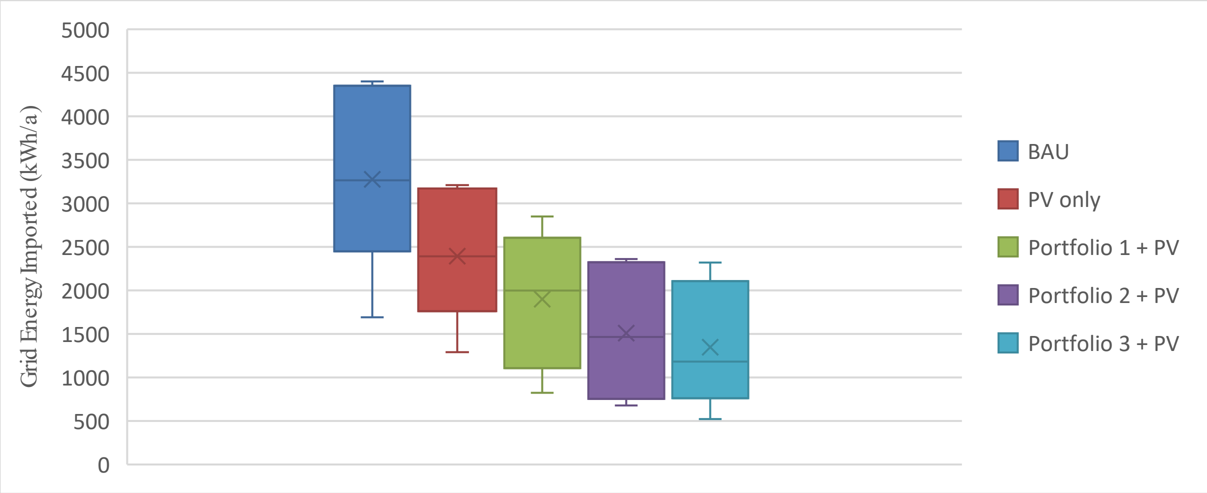
The following three energy upgrade portfolios with increasing ambition (and expense) were developed based on a set of principles (outlined in Section 2.3.2) that can be applied to tailor upgrades across Community Housing Provider (CHP) building stock.

Summary of upgrade portfolio inclusions (in addition to shared solar)

	Portfolio 1: basic	Portfolio 2: moderate	Portfolio 3: advanced
Upgrade measures (applied to relevant apartments only)	• Draught sealing • Water-efficient showerheads • HWS Timers (indoors) • HWS insulation (outdoors; Glebe only) • Roof/ceiling insulation (top floor) • CFL to LED lighting • Retailer switch	Portfolio 1 + • Heat pump HWS (to replace HWS insulation in Glebe, and for outdoor units in Brookvale) • Ceiling fans x 2	Portfolio 2 + • Reverse cycle heating/cooling (targeted) • External shading (targeted)
Avg cost/dwelling	$1,200-$1,400	$3,700	$5,000-$8,000

The modelled impact on the energy imported from the grid of shared solar plus each portfolio of complementary upgrades is shown for the Glebe building as an example in the figure below.

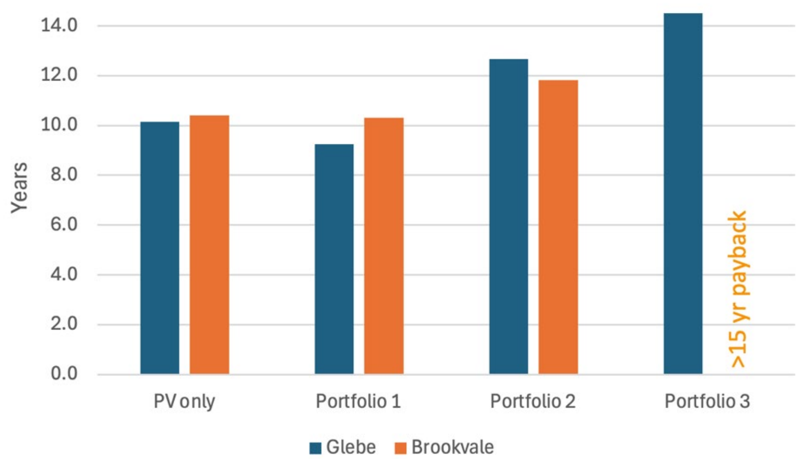
[1] Using 2% annual energy escalation and 4.5% discount rate where relevant.



Impact of modelled scenarios on grid imported energy in Glebe building

Business Case for Shared Solar Plus Upgrades

Discounted payback periods for each building are shown below when shared solar is combined with upgrade portfolios.[2]



Discounted payback periods for PV Only/Portfolios for each building (standardised tariff scenario)

Adding at least modest upgrades (Portfolio 1) improves both financial and health outcomes and is clearly viable, while more ambitious upgrades (at least Portfolio 2) are possible with a blended portfolio model. The specific conclusions drawn from this analysis are summarised in the table below.

Conclusions on financial viability and thermal comfort impact of modelled PV Only/portfolio scenarios

Portfolio	Financial Viability	Thermal Comfort/Health Effect
PV Only	Cost-effective with a 10.1/10.4-year discounted payback	None
Portfolio 1 (basic)	Shorter payback period over 'PV only' by ~1 year. Higher capital costs are covered by additional energy savings and increased solar self-consumption.	Modest but meaningful: Draught stopping, insulation.

[2] The financial analysis was very sensitive to the tariff assumptions in the modelling. While different tariff scenarios are presented in Section 2.4, only the most representative 'standardised tariff' scenario is shown in the Executive Summary.

Portfolio 2 (moderate)	Slightly longer payback periods (12-13 years), which are viable if supported by long-term finance, albeit more sensitive to finance length and rates.	More substantially improves summer thermal comfort by adding ceiling fans.
Portfolio 3 (advanced)	If based exclusively on energy savings, payback is equal to or greater than 15 years. Still financially viable from societal perspective with only a $63-198/dwelling/yr health dividend: a fraction of the dividend demonstrated in Victorian Healthy Homes. Upgrades beyond Portfolio 2 could be funded with grants (i.e. where no repayment required).	Most substantially improves winter/summer thermal comfort by adding window shading and reverse cycle heating/cooling systems to dwellings struggling to meet WHO temperature guidelines.

Essentially this analysis reveals a viable but relatively narrow and time-critical pathway to allow social housing tenants to capture the benefits of solar now that the technology is available, while harnessing this as a revenue stream to improve thermal comfort and, potentially, health outcomes. The model hinges on financing arrangements and is potentially vulnerable to reducing solar PV renewable energy certificates towards the scheme closure in 2030. Additional policy support may be needed to fill this gap to allow the social housing sector to roll out shared solar in the coming years.

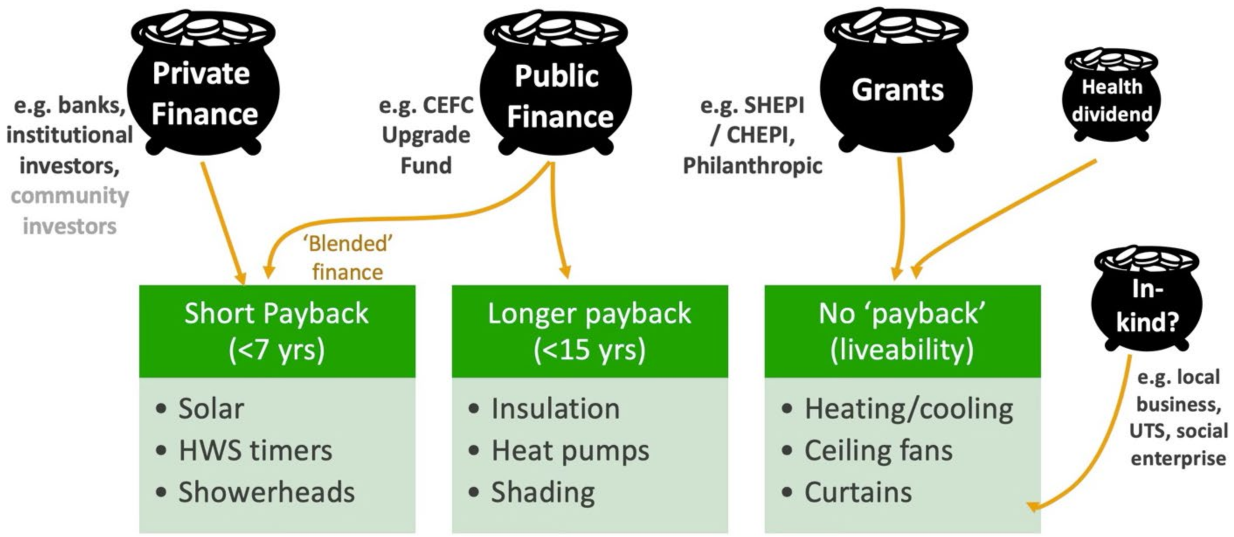
Recommended Delivery Model

Three delivery models – a rebate swap, a retailer intermediated model and a battery virtual power plant (VPP) – were explored to address the financial and operational challenges of implementing shared solar and complementary upgrades. The retailer intermediary model was deemed a suitable solution to address the split incentive and the most viable for implementation. This model involves a retailer financing the solar and upgrades, managing billing, and offering discounted solar usage to tenants. It requires no capital investment from the CHP and avoids debt on the CHP balance sheet. The model also allows for exploring partial rebate swaps to increase the depth of energy upgrades.

A similar proposed model is already in development in the market but is yet to be deployed in social housing apartments and needs to be connected to a lower cost, longer-term finance source to allow inclusion of other energy upgrades.

Funding and financing sources

Low-interest, long-term finance could be achieved using the Clean Energy Finance Corporation (CEFC) Home Energy Upgrades Fund. The development of a CEFC mechanism would be relatively complex and take at least 12 months to be negotiated and designed. Therefore, for Phase 2 of the project we recommend that the long-term financing architecture be designed alongside a demonstration of the model's viability in social housing apartments in Glebe and Brookvale. In the absence of immediate CEFC finance, a similar outcome could be achieved by blending higher cost private finance for solar with SHEPI/CHEPI innovation stream or other grant funding to deliver a wider range of complementary upgrades, at an acceptable level of discount for tenants. This blended finance approach is described visually below.



Recommended blended finance approach for different measure types

Future Research and Innovation

The project identified several strands of important future work, including i) the development of smaller, more cost-effective heat pump hot water systems for small social housing apartments, ii) the viability of load shifting with 50L electric hot water storage systems and iii) clarifying how switchboard and metering costs are reconciled.

Section 5 describes several other important reflections for scaling future project delivery, including home auditing software capabilities, site selection and tenant engagement and recruitment.

1 Introduction

1.1 Background

National and state governments have adopted a target of achieving net zero emissions by 2050, with NSW committed to an interim goal of 50% reduction in emissions (over 2005 levels) by 2030. The Climate Council recently called for faster reductions—recommending a 75% reduction by 2030 and net zero emissions by 2035.

While improving the environmental performance of new buildings is critical, a significant proportion of all buildings that will exist in 2050 have already been built. Climateworks[3] research suggests that the cheapest way to reach net-zero emissions buildings by 2040 involves improving the energy efficiency of existing homes by nearly 50%. Solar power alone does meet net zero. This will require significant energy efficiency upgrades to the existing housing stock, including many of the more than 150,000 social housing dwellings in NSW.

Social housing tenants and lower income households can be particularly vulnerable. They are less empowered to maintain comfortable conditions inside their homes and are often less able to cope with extreme weather conditions where complex health and wellbeing needs exist. Improving the energy efficiency of social housing thus presents the opportunity to bring health and wellbeing improvements for tenants, while delivering healthcare savings for governments and wider environmental benefits.

To implement energy upgrades at scale requires a delivery model that householders trust, and that provides a sustainable business case while fairly distributing value creation. While individual interventions can provide energy savings and other benefits, an integrated program involving multiple interventions can unlock additional value. For example, combining rooftop solar with controlled hot water enables additional savings through increased energy self-consumption, while a new solar installation with a smart meter provides opportunities for empowerment and reduced energy bills through demand flexibility, no-disadvantage time-of-use tariffs, energy use monitoring, and billing advice.

1.2 Context and project objectives

The technology for shared solar for apartments is now available and tested. However, these shared solar applications cannot be readily replicated by social housing providers, as the housing provider does not capture sufficient benefit to overcome reliance on grant funding to apply shared solar across their portfolios. Social housing apartments in NSW are typically over 20 years old and may require load flexibility or upgrades to the thermal shell or heating, cooling and hot water systems to enable apartment households to take the greatest advantage of a shared solar system.

This project aimed to research and design a financially self-sustaining and replicable model for shared solar and thermal upgrades of social housing apartments by:

- Understanding which stakeholders' benefit/lose and by how much with shared solar
- Determining how to capture missing value through:

[3] *Climateworks Centre*, *Climate-ready homes: Building the case for a renovation wave in Australia* (2023), https://www.climateworkscentre.org/wp-content/uploads/2023/11/Climate-ready-homes-Building-the-case-for-a-renovation-wave-in-Australia-Summary-report-Climateworks-Centre-December-2023.pdf, pp. 21, 33.

    - Improving solar utilisation through hot water load shifting and complementary energy upgrades with other thermal comfort and health benefits.
    - Tenant energy rebate swaps.
    - Peak Demand Reduction Scheme (PDRS) revenue streams.
    - Retail partnerships (so solar exports always yield financial benefit for tenants).
    - Alternative business models.

