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**RESEARCH PAPER**

# Who Accesses Solar PV? Energy Justice and Climate Justice in a Local Government Rooftop Solar Programme

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**Abstract:** Certain groups within society, such as the poor, the elderly, and those renting their homes, are at risk of bearing disproportionate costs from the transition to a low-carbon economy. These groups are particularly at risk of energy- and climate-related injustices linked to their ability to purchase sufficient energy (low-carbon or otherwise) or to adequately heat or cool their homes. The Solar Saver programme in Melbourne, Australia, was an early attempt by Darebin City Council, a local government, to address these issues. The programme enables seniors, low-income residents, and tenants in the City of Darebin to install solar PV in their homes at no upfront cost. The system costs are repaid interest-free over 10 years through residents' council rates. This article assesses the success of the programme in reaching its target audience and achieving justice for participants in 2018 and 2019. We find that local councils are important and trusted delivery agents of household energy programmes. We also find that schemes like Solar Saver must be actively targeted to achieve energy- and climate-justice outcomes for residents who are at risk of energy poverty and disproportionate climate impacts.

**Keywords**: Energy justice; Energy poverty; Climate justice; Solar PV; Renewable energy.

## 1. INTRODUCTION

Despite its benefits, there are financial and human costs to transitioning to a renewable-based, low-carbon economy. In this transition, improving energy efficiency in high-consumption homes as well as decarbonising

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industry, electricity generation, transportation, and other critical sectors is vital (Sovacool, Lipson, and Chard 2019; Carley and Konisky 2020). In developed economies, where carbon reduction efforts are strongest and are beginning to be heavily legislated, an "inclusive, just energy transition" involves "structural transformations" towards meeting the 1.5°C objective in the Paris Agreement (UN Energy 2021). Differences in levels of government support, housing tenure, and energy efficiency can leave the poor, the elderly, and those renting their homes at risk of bearing the financial and practical costs of this transition (Ashby *et al.* 2020; Bickerstaff, Walker, and Bulkeley 2013b).

Melbourne, Australia, a large metropolis of almost five million people, experiences strong temperature variability—in 2021, temperatures ranged from –3.7 °C at night in May to 41.5 °C during the day in January (Bureau of Meteorology 2023). As a result, household energy bills can run up to thousands of dollars a year, even with a deregulated market for electricity as well as the availability of natural gas in some areas (Wrigley 2023). Energy or fuel poverty exists in the region, meaning some households cannot afford to use as much energy as required to live well, especially when costs rise (Day, Walker, and Simcock 2016; Waitt and Harada 2019). In addition, as climate variability increases and climactic events become more severe, these groups may face greater difficulties coping with the impacts of climate change—such as increased heat waves—than the general population (Bickerstaff, Walker, and Bulkeley 2013a).

Across the world, state-led programmes that are aimed at addressing energy poverty in low-income and senior households often face challenges, with some programmes inadvertently imposing unfair or disproportionate costs on vulnerable residents (Bickerstaff, Walker, and Bulkeley 2013b). Distributional inequalities in access to low-cost, sustainable energy may occur. With the energy transition already underway in Australia, identifying ways to reach those who may have difficulties in dealing with temperature extremes and energy transition costs is vital. This article charts the strengths and weaknesses of an innovative residential rooftop solar photovoltaic (PV) programme, arguably the first of its type, which was designed to assist residents in the City of Darebin who were in need of reduced power costs. We explain how the project has operated over time, whom it has reached, and the general lessons it offers for other energy transition programmes.

Specifically, the article determines the extent to which this solar PV programme has been successful in achieving climate justice (CJ) and energy justice (EJ). Its success is determined by how well the programme has been able to reach its target audience; the household income of participants, which acts as a proxy for the extent of financial assistance required to

acquire solar PV to access low-cost energy; and the extent to which the participants have been better able to access affordable energy after solar PV installation.

**Box 1:** Australian Climate Policy, 2012–2022

*Recent Australian Climate Policy: 2012–2022*

Australia is a significant contributor to climate change due to its mining activities and export of fossil fuels (McDonald 2015), making climate policy a contentious political issue. Until very recently, Australia had chosen economic security over climate action, despite its vulnerability to the impacts of climate change (McDonald 2015). Australia introduced a carbon price in 2012, which was repealed in 2013 after the election of a conservative federal government (Crowley 2017). The next eight years saw a stalemate on climate policy under this government. The Morrison government announced its target of reaching net zero by 2050 in 2021 (Taylor 2021), and the centre-left Labor government elected in 2022 quickly legislated this target, along with an interim target of 43% emissions reduction compared to 2005 levels by 2030 (McAllister 2022).

**Source:** Crowley (2017); McAllister (2022); McDonald (2015); Taylor (2021)

## 1.1 Background on the Solar PV Programme

The case presented here is of a residential rooftop solar PV programme, called Solar Saver (SS), in the City of Darebin, a Melbourne local government area (LGA) located just northeast of the Melbourne central business district, with a target audience of low-income residents, seniors, and tenants (hereafter referred to as the "target audience"). Similar to Melbourne as a whole, the City of Darebin is a moderately affluent city with wide income diversity. Darebin City Council was the first local government in the world to declare a "climate emergency" (Council Action in the Climate Emergency n.d.) and is known in Melbourne for being progressive and environmentally conscious.

The programme began in 2014 and has had varied eligibility criteria from year to year since its inception to the present day (see Table 1). In 2018–19, it aimed to cover some of the upfront costs of rooftop solar PV for these households and to support residents in dealing with climate impacts and energy costs (Darebin City Council 2015). The programme had previously been identified as an innovative and award-winning renewable energy financing model (Mey, Diesendorf, and MacGill 2016; Meiklejohn *et al.* 2018) and as a successful means of addressing the problems that energy programmes targeted at vulnerable populations encounter (Browne and

Schultz-Byard 2021; Law, Meiklejohn, and Mountjoy 2015; Toovey and Malin 2016).

