Is rooftop solar a play-thing of the well-to-do?

A critique of the argument and evidence

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Abstract

The Australian Energy Markets Commission (AEMC) is nearing its Final Determination on rules to allow distribution network service providers ("distributors") to charge distributed generators (mainly households with rooftop solar photovoltaics) to inject electricity into distribution networks. The "equity" of rooftop solar has been raised by proponents of the rules, and by others. Equity issues include how network expenditure to integrate distributed energy is recovered, how changes in the recovery of sunk costs is affected when solar homes increasingly self-consume, and the claim that solar installation is positively associated with wealth. Our previous objections to the first two arguments remain unanswered. With respect to the claims of wealth effects, we find that across all homes solar uptake is positively associated with wealth. But this headline fails to account for the fact renters do not install solar, because they lack the wealth to do so, but because property rights, transaction costs and building form make it difficult or impossible for them to install solar. The analysis of owned homes reveals that poorer households install solar at a similar or greater rate than richer households. Existing studies have failed to account for the difference between rented and owned homes in their ability to choose solar. When correctly segmented, the positive relationship between wealth and solar evaporates. Analysis of population data also suggests a negative relationship between household income and solar uptake. In Victoria in particular means-tested solar support policies in Victoria are stimulating the uptake of solar in greater number by less well-off households, than in the rest of Australia. ACOSS and St Vincent de Paul's proposals are not well-founded. If implemented as the AEMC has set out in its Draft Determination, they will be regressive. Since export charges lack a rationale in economics, they are best characterised as a tax. This critique concludes that the tax will disproportionately affect those that are less well-off. The AEMC's Chair has suggested that equity will be its central concern in its final determination. This must mean reversing the decision in the Draft Determination.

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Introduction

The Australian Energy Markets Commission is nearing its Final Determination on rule change proposals to allow distribution network service providers ("distributors") to charge distributed generators (mainly households with rooftop solar photovoltaics) to inject electricity into distribution networks.

One of the central issues in this debate has been the "equity" and "fairness" of household rooftop solar, terms that the AEMC's Draft Determination mentions 37 times and 10 times. While the Draft Determination says that the AEMC "*is limited in its ability to consider notions of equity and fairness*"[1], in her first comments after the receipt of submissions on its Draft Determination, the AEMC's Chair has (rightly, we think) brought equity to the fore: "*We need to design a solution that works for the 2.7 million homes and businesses who have solar – as well as the 10 million who don't. …*"[2]

This article examines three dimensions of equity briefly revisiting the first two, contained in the argument that solar homes impose additional network costs on others, that have already been widely debated. The rest of the article is dedicated to the question of whether rooftop solar is disproportionately taken up by the well-off, as St Vincent de Paul and the Australian Council of Social Services (ACOSS) suggest.

Does rooftop solar cause additional expenditure by distributors?

The rule change proponents (and the AEMC) argue that rooftop solar causes additional distributor expenditure in order to accommodate injections to the grid. They argue that if this expenditure is not recovered from solar exporters it will be inequitable. Many of the equity claims by market participants allude to this as one of the main equity issues.

In our research[3] and commentary[4], we have pointed to the evidence that the expenditure in question is small – typically around 1-3% of distributors' capital outlays. Ausnet Services, Victoria's largest distributor, suggests that recovery of this expenditure will cost households 72 cents per year[5].

In response to our arguments, ACOSS has suggested that while distributed energy integration expenditure is small now it will grow in future.[6] This is possible, but not necessarily likely.

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[1] AEMC, Access, pricing and incentive arrangements for distributed energy resources, Draft rule determination, 25 March 2021, p. 16.

[2] https://reneweconomy.com.au/victoria-tesla-and-enphase-line-up-against-proposed-solar-export-tax/

[3] Mountain, B.R., S. Percy and K. Burns(2020) "Rooftop PV and electricity distributors: who wins and who loses?". VEPC Working Paper 2006. DOI: 10.26196/5ecb4af97f78c.