- Working with stakeholders to design a rollout that fills any capital shortfall, considering above viable policy mechanisms, aligned with NSW/Federal funding, green bond or other long-term finance, social impact investment, or in-kind from local partnerships.

1.3 Research approach and site selection

The project uses an action-learning research approach with a three-phased structure to scale up the concept over time:

- **Phase 1** (this report) involves value sharing analysis and solution design, using Bridge Housing sites as case studies for pilot design but trying to solve for a broader problem across the sector. Test sites were selected in close consultation with the Bridge Housing team:
    - Site 1 is a 1970s social housing apartment block in Glebe with 30 units, which is typical of small, 1-2 occupant apartments with space constraints and a range of unit orientations.
    - Site 2 is a ~1980s 2-storey unit block that was selected as a site in which gas usage was understood to be used in hot water and cooking. This site is in Brookvale, as there is very limited gas in Glebe.[4]
- **Phase 2** covers piloting the delivery of integrated upgrade package elements at the pilot sites to determine any implementation impediments, clarify unexpected costs or benefits, to increase confidence prior to a broader rollout.
- **Phase 3** involves identifying and refining a preferred delivery model that will work at scale across Bridge Housing and other CHP portfolios, as well as considering any broader systemic support needs, such as software or workflow development and integration with existing and emerging government incentive and facilitation programs.

1.3.1 Key research activities

Phase 1 involved four key research activities as described in Figure 1 below. Modelling was first undertaken to understand the business case before and after optimisation with load shifting and other upgrades to confirm if a financially viable outcome was possible given the known site constraints. This utilised the BOOM! Power tool as a means of assessing the workflow and assessment capability of the predominant tool for upgrade delivery in the social housing market. Tenant engagement was undertaken to capture qualitative data around the lived experience of energy, comfort and lifestyle impacts. Tenant engagement was delivered in two stages, with one being the launch event at each site, allowing tenants to have the opportunity to interact with the research team and second was to share the modelled options/scenarios and invite tenants was to sign up for an in- home audit. Tenant engagement was led by Centre for Social

[4] A third NSW Homes terrace site in Glebe was originally planned to broaden the base of housing types and providers, but was ruled out as upgrades for this area are not within the housing provider's short-medium term plan.

Justice and Inclusion (CSJI) at UTS, with home audits undertaken by ISF, in close collaboration with the Bridge Housing Technical and Tenant Engagement Officers. Feedback from audit data was integrated with modelling to clarify the portfolio of proposed upgrades and adjust the interaction with the shared solar business case.

The final step was to understand different solutions to address split incentives and capital shortfall through interviews with relevant industry parties and industry reference group meetings. The reference group guided the research process by contributing knowledge and expert inputs in the areas of policy design, project structure and deliver models at relevant stages. A co-design workshop with members of the reference group and tenants was also used as an opportunity to help strengthen the project design and delivery options. Phase 2/3 planning was then built around the outcomes of this process.

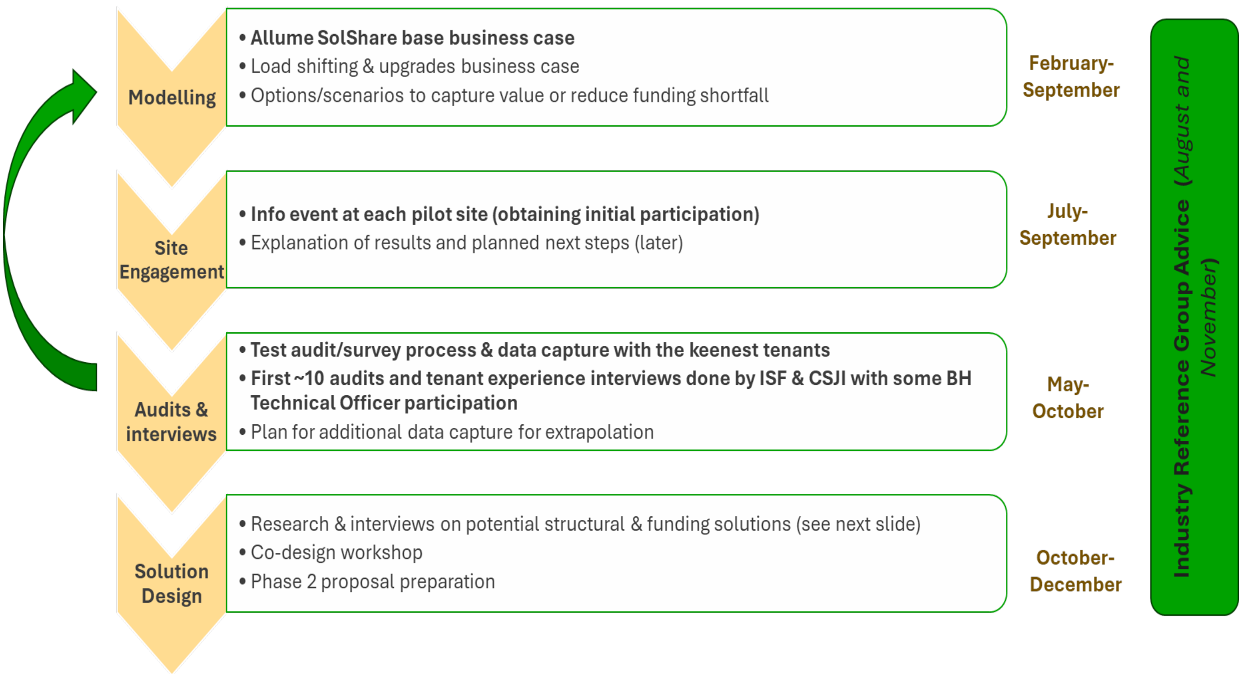


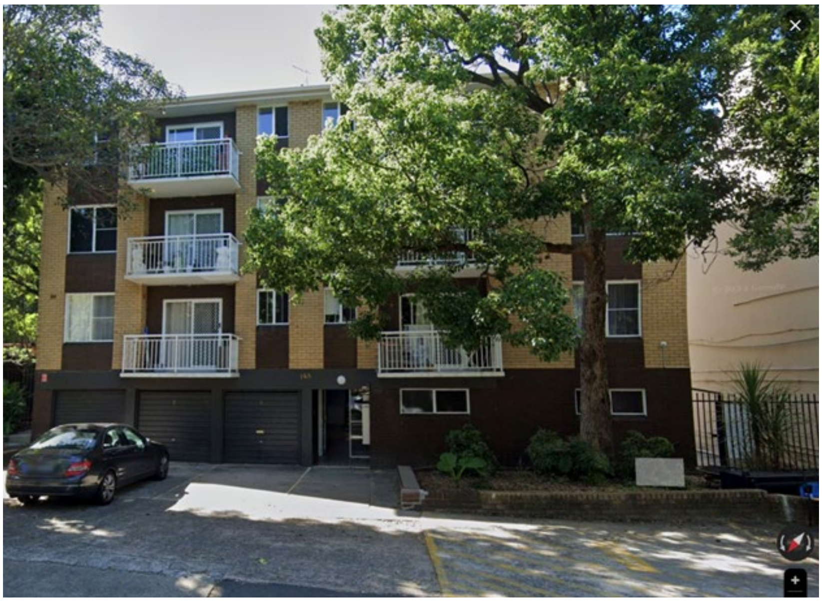
Figure 1 Key research activities in Phase 1

2 Modelling and analysis

2.1 Current energy use and thermal performance of dwellings

2.1.1 Glebe

The apartment block in Glebe is a 1970s three storey walk up structure with garages underneath (see below Picture 1). The block contains 30 x 1-bedroom units sized approximately between 35-40 square meters. Most layouts are similar but with very different orientations. The roof is in reasonable condition with little to no shading and sufficient space for 25-45kW of solar (with orientation varying from NE, NW and SW).



Picture 1: Glebe apartment block

Energy audits conducted in a sample of six representative units, and broader conversations with other tenants, confirmed that most tenants were home during the day and consumption was thus distributed between 6am and 11pm, rather than just a morning and evening peak. Based on the review of customer bills, energy consumption was low but variable, with consumption ranging from 5-12kWh/day (annual average) for audited dwellings.

Some units were uncomfortably hot, whereas others were uncomfortably cold and many were mostly comfortable. Tenant experiences interviews suggested that an excess or lack of solar access was the biggest determinant of thermal comfort. This is primarily determined by the aspect of the exposed facades but is also influenced by the shading from nearby trees and the level of building. Units with NW and SW exposure tended to get very hot in summer, particularly those on the top floor. Units with SE exposure tended to get very cold in winter, particularly those on the bottom floors. Health conditions also made some tenants more sensitive to thermal discomfort.

Quotes from the Glebe residents highlight thermal comfort situation in some of the units:

"*The cold weather [is challenging] …I've not really felt cold down to my bones like that, other than about 15-20 years earlier when I was down in Melbourne staying in a caravan in the middle of winter*" – Glebe resident

While excessive heat was noted to have effects of sleeping behaviour of some residents:

"...when it's really hot...sometimes I can't sleep and then... I would just go out for a walk"
– Glebe resident

However, thermal discomfort did not necessarily translate to high energy use, as tenants were often very sensitive to energy bills. Fear of debt/debt collection from power companies had a strong influence on energy behaviour for some residents due to past experiences.

In this building, 2 of the 6 audited residents owned portable air conditioners, and only small (low energy) desk fans were used for cooling otherwise. Energy bills were higher in winter, due to the only heating option being inefficient resistive heaters. Such heaters are small and inexpensive to buy, but very expensive to run. Average daily usage was double in winter for some households as a result. Mould was generally not reported as a common issue in this building.

While thermal modelling was not part of the core scope, the below image illustrates the impact of solar access on thermal performance: a unit with NNW aspect yields a 3.7-star NatHERS rating, being outside World Health Organisation (WHO) temperature guidelines 8% of the time. A unit with the exact same layout with a SSE aspect (i.e. facing the opposite direction and thus getting almost no direct sun) yields a 2.3-star NatHERS rating, with temperatures below the lower WHO guideline threshold of 18 degrees in living areas more than 20% of the time (see below Picture 2)

The conclusion here is that the assessment of upgrade priorities for social housing apartment must take account of aspect or solar access, not just floor areas or energy consumption.

Picture 2: Energy performance star rating from HERO Modelling for Glebe apartments

2.1.2 Brookvale

The apartment block in Brookvale is a 1970s-1980s two-storey walk up structure with open parking area at the back end of the property (see Picture 3 below). It includes 13 x 1-bedroom units sized approximately between 35-40m². Unit layouts were quite variable, covering a range of shapes and orientations. The roof has moderate shading to the western end of the building and limited shading to the east end of the building. The roof is sufficient for largely unshaded solar access of at least 15kW but probably up to 25kW (additional roof area is available but increasingly shade affected).

After performing audits, the extent of gas usage was found to be much less substantial than inventory data indicated, with no units having gas cooking and only two units being connected to gas hot water. This makes this site less useful as a 'full electrification' case, although still enables the assessment of gas to electric heat pump hot water system conversion.

Picture 3 Brookvale apartment block

Energy audits conducted in a sample of five representative units confirmed that, similar to Glebe, most tenants were home during the day. Based on the review of customer bills, energy consumption was also low but variable, with consumption ranging from 6-10kWh/day (annual average) for audited dwellings.

More often than in Glebe, units were reported as uncomfortably hot, and more tenants owned portable air conditioners. Based on layout and aspect alone, however, it was more difficult to predict thermal performance. Extrapolating anticipated energy usage from a subset of audited units was more challenging than in Glebe.

Mould was more commonly reported as an issue in this building, and influenced tenants' willingness to use fans, for example, as some considered this to be recirculating stale air.

2.1.3 Comparing buildings

The features of each building compared are shown in Table 1 below.

Table 1: Comparison of pilot site buildings

	Glebe	Brookvale
Number of units	30 x 1 bedders	13 x 1 bedders
Construction	Double brick (1970s)	Double brick (1970-80s)
Primary aspect	NE (12), NW (12), SE (6)	NE (7); SE (4); SW (2)
Cooking	Electric (coil)	Electric (coil)
Water heating	50L electric resistance (50% indoor; 50% outdoor)	Gas storage 240L (2 units) 50L electric resistance (7 indoor; 4 outdoor)
Electricity usage	5-12kWh/day	6-10kWh/day
Portable air conditioning	None (or very limited)	Low-Moderate
Resistance heating	Low to moderate	Moderate
Roof/ceiling insulation (top floor)	Fibreglass (<R1.0) Foil sarking (some tears)	Blown sawdust (<R1.0) Foil sarking
Common area loads	Corridor/carpark lighting (nighttime), recycled greywater treatment (times of water use, primarily 6am-11pm)	Corridor lighting, common area kitchen (rarely used & hot water system disconnected so largely nighttime only)

While no sub-metering data was available, constructed energy end uses were highly variable between apartments. Water heating, for example, varied from 25-58%, depending on HWS type, showering patterns and showerhead efficiency. Some with no heating or cooling energy lived in quite thermally comfortable premises, while others just withstood high level of discomfort during summer or winter.