The programme offers a no-interest loan for solar panels and installation, which is delivered by the local government rather than the private sector. Residents repay the loan over 10 years through a special charge on their council rates (Darebin City Council 2016b). In Australia, council rates are quarterly local government taxes that cover essential services such as waste collection and road maintenance. This special charge is enabled through the Victorian *Local Government Act 1989,* the main piece of legislation in the state governing the establishment and operation of local councils, and charges are due from the owners of each property (Darebin City Council 2018b). One innovation of the SS programme was that homeowners and tenants were both eligible to participate, recognising that renting is usually a severe barrier to installing renewable energy systems on a property. However, tenants have to obtain approval from their landlord to participate.[1]

The complication in this case is that the eligibility criteria and the size of the programme have changed from year to year (see Table 1). Several "rounds" have been offered since 2014, each with limits on how many households could receive discounted rooftop solar PV. In 2018–2019, eligibility for the scheme was opened to all residents, with the priority target audience remaining low-income residents, pensioners, and renters, to facilitate residents' access to the scheme and increase penetration of rooftop solar PV systems in the City of Darebin (see section "4.1 Expansion of the SS Programme").

Table 1 captures the eligibility criteria used by the programme since its inception. In this table, "senior" refers either to those aged 60 years or above or those having a partial capacity to work and with incomes under a certain threshold (Services Australia 2020). "Low income" refers to households with a total income under US$55,212[2] per year, with over 30% of this income spent on average on rent or mortgage, and a combined income under US$44,020 per year (Darebin City Council 2020). To be eligible, tenants must rent privately from a landlord or a real estate agent and must meet the low-income criteria. Reaching these residents is important as they are more likely to be disadvantaged than owner-occupiers, and, thus, less likely to be able to afford the high costs associated with purchasing a home (Australian Government Productivity Commission 2019) or participate in energy transitions away from fossil fuels. The

[1] An alternative programme is also offered in Darebin through which residents pay the system costs upfront at a discounted price due to economies of scale (City of Darebin 2018).
[2] Currency conversion based on AU$1=US$0.75.

majority of electricity in Victoria is still sourced from its ample supplies of energy-intensive brown coal, although that percentage is dropping rapidly as supply from renewables increases. It is illegal for landlords to pass on the costs associated with solar PV installation to tenants through the programme, meaning that only landlords must pay even if the solar PV installation is requested by the tenant.

**Table 1:** Eligibility Criteria in Different Rounds of the SS Programme and the Number of Participants in Each Round

| Year | Eligibility | Number of Participants |
|---|---|---|
| 2014 | Seniors only | 300 |
| 2015 | Seniors only | 200 |
| 2016 | Seniors, low-income & tenants | 207 |
| 2017 | Pause in programme | – |
| 2018 | Open eligibility | 481 |
| 2019 | Open eligibility | 518 |
| 2020 | Low income only | 113 |
| 2021 | Low income only | 74 |
| 2022 | Low-income and renters | 36 (as of November 2022) |

**Source**: Darebin City Council (2017a; 2016a; 2018a; 2019c; 2019b; 2019a)

## 1.2 Climate Justice and Energy Justice

Despite the recent reductions in production costs, solar panels, their associated controllers, and wiring add up to significant costs. This means that households that have a higher financial capacity are generally more likely to be able to access solar panels and their associated benefits, while those with fewer resources are less likely to install them (Boardman 1993, 2012). This article addresses whether this inequality in access to solar PV is addressed or reinforced through the SS programme.

Similar forms of inequality have been theorised as key elements in climate justice (CJ), which applies "conceptions of distributive and social justice" (Schlosberg 2013, 46) to the climate debate and draws attention to differential inequalities in the impacts of climate change. CJ developed from the North American environmental justice movement (Schlosberg and Collins 2014). Similarly, the term energy justice (EJ) applies the principles of unequal access to energy consumption, including barriers to accessing available options as a response to high utility costs and extreme weather (Jenkins *et al.* 2016). EJ applies principles of justice to various dimensions of energy, focusing on the victims of injustices—for example, those with insufficient access to energy, such as cooling—and maps the localities where such injustice occurs (Jenkins *et al.* 2016). The proponents of these

concepts discuss "energy poverty" (Day, Walker, and Simcock 2016) or "fuel poverty" (Waitt and Harada 2019), which are interpreted as symptoms of energy injustice. In the energy justice field, distributional injustices are identified to reduce inequities in access to adequate energy (Jenkins *et al.* 2016).

CJ and EJ encompass several dimensions (see Table 2). These dimensions of justice acknowledge that groups within an area—here, an LGA—experience climate risk and energy access unequally (Forsyth 2014). For this reason, programmes to address CJ and EJ must be targeted towards the most affected groups to ensure justice is achieved.

**Table 2:** Conceptions of Justice as They Relate to Climate Justice and Energy Justice

| Dimension of Justice | Climate Justice | Energy Justice |
|---|---|---|
| **Distributive** | Geographic distribution of climate change impacts (Schlosberg and Collins 2014). | Distribution of benefits and detriments of energy infrastructure and services (Jenkins *et al.* 2016, 176). |
| **Procedural** | Participation of a range of actors in climate change–related policymaking processes (Schlosberg 2004). | "Access to decision-making processes that govern the distributions" of benefits and detriments of energy infrastructure and services (Jenkins *et al.* 2016, 176–178). |
| **Recognition** | Acknowledgement of differential climate change impacts between groups (Schlosberg 2004). | "Adequate recognition of all actors" including social aspects, cultural contributions, and concerning the law (Uffelen 2022, 7). |

**Source**: Schlosberg (2004); Schlosberg and Collins (2014); Jenkins *et al.* (2016); Uffelen (2022)

Our key research question is whether the SS programme successfully addresses both of these conceptions of injustice, differentiated by the type of home occupancy. Survey and interview questions were designed to determine the respondents' level of energy access before and after solar panel installation as well as their specific situation, including dwelling type, income level, and housing tenure.

