# The final frontiers of rooftop solar: opportunities for energy entrepreneurs

**Solar is one of the most popular technologies for cleantech entrepreneurs to build their businesses upon.** This is perhaps unsurprising given how fast the technology has progressed in the last decade. Furthermore, it is the technology upon which some of the most successful clean energy businesses have been built. Rooftop solar photovoltaics (PV) has been particularly popular and yet, in our view, there are still areas of untapped opportunity.

**We intend for this discussion paper to help entrepreneurs new to the sector discover business opportunities in rooftop solar.** To do so, we have summarised statistics and research on the uptake of rooftop solar in Australia. We have also identified startups that are focussing on underserved areas and pointed out potential gaps that other entrepreneurs may wish to address.

**There appears to be four main areas where solar uptake is lagging and could benefit from additional innovation.** These areas are:

- **Rental properties:** The proportion of rental properties with solar installed is one-seventh that of owner-occupied premises, largely due to the split incentive problem.
- **Properties occupied by first home buyers:** People appear to be far less likely to install solar panels on the first home they buy, at least initially.
- **Apartments and semi-detached premises:** Standalone homes are five times more likely to have solar installed than other dwelling types, most likely due to strata laws and other barriers faced by apartments and semi-detached buildings.
- **Commercial and industrial (C&I) buildings:** C&I uptake of solar has lagged residential buildings, despite potentially standing to benefit more from the technology.

**While some solar startups are focussing on renters and apartment-dwellers, the C&I sector is relatively underserved, in our opinion.** Matter, SunTenants and SunYield have developed solutions for rental properties while Allume Energy serves apartment buildings. Some of these startups and a couple others do cater to C&I buildings. However, we haven't seen the same focus on addressing the barriers facing C&I solar uptake, suggesting there could be untapped opportunities in this area.

(Energy)Lab

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**About EnergyLab**
We are Australia's leading platform for launching new energy businesses. Our Acceleration Program was the first in Australia to focus on energy startups and is currently available in four cities. To find out more visit energylab.org.au.

**About EnergyLab's research**
EnergyLab prepares discussion papers such as this to help facilitate productive conversation around clean energy innovation, and to promote and support clean energy entrepreneurship.

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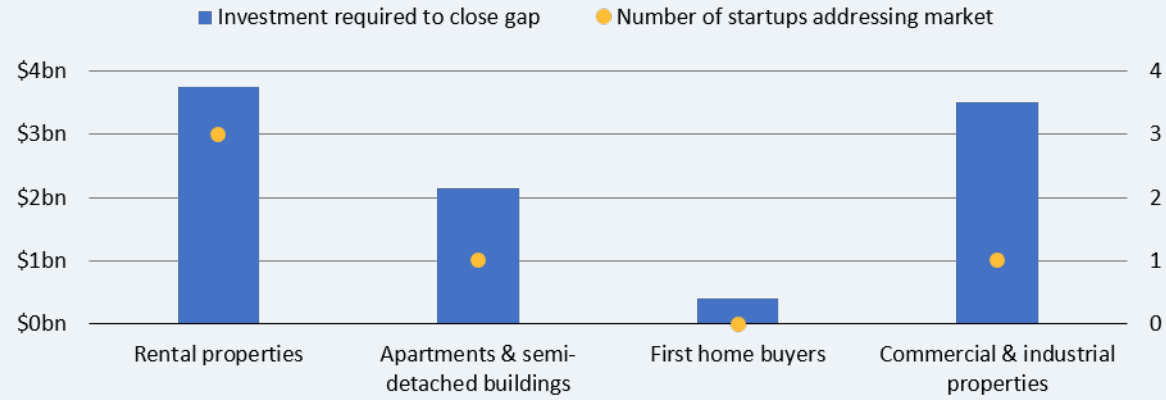
**If the barriers to these four areas are fully addressed, Australia's rooftop solar capacity could double.** We estimate that in the order of 7 GW of rooftop solar could be installed, requiring close to $9 billion of investment. We hope this paper proves useful to entrepreneurs who wish to set their sights on this opportunity.

*Figure 1: Summary of opportunities to increase solar uptake and number of startups addressing area*




Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; Geoscience Australia 2017 National Exposure Information System (NEXIS) Building Exposure; EnergyLab analysis

Note: There is some overlap between apartments & semi-detached buildings and the other two residential categories

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# Introduction

**Many entrepreneurs wishing to contribute to the clean energy transition pursue business ideas that will increase the uptake of solar power.** We estimate about a quarter of the clean energy startups in Australia are utilising or encouraging the uptake of solar and a similar proportion of participants in EnergyLab hackathons pitch ideas relating to the technology. The popularity of solar doesn't appear to be declining so we expect we will be supporting solar entrepreneurs for some time to come.

**This discussion paper is intended to help entrepreneurs starting down this path identify potential business opportunities.** At our hackathons we try to help participants come up with clean energy startup ideas by educating them about the sector, helping them brainstorm ideas for clean energy startups, and narrowing down on the most viable ideas that aren't being tried already. We hope this paper will assist with that process for prospective solar entrepreneurs, regardless of whether they attend our events.

**In the pages that follow, we will identify gaps in the uptake of rooftop solar in Australia, discuss the barriers that are present, and point out what has been tried to address them so far.** By compiling existing datasets on rooftop solar uptake in Australia and combining them with other data sources we have produced a series of charts that illustrate where rooftop solar uptake is lower than average. A survey of the literature revealed why most of these discrepancies exist, and our own databased of startups was consulted to identify startups trying to address them.

**This paper is broken into a section for each of the four main areas of opportunity and a section summarising other areas of interest.** The areas we believe solar uptake to be lower than it could be and present the greatest opportunity is amongst renters, non-detached buildings, first home buyers and the commercial and industrial sector. Other avenues proved less fruitful but have been summarised in the final section for reference.

**Most of our findings won't be surprising to anyone familiar with the market.** It is common knowledge that it is difficult for renters and apartment-dwellers to benefit from rooftop solar. This paper doesn't claim to break new ground on this front but rather provide a summary for anyone new to the sector and looking for opportunities to contribute to the clean energy transition.

**We will not discuss portable solar or solutions that involve investing in solar installations located anywhere except the building in question.** We believe these initiatives are important and play a valuable role in increasing the uptake of renewable energy. However, in this paper, we are primarily concerned with the challenge of installing solar panels on every viable rooftop in Australia.

**Please note we have not conducted a rigorous statistical analysis.** If you want something containing phrases like "multivariate linear regression techniques" then we refer you to the excellent work of ACIL Allen Consulting and the Queensland University of Technology (QUT).[1] In this paper, we instead attempt to provide an easy-to-understand portrayal of the state of solar in Australia for anyone interested in increasing it, even if you weren't paying attention in stats class.

[1] ACIL Allen Consulting 2013 Drivers of Domestic PV Uptake; Sommerfeld et al 2017 Influence of demographic variables on uptake of domestic solar photovoltaic technology

**As a final note of warning, care should be taken when comparing solar uptake statistics from different sources.** It is particularly important to pay attention to denominators i.e. what any given percentage is *of*. Depending on the source, a solar uptake statistic might be taken as a proportion of buildings or dwellings (the main difference being there are multiple dwellings in one apartment building), occupied dwellings or all dwellings (only about 90% of dwellings in Australia are occupied[2]), all dwelling-types or just detached houses. It is also worth being aware that most people, including ourselves, assume that solar installations less than 10 kW are residential installations.[3] While that isn't strictly true, it has historically been a good enough proxy (although might not be for much longer due to a trend by households to purchase larger systems[4]). Throughout this paper, we've tried to be as explicit as possible about how we're producing our statistics to try to avoid confusion. Now, caveats and excuses aside, let's move on to a popular topic for solar enthusiasts: the rooftop solar outlier that is rental properties.

[2] ABS 2016 Census QuickStats

[3] APVI 2018 Solar Map; Solar Choice 2015 Average Australian solar system size up to 5kW: SunWiz; The Conversation 2016 FactCheck Q&A: is Australia the world leader in household solar power?