[4] https://theconversation.com/now-they-want-to-charge-households-for-exporting-solar-electricity-to-the-grid-itll-send-the-system-backwards-158055?utm_source=twitter&utm_medium=bylinetwitterbutton, https://reneweconomy.com.au/the-sun-tax-debate-misconception-and-false-accusation/, https://reneweconomy.com.au/facts-matter-and-so-do-the-size-of-the-tariffs-proposed-for-the-solar-export-tax/

[5] Ausnet Services. 2019. Final negotiation notes for the Customer Forum. Melbourne. Available: https://www.ausnetservices.com.au/Misc-Pages/Links/About-Us/Charges-and-revenues/Electricitydistribution-network/Customer-Forum

[6] https://reneweconomy.com.au/a-step-towards-more-sun-for-everyone-and-a-fairer-energy-transition/

For example, SA Power Networks which has much higher solar penetration than most other distributors do not expect to spend much more per customer on distributed energy integration over the coming five years than Citipower or Jemena (distributors in Victoria) which have the lowest rooftop solar penetration in their areas.

While it is very likely that distributed solar will continue to expand, emission reduction policy is also likely to result in an expansion of residential electrical demand for example for electrical vehicles and the installation of heat pumps for water heating and space conditioning. Furthermore, the ability to address injection constraints through the application of technology (e.g. "smart inverters") and dynamic line limits remains largely unexplored.

Concerns about possible network expenditure cross-subsidies associated with distributed energy integration merits attention when there is evidence that these expenditures are material or are likely to become material.

Does rooftop solar affect the recovery of distributor revenues?

In their submission, to the AEMC's Draft Determination, many interested parties and the rule change proponents raised an issue of "equity" that they suggest arises when households with rooftop solar consume less electricity from the grid, leaving more of the distributors' sunk costs to be recovered from other customers.

This is an understandable concern, but is it material? Our study[7] of the situation in Victoria found that between 2010 and 2019, per capita electricity consumption in Victoria declined by 25%, of which 10 percentage points was explained by self-consumption of rooftop solar, with the remaining 15% explained by other factors. The solar-related reduction in network volumes resulted in network usage charges that are $1.3/MWh or about 0.3% (of the typical retail price of electricity) higher than they otherwise would be. This is obviously inconsequentially small. We have also pointed out that merit order price effects swamp network price effects. The rule change proponents and others[8] continue to insist that the network price effect is material and that the merit-order price effects, while true in the past will evaporate in future. No evidence has been adduced for either of these two claims.

Network price effects also raise thorny questions of principle that have been ignored by the rule change proponents. Does any household that reduces its consumption of grid-supplied electricity cause a cross subsidy, or is this only deemed to occur when households reduce their grid consumption when self-consume their solar production? What about if households (or other customers) increase their grid consumption, are they then deemed to be providing a subsidy to others that others should compensate them for? What about households that already use less electricity (not following the installation of solar) - are they deemed to be cross-subsidised by other higher consumption households and so liable to pay compensation? None of these quandaries and logical inconsistencies have been taken on by those that assert that rooftop solar should be blamed for volume-based cross subsidies.

[7] Mountain et al. (2020), op. cit.

[8] See for example https://www.abc.net.au/religion/solar-justice-who-should-pay-for-the-grid/13376586

Is rooftop solar disproportionately taken up by the rich?

This is perhaps the most important "equity" issue of all. If rooftop solar is a play-thing of the rich, this can be expected to colour the consideration of the merits of export charges (quite reasonably we think) even if there is no evidence about material expenditure or volume-related cross-subsidies.

ACOSS and St Vincent de Paul have claimed that solar is disproportionately taken up by the well-off. In support of this argument ACOSS[9] cite the findings in a report[10] it commissioned and academic research (see Best, Chareunsy, & Li, 2021). The report concluded that "*Solar power lowers bills, but those with low wealth are locked out*". The academic research concluded that "*High-wealth households disproportionately receive the benefits (and subsidies) that solar can bring*". This is consistent with an earlier paper (Best, Burke, & Nishitateno, 2019) that concluded that "*higher net wealth is generally associated with higher likelihood to install [rooftop solar*]".

The report and the published research use household survey data from the 2012 Household Expenditure Survey and the 2015/16 and 2017/18 Survey of Income and Housing (SIH) undertaken by the Australian Bureau of Statistics. Best et al. (2019) use the SIH datasets to examine the determinants of rooftop solar installation and Best et al. (2021) use the data to examine the equity and effectiveness of Australian small-scale solar schemes.