## 2. LITERATURE REVIEW

Installation of rooftop solar PV in Australia has increased drastically in recent years, as costs per kilowatt (kW) have reduced (Clean Energy

Council 2022). Regardless, groups who would benefit the most from the associated energy and cost savings continue to be left out of the solar PV market because they lack capabilities—such as the ability to pay upfront costs—exacerbating socio-spatial inequalities in the urban landscape (Bridge and Gailing 2020, 1037). Though the SS programme targets solar PV installations by low-income residents, tenants, and seniors, the extent to which these groups benefit is unclear.

Inequalities that arise in access to solar PV occur at multiple scales of the energy transition, since urban environments such as Melbourne—a western city with sharp income differentials and racial diversity—have "uneven power relations" (Heynen 2014, 600). The urban political ecology of renewables indicates that only well-off residents can access solar, but the aim is to establish an "empowering… socionatural condition" (Heynen 2014, 600) addressing the differential access to this particular resource.

CJ focuses on inequalities in the distribution of climate change impacts and addresses these inequalities through the transition to a zero-carbon economy by "providing assistance to vulnerable communities" (Schlosberg and Collins 2014, 366) most heavily impacted by climate change. The approach began as a response to capitalist modes of energy production where energy producers profit while accelerating climate change and unjustly and disproportionately impacting vulnerable communities (ibid).

The CJ and EJ frameworks both encompass concerns around who benefits from and who bears the costs of emissions-mitigating activities, as well as the varying degrees of capability to respond to climate change through mitigation and adaptation (Jenkins 2018). The two approaches can be considered in parallel. For example, the rising costs of energy may worsen and exacerbate affordability issues as climate change intensifies (Jenkins *et al.* 2016; Shepard and Corbin-Mark 2009). EJ posits that humans should have adequate access to energy as a basic human right (Day, Walker, and Simcock 2016), while the CJ perspective "means providing for those rights to which we have already agreed" (Schlosberg and Collins 2014, 365), such as access to energy. An integrated approach to EJ and CJ would address inequities in access to affordable energy while also addressing the inequitable impacts of climate change. Redressing inequity can include providing affordable, low-carbon cooling during heat waves. Addressing CJ without explicitly focusing on EJ risks placing the costs of climate action on the already vulnerable disproportionately, thus exacerbating energy injustices (Walker and Day 2012).

Local governments are an important site of climate governance and for addressing CJ, because they are physically close to the people they govern in cities such as Melbourne (Broto and Bulkeley 2013). In addition, while they are municipal institutions that must deliver value for money, they are not capitalist or profit-seeking. They have direct interaction with "people's lived experience of climate change" (McKendry 2016, 1357). In the absence of a strong national climate policy (see Figure 1; Mey, Diesendorf, and MacGill 2016; Hadfield and Cook 2019), some local governments stepped in much earlier by setting their own emissions targets and implementing carbon mitigation programmes (Mey, Diesendorf, and MacGill 2016; Darebin City Council 2017b; Broto and Bulkeley 2013; Batterbury 2010). Addressing inequalities in access to renewables is one way local governments can attempt to address both CJ and EJ, although other local government programmes worldwide, operating at similar scales or with similar budgets, have been criticised for exacerbating existing inequalities (McKendry 2016; Broto and Bulkeley 2013).

## 3. METHODS

The research was conducted using a questionnaire targeted at programme participants and interviews with programme participants, Darebin City Council staff, and city councillors.[3] The questionnaire revealed general information on participants' attitudes and motivations and the impact of solar PV on their energy consumption; participant interviews then expanded on this information. Interviews with staff and councillors were used to gain insight into the political and social context underpinning the programme. In this paper, "participants" refers to Darebin residents who took part in the SS programme; "interviewees" refers to individuals who were interviewed as part of this research.

### 3.1 Questionnaire

In October 2020, an email was sent out by the programme staff to all the participants of the 2018 and 2019 rounds, asking if they were interested in participating in the research. Responses were received through November 2020. The questionnaire was then sent via email to willing respondents. Some 898 initial emails were sent out by programme staff; of these, 295 (32.8%) were classified under the programme as "high priority" (i.e., low income or senior); 542 (60.4%) as "general priority"; and 60 (6.7%) as inconclusive (blank answer on the registration form). The questionnaire was returned by 48 respondents from different groups: they were self-selecting,

[3] Research clearance was obtained through the human ethics board at University of Melbourne.

with only highly engaged participants filling it out. However, the responses to individual questions indicate a bias towards participants who worked fewer hours or were retired, with fewer responses from those who were time-poor. Ethical considerations prevented us from recruiting potential respondents directly. Additionally, drawing respondents from the 2018 and 2019 rounds made it difficult to fully assess the justice criteria, since the programme was open to any resident in Darebin in those two years.

### 3.2 Interviews

One questionnaire question asked participants to indicate whether they were interested in being followed up for an interview. From a sample of 41 positive replies, four were randomly selected. Three of these individuals were retired and one was employed full-time. One of the retirees was on a low income, one was on a medium income, and one income unknown. The full-time employed individual was on a high income. Semi-structured interviews were conducted and recorded with the interviewee's permission. From Darebin City Council, three individuals were interviewed: one former and one current elected councillor, and a former programme staff member. Direct quotes from these interviews are used in the key findings section, but they are not attributed to an individual to maintain confidentiality. Programme developments were monitored after the initial research was conducted.