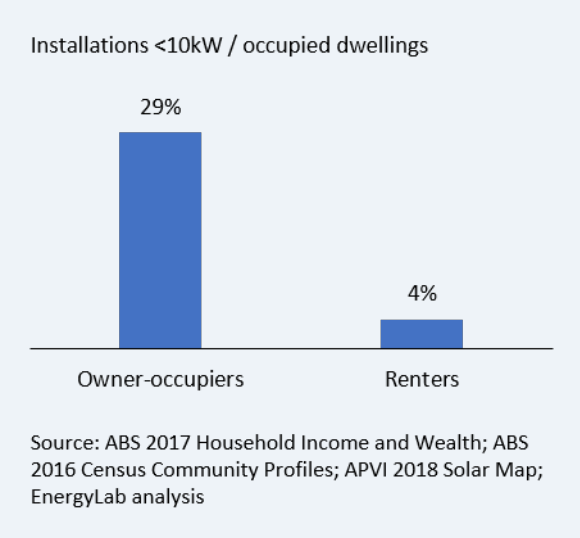
[4] AFR 9 March 2018 Australians households embracing bigger solar PV roof installations

# Rental properties

**Renting is often cited as one of the main barriers to benefiting from rooftop solar.** An Australia-wide study found that renting was one of the main reasons for not installing solar for 34% of households, second only to solar being too expensive.[5] Research on City of Melbourne residents produced similar findings.[6] QUT looked at demographic predictors of solar uptake and similarly found homeownership as the most important variable.[7]

**As a result, owner-occupiers are seven times more likely to have solar on their roof than renters.** Of the households in Australia that are mortgaged or owned outright, 29% have solar panels installed. In contrast, of households that are rented, only 4% have solar (Figure 2). To understand this disparity, it is necessary to look at the value proposition from each party's perspective.

*Figure 2: Proportion of owner-occupiers and renters with rooftop solar*




Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

**Most renters are unwilling to install solar panels because they are unlikely to receive a positive return on their investment.** The average payback period for a rooftop solar installation is currently at least four years[8]. However, only about 5% of rental leases are fixed for five years or more.[9] That means most renters would be at risk of being kicked out of their property before their investment paid off. Given the likelihood of the panels outlasting the tenants, it might make more sense for the owner to pay for the installation, but that approach has its own issues.

**Owners could install solar but are unlikely to do so due to the split-incentive problem.** This is the barrier most-often cited for a lack of solar on rental properties[10] and refers to the fact that if the owner installs solar panels then they will typically bear the installation and maintenance cost while their tenant receives the benefit of lower electricity bills. As a result, most landlords unsurprisingly don't find installing solar to be a compelling value proposition – unless they can share in the benefits.

**The problem could be solved with a little collaboration between the tenant and the landlord, but that is rare.** One such approach might involve the landlord installing solar in return for an increase in rent. As long as the rent increase was less than what the tenant saves in electricity, everyone would be better off. In a related New Zealand study, it was found that tenants were willing to pay more rent if their landlord

[5] UMR & Energy Consumers Australia 2016 Usage of solar electricity in the national energy market
[6] City of Melbourne 2015 Community Attitudes and Barriers to Rooftop Solar
[7] Sommerfeld et al 2017 Influence of demographic variables on uptake of domestic solar photovoltaic technology
[8] Solar Choice 2018 Is home solar power still worth it in Australia in 2018?; Australian Energy Council 2017 Solar Report
[9] CHOICE, National Shelter & NATO 2017 Unsettled: Life in Australia's private rental market
[10] Sturmberg & Cumming 2018 Raising the roof: Solar for renters and apartment dwellers; ABC 2018 Solar boom: New schemes may help renters get solar panels on their roof

improved the energy efficiency of their homes and that the rent increase would make such upgrades profitable for the landlord.[11] However, there is unfortunately little trust between landlords and tenants, making this solution uncommon.

**There are also other issues with this approach.** As pointed out by Sturmberg & Cumming, it can be difficult to calculate the benefit of installing solar in advance and therefore knowing how much of a rental increase is fair. And once the solar panels are installed (and the rent is put up), the landlord will have little incentive to maintain the panels and ensure the tenants are receiving the electrical output (and bill savings) they expected.[12] Fortunately, these issues can be solved with the right approach.

**Several Australian businesses have created solutions to these problems.** While no longer operating,[13] Prepaid Solar led the way with a solution they launched in 2014. Under their arrangement, the landlord not only installed solar panels but also paid for the property's electricity bill. To make this profitable and manage the risk for the landlord, Prepaid Solar installed a prepaid meter in the rental property. Tenants then used this meter to pay upfront for any electricity they wished to consume, which Prepaid Solar passed on to the landlord (minus a fee).[14] Matter later took a similar approach, but on a post-paid basis where the renter retains their relationship with their existing retailer. As a result, the tenant receives two bills – one from Matter for their solar consumption and another from their retailer for their remaining energy use.[15] SunTenants takes a different approach entirely by helping tenants and landlords agree on a rent increase in exchange for installing solar panels. SunTenants then monitor the system's output to ensure that everyone benefits, addressing the issues discussed above.[16]

While all these offerings focus on existing buildings, SunYield has emerged recently with a different model that targets new build rental properties. Stoddart Group and Powershop (the companies behind this solution) claim to be able to save tenants $275/year while increasing returns for property investors. But what makes SunYield unique is that even if the tenant opts out, the landlord still receives payment for electricity exported to the grid, thanks to a smart switchboard that is installed with the solar panels.[17]

**If these initiatives are successful, they could unlock about 3.2 GW of solar capacity.** That is to say, if the same proportion of renters had solar on their roof as owner-occupiers, about 640,000 solar installations would be added to Australian rooftops. Taking an average installation size of 5 kW[18] that equates to 3.2 GW of generation capacity. With an average cost of $5,840 for a 5-kW installation[19] around $3.7 billion of investment in renewable energy would be unlocked.

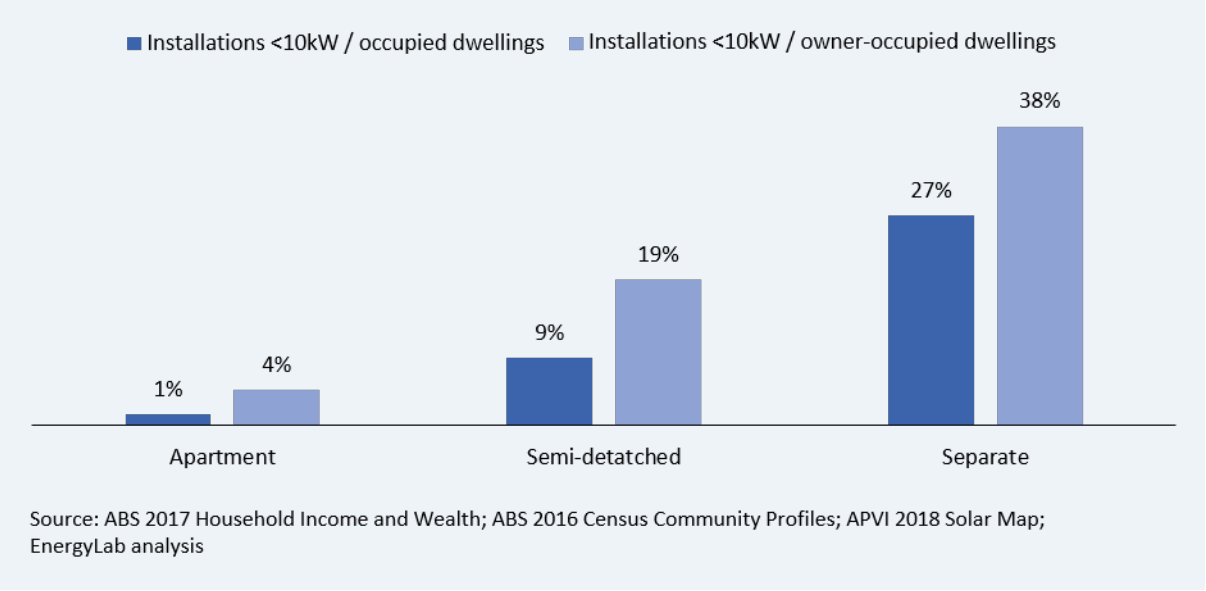
[11] Phillips 2012 Landlords versus tenants: Information asymmetry and mismatched preferences for home energy efficiency
[12] Sturmberg & Cumming 2018 Raising the roof: Solar for renters and apartment dwellers
[13] Personal communication on 3 April 2018
[14] RenewEconomy 2014 Solar for renters: Prepaid meter technology targets untapped PV market; Prepaid Solar 2013 Tenants
[15] SMH 2016 Digital Solar opens up solar power to Australian renters; Matter 2018 Solar for Renters
[16] SunTenants 2018 Sun Powered Rentals
[17] The Fifth Estate 2018 New scheme aims to get solar on investment property roofs; One Step Off The Grid 2018 Rental solar scheme targets 15,000 Queensland investment homes; SunYield 2018 For Tenants
[18] SunWiz 2015 Average System Size Hits 5kW
[19] Solar Choice 2018 Current solar power system prices: Residential and Commercial

# Apartments and semi-detached buildings

**Apartments and semi-detached buildings are much less likely than detached houses to have solar installed.** While 27% of detached houses in Australia have solar panels, only 9% of semi-detached homes like townhouses have solar. Apartments are even further behind, with only 1% of households living in apartments having solar panels, as illustrated in Figure 3. The huge disparity is due to apartments and semi-detached buildings being plagued by a range of issues, some of which we have discussed already.