2.2 Business case for shared solar (without upgrades)

Before undertaking modelling of upgrades in combination with shared solar, a business case for shared solar was undertaken in isolation, to confirm that industry estimates of societal payback period were within an acceptable level and to test the project concept. Given the earlier available data, Glebe was used as the case study to explore this question.[5]

[5] Brookvale had a similar daily energy consumption, tenant load profile pattern (albeit some greater weighting towards summer cooling usage over winter heating usage) and optimal solar sizing of 1-1.5kW per unit. Brookvale was therefore considered to have a similar or shorter payback period.

Shared solar of 30kW (1kW per unit) was deemed optimally cost-effective using the BOOM software tool. Using this sizing and in the absence of other upgrades, costs were compared with the discounted 15-year bill savings and export revenue, as shown in Figure 2.[6] Shared solar was found to have a potentially attractive – albeit longer – payback period than is typical for stand-alone dwellings, primarily due to additional capital costs associated with sharing power between units.

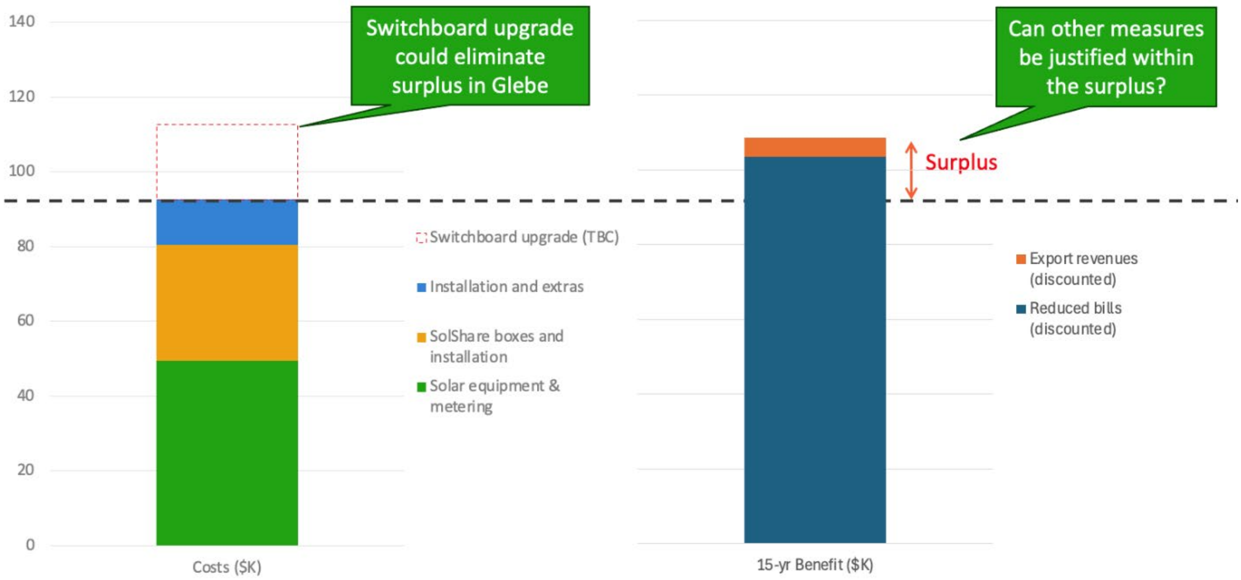


Figure 2: Preliminary business case for Glebe comparing capital costs and 15-year benefits (discounted)

The project showed a payback of 9.2 years (simple) or 12.2 years (discounted), however the business case was dependent on two important detailed design factors:

- Whether a switchboard upgrade is triggered: This could increase costs in the order of $20,000 if required, based on an electrical assessment at the time of building acquisition several years ago. A solar specialist is yet to visit the site to make an assessment. A switchboard upgrade on the project ledger would substantially reduce the potential surplus (refer to the recommendations in Section 4.3.3 for further discussion of this issue)
- Number of SolShare boxes required: The building has 30 units on single phase power in addition to separately metered 3-phase common area loads, totalling 33 meter connections. Each SolShare box costs in the order of $15,500 (installed) and can support up to 15 meters. If all meters were to be serviced assume this technology, *three* SolShare boxes would be required as a cost of $46,500, or 40% of total capital cost. To 'optimise' costs, only two SolShare boxes were included, with a separate small solar system servicing the common areas.

For relative scale, the capital costs of a shared solar (only) project, if repaid over 15 years, would be equivalent to participating households swapping about 85% of their $385/yr low-income energy rebate. The concept of rebate swaps as an actual financing mechanism is discussed further in delivery models in Section 3.

The 4c/kWh feed-in tariff for energy not consumed behind-the-meter is reflective of the 2025 retail market. While it could be argued that this may decline, in the ultimate proposed model explored through this project,

[6] Net present value (NPV), using a discount rate of 4.5% p.a. and a solar feed-in tariff of 4c/kWh.

the retailer sells this energy to a portfolio of business customers with daytime demand, consuming power at retail rates so the effective value may be substantially higher than this.

The preliminary analysis also suggests that given that if there was a degraded financial case for other buildings – due to heavy shading of solar access, having numbers of units that do not divide neatly by 15, or having to finance high switchboard upgrade costs – then not all social housing buildings will be cost-effective for shared solar.

If site conditions are right, however, the preliminary analysis indicates that if a long-term, low-cost financing arrangement of up to 15 years was available, a surplus financial benefit could plausibly be used to fund additional energy upgrades. The scale of this surplus in the Glebe case is modest – in the order of $500-1,200 per unit – if these measures merely represent additional costs. However, if in addition to driving thermal comfort improvement, these measures can also drive energy savings or shift demand to daytime hours, they could further improve the cost-effectiveness of shared solar. Therefore, to assess the merits of combining energy upgrades and solar, modelling of 'portfolios' of *shared solar plus upgrades* is required. These additional measures are explored in the subsequent sections.

2.3 Complementary upgrade measures

A representative sample (~25%) of units across both buildings underwent a detailed energy audit and tenant experience survey to determine viable complementary upgrades, and occupant preferences regarding shared solar, hot water changes and thermal comfort issues. After the audits were completed, three upgrade portfolios were developed. Basic ($1200-1400/unit), moderate ($3700/unit) and advanced ($5000-8000/unit) measures, withincreasing cost comes deeper energy upgrades and thereby greater energy savings.

Given that the exhaustive suite of measures included in the high-cost portfolio is unlikely to be able to be funded through this model, prioritisation is required. To this end, the approach taken was to:

- Consult with IRG members and tenants about the upgrades they would prioritise and why
- Develop a set of principles to guide the selection of upgrades
- Interpret these principles for specific measures in the case study buildings.

2.3.1 Tenant, CHP and industry stakeholder perspectives

All proposed complimentary measures were discussed with IRG members (comprising CHP representatives government and other industry stakeholders) and tenants, to understand their priorities and rationale for prioritising one measure over the other at a co-design workshop. Participants were given an approximate upgrade costs and a nominal budget of $2,000 per unit to work with. Tenants tended to select more options that drive direct bill savings due their recent experiences of increased electricity bills, whereas CHPs and CHP representatives favoured measures that balance both comfort as well as impact on bills (Figure 3). This was likely influenced by the thermal comfort measures being more expensive and a budget constraint having been applied. Draught sealing, showerheads and insulation were the most selected items, as shown in Figure 4. CHPs and CHP reps tended to favour options with good cost-effectiveness and minimal need for behaviour change or maintenance.

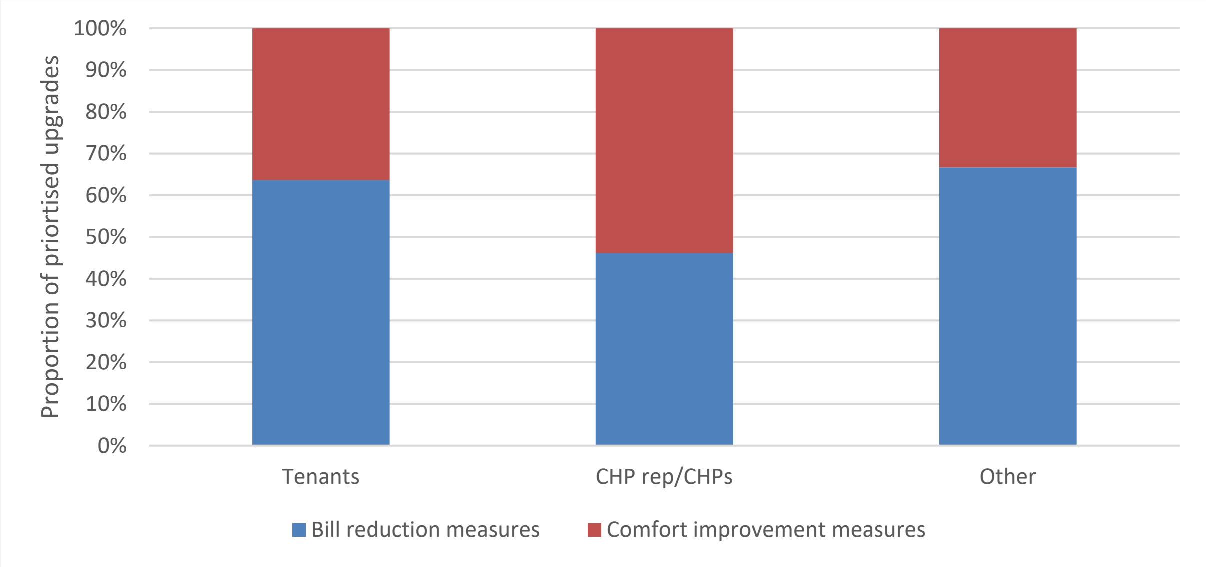


Figure 3: Bills vs comfort improvement focus by stakeholder type

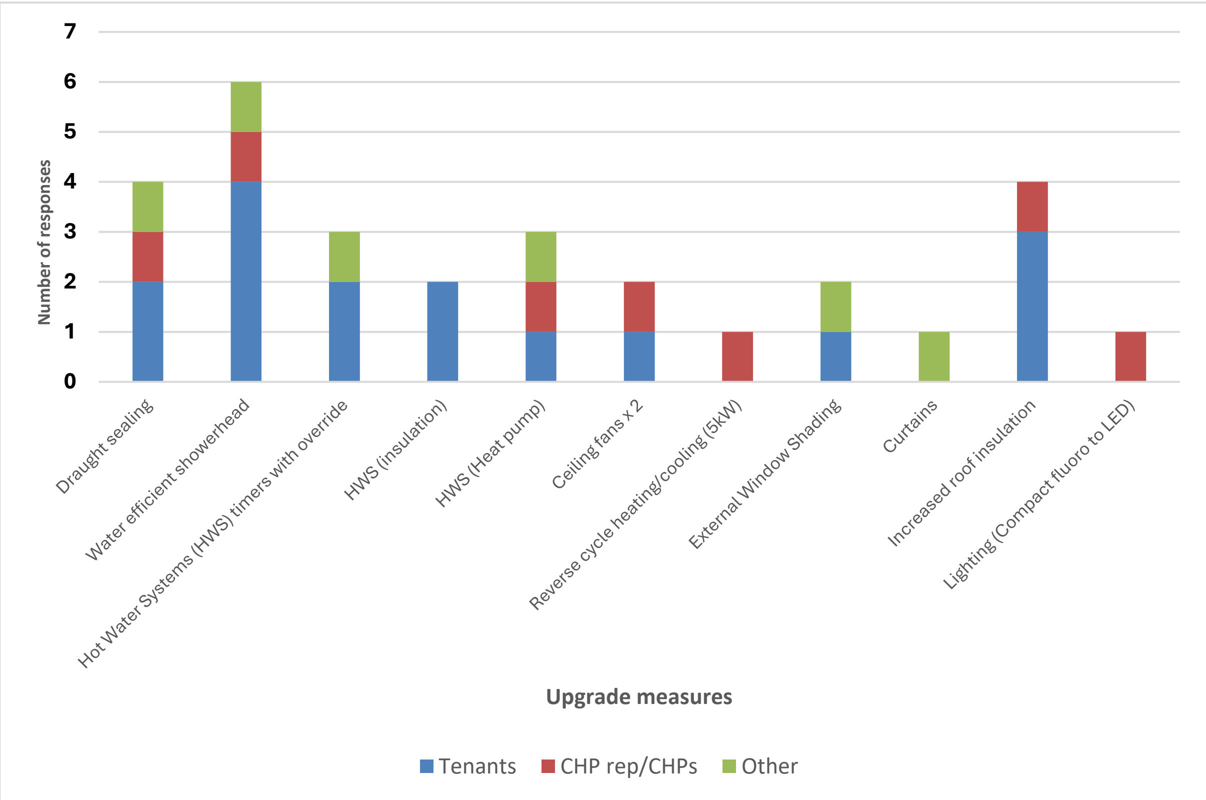


Figure 4 : Upgrade preferences by stakeholder types

2.3.2 Principles for selecting upgrade portfolios

One finding of the tenant engagement and auditing process was that every dwelling in a building should not get the same upgrades by default, as the variation in solar access or positioning in the building (top vs. bottom floor) can have a huge impact on whether a unit needs to address heating, cooling, or both.