### 3.3 Analysis

Questionnaire responses were examined to determine whether respondents were better able to afford the energy they consumed after solar PV installation and whether they were now able to use as much energy as needed. The analysis focused on affordability rather than gross cost savings. General questions were posed around the participants' ability to afford all living expenses, including energy bills. The distinction made between "affordability" and "ability to use adequate energy" is crucial here. The former refers to a participant's ability to afford energy and other bills.[4] If they indicated that they were able to afford essential bills "mostly without problems" before solar and "with no problems" after, an improvement in affordability was recorded. The latter refers to the participant's ability to use

[4] Determined by the difference in response to the questions "How well were you able to afford all your essential bills (energy, food, rent/mortgage, etc) before having the solar panels installed?" and "How well were you able to afford all your essential bills (energy, food, rent/mortgage, etc) after having the solar panels installed?"

energy.[5] If a participant indicated they were able to heat their home "some of the time" before solar and "as much as I want" after, this was recorded as an improvement in the ability to use adequate energy. Greater improvements in affordability and energy use were taken as indications of higher levels of programme success and the achievement of EJ and CJ outcomes.

People's motivations for installing solar PV[6] and the impact of solar on participants' lives[7] were also investigated. These questions determined whether participants had financial motivations for participating, indicating whether financial need drove decisions and thus whether the programme helped in achieving EJ, and potentially CJ, outcomes. Responses were grouped and counted to determine the frequency of responses.

Participants' income levels were also grouped into quintiles and compared with the Australian Bureau of Statistics (ABS) data for the entire LGA, to determine the participation rates in each income group and the extent to which low-income groups had accessed the scheme.

Interviews were transcribed using NVivo to code answers to key research questions as well as to identify themes. EJ, CJ, and inequalities in access to solar PV were examined, along with any emergent relevant but unexpected themes. Grouping interview codes relevant to the key research questions and identifying overarching themes based on the linkages between the codes assisted thematic analysis (Bryman 2012).

### 3.4 Limitations

The most significant limitation encountered was the lack of access to the original programme participants' contact information. Council staff lacked the capacity to follow up on survey non-respondents. This meant that participants without an email were excluded from the survey. Additionally, council-wide electricity consumption data to enable a control group comparison against survey responses around bill cost changes after solar PV installation (Table 4) was sought but could not be obtained.

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[5] Determined by the difference in response to the questions "To what degree were you able to heat your home in winter before having the solar panels installed?" and "To what degree are you now able to heat your home in winter as a result of having the solar panels installed?"

[6] Examined through the question "What was your main motivation for having solar panels installed on your home?"

[7] Examined through the question "How else has having solar panels installed on your home impacted your life? Please explain."

## 4. KEY FINDINGS

We report on selected findings, with a focus on the extent to which the SS programme has met the needs of poorer households. There are definitional problems in establishing "low income" as a proxy for justice. For this case study, we have inferred that low income refers to anyone receiving Australian Government Centrelink payments (government assistance to those on low income); those with a total yearly household income less than US$55,212 (US$1,062 per week), with more than 30% spent on rent or mortgage; those with a total yearly household income less than US$44,020 (US$847 per week), regardless of the proportion spent on rent or mortgage; or those receiving a "rates rebate", which is a deduction on council rates for holders of eligible concession cards (e.g., pensioner concession card). A "senior" is a resident who holds a pensioner concession card (see section "1.1 Background on the Solar PV Programme" for pension eligibility).

Household rather than individual incomes were taken as a wealth indicator since these form the eligibility criteria for the scheme and are a more realistic measure than individual earnings.[8] Around 32.8% of SS participants in 2018–2019 self-classified themselves in their applications as "low income" or "senior" (data could not be disaggregated between the two categories). This data is not easily comparable with the Darebin LGA as a whole due to a lack of senior-specific ABS data. However, a rough percentage can be determined, as 14.2% of Darebin residents are aged 65 and over, and 26% of Darebin residents earn a weekly household income under US$750 (Figure 1; in keeping with the SS programme's definition of low income). Therefore, 40.2% of Darebin residents can be classified as either senior or low-income. There may be a degree of overlap between these categories.

The income distribution of survey respondents ranged between US$375 and US$1,950+ per week. The majority of survey respondents (41%) fell in the US$750 to US$1,350 per week income range, and no survey respondents fell in the lowest income category of less than US$375 per week. Additionally, 20.5% fell in the US$375–750 per week range and 10.3% in the US$1,950+ category.

While significant conclusions cannot be drawn, the percentage of participants accessing SS who identify as low-income or senior (32.8%) may be less than in Darebin as a whole (40.2%). Therefore, the programme may

[8] Eligibility criteria applies during restricted years, but not in 2018 and 2019.

not have adequately focused recruitment efforts on the target audience after the programme's expansion in 2018–2019.

Though examining EJ and CJ outcomes for those occupying rental properties was an objective of this research project, the programme did not adequately reach tenants. This could be seen from tenants' lack of response to the survey (see "4.2 Low Uptake by Tenants").

Table 3 shows the percentage of survey respondents who experienced either an improvement in energy affordability after solar panel installation (i.e., an improvement in the ability to afford the energy they consumed after solar PV installation) or an improvement in energy use (i.e., an improvement in the ability to use as much energy as needed where they had been unable to previously), or both (see "3.3 Analysis"). Only 33.4% of respondents experienced an improvement in one or both measures, indicating either that most respondents had little difficulty in being able to afford or use adequate energy prior to the solar PV installation, or that the installation of solar PV did not help improve their situation. With all but four respondents reporting a decrease in energy bill costs after installation (Table 4), the former appears more likely.