**The discrepancy can be partly explained by the fact apartments and semi-detached homes are more likely to be rented.** More than 50% of apartments and semi-detached buildings are rented while less than a quarter of separate houses are rented out.[20] To estimate the impact of this factor we have calculated solar installations as a proportion of owner-occupied dwellings (Figure 3). While this isn't a true representation of the proportion of owner-occupied dwellings of each type that have solar, it is a good enough approximation for our purposes. Taking into account ownership as such, apartments and semi-detached dwellings are still well behind, indicating there are other factors at play.

*Figure 3: Proportion of apartments, semi-detached dwellings and separate houses with rooftop solar*




Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

**Strata title (an Australian invention) appears to be the main culprit for low penetration of solar amongst apartments and a major barrier for many semi-detached dwellings.** This legal arrangement enables people to own a section of a property individually while collectively owning common property areas through an owners' corporation (OC), also known as a body corporate or strata company.[21] Almost all apartment buildings and many semi-detached buildings in Australia are owned under this arrangement, which can make installing solar difficult. Rooftops are typically considered common property so any decision to install solar would require approval from the OC at which every individual property owner usually has one vote. If the solar installation is to be used for an individual unit in an

[20] ABS 2018 Community Profiles
[21] SCA 2018 What is Strata?

apartment building, then a special by-law needs to be developed.[22] The extra effort required to go through this process can put off many homeowners and as such solar salespeople often deprioritise strata-title dwellings.

**In addition, there are structural barriers to installing solar on semi-detached dwellings.** Installing solar panels on a terrace house can be made difficult and expensive by a need to install non-standard wiring and upgrade and move meter boards. There may also be a requirement to install solar panels on the back of the property to maintain the street-side aesthetic, which might not be the optimal place to position the panels.[23] In addition to this, it is possible that the economic case for solar on semi-detached dwellings is typically lower, with reduced roof space, lower energy use, and possibly a sub-optimal building orientation.

*Figure 4: Semi-detached homes in Sydney – how many solar panels can you spot?*

**Apartments also suffer from structural barriers to solar.** Special mounting systems might interfere with waterproofing and cabling may penetrate fire separation boundaries. If the apartment is above a certain height, then cranes might be required, and the installation company may charge more for working at heights. Shading is also more likely to be an issue, as apartment blocks are often clustered.[24] Even though these issues hold back solar uptake in apartments, there are still enough that have taken up solar for a range of installations approaches to have been developed.

[22] Roberts, Bruce & MacGill 2015 PV in Australian Apartment Buildings – Opportunities and Barriers
[23] Solaray Energy 2016 Solar Power For A Terrace House
[24] Roberts, Bruce & MacGill 2015 PV in Australian Apartment Buildings – Opportunities and Barriers

**There are a few different options for wiring solar into an apartment building.** Detached and semi-detached dwellings usually have clearly delineated roof space that can be used to install solar panels for the sole use of its occupants. However, the roof space of apartment buildings is typically shared, which makes identifying an installation site less straight-forward. Three main solutions to this problem have evolved:

- **Option 1**: Divide up the roof space amongst apartments, let interested residents install panels on their part of the roof, and feed the output through their electricity meter.
- **Option 2**: Install a solar installation sized to just service the common loads in the building, such as elevators and pool pumps.
- **Option 3**: Install one large installation on the roof and share it amongst the residents and sometimes common areas.

There are various advantages and disadvantages to each of these three options.

**Option 1, allocating a unit a portion of the roof space for solar, is the most straight-forward but relies on a motivated resident.** If one apartment-dweller wishes to install solar panels, it is possible to allocate a section of the roof to that apartment and wire the solar output to their benefit. However, as such an installation creates risks and inconvenience for all residents while only benefiting one, it can be hard to secure the votes necessary to approve this type of installation.[25] A more popular option might be an installation that benefits all residents equally.

**Option 2, installing solar to serve common loads, is the most common approach.**[26] These installations benefit all residents by offsetting the cost of running common areas, the savings from which can be passed on in decreased strata fees. One issue with this approach is that it can be expensive for an OC to borrow money for a solar installation, as the OC does not technically own common property and therefore the loan would be unsecured. The installation could be financed from a special levy or a sinking fund, but this is not always possible.[27] Another issue is that rooftop solar generation potential may be greater than common loads for most apartment buildings. According to UNSW researcher Mike Roberts, "over 60% of apartments are in buildings of 3 storeys or less, which are likely to have generation potential in excess of common property loads."[28] As such, an approach that can utilise a larger system may be more suitable for many apartment buildings.

**Option 3, sharing one large installation, has the main benefit of maximising potential solar output and utilisation.** There are economies of scale in installing larger systems and sharing increases utilisation – when one apartment isn't consuming electricity, another can use the solar output instead. However, such installations can be expensive and face legislative barriers.[29] Installations of this type are likely to be over 10 kW, and larger installations in most local government areas require the additional time and expense of submitting a development application.[30] Other barriers are dependent on how exactly the solar energy is to be shared.

**Under Option 3, the solar output can be shared either behind the meter or through an embedded network.** Under an embedded network arrangement, one party takes responsibility for the electricity bill

[25] Roberts, Bruce & MacGill 2015 PV in Australian Apartment Buildings – Opportunities and Barriers
[26] Roberts et al 2016 Using PV to help meet Common Property Energy Demand in Residential Apartment Buildings
[27] Roberts, Bruce & MacGill 2015 PV in Australian Apartment Buildings – Opportunities and Barriers
[28] Roberts, Bruce & MacGill 2017 PV for Apartments: Which Side of the Meter?
[29] Ibid
[30] Roberts, Bruce & MacGill 2015 PV in Australian Apartment Buildings – Opportunities and Barriers

for the entire apartment building and charges a fair portion to residents, taking into account any solar energy produced. While retrofitting an apartment building in such a way can be expensive and adds an ongoing administrative cost, the possible savings are also quite large.[31] However, there are additional regulatory barriers to this route, such as the need to appoint an Embedded Network Manager in some instances.[32] The alternative 'behind the meter' option involves installing additional meters and wiring to enable each apartment to benefit from a portion of the solar output and be billed accordingly. Occupants can either arrange this themselves or outsource to a third party.

**One Australian startup is trying to encourage apartment buildings to take up Option 3 with behind-the-meter solutions.** Allume Energy facilitates apartments sharing a large solar installation, charging $490 upfront and $4.99 per month for each apartment that wishes to benefit from the installation. They then use smart meters and an online platform to keep track of how much of the solar output each apartment is using and billing them accordingly.[33]

**If the barriers to solar uptake amongst non-detached dwellings are addressed, an additional 1.4 GW of solar panels could be installed.** If the same proportion of apartments and semi-detached buildings had access to solar as stand-alone homes, there would be around 470,000 additional dwellings using solar power. We'll assume a lower system size of 3 kW per dwelling (either for an individual system or a share of a larger system) due to the lower energy consumption and roof area of apartments and semi-detached buildings compared to detached houses. Based on these numbers and a cost of $4,550 per dwelling[34] that equates to 1.4 GW and $2.1 billion of investment.