Given that the model cannot fund all upgrades, the following set of principles were developed to aid prioritisation and tailoring of measures, responding to a suggestion raised at the co-design workshop:

1. Upgrades should be based on the dwelling, rather than the current tenant's specific usage of the dwelling.
2. CHPs should target a minimum level of thermal comfort for passive health benefits (star rating, modelled thermal load bounds, or a feature-based approach). This implies that building fabric improvements will likely only be to some unit types (e.g. insulation benefits top floor only, shading to exposed aspects only).
3. Upgrades should not rely on a tenant's specific lifestyle pattern or assumed behavioural change to deliver benefit. For example, encouraging load shifting to improve overall benefit is desirable but should not be required to derive *any* benefit.
4. Upgrades that could affect service (e.g. HW flexibility or showerheads) should be on an opt-in basis (when unit is tenanted; otherwise, default).
5. Reverse cycle heating/cooling upgrades need to be carefully managed. These should only be implemented *after* building envelope upgrades (as a duty of care to manage bill increases) and highest priority should be when this presents a solution to mould issues and cold units with no alternative to resistance heating. Hot units should only be targeted for reverse cycle for cooling *after ceiling fans* have been installed.
6. Heat pump hot water systems should be the default for all *hot water replacements* unless technically unviable. Load-shifted electric storage (opt-in) should be considered where heat pumps are not feasible or financially viable. This can be supported with some market innovation that can deliver solutions for smaller units and are relatively cheaper (see Section 4.3).
7. Partial rebate swaps should only be considered if they can be restored when the tenant moves and where financial benefit for that tenant can be guaranteed (note that this favours bill savings over thermal comfort measures).

2.3.3 Proposed upgrades in context

The initial shared solar business case (section 2.2) indicated that if low-cost, long-term finance could be secured, this would allow a surplus from solar savings to fund a set of complementary energy upgrades. A higher interest rate or shorter term would mean that fewer upgrades could be undertaken. The more an upgrade increases solar self-consumption the greater its complementarity, effectively meaning that more upgrades are possible within a viable business case. The proposed upgrades are outlined below, organised as increasingly ambitious (an expensive) portfolios of options.

Draught sealing (All portfolios)

The level of draughtiness varied across the units audited. Neither building is exceptionally good nor exceptionally poor. Balcony doors and sliding windows were generally reasonably well sealed, so an average allocation of $400/unit was made to cover filling permanent wall vents (required in Glebe, and potentially in Brookvale[7]), and for front door seals (both buildings). This would primarily help to reduce heating energy losses in Glebe, and heat/cooling energy losses in Brookvale, where cooling is also used.

[7] Needs to be confirmed by CHP on next site visit.

Behavioural factors also need to be considered. Some tenants leave doors/windows open for fresh air (smokers), general ventilation, or background noise, so draught sealing may have a limited effect without encouraging a shift in behaviour when any space heating or cooling is taking place. Any filling of permanent wall vents would need to be accompanied by tenant education to ensure spaces are occasionally manually ventilated, particularly in Brookvale where mould issues are experienced. This may also help to reduce cockroach ingress experienced by some tenants.

Water-efficient showerheads (All portfolios)

These are technically 'standard' on all Bridge Housing units but may have been replaced by tenants with inefficient versions at some point or never have been physically tested for flow rate. Audits found that 50-60% of sampled units had efficient showerheads (tested at 5-9L/min, or 4-5 stars). 40-50% of sampled units had very inefficient showerheads with flow rates from 11-15L/min (1-2 stars). It was assumed that units over 9L/min (worse than 3 stars) would be replaced with a 7.5L/min (between 3-4 star) showerhead. No financial allocation was made as this is likely be fully covered by ESCs.

As some tenants may be hesitant to take a lower flow showerhead, these should be offered on an opt-in basis or upgraded as standard upon change of tenancy. A side benefit of this upgrade is running out of hot water less frequently (which was relatively common with 50L systems), or being able to take longer showers before running out of hot water.

Hot Water System (HWS) Upgrades

Three options are recommended depending on a) whether the existing HWS is indoors or outdoors, or b) a low- or medium-cost option is justified, based on available finance rates/terms.

- HWS timers with override (Portfolios 1 and 2): Where units have *internally located* (kitchen or bathroom/laundry) 50L electric storage systems, the cost of relocating the system to outside and pipework was assumed to be prohibitively expensive, and basic timers are recommended to increase self-consumption when paired with solar. We anticipate timers to be generally viable for households with a 1-shower/day pattern. With 2 or more showers/day (morning and night pattern), a timer set only to recharging during solar hours would not adequately service the tenant HW needs. A user override button/functionality and/or ability to switch off the timer is important to ensure that hot water availability is not disrupted for temporary changes in showering patterns or occupancy.
- HWS Insulation (Portfolio 1): *Externally located* systems generally did not have substantial insulation (although some are covered with a metal box and pipe lagging was generally present), leading to higher than desirable heat losses. A $300 allowance was made for the outside units in basic portfolio (#1). An upgrade to heat pump HWS is preferable and viable for outside units. As these were more expensive, they were confined to Portfolio 2.
- Heat pump HWS (Portfolios 2 and 3): Where HW systems are *located externally*, a straight switch from electric resistance (Glebe/Brookvale) or gas storage (some Brookvale units) to heat pump is recommended. As there are currently no high-quality, low-cost small heat pump systems available, this is a relatively expensive measure. For units switching from electric storage an allowance of $2700/unit is made, which assumes $3600 retail cost (for 175L Quantum system) minus $720 STCs, minus $970 ESCs, plus $750 installation. Certificate values for switching from gas storage are slightly lower, adding around $300 to the cost (i.e. $3000/unit allowance).

See the recommendations for an additional innovation project to bring more appropriate small heat pump systems to the Australian social housing market.

Ceiling fans x 2 (Portfolios 2 and 3)

All audited units across both buildings relied heavily on desk fans for cooling, while some complemented these with portable air conditioners (primarily in Brookvale). Desk fans are relatively efficient but provide a lower level of service than ceiling fans, particularly in bedroom spaces. An allowance of $1100/unit was made for the recommended installation of two high-efficiency DC ceiling fans: one in the bedroom and one in the living area.

These may lead to a slight increase in energy consumption through the ability to better rely on ceiling fans overnight, but a higher level of tenant comfort. This is considered an important 'base upgrade' in a warming climate, wherever sufficient roof height allows. Some tenants reported hesitance to use fans as they recirculate 'stale air' in units concerned about mould. Tenant education of the best combination of fans/windows/air conditioning would be beneficial.

Reverse cycle heating/cooling (5kW; Portfolio 3)

According to the principles outlined in Section 2.3.2 above, air conditioning is only recommended when roof/ceiling insulation is present and other base upgrades like ceiling fans has already been undertaken. This fulfils a duty of care to prevent bill shock, as such systems are expensive to run for cooling (but represent a substantial saving when used for heating).

An allowance of $4000/unit is made for a 5kW unit installed in the living area. As this is an expensive upgrade and can increase energy bills, it is only recommended in units with very poor solar access (such as S or SE aspect or with heavy shading from trees) and in units where there is a combination of a heating need, a cooling need, and mould (such as where dehumidifiers are being used). This means it is recommended for some Glebe units, and all Brookvale units, but only in Portfolio 3, which is unlikely to be fundable through this bundled approach (unless additional dedicated grants are available).

External window shading (Portfolio 3)

External operable blinds are recommended on units with strong exposure to the westerly sun, particularly in sleeping areas (Upper NW corner units in Glebe and Brookvale units with a W/SW bedroom window). These tend to be units located higher in the building (less covered by shading), which also require roof/ceiling insulation. The latter is considered higher priority as it addresses heating *and* cooling, so window shading has been only included in Portfolio 3, with an allowance of $750. Ideally, this type of measure would also be included in Portfolio 2, and also be SHEPI grant funded as it has good health/thermal comfort improvement outcomes and may not have a 'financial payback' as many units suffering from heat to do not use conditioning to address the problem as just suffer the discomfort.

External shading is also only recommended where access to the window is possible without building expensive scaffolding systems, such as from the ground (directly or to second floor via a ladder), or on balcony windows. Where highly exposed bedroom areas cannot have shading installed, low-cost, internal white (reflective) blockout blinds could be considered if the tenant has issues with sleeping temperature.

While curtains would generally be beneficial, these are typically a tenant responsibility. The auditing revealed that many tenants 'make do' with sheets, sarongs or other light/permeable materials that have limited thermal benefit. This measure was not able to be thermally modelled and the relative benefit of installing heavier curtains was unclear given some kind of curtain was already in place. Therefore, curtains were not included in any portfolios but could be considered for inclusion in the CHP 'standard offering' for units to provide both privacy and thermal benefits avoiding makeshift curtains being used as a default.

Increase roof insulation (all portfolios)

This is recommended for all top floor units, as only a small amount of very old fibreglass (Glebe) or blow-in (Brookvale) insulation was present, which we estimate to have an R-value of < 1.0. Increasing insulation by R3.0 would reduce winter discomfort hours by 23% and summer discomfort hours by 5%. Glebe also had some tearing of the foil sarking, which would reduce protection from heat on summer days. These should also be repaired at the same time as installing additional insulation.

An allowance of $17,000/11,900 (total) for Glebe/Brookvale was made based on floor areas, and including electrical compliance inspection for safety. While this is expensive on a per-unit basis ($1700/unit), this is considered a basic necessity for top-floor dwellers and average cost across the building was acceptable even within Portfolio 1.

Lighting (CFL to LED)

Most units had relatively efficient lighting, with LED increasingly used as standard. However, some heavily used lights were still CFL and thus a modest saving is achievable from a switch to LED globes. Only a very small cost allowance of $33/unit was made, although these may be fully covered by ESC certificates.

Retailer tariff switching

Tenants often had limited visibility of their energy use/bills and around 60% were not on the most competitive energy plans, even if the plans were offered by *their own* retailer. Tenants did not necessarily trust retailers when the energy regulator requires them to inform customers (via their bill and/or phone calls) that they may be better off on a different plan, meaning that 'do nothing' becomes the default. Tariff switching is a no capital cost, no regrets option that is recommended for all portfolios. There are arguments for and against including retail tariff switching in the business case analysis – these are explored in Section 2.4, and a tariff switching case is presented separately, in which customers on less competitive plans can come onto a more competitive rate (those above a 0.33c/kWh flat rate or 90c/day fixed charge come down to this level).

2.3.4 Proposed upgrade portfolio inclusions

A summary of the complementary energy upgrade portfolios alongside shared solar are shown in Table 2 below. This applies the principles from Section 2.3.2 to the case study buildings.

Table 2: Summary of upgrade portfolio inclusions (in addition to shared solar)

	Portfolio 1: basic	Portfolio 2: moderate	Portfolio 3: advanced
Upgrade measures (applied to relevant apartments only)	• Draught sealing • Water-efficient showerheads • HWS Timers (indoors) • HWS insulation (outdoors; Glebe only) • Roof/ceiling insulation (top floor) • CFL to LED lighting • Retailer switch	Portfolio 1 + • Heat pump HWS (to replace HWS insulation in Glebe, and for outdoor units in Brookvale) • Ceiling fans x 2	Portfolio 2 + • Reverse cycle heating/cooling (targeted) • External shading (targeted)

The *specific* unit allocations for each of the upgrades is shown in the tables below. Note that the research team did not have full access to all units in the buildings, and this approach uses extrapolation based on floor plan layout, aspect and hot water system location as observed from outside. The unit numbers bolded are those for which greater certainty exists – either because they were audited directly (and bills sighted) or hot water system location and type was assessable from outside the building.

Glebe

Energy upgrade	Applicable units: Quantity	Applicable units: Unit #s	Installed cost est. (per unit)	Impact on bills	Impact on comfort/health	Portfolio inclusions: P1	Portfolio inclusions: P2	Portfolio inclusions: P3	Portfolio costs: P1 cost	Portfolio costs: P2 cost	Portfolio costs: P3 cost
Draught sealing	30	All	$400	Low-Med	Medium	Yes	Yes	Yes	$12,000	$12,000	$12,000
Water-efficient showerhead	15	As required (but including **#1** & **#5** of audited sample)	$0	Med-High	None	Yes	Yes	Yes	$0	$0	$0
Hot Water System (HWS) timers with override	12	**4-7, 14-17, 24-27**	$150	Med-High	None	Yes	Yes	Yes	$1,800	$1,800	$1,800
HWS (Insulation)	18	**1-3, 8-13, 18-23, 28-30**	$300	Low-Med	None	Yes	No	No	$5,400	$0	$0
HWS (Heat pump)	18		$2,700	High	None	No	Yes	Yes	$0	$48,600	$48,600
Ceiling fans x 2	30	All	$1,100	Low	Med-High	No	Yes	Yes	$0	$33,000	$33,000
Reverse cycle heating/cooling (5kW)	9	1, 8, 9, 11, 18, 19, 21, 28, 29	$4,000	Increase/ Decrease	High	No	No	Yes	$0	$0	$36,000
External window shading	9	10, 20, 30, 22, 25, 26	$750	Low	High	No	No	Yes	$0	$0	$6,750
Increase roof insulation	10	**21-30**	$1,700	Medium	Med-High	Yes	Yes	Yes	$17,000	$17,000	$17,000
Lighting (Compact fluoro to LED)	15	As required	$33	Low	None	Yes	Yes	Yes	$495	$495	$495

	P1 cost	P2 cost	P3 cost
TOTAL	$36,695	$112,895	$155,645
AVERAGE PER UNIT	[illegible]	[illegible]	[illegible]

Brookvale

Energy upgrade	Applicable units: Quantity	Applicable units: Unit #s	Installed cost est. (per unit)	Impact on bills	Impact on comfort/health	Portfolio inclusions: P1	Portfolio inclusions: P2	Portfolio inclusions: P3	Portfolio costs: P1 cost	Portfolio costs: P2 cost	Portfolio costs: P3 cost
Draught sealing	13	All	$400	Low-Med	Medium	Yes	Yes	Yes	$5,200	$5,200	$5,200
Water-efficient showerhead	8	As required (but including **#12** & **#13** of audited sample)	$0	Med-High	None	Yes	Yes	Yes	$0	$0	$0
Hot Water System (HWS) timers with override	7	**2, 3,** 6, **7, 11, 12, 13**	$150	Med-High	None	Yes	Yes	Yes	$1,050	$1,050	$1,050
HWS (Heat pump)	6	**1,** 4, **5, 8, 9, 10**	$2,700	High	None	No	Yes	Yes	$0	$16,200	$16,200
Ceiling fans x 2	13	All	$1,100	Low	Med-High	No	Yes	Yes	$0	$14,300	$14,300
Reverse cycle heating/cooling (5kW)	13	All	$4,000	Increase/ Decrease	High	No	No	Yes	$0	$0	$52,000
External window shading	4	2, 3, **7, 13**	$750	Low	High	No	No	Yes	$0	$0	$3,000
Increase roof insulation	7	**2, 3, 6, 7, 11, 12, 13**	$1,700	Medium	Med-High	Yes	Yes	Yes	$11,900	$11,900	$11,900
Lighting (Compact fluoro to LED)	7	As required	$33	Low	None	Yes	Yes	Yes	$231	$231	$231

* Conversion from gas (Unit 4, 5 and possibly 6) will be closer to $3,000 due to lower ESC certificate value.