**Table 3:** Percentage of Survey Respondents who Experienced an Improvement in Energy Affordability, Energy Use, or Both (n=48)

| Measure | % of Respondents |
|---|---|
| Improvement in energy affordability | 10.4 |
| Improvement in energy use | 18.8 |
| Improvement in both affordability and energy use | 4.2 |
| Total | 33.4 |

**Source**: participant survey responses

**Table 4:** Survey Respondents' Answers to the Question "Please Estimate How Much Your Bills Have Reduced Since Having Solar Panels Installed" (n=48)

| Change in Bill Cost after Solar PV Installation | % of Respondents |
|---|---|
| Reduced by 0–25% | 31.3 |
| Reduced by 26–50% | 35.4 |
| Reduced by 51–75% | 12.5 |
| Reduced by 76–100% | 12.5 |
| Increased | 2.1 |
| I don't know | 6.25 |
| Total | 100 |

**Source**: participant survey responses

As indicated by Table 5, only 25% of survey respondents reported that their major motivation for participation in SS was financial. These respondents also indicated energy bill reductions after solar PV installation, and one-third also experienced an increase in either affordability or the ability to use adequate energy. Since this finding suggests that most participants were not motivated by finances, it does not support the attainment of EJ criteria through meeting financial need. Residents with higher incomes may have been motivated by financial savings, which may not be linked directly with an increase in affordability or adequate energy use. Environmental motivations were a driving factor for 60.4% of the participants, indicating that financial need was secondary for most of them.

**Table 5**: Response Rates to the Survey Question "What Was Your Main Motivation for Having Solar Panels Installed on your Home?" (n=48)

| Motivation for Participation | % of Respondents |
|---|---|
| Environmental | 60.4 |
| Financial | 25.0 |
| Both environmental and financial | 12.5 |
| Other (not specified) | 2.1 |
| Total | 100.0 |

**Source**: Participant survey responses

Table 6 lists the various ways in which having solar PV installed impacted survey respondents' lives. Some 39.5% of the respondents made a positive behavioural adjustment in their energy consumption. After solar PV installation, 12.5% of the respondents became more aware of their energy consumption. While improving awareness of and changing behaviours around energy consumption is not an explicit aim of SS, it is a potentially significant outcome. The presence of solar panels may encourage more concern about energy use but may also encourage increased energy consumption.

Additionally, 4.2% of the participants experienced improved thermal comfort after solar PV installation, and a further 4.2% of solar panel recipients felt less guilt about using electricity. Since there were no other efficiency upgrades made to homes as part of SS, an improvement in thermal comfort was not a specifically intended outcome of the programme. Instead, these participants likely felt more comfortable using their heating and cooling from a financial standpoint. Of these 8.4% respondents, one stated that "in the summer, as an older woman, I don't have the stress of feeling too hot"—a clear EJ and CJ outcome, as the participant was able to improve their thermal comfort and reduce their

energy costs. However, another stated that "the main reason [for having solar PV installed] was to 'power' the three pool pumps"—it is unlikely any justice was obtained here, given the high cost of swimming pool ownership and maintenance.

Interview transcripts from scheme managers and local elected officials responsible for the scheme were analysed for emerging themes. Three major themes emerged:

- Maintaining and actively reaching the target audience became difficult after the SS programme's expansion;
- SS has low uptake among tenants; and
- The local council plays a unique role in delivering the programme.

**Table 6**: Frequency of Responses to the Survey Question "How Else Has Having Solar Panels Installed on Your Home Impacted Your Life? Please Explain." If a Respondent Gave Multiple Answers, all Answers were Counted (n=48)

| Response | Frequency | % of Respondents |
|---|---|---|
| Made a behavioural adjustment in energy use | 19 | 39.5 |
| Financial impact | 12 | 25.0 |
| Improved environmental contribution | 7 | 14.5 |
| Increased awareness of energy consumption | 6 | 12.5 |
| No other way | 4 | 8.3 |
| Reduced guilt about energy consumption | 2 | 4.2 |
| Improved thermal comfort | 2 | 4.2 |
| Other | 2 | 4.2 |

**Source**: participant survey responses

### 4.1 Expansion of the SS Programme

In 2018, the SS programme expanded from its initial focus on poorer or disadvantaged households to include all residents. The aim became to double the solar generation capacity in Darebin from 19 MW to 38 MW (Darebin City Council 2017b). This caused several problems for SS, including financial strain on the council, a surge in demand for participation, and difficulties in reaching the households genuinely requiring financial assistance.

First, programme expansion strained council budgets, as the greatest proportion of funds were put towards installation costs, with "a small amount that went into… operations". However, "administration costs were—are—significant", despite the programme being perceived as understaffed; in the words of one respondent, "ambition from councillors

was not translating into the appropriate resourcing and organizational support [from the Council]." Upon programme expansion, there was "a lot of cash going out, and only a little trickle coming back in", resulting in a significant deficit for the council. In 2020, the programme was scaled back to the pre-2018 target households only, "mainly because of the impact of COVID-19 on the budget", but also partially "to maintain the programme into the future". This demonstrates the enduring financial strain of programme expansion, which was made particularly difficult by the pandemic.