In both articles, the datasets cover all households irrespective of whether the home is owned or rented. However, the authors recognise that the installation of rooftop solar in rental properties is affected by property rights (landlords invest in solar but tenants get the benefit of lower price; tenants cannot take the solar system with them when they relocate), transaction costs (the problem of allocating solar production to specific tenants in a building) and the roof space per household (building form). These factors do not affect the decision to install solar in owned homes. For this reason, the relationship between wealth and solar uptake will be very different in owned homes than in rented homes or apartments. The extent of the difference between owned and rented homes becomes obvious when segmenting the dataset into owned and rented homes. This is presented in Figures 1a and 1b.

Figure 1a shows the proportion of all homes (rented and owned) with solar, across a distribution of 10 bands of net worth. Figure 1b presents segmented results separately for owned homes from rented homes. Not shown in Figure 1b is that rented homes are heavily skewed to the bottom of the wealth distribution. This means that when renters and owned homes are pooled, as they are in Figure 1a, the dominant effect of a large number of renters only a small number of which have few solar panels results in the distribution in Figure 1a.

By comparison, the share of solar homes changes little in response to household net worth for owned homes.[11]

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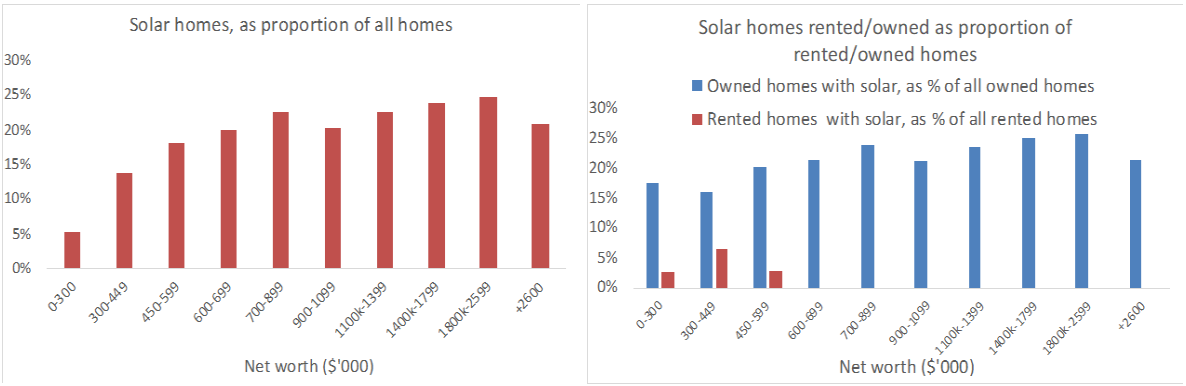
[9]Ref: https://www.aemc.gov.au/sites/default/files/documents/acoss_actcoss_qcoss_sacoss_tascoss_vcoss.pdf

[10] Phillips, B., 2018. "Energy stressed in Australia". A report prepared for ACOSS and the Brotherhood of St Lawrence. ANU Centre for Social Research and Methods.

[11] It should be noted in addition that these charts are based on data gathered in 2017/18. Since that time solar uptake has continued to expand (about 25% more households have solar) and as shown

Figure 1a and 1b. Solar homes analysed by net worth



Source: (Australian Bureau of Statistics, 2019).

Figure 1b uses the same data but splits owned homes from rented homes. Not shown in Figure 1b, is that rented homes are heavily skewed to the bottom of the wealth distribution. It is clear from these charts that the proportion of rented homes with solar is much lower than for owned homes and skewed to the bottom of the net worth distribution. By comparison, the proportionate installation of solar changes little over the net worth distribution for owned homes[12]. It is obvious from this (as it should be from a first-principles consideration of transaction costs, property rights and building form), that the market for rooftop solar in rented dwellings is completely different to the market for rooftop solar in owned dwellings.

An analysis of the relationship between net worth and solar installation that fails to account for the big difference in the factors that affect solar uptake in rentals rather than owned homes distinction will therefore be confusing the effect of wealth on rooftop solar installation from the effect of rental on rooftop solar installation. Taking account of the difference means segmenting the data into two separate datasets: owned homes and rentals/apartments. This has not been done in either the descriptive report or in the published articles. Instead, property type (i.e. renting/apartment) has been reflected as explanatory factors, just like wealth in a single regression of the whole dataset. This means that the relationship between wealth and solar installation fails to account for the completely different way it is reflected in owned homes versus rentals/apartments[13].

later, this expansion has been much greater in areas of lower socio-economic advantage and higher socio-economic disadvantage.