	P1 cost	P2 cost	P3 cost
TOTAL	$18,381	$48,881	$103,881
AVERAGE PER UNIT	$1,414	$3,760	$7,991

Figure 5 Unit allocations for each of the upgrades

2.4 Combined business case for shared solar *plus* upgrades

The combined effect of solar and energy upgrade portfolios was analysed relative to the business as usual (BAU; no investment) case. Solar self-consumption (the percentage of solar that is used behind the meter and thus not exported) varied according to the modelled load profiles, which were constructed based on the audited sample of energy end use breakdowns. Average solar self-consumption in the PV only case was around 60-70% in these buildings and increased by up to 8% when portfolio upgrades with some load shifting were undertaken.

While there was a reasonable amount of variance in energy savings between units, all but one unit type saved a significant amount of energy, before considering solar. Portfolio 1 upgrades reduced consumption by an average of 13-16%, Portfolio 2 upgrades by an average of 19-25%, and Portfolio 3 by 27-29%, as shown in Table 3.

Table 3: Underlying energy demand reduction from BAU scenario by option/portfolio for each building

	Glebe			Brookvale		
	AVG	MIN	MAX	AVG	MIN	MAX
PV Only	0%	0%	0%	0%	0%	0%
Portfolio 1	13%	7%	21%	16%	8%	32%
Portfolio 2	25%	19%	31%	19%	-1%	45%
Portfolio 3	29%	20%	42%	27%	13%	49%

When combined with solar, the effect of each modelled scenario on imported grid energy is shown for Glebe (Figure 6) and Brookvale (Figure 7) below. The coloured boxes encapsulate the middle 50% of the audited premises results. The 'X' shows the average, while the 'whiskers' above and below show the maximum and minimum within the sample. A progressive trend towards substantial grid energy reduction is evident across both buildings.

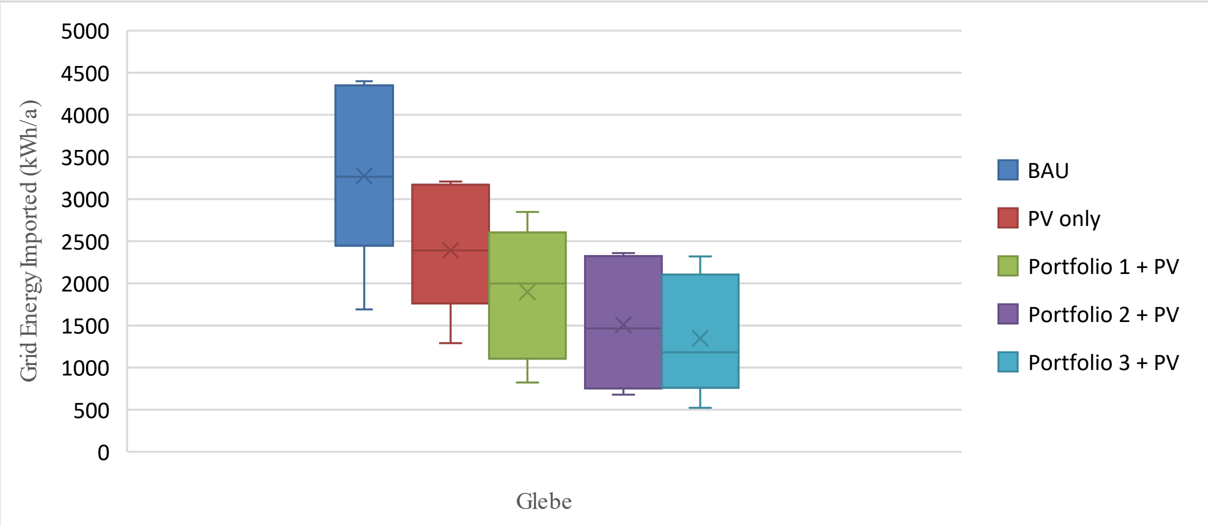


Figure 6: Impact of modelled scenarios on grid imported energy in Glebe building

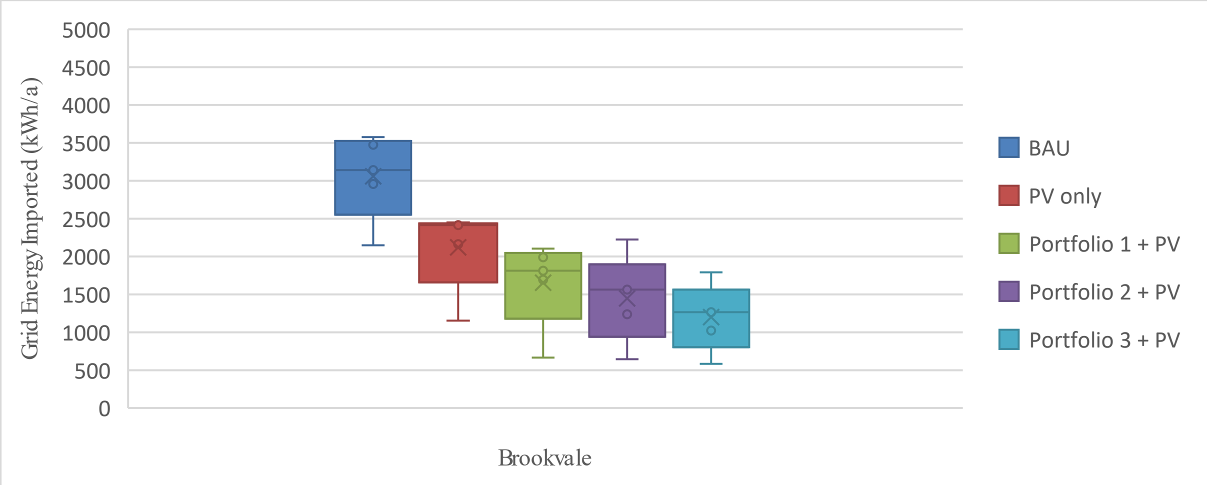


Figure 7: Impact of modelled scenarios on grid imported energy in Brookvale building

Capital costs for upgrades are as per the tables shown above, while shared solar costs were:

- Glebe: $94,439 (30kW with 2 SolShare boxes + 1 kW dedicated common area system; no switchboard upgrade)
- Brookvale: $43,049 (15kW with 1 SolShare box; no switchboard upgrade)[8]

The base assumptions for the analysis are as follows:

- Period of analysis: 15 years
- Real discount rate: 4.5%
- Inflation rate: 0.0%
- Electricity price escalation rate: 2.0%
- Gas price escalation rate: 2.0%
- PV system degradation rate: 0.5%
- Solar FIT ($/kWh): 0.04

Note that the sizing of solar was affected by the assumed feed-in tariff. A 4 c/kWh FIT essentially takes the position that excess solar will carry a low market value over the system lifetime and as a result the optimal system sizing is modest, in the order of 1 kW per dwelling (and the same for the common area system in Glebe). In the proposed retail intermediary model (see Section 3.2), daytime energy is on sold to business customers at retail rates, so it would not be unreasonable to increase the 'effective' FIT to reflect this model. This might mean that the facilitating retailer chooses to *maximise* the installed PV capacity on the available roof space if it is cost-effective within its financial model.

Discounted payback periods for comparative cases are shown below for Glebe (Figure 8) and Brookvale (Figure 9). This analysis was very sensitive to the tariff assumptions in the modelling. Tenants were on hugely varying rates, with the lowest flat rate tariff being more than 40% less than the highest flat rate tariff. While tariff switching is a no regrets option that is recommended for all portfolios, there are arguments for and against including this in the business case analysis. Given that tariff switching is not dependent on solar or energy upgrades to take place and can be done with no capital cost, it could be

[8] As there are only 13 units, if the common area is single phase, this could be connected to the SolShare system for almost zero marginal cost, even though solar benefits on this meter would be limited (as it is mostly night-time lighting). If the common area is 3-phase it would not be worth installing a dedicated solar system due to primarily nighttime loads.

argued that it should be treated separately in the analysis. On the other hand, tenants are very hesitant to switch retailers and just recommending that they visit Energy Made Easy to find a more competitive offer is likely to have relatively limited effect. Even if tenants do successfully switch, they are likely to end up back on an uncompetitive offer in 6-12 months after fixed-term deals expire. Therefore, there is an equally compelling argument to include tariff switching within the analysis, as the proposed retail intermediary model can lock in a discounted rate over the long term. It also gives the CHP full visibility of the rates its participating tenants are on, and contracts could be structured with review periods to ensure competitive rates are maintained.

The authors favour the position that tariff switching should be included in the cost-effectiveness of the portfolios (the 'tariff switch' case below), but the financial case is presented for a range of tariff scenarios, as described in Table 4, below.

Table 4: Tariff scenario comparison

Tariff Scenario	BAU baseline	PV Only/ Portfolio Cases	Impact on Cost-Effectiveness
Current Tariffs	Actual tariffs from audited dwellings[9]	Actual tariffs from audited dwellings[9]	Creates arbitrary bias due to extrapolation of rates to unaudited properties. Causes Glebe to appear less cost-effective due to lower weighted average tariff (Glebe: 28.5c/kWh; Brookvale: 33.5c/kWh).
Tariff Switch	Actual tariffs from audited dwellings[9]	Actuals but tenants with expensive plans are switched to a competitive rate (33c/kWh and 90c/day fixed charge).	Improves cost-effectiveness of PV only/portfolios as tariff switching benefit is added to solar and energy savings from upgrades. Represents 'best case'.
Standardised Tariffs	Uniform rate (33c/kWh and 90c/day fixed charge)	Uniform rate (33c/kWh and 90c/day fixed charge)	More reflective of 'true' economics of the model given not all actual tariffs are known. Makes paybacks in each building more similar (more viable in Glebe, less viable in Brookvale).

Providing the range of tariff scenarios helps to improve the robustness of conclusions drawn in Section 2.5, below.

[9] Extrapolated to similar unit layouts

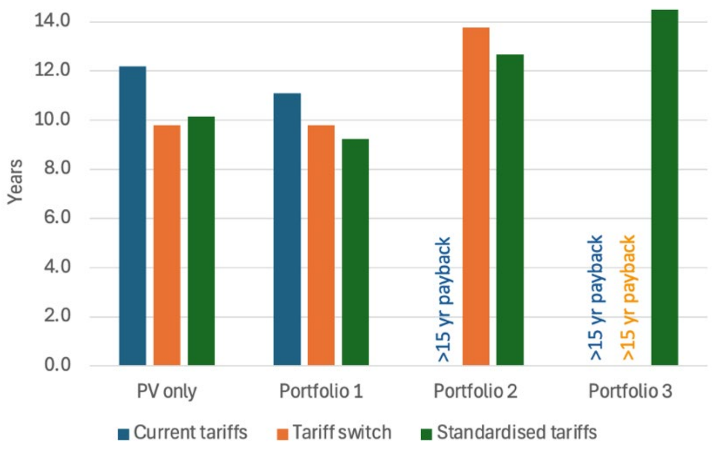


Figure 8: Discounted payback periods under different tariffs for Glebe building

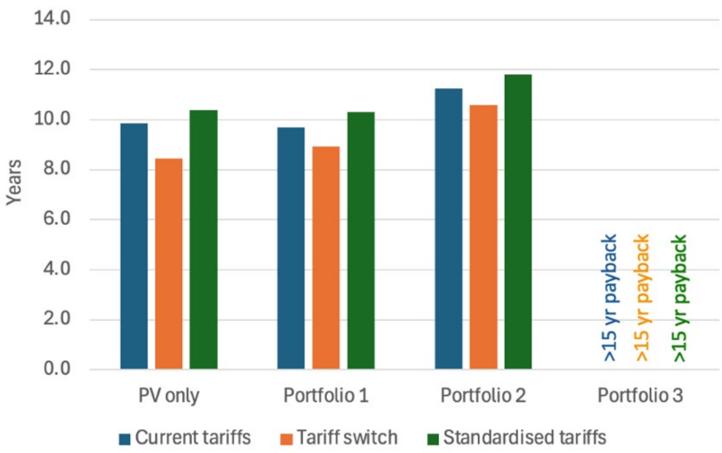


Figure 9: Discounted payback periods under different tariffs for Brookvale building

Drawing on the 'standardised tariffs' case in green only (for simplicity and representativeness) we can see that Portfolio 1 improves the financial case compared to PV only by adding additional efficiency and thermal comfort measures. Portfolio 2 is also financially viable within a 15-year term for both buildings, although payback periods increase and thus make the case more dependent on finance terms and interest rates. Portfolio 3, which includes the most expensive thermal comfort measures, is generally not cost-effective in a 15-year term based on energy savings only. However, this includes the targeted application of reverse cycle air conditioning to hot/cold dwellings and would likely have the greatest health benefit in terms of allowing residents to keep premises within recommended WHO temperature bounds. Portfolio 3 would present the same investment case as Portfolio 1 if it were able to deliver a mere $63 (Glebe) or $198 (Brookvale) per dwelling per year health dividend. This compares with the $887 demonstrated health dividend found in the Victorian Healthy Homes project (UTS, 2022)[10] resulting from the homes of vulnerable residents being made warmer for a single winter season.