Second, the expansion of SS caused a surge in demand and led to associated delays in installation. One interviewee noted that the council was "so maxed out on our waiting list, we weren't promoting it for the past two years because we couldn't fit everybody in". One participant interviewee said that they "didn't hear anything [from the council] for quite a few months", causing uncertainty about their inclusion in the scheme. This excess demand became an issue for SS: understaffing meant that prospective participants waited months for their installation to begin, and SS lacked the capacity to focus recruitment efforts on its target audience. Despite the backlog, a former SS staff interviewee confirmed that "we will always prioritise [seniors] and low-income households so that they weren't on any waiting list; they would just get in"; this was done by prioritising sending these households to suppliers first.

Third, the scheme encountered difficulties in reaching senior and low-income households in general. One interviewee asserted that "in the early iteration of [the scheme], before we injected more money into it, it was absolutely a success. In terms of, you know, reaching those [senior] households, not so much low income." Another interviewee stated, "I would say though, once we did expand the programme, whether we actually concentrated our recruitment efforts enough to make sure that we're continuing to capture the vulnerable parts of the community, maybe that's a question."

These claims are supported by the survey responses from a substantial proportion of senior participants, but an under-representative proportion of low-income respondents (see Figure 1).

Another interviewee stated that "once we got to a certain scale… there was a little bit of worry that we weren't managing that aspect of it around the poverty." While SS became successful in overall participation, it is evident that the target audience may not have been adequately prioritised after programme expansion.

### 4.2 Low Uptake by Tenants

Enabling access to solar PV by tenants was a clear goal of SS, with council documents stating that the "council will continue to explore innovative ways of engaging tenants and landlords to jointly participate in the program" (Darebin City Council 2017a, 2) after expansion and council interviewees stating that "there was a lot of work done on engaging real estate agents and [tenants]". It is crucial to note here that the aim was to get landlords, not tenants, to pay for any costs to their properties such that the solar panels would remain on the property should tenants move on.

Despite this important distinction, there is evidence that reaching tenants became a real challenge over the scheme's various iterations: this issue was brought up several times by interviewees, and though there is anecdotal evidence that there were some tenant participants, it only amounted to "a handful each round". This was reflected in the survey responses, which included no tenants.

The difficulty in reaching tenants through home upgrade programmes is due in large part to the split incentive phenomenon, where landlords lack incentives to upgrade their rental properties with energy-efficiency measures and solar PV because they are responsible for the costs but do not realise the benefits (Bird and Hernández 2012). Despite claims that the SS model has overcome the split incentive (Browne and Schultz-Byard 2021), the programme has unfortunately been unsuccessful in doing so.

Interestingly, one of the randomly selected participant interviewees, who was a landlord, offered some insight into the perceptions of landlords towards helping their tenants access solar energy, "Why would we want to give them solar panels and we're having to pay for it? The landlord would want to call back that money [for the solar panels] by increasing the rent". Due to the structure of SS and its utilization of the Victorian Local Government Act for rate repayments, landlords are legally unable to share costs with tenants, making the split incentive an enduring issue. However, in 2022, a stream was added to the scheme for tenants, wherein landlords were made to be solely responsible for repayments (Darebin City Council 2022b).

Ultimately, as one interviewee suggested, engaging tenants "was just put in the 'too hard' basket… I think that perhaps we could have done more work. It was kind of a lower priority because we already had great uptake for the programme".

### 4.3 The Role of the Local Council

An integral component of SS is the local council as the delivery agent. The Council is politically progressive and was effectively led by the Australian Greens party during the study period, in an alliance with independently elected councillors. As the first local government in the world to declare a "climate emergency", Darebin is well-known and regarded as "an environmentally conscious city" and very much sees itself as a leader and a "role model for others" in climate action.

The ability of Victorian councils to declare special rates [local government taxes] through the Local Government Act is a critical financial mechanism for SS, enabling participants to receive solar PV with no upfront costs. Other entities in the state do not possess this repayment mechanism, making delivery through local councils key. Indeed, the state-wide Solar Savers scheme was introduced through a pilot in 2016 based on the SS model. Solar Savers initially operated in 26 rural and metropolitan Victorian LGAs and offered solar PV to senior households through a low-interest bank loan or the same rates repayment mechanism offered by SS (Eastern Alliance for Greenhouse Action n.d.). Currently, only nine metropolitan and one rural Victorian LGA offers Solar Savers to low-income and senior households through a low-interest loan or through a bulk buy mechanism (where economies of scale enable discounted costs) (Solar Savers 2019).

One participant stressed the importance of the council's role in educating residents, stating that its distribution of the programme's informational materials prompted him to "update [his] knowledge" and realise that solar PV is no longer as expensive as it once was. Another participant noted the importance of the council's engagement around SS, which enabled them to realise that they were eligible. Several interviewees mentioned that "people trust the council", which was integral for participants to trust its suppliers and to believe they were getting a fair deal. The council's role in procuring suppliers on behalf of participants removes a potentially insurmountable barrier for some:

> There was a role for the council because, particularly for vulnerable households, the cost is not the only barrier. In fact, it's potentially an even bigger barrier to be able to navigate the solar [installation] system and advocate for yourself with a solar company and power companies, to even just be able to understand the information and have the confidence and the trust that you're getting a reliable supplier who's not going to rip you off.

Despite the relative affluence of some interviewees, they mentioned uncertainty around finding a trustworthy solar installer and the burden of having to navigate the system, indicating the importance of this element of the programme.