[12] It should be noted in addition that these charts are based on data gathered in 2017/18. Since that time solar uptake has continued to expand (about 25% more households have solar) and as shown later this expansion has been much greater in areas of lower socio-economic advantage and higher socio-economic disadvantage.

[13] This can be seen for example in the low R-squared score in the models (7-15%) – the regression equation establishes a relationship across the full distribution but for most of the distribution there are no rented solar homes and very few rented homes. This also explains why the relationship between wealth and solar uptake is so heavily affected by whether or not "Rent" and "Apartment" are included as dummy variables in the regressions.

Other evidence

We have matched the latest post-code specific data on rooftop solar installation (from the Clean Energy Regulator) to the ABS's post-code specific Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD) which summarises information about the economic and social conditions of people and households within an area, including both relative advantage and disadvantage measures. IRSAD is based on census information. While such aggregate data cannot provide firm conclusions on causality, it provides information – explained below – which is strongly suggestive of a negative association between solar and relative socio-economic advantage and disadvantage, and income in particular. Figure 2a, 2b and 2c presents analysis of the solar installation and IRSAD data (decile 1 = lowest advantage and highest disadvantage).

Figure 2. Solar homes and Index of Relative Socio-economic Advantage and Disadvantage

Source: (Australian Bureau of Statistics, 2016) and (Clean Energy Regulator, 2021).

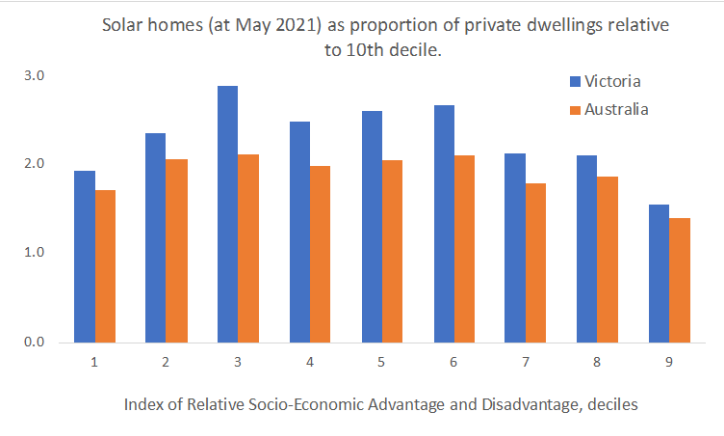
Figure 2a shows that solar homes as a percentage of occupied dwellings is roughly constant from the second to eighth decile after which it drops down, increasingly steeply in successive measurement years. It is also a little lower in the first decile. The data shows the picture for all homes until 2012, until 2017 and until 2021. The chart shows that solar penetration has been growing much more quickly in the first to eighth deciles than the ninth and tenth, so that by 2021 there is now a big disparity in solar installation rates in the areas of the nine and tenth decile areas of highest socio-economic advantage and lowest socio-economic disadvantage, as compared to the other eight decile areas.

Figure 2b shows that the proportion of rented properties is approximately constant across the deciles, except in the first where the proportion that is rented is noticeably higher. We suggest that this is likely to be a large part of the explanation for the lower solar uptake in the areas of the lowest socio-economic advantage and highest disadvantage, compared to the other areas.

Figure 2c maps the proportion of private dwellings with solar as a percentage of occupied dwellings (to May 2021) in each decile but also showing the proportion of households with annual income in three bands ($1-$51,999, $52,000 to $103,999, + $104,000). It shows that solar uptake trends down from the second to 10th decile, while at the same time the proportion of homes with income in the highest band trends monotonically up and those in the lowest band trends monotonically down. This strongly suggests that rooftop solar installation is negatively correlated to income.[14]

Finally, we examine the situation in Victoria, where means-tested solar support policies since 2018 (the Solar Homes program) have sought to encourage rooftop solar uptake in lower income and lower wealth households. By April 2021, 129,485 additional homes had installed PV pursuant to the policy, 66 percent of which had income below $100k per annum[15]. Figure 3 uses the same population data used in Figure 2, but also breaks out Victoria and expresses proportional solar uptake relative to the uptake in the 10th decile.