The more detailed figures underlying this analysis are shown in Table 5 (Glebe) and Table 6 (Brookvale) below for the standardised tariffs' case only.

[10] Page, K., Hossain, L., Wilmot, K., Kim, Y., Liu, D., Kenny, P., van Gool, K. & Viney, R (2022). Evaluation of the Victorian Healthy Homes Program – Final Report. Sydney: University of Technology Sydney.

Table 5: Financial case results for Glebe Building (using 'standardised tariffs' case)

	PVonly	Portfolio 1	Portfolio 2	Portfolio 3
Initial investment	$(94,439)	$(131,134)	$(207,334)	$(250,084)
Annual savings and revenues	$10,619	$15,714	$19,307	$21,052
NPVrelative to BAUcase	$30,785	$55,950	$23,812	$2,345
Simple Payback period (years)	8.0	7.4	9.5	10.5
Discounted Payback period (years)	10.1	9.2	12.7	14.5
Residual benefit after 15 years	$57,687	$87,872	$109,772	$120,241
Health dividend to match 'PVonly' ($/HH/a)	$ -	$ -	$15	$63

Table 6: Financial case results for Brookvale Building (using 'standardised tariffs' case)

	PVonly	Portfolio 1	Portfolio 2	Portfolio 3
Initial investment	$(43,049)	$ (61,430)	$ (92,200)	$(147,200)
Annual savings and revenues	$ 4,730	$ 6,729	$9,049	$ 10,121
NPVrelative to BAUcase	$ 12,917	$ 18,879	$16,198	$ (25,738)
Simple Payback period (years)	8.2	8.1	9.0	12.8
Discounted Payback period (years)	10.4	10.3	11.8	N/A
Residual benefit after 15 years	$25,955	$37,905	$51,531	$57,951
Health dividend to match 'PVonly' ($/HH/a)	$ -	$ -	$ -	$198

2.5 Conclusions

The conclusions from this analysis are:

1. Shared solar **PV only** is cost-effective with a 10-12 year discounted payback, but only reduces tenant bills.
2. Basic **Portfolio 1** upgrades of $1200-1400 per dwelling improve the business case when bundled with shared solar. Higher capital costs are covered by additional energy savings and increased solar self-consumption. This option reduces tenant bills and improves thermal comfort through roof/ceiling insulation and draught sealing.
3. Moderate **Portfolio 2** upgrades of $3,700 per dwelling can be bundled with shared solar within slightly longer payback periods, which are viable if supported by low-cost, long-term finance. Discounted payback periods increase from 10.1/10.4 years (for PV only) to 11.8/12.7 years (Portfolio 2). This would more substantially improve summer thermal comfort by adding ceiling fans (alongside more efficient hot water systems).
4. Advanced **Portfolio 3** upgrades of $5,000-$8,000 per dwelling extend payback period to or beyond 15 years, making financial viability borderline even with low-cost, long-term finance. This portfolio would substantially improve thermal comfort by adding window shading and reverse cycle heating/cooling systems. Pursuing some of these 'unfinanceable' options that are less viable in a traditional cost-benefit analysis (because much of the benefits are captured in comfort or health improvements rather than bill savings) could be approached through combining SHEPI grant funding, for which no repayment is required. From a societal perspective, thermal comfort focused Portfolio 3 would present the same investment case as Portfolio 1 if it delivered just 25% of the health dividend demonstrated in the Victorian Healthy Homes project.

Given the variability of energy tariffs observed in these buildings, discussions may need to be hosted with the facilitating retailer regarding the small number of customers that *are* on very competitive offers (25-30% below standard rates), to ensure that the solar and upgrades model retains its attractiveness for these tenants.

2.5.1 Sensitivity of conclusions

Portfolios 1 and 2 remain financially viable within a 15-year horizon with the following changes to the financial assumptions:

- 1% per year escalation in gas or electricity rates (as opposed to 2% per year)[11]
- Effective solar FIT of zero (as opposed to 4c/kWh).
- Discount rate of up to 6% for Glebe or 7.3% for Brookvale (as opposed to 4.5%). This suggests that there may be some latitude to blend low-cost government finance with higher cost private social impact capital.

If the finance period is limited to 10 years, it is difficult to go beyond Portfolio 1 in terms of complementary upgrades.

Expensive switchboard upgrades funded through the project could substantially reduce the scale of financial benefit in both buildings.

On the positive side, the financial cases for Portfolios 2 and 3 could be further improved by installing heat pump hot water systems under the existing hot water heater replacement cycle, lowering the effective capital cost by around $1,000 per installation. If, in addition, more cost-effective heat pump options were able to reduce capital costs by a similar margin (see innovation project option in Section 4.3.1), this would bring the discounted payback period for Glebe Portfolio 2 down from 12.7 to 11.2 years.

Essentially this analysis reveals a viable but relatively narrow and time critical pathway to allow social housing tenants to capture the benefits of solar now that the technology is available, while harnessing this as a revenue stream to improve thermal comfort and, potentially, health outcomes. The model hinges on financing arrangements and is potentially vulnerable to reducing solar PV renewable energy certificates towards the scheme closure in 2030. Additional policy support may be needed to fill this gap to allow the social housing sector to roll out shared solar in the coming years.

[11] Portfolio 1 is also robust with no escalation rate

3 Delivery models for shared solar plus upgrades

A key motivator for this was project was the recognition that a traditional CHP 'own and operate' model (as is standard for solar PV in owner-occupied dwellings) does not capture enough revenue to get close to paying back capital investment in shared solar, let alone other upgrades. Therefore other 'business models' or 'delivery models' were considered that both optimise the financial case – by improving efficiency and maximising consumption during solar hours – and divert some tenant benefit to pay for the solar. As a result, three options to solve these issues were brought to the IRG for consideration. This section describes the feedback and conclusions drawn from this process.

3.1 Model 1: Rebate Swap

3.1.1 Description

In the 'Bill Buster'[12] type full rebate swap model, the CHP pays capital and operating costs for solar and upgrades, tenants receive the full benefit of free solar, but tenants sign over their $385/yr low-income energy rebate to the CHP (to repay the capital cost) while living in the premises, in return for an equivalent or greater bill saving.

3.1.2 Stakeholder feedback

IRG feedback on this option was the least favourable, due to the following concerns:

- Tenants pay for an asset they don't own and do not necessarily get guaranteed benefit from, due to retail tariff arrangements or behaviour/lifestyle factors.
- CHPs were concerned about additional administration and delivery costs/resourcing.
- Generally considered politically challenging as the optics do not necessarily look good from every angle.
- The collection of the rebates could be challenging to harmonise with current payment of the rebate, which goes directly to retailers.
- While tenants were generally supportive, they would need to be guaranteed greater benefit than rebate, and that rebate would be restored if they moved home.
- IRG members agreed that a guarantee of the benefit exceeding the forgone rebate may resolve concerns, but such a guarantee is only possible with the direct involvement of the retailer (which does not occur in this model).

3.1.3 Conclusion

The viability of this model was considered too challenging at this time – particularly given the bill buster model was discontinued in 2024 – and was not taken past the first IRG. However, the option of partial rebate swaps was reserved as an option if it could be used as part of other delivery models that could *guarantee* the tenant financial benefit is equivalent or greater.

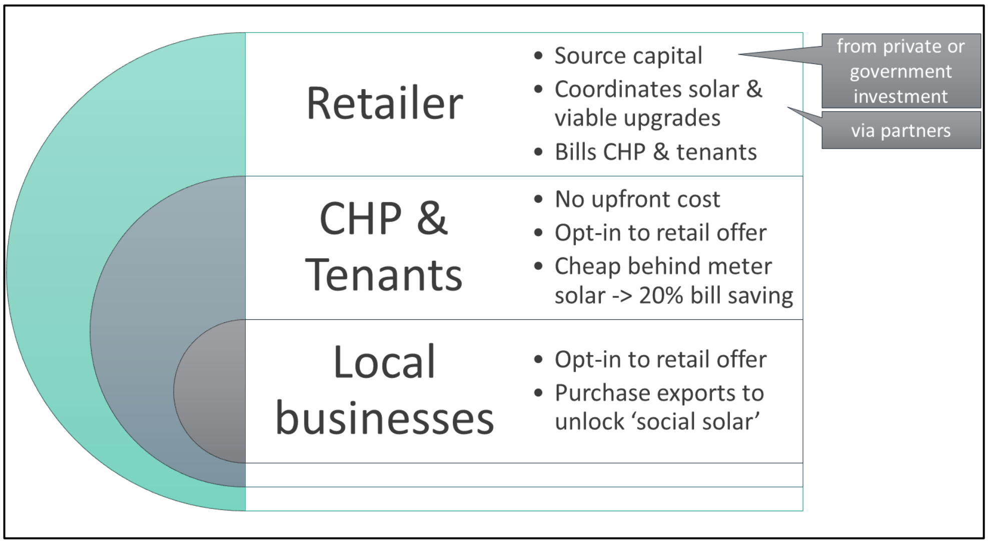
[12] When this project was initiated, the NSW Government offered a 'bill buster' option to trade in 10-years of the low-income energy rebate for a solar power system that delivered a greater level of benefit than the rebate. This option was discontinued in 2024.

3.2 Model 2: Retail intermediary

3.2.1 Description

This model (Picture 4) uses an electricity retailer intermediary to finance solar/upgrades and to repay the capital cost with a combination of solar export revenue and providing tenants with *heavily discounted* (rather than free) solar usage. In this model, retailer sources capital and co-ordinates the solar and upgrades, while also managing the billing for the CHP and tenants. There is no choice of retailer (i.e. no 'retail contestability') for participating tenants but participation is voluntary. The retailer bears the risk that they can retain tenants by offering a better deal than those on standard retailer arrangements. If a tenant opts out of the scheme, more solar energy is reallocated to other tenants in the building.

A similar model is in operation for shared solar in stand-alone social housing dwellings but has not yet been applied in social housing apartments. It also does not include other substantial upgrade measures, which is a key objective of this project. The existing model run by 369 Labs, depicted in Picture 7, offers behind the meter solar at a 50% discount on retail rates, with overall bill savings of approximately 20%. It also allows local businesses with daytime electricity demand to support social housing solar by purchasing its solar exports.



Picture 4 : Shared Solar with Retail Intermediary model (in development by 369 Labs/Allume)

3.2.2 Stakeholder feedback

Potential challenges or concerns identified with this model are:

- The lack of tenant choice of retailer was not considered ideal, but does create the ability for the CHP to ensure that participating tenants are on the best plan and that this remains competitive in the market. This is not possible under standard competitive retail arrangements and two-thirds of tenants audited were not on a competitive plan.
- Any in-home measures funded by the arrangement (e.g. hot water systems) would become a 'stranded asset' to the retailer if the tenant opted out in the future.

- Several tenants expressed some hesitancy to switch retailers. Note, however, that this issue affects *any model* requiring a change of retailer, or even any retail tariff switching to get

customers a better deal (outside of solar). Clear communication is critical, as hesitancy over switching was primarily due to:
    - Some tenants using their energy account as a de facto savings account to redraw when needed.[13]
    - Concern over whether rebates and other concessions would still be applied, however in both cases these are regulated additions that any retailer must administer.
- Tenant and public interest representatives were uncertain as to whether the retailer incentive to retain customers by offering a better deal (e.g. a net 20% discount) was strong enough to prevent progressive erosion of tenant benefit over time, or if other consumer protections need to be considered.

CHPs were keen to understand the level of engagement and extra resources required for them in this model, but most activities are undertaken by the retail intermediary, which does not place financial resource constraints on the CHP.

3.2.3 Conclusion

This model – which is a hybrid of the 369 Labs/Allume product in development, with additional components developed through this project, was preferred as it requires no capital investment from the CHP, avoids debt on the CHP balance sheet, and carries relatively few downsides. As the retailer is fixed, a pilot could explore using partial rebate swaps to increase the depth of energy upgrades that are possible within the model.