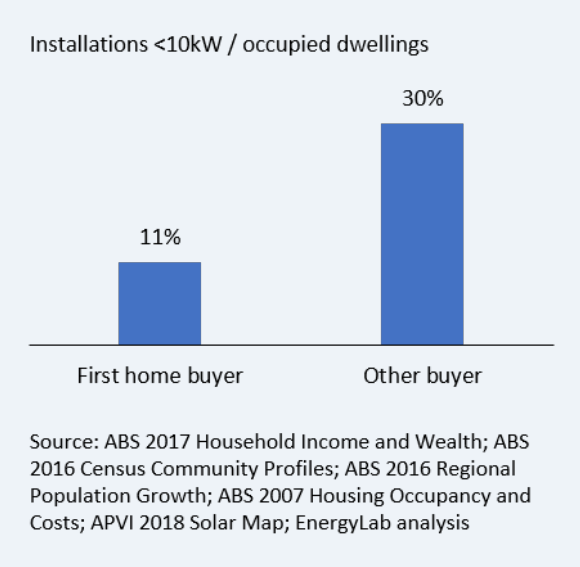
[31] Roberts, Bruce & MacGill 2015 PV in Australian Apartment Buildings – Opportunities and Barriers
[32] AEMC 2015 Embedded Networks; Clayton Utz 2016 AER releases new Network Registration Exemption Guideline
[33] AFR 2017 Startup Allume lets solar panels be 'shared' by strata dwellers
[34] Solar Choice 2018 Current solar power system prices: Residential and Commercial

# First home buyers

**People living in the first home they purchased are much less likely to have rooftop solar than other owner-occupiers.** Only 11% of first home buyers have solar, compared to the national average of 21% and 30% for other homeowners (Figure 5). It's worth noting that we're using the Australian Bureau of Statistics (ABS) definition of first home buyers here, which refers to someone living in a home they purchased in the last three years where that dwelling was the first they had ever purchased.[35] We couldn't find any research why this group are less likely to have solar panels but we have a couple theories of our own.

**The variance could be due to financing issues.** First home buyers may feel they have extended themselves enough in buying a property and aren't willing or able to secure additional debt financing to install solar. This may be exacerbated by a push to reach a 20% deposit to avoid the need to pay lender's mortgage insurance. People are also increasingly reliant on financial support from their parents to buy their first home.[36] It's possible that while people are happy to borrow from their parents to enter the property market, they are less comfortable doing so to make upgrades to reduce their electricity bills.

*Figure 5: Proportion of first home buyers with rooftop solar compared to all other owner-occupiers*




Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; ABS 2016 Regional Population Growth; ABS 2007 Housing Occupancy and Costs; APVI 2018 Solar Map; EnergyLab analysis

**The explanation could alternatively be that first home buyers don't consume enough electricity during the day to benefit from a solar installation.** About 60% of first home buyers are double income couples.[37] They might be interested in solar but if everyone in the household is elsewhere during the day, working to pay it off, there might be little sense in installing it.

**Entrepreneurs might be able to increase solar penetration by creating products specifically targeted at first home buyers.** A financial product tailored for this market could be designed that is offered at the point of purchase. Or, if the barrier is that first home buyers aren't home enough to benefit from solar, then packaged products may be needed to install solar and shift load to peak times at the same time. The barrier could also lie somewhere else entirely and therefore require a different solution – we'll leave that to the market research of prospective entrepreneurs.

**The potential impact of addressing these barriers is modest but could be a starting point for a new cleantech startup.** About 7% of owner-occupied homes in Australia are occupied by first home buyers

[35] ABS 2007 Feature Article: First Home Buyers in Australia
[36] HIA 2014 First Home Buyers: The Big Picture; The Guardian 2016 Australian first-home buyers face higher than ever loan default risk, says report
[37] Ray White 2015 Infographic: First Home Buyers; ABS 2007 Feature Article: First Home Buyers in Australia

(according to the ABS definition).[38] If the same proportion of those buildings had solar installed as the remainder of owner-occupied homes, an additional 70,000 solar installations or so would be in place. That's the equivalent of about 300 MW of solar and approximately $400 million of investment. While this isn't a large enough market to build a high-growth venture in, it could prove to be a foothold from which a startup could expand to other products or customers segments.

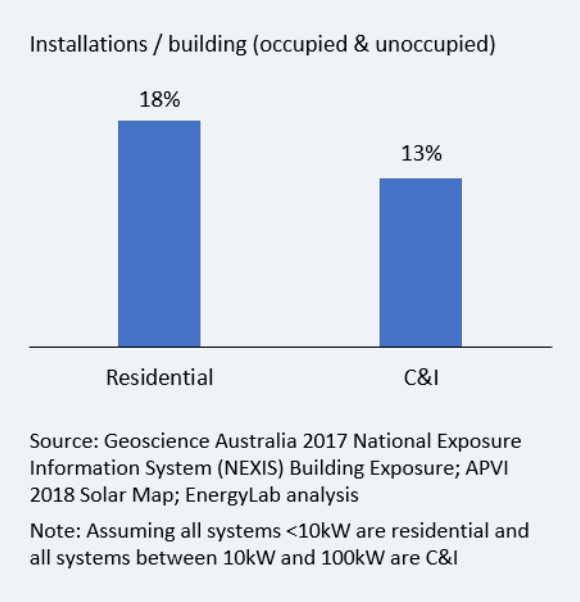
[38] ABS 2007 Feature Article: First Home Buyers in Australia

# Commercial and industrial buildings

**So far, this paper has focussed on residential properties, but commercial and industrial (C&I) buildings are an important part of the picture.** While only 3% of Australia's building stock is classified as C&I, those buildings make up about 16% of total roof space.[39] That is a significant proportion of Australia's rooftop solar potential that has remained relatively neglected to date.

**Uptake of solar in C&I buildings has lagged the residential sector.** While 18% of all residential buildings have solar installed, only about 13% of C&I buildings have rooftop solar (Figure 6). This is despite the fact that C&I buildings are particularly well suited to rooftop solar.

*Figure 6: Proportion of residential and C&I buildings with rooftop solar*




Source: Geoscience Australia 2017 National Exposure Information System (NEXIS) Building Exposure; APVI 2018 Solar Map; EnergyLab analysis

Note: Assuming all systems <10kW are residential and all systems between 10kW and 100kW are C&I

**There are several good reasons why solar uptake should be *higher* amongst C&I buildings.** They often have plenty of space on their large, flat rooftops for a solar installation, the businesses that occupy them usually use more energy during the day when the sun is shining than at night, and often those buildings host energy-intensive operations. There are also potential tax advantages, and large roofs and high energy demand allow for economies of scale.[40] Finally, solar power can reduce demand charges in the right conditions with proper management.[41] However, despite these factors in solar power's favour, several barriers have held it back.

**Some of the major barriers facing solar in C&I properties have already been discussed: strata title and the split incentive problem.** Many C&I properties are managed under strata title and therefore suffer from the same barriers to solar as residential apartments and semi-detached buildings. Similarly, many C&I buildings are rented, resulting in the same split incentive problem holding back rented residential buildings. But there are additional barriers unique to the C&I sector that must be contended with.

**An increasing tendency for 'slender' roofs could become another barrier to C&I solar uptake.** According to Smart Commercial Solar, the majority of new industrial buildings are built with rooftops unable to bear the weight of a solar installation.[42] This may create opportunities for businesses that can provide and install lightweight solar panels. At least one Australian company, Energus, appears poised to fill this need by producing solar panels that are apparently 75% lighter than conventional solar panels.[43] However, such

[39] Geosciences Australia 2017 National Exposure Information System (NEXIS) Building Exposure - Statistical Area Level 1
[40] APVI 2011 Modelling of PV and Electricity Prices in the Australian Commercial Sector; Todae Solar 2018 Financial Benefits for Businesses
[41] Energy Matters 2017 Reducing Commercial Electricity Demand Charges; NREL 2017 How to Estimate Demand Charge Savings from PV on Commercial Buildings
[42] AFR 2018 'Slender' roofs won't bear a solar future; SolarQuotes 2018 "Slender Roofs" Not Just An Issue For Commercial Solar
[43] RenewEconomy 2017 "Sun King" returns with ultralight, flexible PV to reshape solar market; Energus 2018 eArche

installations (at least initially) are likely to come at a premium, exacerbating another barrier to commercial solar.

**Presently, the biggest barrier to C&I solar appears to be that the economics of solar do not mix well with traditional business decisions.** Many businesses assess investments based on payback period – how many years until the initial investment is paid back. One of the main disadvantages of this approach is that it doesn't take into account any cash flows after the payback period.[44] In the case of solar, electricity will be generated for many years, if not decades, after the initial capital outlay has occurred.