Figure 3. Solar homes in May 2021 in Victoria and Australia mapped to IRSAD deciles



Source: (Australian Bureau of Statistics, 2016) and (Clean Energy Regulator, 2021).

It is evident from this that the Solar Homes policy is having a much bigger impact on solar uptake, with much higher rates of solar uptake in the areas of relatively lower socio-economic

[14] The standard (but often trite) criticism of the use of population level data is that inferences on individuals cannot be made based on the group in which the individual is part. But consider this: if the argument is that it is the advantaged in the lower socio-economic deciles that are installing solar, why would that not also apply in the higher socio-economic deciles in which case we would see solar uptake that is higher in higher socio-economic deciles than in the lower? But the opposite is evident. In fact the solar installation rates are so much higher in the lower socio-economic deciles (and incomes so much lower in those deciles) that a conclusion of "strongly suggestive" is surely appropriate.

[15] https://www.solar.vic.gov.au/solar-homes-program-reporting

advantage and higher disadvantage, compared to the situation in the rest of Australia. This strongly suggests that the Victorian Government's policy is evidently achieving its objectives.

Conclusions

This note has examined the arguments on equity and rooftop solar, with a particular focus on the relationship between wealth and solar uptake. We find that arguments we have previously made (that expenditure by distributors to accommodate rooftop solar is inconsequentially small) still stand. Similarly our earlier conclusion, that revenue recovery changes that arise as a consequence of rooftop solar self-consumption are small and dwarfed by energy market price effects, continues to stand.

Most of this note has reviewed published studies of the relationship between rooftop solar and wealth. These studies have recognised that solar uptake in apartments and rented dwellings is affected by transaction costs, property rights and building form (the relationship between roof space and dwellings space). These factors do not affect decisions to install rooftop solar in owned homes.

Yet the studies have failed to account for this difference by segmenting the data into two separate buckets. Instead, owned homes have been lumped together with rentals/apartments, and "apartment" and "rental" are included as variables as if they are competing with wealth as explanations for solar uptake in the same way in owned homes and in rentals/apartments. This confuses the effect of wealth on solar installation with the constraints on solar installation that are particular to rentals and apartments.

In other words, it would be correct to observe that across all homes, solar uptake is lower in the lowest wealth deciles than in the higher. But this fails to account for the fact although households that rent are generally much less wealthy than households that own their own homes, renters do not install solar because they lack the wealth to do so, but because property rights, transaction costs and building form typically make it difficult or impossible. The analysis of owned homes reveals that less well-off homes install solar at a similar or greater rate than more well-off households.

Other useful evidence can be found in an analysis of the relationship between the Index of Relative Socio-economic Advantage and Disadvantage and solar uptake, using population data. This is strongly suggestive of a negative relationship between solar uptake and income.

The impact of a progressive solar subsidy policy in Victoria is visible in much higher solar uptake in areas of lower socio-economic advantage and higher socio-economic disadvantage in Victoria, compared to the rest of Australia. Evidently the Solar Homes policy is achieving the Government's equity objectives.

The credibility of charges to export surplus rooftop solar production to the grid depends on plausible evidence that solar uptake is skewed to the wealthy. But after properly accounting for the difference between rented homes/apartments and owned homes, the claim of a positive relationship between wealth and solar uptake evaporates. Further study of survey data is likely to reveal a negative relationship between income and solar uptake, and between wealth and solar uptake. This is particularly the case considering the evidence that rooftop solar is being installed in less well-off households at a much greater rate than in better-off

households, as is to be expected in the normal process of technology diffusion in retail markets.

For these reasons, we conclude that ACOSS and St Vincent de Paul's proposals are not well-founded. If implemented as the AEMC has set out in the Draft Determination, they will be regressive. Since export charges lack a rationale in economics, they are best characterised as a tax on the sun. This analysis shows that if the Draft Determination stands, export charges will disproportionately affect those that are less well-off. The AEMC's Chair has correctly raised the importance of equity in the AEMC's final determination. This must mean reversing the decision in the Draft Determination to avoid its regressive effects.

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