Note that in July 2025, the Federal government home battery rebate will come into effect which will shift the economics of including a battery within this model.

3.3 Model 3: Battery virtual power plant (VPP) with monthly allowance

3.3.1 Description

This model (Picture 5) is similar to the retail intermediary model (#2) but uses a battery to increase the use of solar and changes the pricing structure to give tenants a free daily allowance (~6kWh/day), before charging retail market rates. Due to the high capital cost of the battery, this model requires subsidisation at today's prices or is only financially viable in higher usage households (i.e. not these buildings/ households). In this model, the battery/VPP operator sources the capital and is responsible for designing and the installing solar and battery and coordinating the use of the batteries to optimise financial benefit. Investment could come from a combined source of private and state government incentives. A partner retailer facilitates the process and signs up CHP and tenants to a retail offer that has a mix of solar/battery and grid energy. Tenants and CHPs do not pay upfront costs and get a 6kw/h predictable per day free allowance and extra energy consumed is charged at fixed market rates.

This model – described in Picture 8 – is based on an offer in-development from technology and energy services company, LAVO. It is similar to others like National Renewable Network (NRN) and bears some similarity to the Tesla VPP in South Australia (but with different state incentives and pricing structures).

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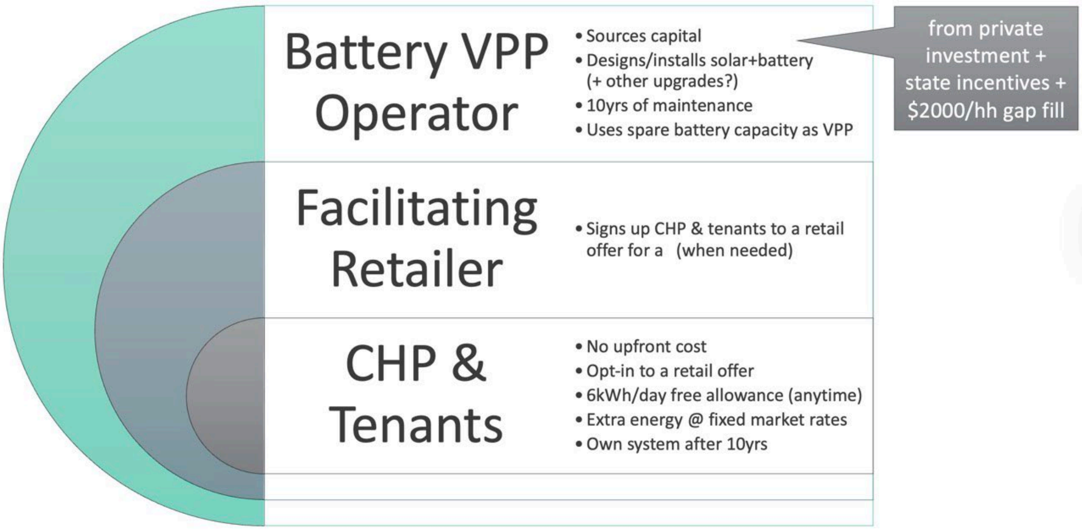
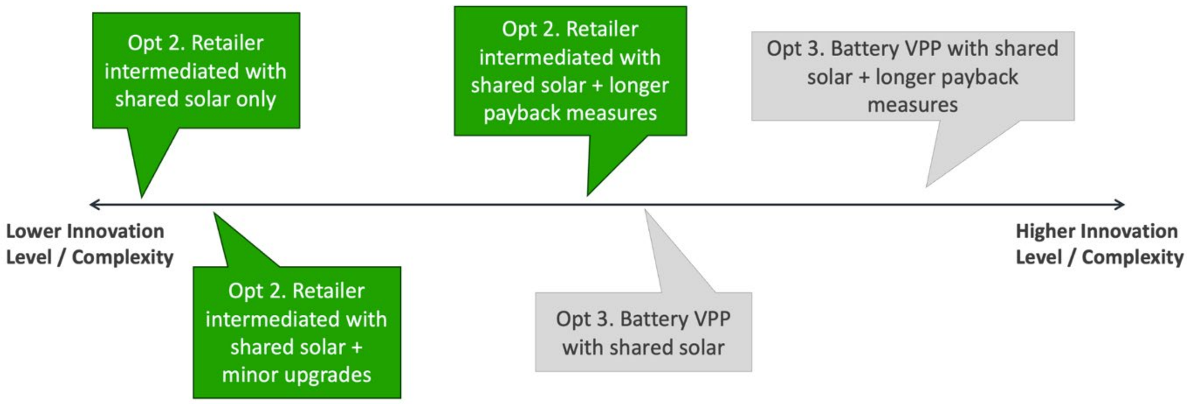
[13] The CHP, social services provider or retail delivery partner would need to carefully manage this concern to ensure that equivalent services are maintained through the new arrangement or an alternative.



Picture 5: Solar/Battery VPP model (based on model in development by LAVO)

This model has not yet been applied in social housing apartments and is still trying to find financial viability. As such, operators are focussed on testing market fit for the base offering, and including other upgrade measures was not on the planning horizon of either operator spoken to for the research. Therefore, as shown in Picture 6, the innovation level and associated risk of this model (grey boxes) is considered higher than Model 2 (green boxes).



Picture 6: Innovation level for model 2 vs model 3

3.3.2 Stakeholder feedback

- Tenants expressed a lot of interest in this model due to the predictability in the pricing structure, with the free daily allowance. They were keen to understand what happens when energy usage is below 6kWh/day (NB: the allowance is implemented on a kWh/month basis rather than daily, but rollover between months was not yet clear).
- A big advantage of this model is that it is less reliant on tenant behaviour to guarantee benefit.
- A major restriction of this model is the difficulty of successfully including complementary upgrades – which is a core goal of the project – at least until the model is more mature.
- Tenant advocates suggested that while the model is not yet cost-effective, using public subsidisation to promote residential battery storage may be better spent in social and community housing than in the private housing market.

- Another CHP representative appreciated the idea of a battery, however, at the same time thought that the option was a bit more complex.

3.3.3 Conclusion

While this model was considered very promising by all, given the project targets a combination of thermal comfort *and* bill reduction and the current model maturity makes this challenging, a near term pilot for a self-funding solar/upgrades is a better option. Model 3 could be considered as an addition in 1-2 years as the underlying solar/battery VPP model is better established.

Note that in July 2025, the Federal government home battery rebate will come into effect which could also shift the economics of this model, so CHPs should raise battery inclusion with prospective delivery model partners.

4 Recommendations for implementation

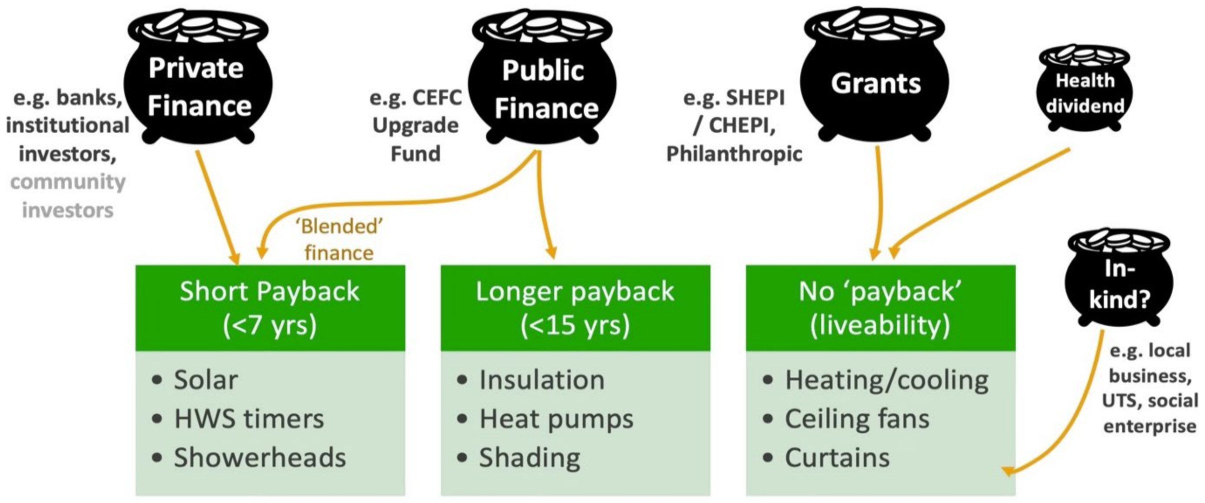
The conclusion of the modelling, analysis and engagement process is to pursue Model 2 'retail intermediary'. This could be achieved through an open or targeted EOI process run by the CHP, although this makes it more challenging to build a clear project brief when the partner and model are not known, and risks straying from the evidence based developed during Phase 1. After this process, the research team have a solid understanding of the small number of parties currently able to deliver shared apartment solar and upgrades using a mechanism to address the split incentive. A direct partnership approach was therefore considered appropriate by the research team to enable a better and more expeditious project design for a Phase 2 pilot. This approach was supported by the IRG.

4.1 Funding and finance sources

The financial analysis suggests that to include additional measures alongside shared solar will require finance with a term of up to 15 yrs at a low interest rate. This would likely require some kind of government role, such as the (low interest) CEFC Home Energy Upgrades Fund. This fund has not yet been deployed to the social and community housing portfolio, but initial meetings suggest that this is a viable proposition. As the CEFC does not deal in small transactions, a sector-wide perspective is likely to be most suitable. We suggest that two possible mechanisms could achieve this goal:

- Using Housing Australia as a finance aggregator, through which a range of delivery agents could access finance for shared solar and energy upgrades. This would align with Housing Australia's existing bond tenor of 10-15 years and could incorporate social (health) and sustainability (thermal performance and climate resilience) metrics as lending criteria to tie fund access to non-financial public benefit outcomes. The Phase 2 retail partner would then likely be the first to access this finance source to link to its shared solar/upgrades social housing offering.
- Working directly with a private fund manager appointed by the Phase 2 retail partner to pool blended finance at scale. This fund could be accessed by any CHP but would only link to the product developed by the Phase 2 retail partner. In this case, greater effort would need to be expended to ensure transparency and accountability for CHPs, and that tenant benefits are not eroded over time. Other emerging retail/technology innovation providers in the social housing sector seeking to tackle the split incentive problem would then have to create their own separate blended finance vehicle with CEFC to access the same low interest finance. This is consistent with how the CEFC currently develops products with large private lending institutions.

Any development of a CEFC mechanism is expected to be relatively complex and take at least 12 months be negotiated and designed. Therefore, for Phase 2 we recommend that the model's viability in social housing apartments be demonstrated at the pilot scale. In the absence of immediate CEFC finance, this could be achieved by blending (higher cost) private finance for solar with grant funding (such as SHEPI/CHEPI or philanthropic) to deliver a wider range of complementary upgrades, at an acceptable level of discount for tenants. This is what is described in the Phase 2 EOI and is shown in Picture 7 below.



Picture 7: Recommended blended finance approach for different measure types

The governance of such financing arrangement needs to ensure that CHPs can participate and access funds within their limited bandwidth and human resourcing. Given energy upgrades sit outside of their core business, any increased administrative costs to manage the upgrades, co-ordinate resources, engage with tenants and deliver projects create another barrier to implementing upgrades.

4.2 Phase 2 Project Plan

The Phase 2 project plan is outline in the attached (confidential) EOI. It continues the action-learning approach to give CHPs and service providers the opportunity to develop understand the respective roles and contributions of participants to prove viability and refine the structure of the offer, before application across the broader CHP portfolio. UTS participates as a research provider and a program designer, advocating for product design elements that in are in-keeping with tenant and public benefit, and are scalable in an environment of increasing competition and innovation in private service providers.

The project has three core components: Pilot and sector scaling design, Pilot delivery and pilot research.

4.3 Future Research and Innovation

4.3.1 Smaller, cost-effective heat pump hot water

In exploring options for heat pump hot water system options for small 1-2 occupant apartments in buildings, we found that:

1. only six products were available on market with acceptable refrigerant (i.e. with a global warming potential of 4 or less)[14] and size (a maximum of 150-200L). Larger units can also trigger the requirement of new Council approvals.
2. these available products ranged from $3,600-6,850 (pre-rebate retail cost) on par with much larger systems servicing homes of 4 or more occupants.
3. the limited choice and high cost mean that a typical simple payback is in the order 10 years, which is much longer than would be accepted.

[14] Using R744 (CO_2) or R290 (propane) refrigerant is considered necessary to ensure that the greenhouse gas mitigation benefit of heat pumps is maintained. Other common refrigerants like R134a have GWP of 1430.

There is a clear opportunity to work with hot water system manufacturers to develop and introduce smaller, more cost-effective integrated heat pump units for small social housing apartments. These could readily replace small 50L electric systems located outside. Split system versions (with an indoor tank and outdoor condenser unit) could be considered for units with indoor 50L electric systems, although additional plumbing or other pipework may compromise viability.

4.3.2 Viability of load shifting with 50L storage systems

The research suggested that where heat pumps are not viable, using smart timers or other control systems for existing 50L electric storage systems to shift all or most recharging to solar hours (as opposed to immediately during/after showering). This appears to be viable for households with a 1-shower/day pattern.

While tenants indicated that they were in support of this measure if it would substantially reduce energy bills, it is less clear whether hot water availability would be compromised by this approach, and whether it would be acceptable to tenants. More research is needed in the field to test this proposition before determining viability for further rollout. This has been integrated into the Phase 2 EOI.