**The payback period of solar is still too high for many businesses to justify on financial grounds alone.** It currently takes 3-5 years for a commercial rooftop solar investment to pay itself back.[45] You might expect the payback period to be shorter, given the benefits mentioned previously. However, businesses typically pay less per unit of energy for power and larger installations are often more tailored, reducing some of the efficiency gains from standardised residential installations.[46] The resulting payback period of 3-5 years is a problem as an Energy Action survey revealed that about 50% of businesses require a payback period of less than three years to invest.[47]

**However, there is reason to believe that the business case for C&I solar is improving and the sector is catching up with residential solar uptake.** Every year for the last five years has seen a record number of C&I rooftop solar systems installed[48] and there is every indication that 2018 is going to be another record year. According to SunWiz, this is due to a combination of system prices declining, commercial electricity rates increasing (due to increasing wholesale costs), and solar companies getting better at selling to the C&I sector.[49] Therefore, while there appears to be an opportunity to develop tailored solutions for this market, there is no lack of competition.

**The realistic potential for additional solar capacity on C&I properties is difficult to estimate but could be around 3 GW.** Bringing the proportion of C&I properties without solar up to the level of residential buildings would increase solar output by over 300 MW. However, increasing uptake to 50% (the proportion of businesses willing to invest at current payback rates), would increase solar output by about 2.6 MW. Both these estimates are based on the current average C&I installation size of about 20 kW but, as the average installation size is increasing, the potential could be much higher.

**Increasing C&I rooftop solar by 3 GW would require around $3.5 billion of investment.** That's based on current installations prices,[50] which will continue to decline, especially if the average system size increases and competition for this sector intensifies. However, this estimate helps illustrate the size of the opportunity.

**An entrepreneur aiming to address the barriers to this market may do well to start in the Ausgrid distribution area.** In November 2017 Ausgrid announced that it would be offering $250 per kilowatt of

[44] Investopedia 2018 What are some of the limitations and drawbacks of using a payback period for analysis?
[45] Solar Choice 2018 Payback periods for commercial-scale solar PV systems: State by state
[46] APVI 2011 Modelling of PV and Electricity Prices in the Australian Commercial Sector
[47] Energy Action 2016 Energy Insights Survey
[48] APVI 2018 Solar Map
[49] RenewEconomy 2018 Solar installs through the roof, as Australians deliver record growth; SunWiz 2018 Can Australian PV keep up the pace set by 2017's record breaking year
[50] Solar Choice 2018 Commercial Solar PV Price Index

solar installed on rooftops of warehouses and other industrial buildings.[51] Given the average cost of a commercial system per kilowatt is $1,170,[52] this subsidy should significantly reduce the payback period.

[51] RenewEconomy 2017 Ausgrid turns to rooftop solar to save on network costs
[52] Solar Choice 2018 Current solar power system prices: Residential and Commercial

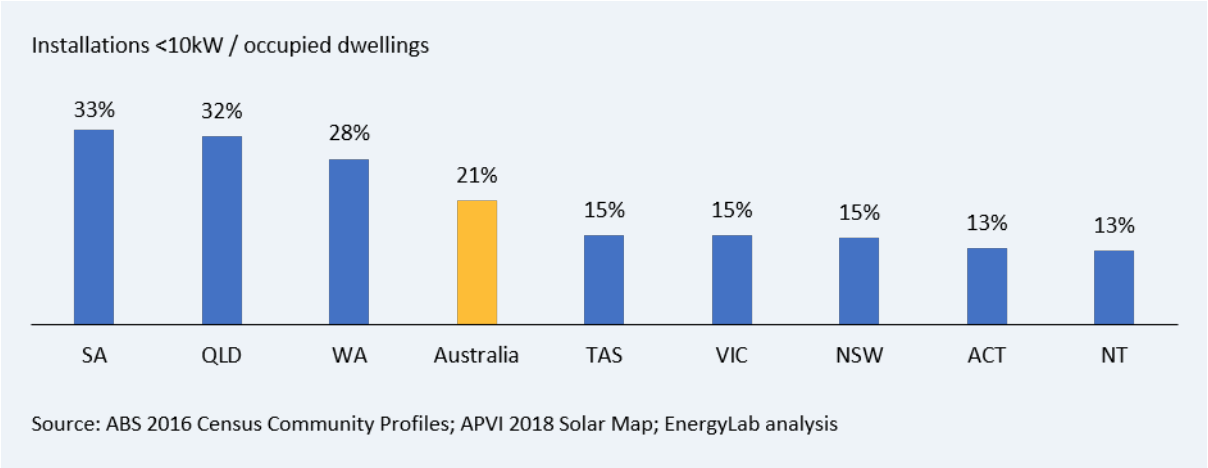
# Other areas investigated

**In our search for untapped opportunities to increase solar uptake, we ventured down many a path to nowhere.** We collected all the existing solar penetration statistics we could find and then created some of our own. Wherever there was a discrepancy we analysed it to determine what the cause might be. Where we found an existing barrier that could be addressed by a startup, we included it in the previous sections. However, more often the barriers we found were already being addressed or were just a consequence of the barriers already discussed, such as a higher than average proportion of rented and non-standalone dwellings. We discuss those findings here so that others don't need to head down the same dead-end streets.

## *States and territories*

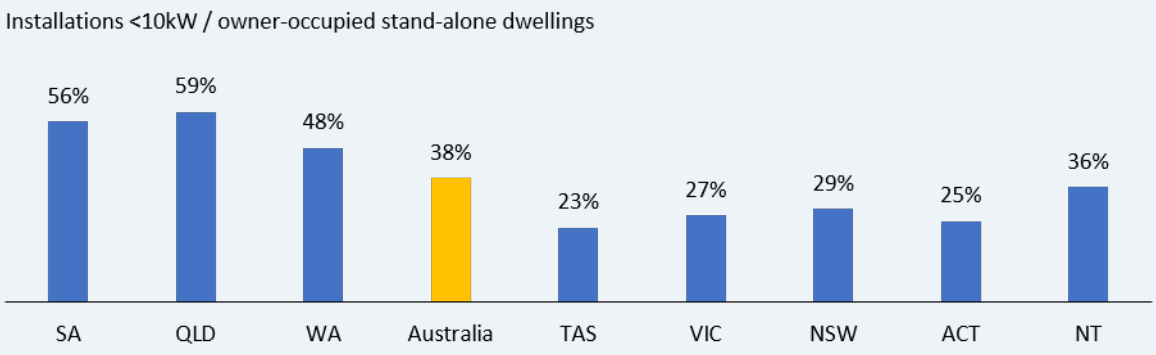
**There is significant variation in solar uptake between the states and territories of Australia.** As anyone who pays attention to the news will know, Queensland and South Australia have a lot of solar – too much according to some. The solar uptake in these states is over 30%, compared to 15% or less for most other states and territories in Australia, as shown in Figure 7.

*Figure 7: Proportion of households with solar in each state and territory of Australia*




**Some of this variation can be explained by the difference in the proportion of owner-occupied stand-alone dwellings in each state and territory.** For example, while the Northern Territory comes in last place in Figure 7, adjusting for renters and non-detached buildings brings the NT up to fourth place (Figure 8). It's worth noting that we don't know the exact proportion of owner-occupied stand-alone dwellings that have rooftop solar in each state – the data in the figure below is simply a proxy, but a good enough one for our purposes.

*Figure 8: Proportion of owner-occupied stand-alone dwellings with solar in each state and territory*

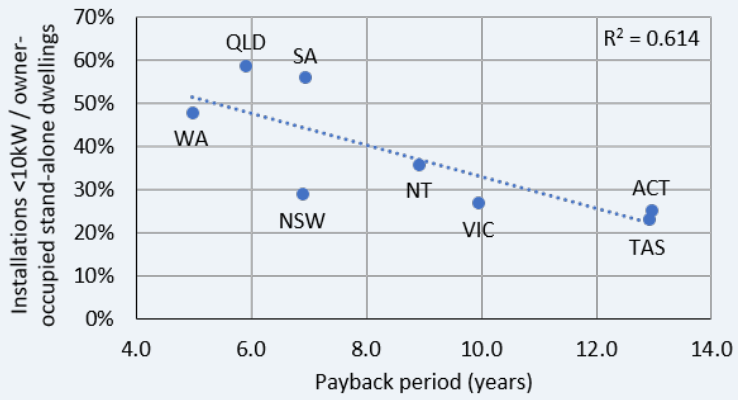



Source: ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

**Geographic differences in payback period is also an important factor.** Payback period is heavily influenced by the amount of sunshine, the cost of installation, electricity prices and feed-in-tariffs – factors that all vary significantly across Australia. We compared uptake to payback period (Figure 9) and found those factors explain a lot, but not all, of the variance.