The council's role in SS was also significant because it filled a policy void left by the Australian federal government. Interviewees from within the council believe that "it's way more efficient and better and will provide a more orderly transition for communities, society, the economy, if [this programme is] done at a federal and state level. But without that, we need to keep chipping away, even if it's just rooftop by rooftop reducing emissions". While local councils are "ideally placed" to run this type of programme, "they don't have the money", making it preferable for the state or federal government to provide funding while local councils deliver. Federal funding could ensure that benefits reach all Australians, not just residents of Victoria. In the absence of this support, however, the council sees itself as putting "upwards pressure towards other levels of government" to take similar action on climate issues. The programme has been successful in doing this, to a degree—the Solar Savers scheme was introduced in 2016 and the Solar Victoria (SV) scheme in 2018. SV is run by the Victorian government and offers a rebate to eligible households[9] for solar PV, solar hot water, solar batteries, and other energy-efficient appliances (Solar Victoria 2021c). SV differs from SS in that participants must pay for system costs upfront but they receive a discount on costs. Additionally, tenants and landlords are legally able to share and repay costs with a no-interest loan on tenanted properties (Solar Victoria 2021b).

## 5. DISCUSSION

The combination of survey results and the SS programme's larger dataset reveals that most SS participants in 2018–2019 owned their homes, receive a moderate to high income, and live in a single-family dwelling. Determining the degree to which the SS programme achieved CJ or EJ outcomes—which is not completely satisfactory given the recipients' profiles—requires a comparison of the programme's goals and achievements during the years examined.

To briefly revisit the definitions of justice, EJ was defined as the distributional aspect of inequities in access to energy (Jenkins *et al.* 2016), and CJ refers to the disproportionate climate impacts that vulnerable communities face, such as an inability to cool or heat a home (Schlosberg

[9] Eligible households include those with a household taxable income under US$134,028 with a property valued under US$2.2 million (Solar Victoria 2021a).

and Collins 2014). Based on these definitions, we hope to identify positive outcomes in terms of the three indicators described in the following paragraphs. When coupled with the positive outcomes associated with these indicators, the programme's ability to reach its target audience indicates that those who may bear disproportionate costs and impacts of climate change were reached, an indication of both EJ and CJ outcomes.

First, a greater percentage of the target audience's residents participated in SS than are found within the general Darebin population. This indicates that the target audience was effectively reached by the programme. Around 32.8% of the participants in 2018–2019 self-identified as low-income or senior; this was not significantly higher than the 40.2% of low-income or senior residents in the entire Darebin population. A higher percentage of these cohorts served through the programme would indicate that these cohorts – the program's target audience – were reached effectively through the programme. Since this percentage was lower, the target audience was likely somewhat displaced by more affluent residents after the programme's expansion.

Second, participants were primarily motivated by financial savings. Financial motivation indicates that financial assistance with energy costs was required, which is consistent with mitigating EJ (Walker and Day 2012). The SS programme does seem to have achieved EJ to an extent for 25%[10] of participants who required financial assistance to access adequate energy.

Third, participants who received solar panels experienced an improvement in energy affordability and/or energy use. Improvements in energy affordability and/or energy use indicate a resulting improvement in access to affordable energy, a clear indication of EJ outcomes (Jessel, Sawyer, and Hernández 2019). An improved ability to use cooling in summer is an indication of CJ, as this is a method of coping with increased heat waves, particularly for older households (Jenkins 2018; Walker and Day 2012). Around 39.6%[11] of participants experienced either reduced guilt around energy consumption, improved thermal comfort, or an improvement in energy affordability and/or energy use. These participants saved money on their energy bills or were better able to use the energy they needed after solar PV installation. This indicator signifies that residents with extra cooling needs—especially older residents—will be better able to afford to cool their homes with solar PV. As the effects of climate change progress,

[10] 16.7% of these participants were also covered in indicator one.

[11] This figure refers to the total number of participants falling into at least one of these categories indicating achievement of both energy and climate justice—see Tables 2 and 5.

this will become increasingly important for the maintenance of climate justice. This is especially relevant in the City of Darebin, which is an inner-city LGA experiencing the urban heat island effect due to a relatively high proportion of hard surfaces (Sun *et al.* 2019).

In examining the above indicators together, 20.8% of programme participants both experienced EJ or CJ outcomes (indicators two and three) and were low-income or senior residents (indicator one).

The major critique of SS as an effort to assist disadvantaged residents with solar PV is the "mission drift" it has encountered over years of operation. It began as a scheme specifically targeted to help seniors, low-income residents, and tenants access solar PV, but the ambitious mission of doubling solar PV capacity in Darebin in 2018 shifted focus away from this audience. Demand for the scheme generated by the broader group of residents meant that SS staff did not need to intentionally seek out new target audience participants, which made it difficult to consistently achieve socially and environmentally just outcomes. While the programme was able to achieve EJ and CJ for the low-income and senior participants it reached, the high proportion of high-income participants and low uptake by tenants meant these goals could only partially be realised.

The two forms of justice can be addressed simultaneously through the provision of low-cost, low-carbon cooling to those who require assistance accessing it. However, this can be achieved only if assistance is properly targeted; as one interviewee noted, SS "really is a model that can be used for energy and climate justice. But it kind of has to be specifically done that way. It won't just happen by accident". In the absence of focused targeting, the energy-related "unjust socio-environmental conditions" (Swyngedouw and Heynen 2003, 901) that SS sought to address are likely to be maintained.

While the distribution of solar panels need not be an inherently political process, the cost considerations and variations in access can make it so. Because of these costs, most residential solar programmes serve wealthy homeowners, marginally reinforcing their position in a hierarchy of wealth, as they save more money on their energy bills. Meanwhile, residents who are unable to access such schemes, especially tenants, miss out almost entirely. EJ operates with the potential to entrench energy poverty.

Access to solar PV is characterised by "multiple power relations" (Swyngedouw and Heynen 2003, 901) at varying scales. Sufficient wealth, income, and home ownership enable some residents to access and install solar PV easily. The landlord–tenant relationship results in the inability of many tenants to access solar PV, meeting resistance from landlords.