4.3.3 Payment for smart meter and switchboard upgrades

As mentioned in Section 2.2, switchboard upgrade requirements could substantially increase costs for social housing solar. There remains some uncertainty about how such upgrades will be paid for within the sector, particularly as the Australian Energy Retailer is targeting a full smart meter rollout by 2030 and these costs are generally socialised across a retailer's customer base. The installation of smart meters would generally trigger the same switchboard upgrade or other ancillary works as solar, and it is not yet clear how these will be paid for when not all customers are affected equally. Micro retailers, such as that which might facilitate Phase 2 of this project, may also not have the financial capacity to socialise the cost of smart meters or ancillary works as effectively as larger retailers, particularly if a larger proportion of its customer base is social housing tenants.

We understand that this policy issue is being actively considered by the NSW Government, and any broader sectoral solution will need to be considered and reflected in the implementation of this project.

4.3.4 Other techno-economic decision-making challenges

Other technical-economic decision-making challenges confronting CHPs encountered through this project that should be addressed in further work include:

- Defining decision making criteria regarding load flexibility versus heat pump HWS when these could be installed but require additional costs, such as for HWS relocation.
- Determining whether the combination of fans, insulation and external shading adequately prevent the need for reverse cycle cooling systems, and circumstances in which these become standard inclusions.
- How to address and/or fund electrical switchboard upgrades that may be triggered in older premises.
- How the design of a mechanism can address the ownership status of properties that influences the CHP's ability to invest, such as if the property is managed on a long term (15-year) lease.

5 Reflections on assessment and project development process

5.1 Software: capabilities and cost recovery

The analysis revealed that a critical requirement for apartment buildings is the need to consider aspect and position in the building. In the case of Glebe, for example, identical unit layouts varied from 2.3 to 3.7 stars, with NW units some suffering primarily from heat exposure and SE units having effectively no natural heat gain from the sun, creating very different comfort outcomes and changing the selection of upgrade types. The BOOM platform provides an effective means of capturing data on required upgrades and contracting these works to a set of vetted suppliers, but does not currently allow for differentiation of aspect. This may be sufficient if upgrades are driven by the desire to electrify social housing stock (i.e. remove gas) but presents a challenge if an understanding of underlying thermal performance is required. If a minimum level of thermal performance (such as a 3-star+ NatHERS rating, or ensuring that all units are within WHO temperature guidelines 85% of the time), additional or alternative software tools would be required. Feature-based portfolio upgrades – such as ensuring that all units have insulation or external shading on western windows – could potentially sidestep this issue, providing that a methodology could be developed to specify appropriate features according to unit ages, construction and/or aspect.

An important additional software feature beyond current capabilities is to enable the specification of timing of 'flexible' large loads, such as hot water systems. This has a substantial effect on the overall business case for shared solar under the proposed financial model. For example, a unit with an uncontrolled 50L electric storage hot water system and nighttime showering pattern could get no value out of shared solar for its hot water energy demand due to evening recharging (which might represent 50% of the total load). The same unit with a smart timer could achieve close to 100% solar self-consumption for its hot water demand and have a lower evening peak load of 2.4-3.6kW, which would have substantial financial benefit (either for the tenant or the electricity network business, depending on the customer's electricity pricing structure).

The current funding model for the platform is an annual subscription, supplemented by a commission on upgrades delivered through the platform. This subscription model is challenging for CHPs to justify financially for routine operations, as upgrades are commonly episodic, and there is no separate fund from which the subscription can be paid. This is particularly true for smaller CHPs with less scale.

5.2 Site selection: there is no perfect building

Three sites were considered initially as part of this project. Ideally the approach was to shortlist sites for relatively deep energy upgrades. That is, buildings with a confluence of poor-to-moderate energy performance (as indicated by poor aspect or condition), older construction, acceptable solar access on the roof, gas hot water and/or cooking, kitchens or HWS approaching retirement, and not slated for redevelopment. However, close consultation with Bridge Housing staff revealed that these criteria seldom exist in one building, and only a handful of these criteria were commonly able to be fulfilled. Some of these criteria were also effectively not able to be confirmed using available data on the building portfolio, or the actual situation turned out to be different to what was noted in CHP records.

This makes achieving a wide range of deep upgrades in one integrated package more challenging. We recommend that upgrades such as the conversion of hot water systems or gas cooktops generally be dealt with on a replacement cycle basis, unless a shared solar project is being delivered in advance, and these upgrades can be combined.

5.3 Tenant engagement and recruitment

Recruitment for tenant participation in energy audits was done by expression of interest obtained during a launch event information session at each site. Participants were scheduled by CSJI via follow up phone calls. In the case of Glebe, 1-2 weeks elapsed during the scheduling period and circumstances changed for some tenants and they became uncontactable, declined to participate or in some cases were moved to other premises. Given this issue in Glebe, interested tenants were audited on the day of the site event, or immediately scheduled for the subsequent day to prevent drop-off. We had also hoped to catch more residents than could be audited at the event and gather a higher level of information via a 5-minute survey that would allow us to extrapolate audit data to unaudited units. While the second approach was slightly more effective, only up to 50% of residents were reachable through the in-person event, and all agreed to audits. We suggest that reaching all tenants for on-site access may be unachievable.

Participants in the launch event received a $50 Coles voucher incentive, and those taking 1-3 hours for a subsequent energy audit and research interview received an additional $200 Coles voucher in recognition of their time. This incentivisation approach was tailored for a research project where the tenants were required to give up time to be involved, with no guarantee of implementation. The economics of scaling this approach into business-as-usual solar and energy upgrades are not tenable. Given the above lessons, we suggest that:

- Clear initial communication from the CHP in numerous forms (written letter, email, phone call) about the building upgrades and the role of the partner is required to instil trust, and the subsequent contact channel be through the delivery partner.
- The value proposition of participation needs to be very clear and grounded in obtaining the benefit of upgrades.
- A voluntary (rather than universal) approach be taken to tenant participation, with a deadline for electing to participate.
- Some time period for signage installed around the building and word-of-mouth to take effect to maximise participation rates and economies of scale.
- Elect one or two ‘building champions’ to tell others in the building about the upcoming project and how they can participate.

6 Annexure 1 – Survey and Audit questions

External shading and heat retention

A1	In summer, is the amount of sun you receive through the windows/sliding doors:	- Too much - Too little - About right - Other (specify)
A2	In winter, is the amount of sun you receive through the windows/sliding doors:	- Too much - Too little - About right - Other (specify)
A3	How actively do you use window coverings (e.g. curtains/blinds) to control heat gain or loss through your windows/sliding doors? Why?	Open ended

Gas cooking [skip if no gas in the building]

A4	Do you have gas in the building? (no need to ask – just a place to skip)	- Yes - No
A5	What appliances/equipment do you use most to cook your meals?	Open ended
A6	What kind of cooktop/stovetop do you have?	- Electric (resistive) - Electric (induction) - Gas
A7	[If gas to A6] How would you feel about using an electric stove top to cook (rather than gas)?	Open ended

Other kitchen

A8	Do you have a dishwasher?	- Yes - No - I'm considering installing one
A9	*If 'Yes' to A8* How often do you run the dishwasher?	- More than once per day - Roughly once per day - A few times per week - Once per week or less
A10	How many times per week do you hand wash your dishes using hot water?	- Never - Once a week - A few times a week - Once per day - 2 to 3 times per day - More than 3 times per day
A11	What is the make and model number of your fridge?	Open ended

A12	What year was your fridge made?	Open ended
A13	Are there any maintenance issues evident (e.g. door seals, frost build-up)	Open ended

Hot water usage

A14	How often do you run out of hot water?	- Never - Less than once a month - A few times a month - Once a week - A few times a week - Daily
A15	During what seasons does this affect you? (select all that are relevant)	- Summer - Winter - Autumn/Spring
A16	Do you have any issues with water taking a long time to heat up from the tap? In Kitchen or bathroom?	Open ended
A17	Approximately how many showers in total do all the people in your home have per week?	Numerical
A18	What time of day do these showers usually occur (select as many as relevant)	- Morning before 9am - 9am-2pm - 2pm-5pm - 5pm-9pm - After 9pm - Other (specify)
A19	How many minutes is the average shower in your household?	- 4 mins or less - 4 to 7 mins - 7 to 10 mins - More than 10 mins
A20	Is the timing of your showers flexible, if you could (for example) shower during the daytime to make use of 'free hot water' from solar power?	- Yes - No - Sometimes - Unsure
A21	Approximately how many times is the bath run per week?	- Numerical - N/A (No bath)

Laundry

A22	Is your washing machine personal or shared?	- Personal (in home) - Personal (in common area) - Shared (in common area) - N/A (no washing machine)

A23	*Skip if N/A to A22* What kind of washing machine do you use?	- Front-loading - Top-loading - Twin tub - Not sure
A24	Is your washing machine connected to one water tap (cold water only) or two water taps (cold and hot water)?	- One tap – cold water only (if one tap, go to Question 12) - Two taps – cold and hot water - I'm not sure
A25	What water temperature do you set the machine on:	- Cold water - Warm water - Hot Water
A26	Roughly how many loads of laundry do you do each week?	- Numerical
A27	Do you use a clothes dryer, either personal or shared?	- Personal (in home) - Personal (in common area) - Shared (in common area) - N/A (no dryer)
A28	*Skip if N/A to A27 (no dryer)* How often do you use a clothes dryer to dry your washing?	- N/A (I do not have access to a clothes dryer) - Almost never - Once a month - A few times a month - Once a week - A few times a week or more
A29	Do you have difficulty carrying your washing to/from the washing machine or drying line?	- No difficulty - Some difficulty - A lot of difficulty - I get someone else to carry it

Transport

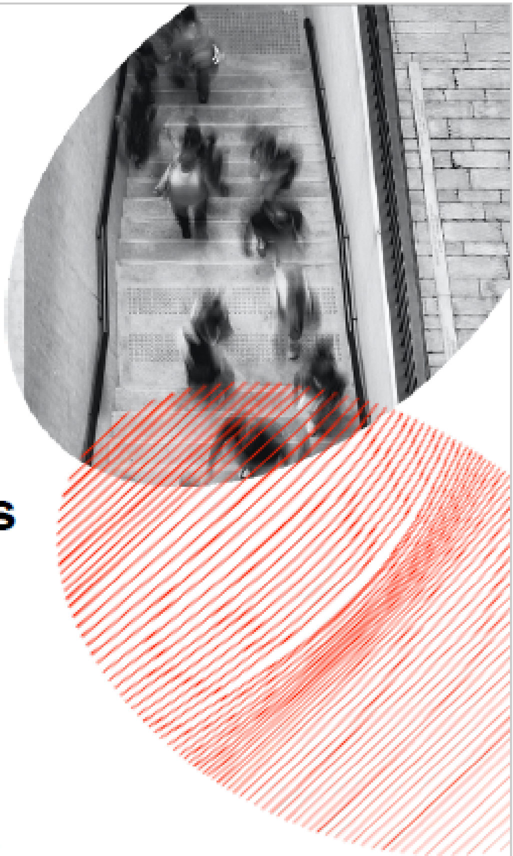
T1	Do you currently have any of the following electric forms of transport: (select as many as relevant)	- e-bike - e-scooter - Car (EV) - Other (specify) - None
T2	*Skip if 'None' selected above* Where do you charge your electric transport device?	- In home - In Garage - Off-site - Other (specify)
T3	Do you have any plans in the next 5 years for getting electric transport? (specify detail for context if relevant)	- Yes - No - Don't know

Energy bills

Q17	Are you keeping up with payment of your household energy costs?	- Always - Mostly - Sometimes - Rarely - Never
Q18a	*Skip by answering N/A if no gas in the building* Do you receive a NSW government low-income gas rebate? (a reduction of up to $110 per year applied to your gas bill)	- Yes - No - Unsure - N/A (no gas in building)
Q18b	Do you receive a NSW government low-income electricity rebate? (a reduction of up to $285 per year applied to your electricity bill)	- Yes - No - Unsure
Q19a	*Skip if 'No' to Q18b* The government recently had a scheme whereby low-income home owners could 'swap' 10-years of their rebate for a free rooftop solar power system. If a similar scheme was made available to social housing *tenants*, and you could save at least the same amount ($285 per year) off your bill, would you be interested in taking up this offer?	- Yes - No - Unsure
Q19b	*If 'No' or 'Unsure' to Q19* How much would you need off your bill to be interested in this, and why?	Open ended
Q20	What other concerns or questions would you have about a rebate swap?	Open ended

7 Annexure 2 - Flyers from tenant engagement and promotional events

You will receive a
$50 Coles voucher



Glebe Energy Transitions

You are invited to attend a free information session hosted by the University of Technology Sydney about improving energy efficiency in your home and lowering your energy bills.

The Glebe Energy Transitions project is looking for participants who can help us understand ways to make social housing more comfortable, reduce greenhouse gas emissions and give tenants more control over how they use energy.

We would like to discuss the possibility of conducting an energy audit in your home and a survey about your experience of energy use and temperature comfort.

The workshop will include a **free lunch** and anyone who participates will be offered a **$50 Coles voucher** for your time and valuable input. We can also provide childcare or translation services if you require.

To register to attend please follow the QR link below or contact UTS via the details on this form.

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