**Most of the remaining difference could be due to the varying histories of solar subsidies in each state and territory.** Of particular note in Figure 9 are South Australia and New South Wales – two states with similar payback periods but very different solar uptake rates. They also have had very different levels of solar subsidisation in the past. Without these subsidies, we estimate that there would only be a three-percentage-point difference between SA and NSW, compared to the twenty-seven-percentage point difference in Figure 9. Our calculation methodology is simplistic and overestimates the impact of the subsidies, but points to the conclusion of differing subsidies being the main reason for the disparity between the two states. The remaining difference could be explained by the peculiarities of the distribution companies that serve each state.

*Figure 9: Solar uptake vs payback period by state/territory*



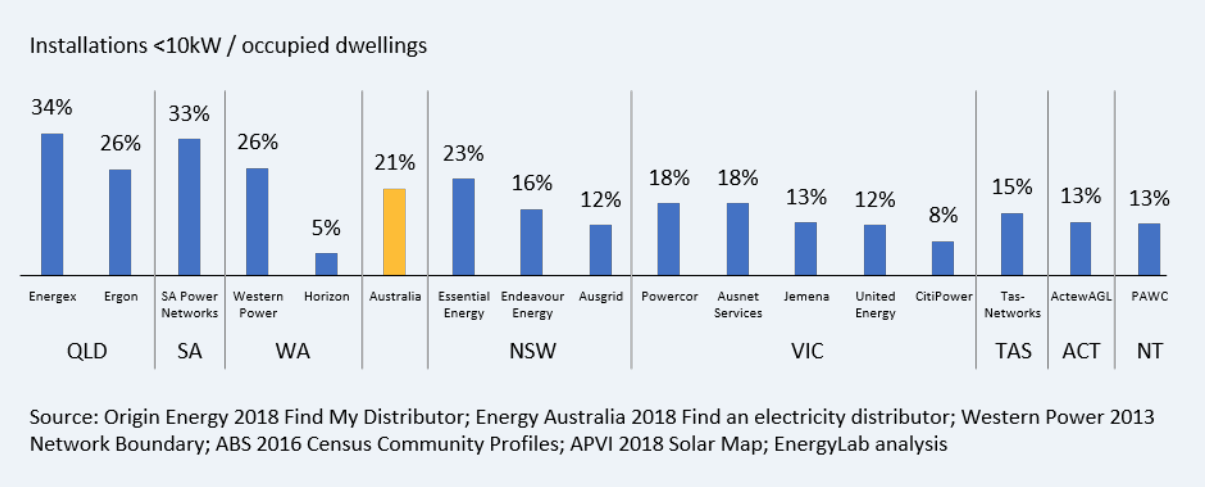

Source: Australian Energy Council 2017 Solar Report; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

Note: Payback period for 4kW systems using a 5.22% discount rate

## *Distribution areas*

**Increasing the level of granularity, we see a lot of variation in solar uptake between distribution areas in Australia.** The highest is in the Energex distribution area in South East Queensland at 34% while the lowest is in the Horizon area in regional Western Australia at 5% (Figure 10).

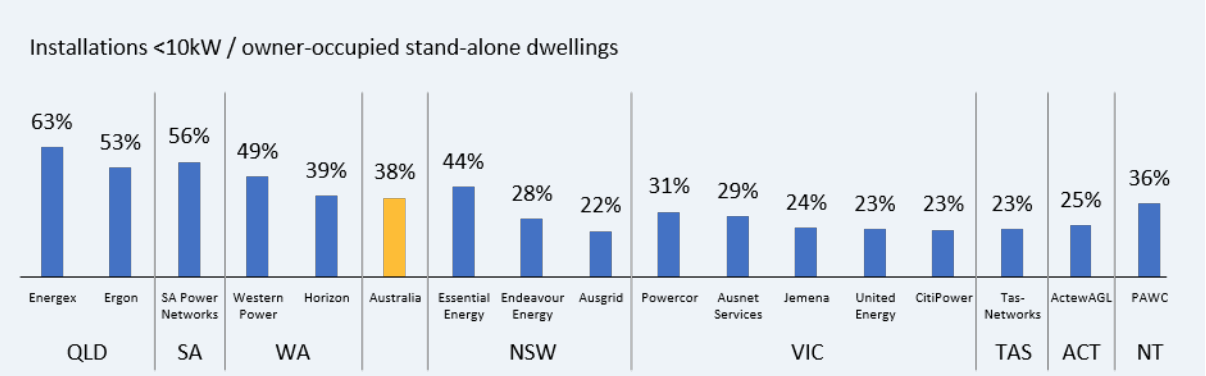
*Figure 10: Solar uptake by distribution area*




Source: Origin Energy 2018 Find My Distributor; Energy Australia 2018 Find an electricity distributor; Western Power 2013 Network Boundary; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

**Much of the variation could be explained by differences in the proportion of rented and non-detached dwellings in each distribution area.** For example, while Horizon power has the lowest solar penetration of any distributor, if you take solar installations as a proportion of owner-occupied stand-alone dwellings, then Horizon's solar penetration is slightly above the Australian average (Figure 11).

*Figure 11: Solar uptake amongst owner-occupied stand-alone dwellings by distribution area*




Source: Origin Energy 2018 Find My Distributor; Energy Australia 2018 Find an electricity distributor; Western Power 2013 Network Boundary; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

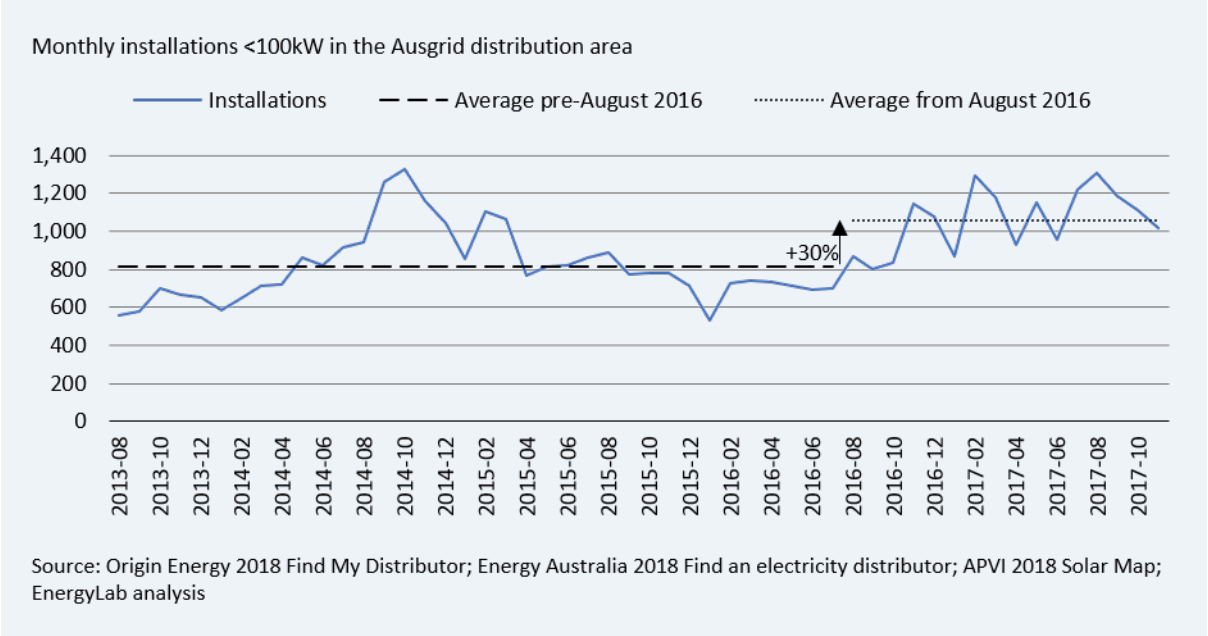
**It is worth noting that it is not particularly meaningful to compare distributors in different states, such as Energex in Queensland and Essential Energy in NSW.** As discussed previously, a difference in subsidies and payback periods has resulted in a lot of variation between solar uptake in the states and territories of Australia. Of more interest is the variation between distributors in the *same* states.