Tenants settled in their desired locations in Australia generally rent because they cannot afford their own homes. An inability to access the money-saving benefits of solar PV may further reinforce societal wealth inequalities, owing to their reduced ability to access cheap renewable energy.

As with many renewable energy programmes, there is a question regarding the true sustainability of the SS scheme. In the wider transition towards renewable energy sources, schemes such as SS focus on offering supply-side interventions and do not address demand reduction. For example, the latter would involve improving the energy efficiency of each home or changing cultural norms to reduce energy use. Demand reduction, ironically, would even reduce the number of solar panels required and, thus, the resultant energy and resources required in each home. Installation of solar panels enables consumers to maintain their current lifestyles without making the significant demand-side changes necessary for combating climate change; this is why we term schemes like SS a form of "weak sustainability" (Neumayer 2010).

In addition, while improving access to adequate energy is important for those households lacking access for technical or financial reasons, solar PV installation may increase their energy use, as they feel less financial pressure when using heating or cooling. This may be counterproductive in terms of true carbon reduction and sustainability, as households rarely derive 100% of their energy consumption from their solar panels. The electricity grid in Victoria is still predominately coal-powered, though the penetration of renewables is increasing and coal power plants are being retired early (OpenNEM 2021; AEMO 2022).

### 5.1 Policy Recommendations

Enabling access to home energy-efficiency upgrades may be a stronger sustainability measure than rooftop solar PV for low-income and senior households. Energy-efficiency upgrades will lower energy consumption while increasing climate resilience, especially for older residents, as they will improve thermal comfort (Williamson *et al.* 2022). Providing relatively simple energy-efficiency upgrades, such as insulation, highly efficient reverse cycle air conditioners, or hot water heat pumps through a similar financial mechanism could result in a similar financial outgoing for the local council while improving thermal comfort for residents and reducing stress on the electricity grid. Addressing low uptake by renters requires the implementation of minimum energy-efficiency standards, which would effectively make energy-efficiency upgrades mandatory on homes falling

below the minimum standard (Lang *et al.* 2022). Standards are set at the state rather than the local level in Australia, meaning that it is outside the scope of the local council's abilities.

## 6. CONCLUSION

We set out to determine the degree to which CJ and EJ are addressed through the SS programme developed and operated by a local council in Melbourne, and whether the programme reduces or reinforces inequality in access to solar PV. This is a question rooted in the political ecology of energy supply and consumption and provides historical lessons as well, given that this form of subsidy was developed quite early by this progressive council.

The findings reveal that EJ and CJ outcomes were achieved for 39.6% of the low-income and senior residents in the participant sample population or slightly less than half of the participants. This finding speaks to an institutional "mission drift" through the life of the SS programme, as it expanded its eligibility criteria.

We also found that programme participants surveyed were primarily motivated to install solar PV for environmental rather than financial reasons. Most participants were able to meet their household expenses, including energy consumption, without great difficulty. As most participants had sufficient financial capacity to meet their energy needs before obtaining solar PV, it does not appear that these participants meet the criteria for households suffering from energy injustice or climate injustice.

The majority of SS participants were homeowners living in detached, single-family homes, and those who rent their homes have been largely left out of the programme. It is well-known that tenants are a particularly difficult cohort to reach for energy-related programmes (Bird and Hernández 2012). Landlords rarely take up energy upgrades on their rented properties despite the availability of generous incentives, suggesting a need for stronger energy regulation—a measure beyond the remit of local government (Law, Meiklejohn, and Mountjoy 2015). Additionally, the inability of solar PV costs to be passed on to tenants through SS is a potential barrier to reaching more tenants.

In the absence of assistance through a programme such as SS, the groups that are least likely to be able to access solar power are tenants, older residents, and those on low incomes. SS attempts to address these inequalities by targeting these groups; however, in 2018 and 2019, the programme did not do this as actively as in other years. The council's goal

of doubling solar PV capacity in the City of Darebin issued in 2017 led to an overwhelming demand from more affluent residents. SS has the potential to reinforce inequality because higher-income residents became the major scheme recipients. Future rounds of the programme should consider limiting eligibility to only those target residents requiring financial assistance, which means investing resources to verify their eligibility. Indeed, in 2022, programme eligibility was limited to "disadvantaged people and discriminated communities", with a household income of less than US$67,500 per year (Darebin City Council 2022b; 2022a). Limiting the scale of the programme may free up funds and staff capacity to actively target residents.

Renewable energy scheme providers must be perceived as trustworthy. This was the case for this council, which helped educate residents about the benefits of solar power and their eligibility, providing them with assistance with navigating the installation process. In Victoria, the council as the scheme provider has the legal ability to implement the mechanism to enable resident repayments for solar PV through council rates. Darebin is a progressive council and has innovated this programme as an exemplar for other governments. As action in this area at the state and federal levels continues to lag, the local council has taken up the challenge of delivering a targeted programme.

In conclusion, the SS programme did not wholly reinforce inequality in access to renewable energy. It enabled access for certain residents who would have otherwise been unable to install solar panels. However, inequalities were not addressed adequately. The implication is that this type of programme cannot fully address inequality in access to energy while also serving high-income or wealthy homeowners, who displace target audience residents, as what has occurred within the scheme during the years of expansion to all residents. As there is clear potential to use programmes such as SS to address the justice concerns of low-income, tenants, and senior households, if programmes are targeted, solar energy schemes may be useful but only with a clear focus on those who really need this source of energy.

**Ethics Statement**: I hereby confirm that this study complies with requirements of ethical approvals from the institutional ethics committee for the conduct of this research.

**Data Availability statement**: The data used to support this research is not available since no means of publicly storing data are available to the author.

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