**Taking into account tenure and dwelling type, there is more variation between distributors in NSW than any other state.** NSW is serviced by three distribution companies: Ausgrid and Endeavour Energy serve the urban areas, while Essential Energy looks after the rest of the state. Essential Energy is above the Australian average while Ausgrid and Endeavour Energy are well below average. This is true whether or not you take out rented and non-detached buildings from the equation.

**The reason for the variance is unclear but could be due to distributor-related difficulties installing solar panels in the past.** We could find little commentary online on the matter, but one blogger implies that Ausgrid has in the past accidentally or otherwise discouraged people from installing solar panels.[53] However, since that criticism was levelled, Ausgrid announced that it was removing red tape for installing solar, reducing fees, paperwork and processing times.[54]

**Whatever the cause, Ausgrid appears to have addressed the barriers to solar in their network and penetration levels are catching up with the rest of the state.** The average number of installations less than 100 kW in size in the three years before August 2016 in the Ausgrid distribution area was just above 800 per month. In the months since August 2016 the average has jumped by 30% (Figure 12). As a proportion of all households in Ausgrid's distribution area, this is still lower than the NSW average. However, if you take installations as a proportion of standalone owner-occupied dwellings then it is about 45% higher than the NSW average. This implies that Ausgrid might have removed the major barriers to the uptake of solar in their network, unlocking pent-up demand in the process.

*Figure 12: Impact of August 2016 changes to Ausgrid requirements for solar installations*




Source: Origin Energy 2018 Find My Distributor; Energy Australia 2018 Find an electricity distributor; APVI 2018 Solar Map; EnergyLab analysis

[53] One Step Off The Grid 2016 Revealed: Ausgrid's strategy to keep solar customers confused
[54] Solar Choice 2016 NSW's Ausgrid to streamline process & reduce costs of going solar

## Remoteness

**Solar uptake varies somewhat by remoteness.** Remoteness is defined by the ABS based on relative access to services.[55] We calculated solar uptake by remoteness and found that there is a significantly lower uptake of solar in remote and very remote parts of Australia (Figure 13).

**However, the small population in remote areas makes the opportunity quite small.** There are less than 250,000 dwellings in the remote and very remote parts of Australia (Figure 14). Bringing the solar uptake in these areas up to that of regional Australia would only increase total solar installations by less than 20,000.

*Figure 13: Solar uptake by area of Australia*

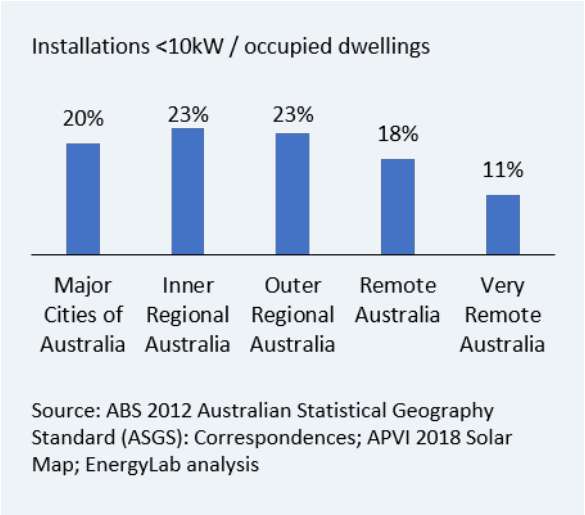
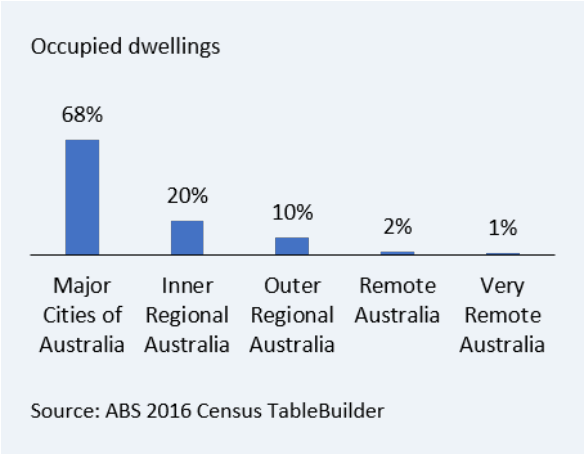


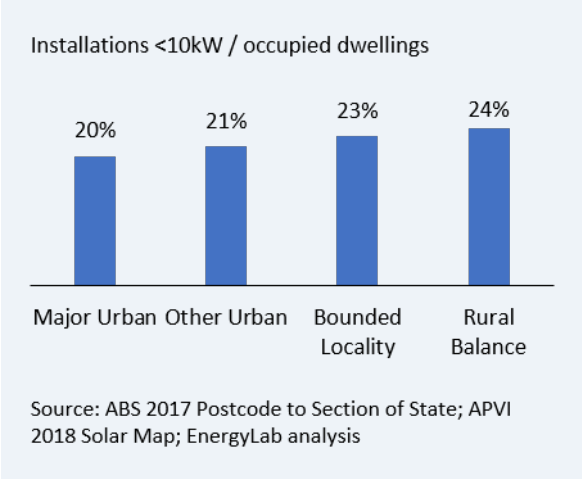

*Figure 14: Occupied dwellings by area of Australia*




## Rural vs urban

**Solar uptake increases slightly as population density decreases.** The ABS differentiate between major urban, other urban, bounded locality and rural balance by population. Major urban areas have a population of 100,000 or more, other urban areas between 1,000 and 100,000, and so on.[56] We calculated solar uptake in each of these four categories and found that solar increases only slightly as population decreases (Figure 15).

*Figure 15: Solar uptake by urban/rural classification*

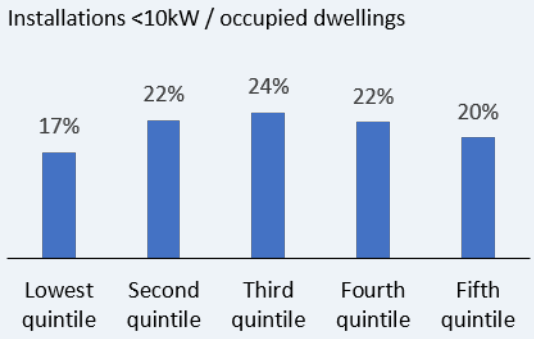



[55] ABS 2018 Remoteness Structure
[56] ABS 2014 Frequently Asked Questions

## Income

**Solar uptake varies surprisingly little by income.** While households in the lowest 20% of incomes do have significantly less solar than the rest of the population, the second, third and fourth quintile have almost identical solar uptake (Figure 16). The reason for low uptake in the lowest quintile could be that such households are more likely to rent or that they have lower credit ratings and are therefore less able to finance a solar installation.[57] While it is undoubtedly important that income isn't a barrier to enjoying the benefits of solar, the 3-7 percentage-point variance between income quartiles wasn't deemed to be a significant enough opportunity to focus on in this paper.

*Figure 16: Solar uptake by household income quintile*



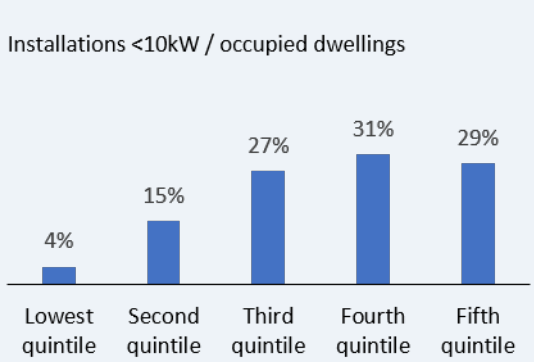

Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

## Wealth

**Wealth is more strongly correlated with solar uptake.** Only 4% of households in the lowest quintile of wealth have solar while 15% of those in the second quintile of wealth have solar panels (Figure 17).

**However, it is likely that most of this difference is due to a higher proportion of renters amongst the lowest two quintiles of wealth.**[58] Home ownership is one of the major sources of wealth in Australia. Therefore, if you don't own (or partly own) a home you are likely to find yourself in one of the lower quintiles, and as a renter also less able to install solar panels on your roof.

*Figure 17: Solar uptake by household wealth quintile*




Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; EnergyLab analysis

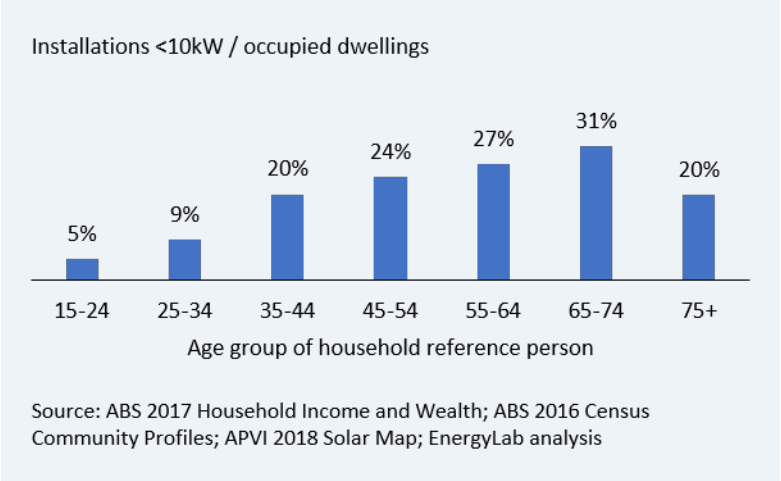
## Age

**The likelihood of having solar installed increases with age until about 75.** The biggest jump is between the 25-34 and 35-44 age brackets, more than doubling from 9% to 20% of people with solar power. There is another small jump around the age of 65 (Figure 18).

[57] Paulos 2017 Bringing the Benefits of Solar Energy to Low-Income Consumers
[58] ABS 2017 Case Study – Slow Growth in Solar Power in Australian Homes

**Most of the variance is likely due to home ownership rates increasing with age.**[59] It is unsurprising that few 15 to 24-year-olds have solar, given the low proportion of people in that age group who own their own home. The low proportion of 25 to 34-year-olds with solar is more interesting and likely related to the lower proportion of first home buyers who have installed solar panels, given the average first home buyer is about 32 years old.[60] Otherwise the proportion of people with solar in each age bracket increases linearly until the age of 75, as might be expected by an increased likelihood of owning a home (and therefore be able to easily install solar panels) as people get older.

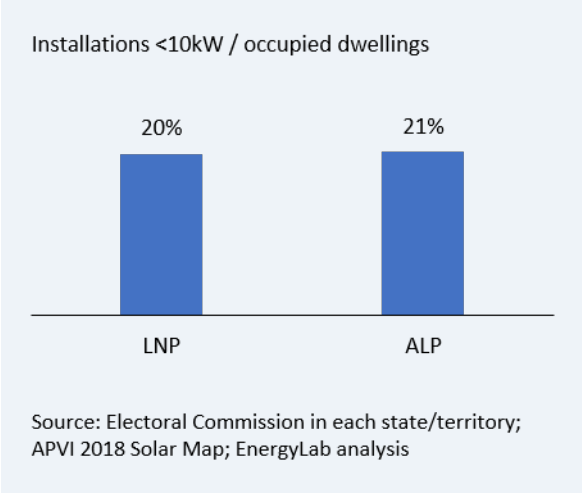
*Figure 18: Solar uptake by age group*




## *ALP vs LNP*

**To finish on a fun fact, the proportion of households with solar panels does not appear to vary by political affiliation**. We calculated solar penetration by state electoral division on a two-party preferred basis. We found that 20% of households in LNP electorates and 21% of households in ALP electorates had solar installed (Figure 19), an insignificant difference considering the accuracy of the underlying data.

*Figure 19: Solar uptake by political party on a two-party-preferred basis*




[59] ABS 2017 Case Study – Slow Growth in Solar Power in Australian Homes
[60] Ray White 2015 Infographic: First Home Buyers

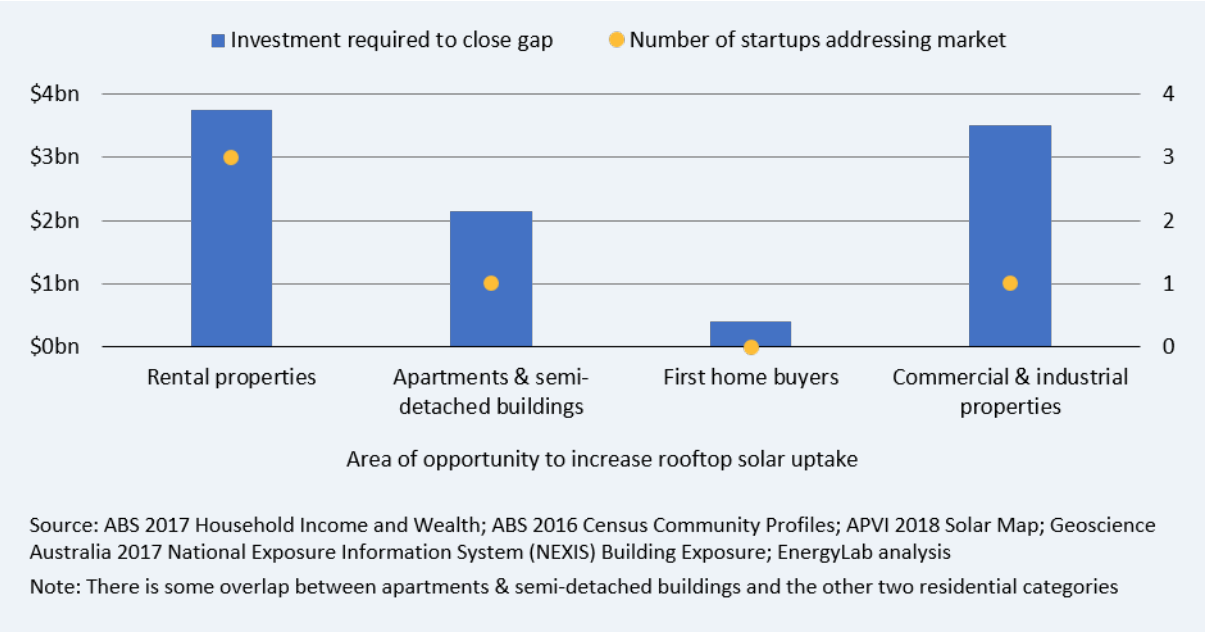
# Conclusion

**In this paper, we have analysed solar uptake in Australia across a dozen angels**. We have looked at geographic factors such as ruralness, remoteness, state and distribution area. We have also looked at a range of demographic factors such as income, wealth and age. More importantly, we have looked at building and occupancy characteristics such as ownership, dwelling type and sector.

**Of the angles discussed there appear to be four main areas of opportunities for solar entrepreneurs: renters, apartments and semi-detached buildings, first home buyers, and commercial and industrial (C&I) buildings.** The problem with installing solar on rental properties and non-detached buildings is well understood and several startups have developed solutions to help address the barriers. The low uptake of solar amongst first home buyers was a surprising finding from our research and one that receives little attention, but perhaps with good justification considering the small size of the opportunity. The final area we looked at, however, appears to be more promising.

**The C&I sector receives little attention from solar startups, despite being a potentially sizeable opportunity.** It is hard to estimate the market size of this sector, as it is still evolving, but it could easily be in the billions of dollars. While some startups cater for C&I properties, this is typically a secondary focus to other areas such as rental properties or apartments. New entrants should be more concerned about competition from existing businesses, as many are increasingly focussing on the C&I sector. However, considering the size of the opportunity and the unique challenges and characteristics of this sector we believe there is still room for innovation.

*Figure 20: Summary of opportunities to increase solar uptake and number of startups addressing area*




Source: ABS 2017 Household Income and Wealth; ABS 2016 Census Community Profiles; APVI 2018 Solar Map; Geoscience Australia 2017 National Exposure Information System (NEXIS) Building Exposure; EnergyLab analysis

Note: There is some overlap between apartments & semi-detached buildings and the other two residential categories

**Rooftop solar capacity in Australia could more than double if the barriers to these areas are addressed.** Currently, there is less than 7 GW of rooftop solar installed in Australia.[61] We estimate that addressing each of the opportunities above could increase solar capacity by about 7 GW (taking into account overlap

[61] APVI 2018 Solar Map

between the residential categories). This would require an investment of close to $9 billion, a significant opportunity for a budding sector. We don't know how exactly these barriers will be overcome, but we hope this paper will inspire entrepreneurs to develop solutions that can help double the uptake of rooftop solar across Australia.