AUSTRALIAN PV INSTITUTE

Impacts of PV, AC, Other Technologies and Tariffs on Consumer Costs

By

The Australian PV Institute

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About the Australian PV Institute (APVI)

The objective of the APVI is:

To support the increased development and use of PV via research, analysis and information

The APVI includes companies, government agencies, individuals, university and other research groups with an interest in photovoltaic solar electricity research, technology, manufacturing, systems, policies, programs and projects. In addition to Australian activities, we provide the structure through which Australia participates in the International Energy Agency (IEA) Photovoltaic Power Systems (PVPS) and Solar Heating and Cooling (SHC) program.

Our work is independent, apolitical and of use not only to our members, but also to the general community. Although strongly advocating for PV, we are not a traditional lobby group, but instead focus on data analysis, independent and balanced information and collaborative research, both nationally and internationally.

Our reports, media releases and submissions can be found at: www.apvi.org.au

The results presented are for the purposes of informing stakeholders and the interested public. They are general in nature and subject to a number of underlying assumptions. As such, readers should not take these results as representing financial or investment advice.

Executive Summary

Over the last 5 years, residential electricity prices across Australia have increased and residential electricity use has declined. The price increases are primarily driven by network expenditure, which itself is driven by both the need for capital replacement of ageing assets and the need to augment networks to meet increasing peak demand. Although air conditioners (AC) have been recognised as the primary cause of increases to peak demand, little has been done to reduce their impact.

The decline in electricity use is putting increasing pressure on electricity utility business models, and has generated a range of responses that focus on maintaining utility revenue and current industry structures. Photovoltaics (PV) has become a particular focus of utilities and a number of government reports, with claims that owners of PV systems are not paying their fair share of network costs, thus increasing costs for other customers.

The uptake of any new technology can affect the bills of other customers in two different ways. Firstly, if a customer is on a kWh-based tariff and uses less electricity because of the new technology, they will make smaller payments to the electricity networks, and this may increase the bills for other customers, if tariffs are increased to maintain the same network revenue. PV, solar water heaters (SWH) and a range of energy efficiency options are good examples of technologies that cause this effect. On the other hand, if a customer uses more electricity, the opposite may occur. ACs are a good example in this case.

Secondly, if a customer significantly increases their electricity use at a particular time of day, this can increase the demand peak, and so the networks may need to be augmented to meet that demand, and again, this can increase the bills of other customers. In this case, ACs can increase other customers' electricity bills, whereas PV, SWHs and other EE options can decrease network peaks and so defer the need for augmentation, thus minimising costs for all customers.

These two counteracting effects complicate the assessment of the real impacts of energy using or producing technologies. We have developed a model that can be used to assess the combined impact of these two effects for a range of technologies – both on the customer responsible for installing that technology, and on other customers. This provides a useful way of assessing possible new tariff structures.

Methodology

The methodology described here is used to assess the financial impacts of the following technologies, assuming an additional 20% of households take them up: AC, PV, PV+battery, SWH and general demand reduction. The impacts on the households that install them, on other households, on transmission network service providers (TNSPs), distribution network service providers (DNSPs) and retailers are assessed.

The impacts of 20% of households taking up the following tariffs are also assessed: EnergyAustralia's regulated 'Domestic All Time' tariff, EnergyAustralia's PowerSmart Home TOU tariff, and a custom designed residential Demand charge tariff. We have divided their impacts into the following three types.

First order impacts: The initial cost impacts of particular tariffs and technologies on the customers that take them up – the 'Responsible Customers'.

Second order impacts: The subsequent cost impacts in the following year – for both the 'Responsible Customers' and for 'Other Customers'. These capture the effect of network operators' altering their tariffs due to changes in revenue. They have been incorporated into the model as follows:

- Weighted Average Price Cap (WAPC): Where the assessment is based on DNSPs being regulated under a WAPC,[1] only TNSPs can alter their tariffs (because TNSPs are regulated under a revenue cap).
- Revenue Cap: Where DNSPs are regulated under a revenue cap, both the TNSPs and DNSPs can alter their tariffs.

Third order impacts: The subsequent cost impacts on all the houses in the model suburb due to changes to demand peaks and therefore changes in network costs. These include the First and Second order impacts above – and so represent the total impact of each option.

The methodology is explained in detail in the main report. Note that the impact of special feed-in tariffs, Renewable Energy Certificates or other customer incentives have not been included in this assessment.

Result Highlights

This section presents only a summary of the results. The main report includes considerably more detail, including the impact of possible customer responses to price signals.

Time of Use tariffs

The first order annual bill financial outcomes for 'Responsible customers' taking up the TOU tariff are shown in Table 17. Although the 'Responsible customers' total bill increases by about 9.5%, payments to DNSPs actually decrease by about 23%. Payments to TNSPs increase by over 100% and to retailers by about 23%. The second order annual bill financial outcomes for the 'Other customers' are also shown in Table 17, where the DNSP is under a revenue cap. The combination of decreased TUOS and increased DUOS increases the total bill by 1.1%.

Table 1. Residential Annual Bill for 'Responsible customers' (First order impact) and 'Other customers' (Second order impact): TOU compared to Standard tariff

	'Responsible customer' First Order		'Other customer' Second Order	
	($)	% change cf Standard tariff	($)	% change cf Standard tariff
Transmission	247	104.9%	104	-14.0%
Distribution	557	-22.9%	757	4.9%
Retail	1,098	23.1%	892	0.0%
Total	1,902	9.6%	1,753	1.1%

Air conditioners

Figure 19 is used to illustrate the approach used for all technologies in the main report. It shows the first, second and third order impacts on both the 'Responsible customer' and the 'Other customers', where the 'Responsible customer' is on a Standard tariff, and the DNSP is regulated under a WAPC, as is currently the case in most states. It can be seen that adding an average size AC initially increases the 'Responsible customers' average annual bill by 9% or about $155. Because AC

[1] DNSPs in Queensland are regulated under a Revenue Cap. Revenue cap regulation will most likely apply to NSW in its next network determination, whereas an average revenue cap will apply to the ACT. It is possible that revenue cap regulation will eventually apply to all DNSPs in the NEM.

increases the 'Responsible customers' electricity use, it increases payments to network operators. TNSPs are regulated under a revenue cap and so the result of the second order impact is for TUOS rates to be reduced, and so customer costs are reduced slightly. Where the DNSP is regulated under a revenue cap (eg. Qld), the DUOS rate would also be reduced, and so customer costs are reduced again. However, when the third order impacts are applied, which include the cost of network augmentation driven by higher peak loads, customer costs increase, with annual bills for 'Other customers' being about $80 higher. The cost to 'Other customers' of all 70% of the households which have installed AC to date is around $250/yr.

Figure 1. First, Second and Third order annual bill impacts under a WAPC: Standard tariff, 20% more households take up AC

Figure 26 summarises the impacts on 'Other customers' when the 'Responsible customer' installs an average AC. The key points are:

- AC increases the bills of 'Other customers' in all scenarios
- Placing the 'Responsible customer' on a TOU tariff (rather than a Standard tariff) results in 'Other customers' bills being:
    i. lower when the DNSP is under a WAPC because the income of the TNSP (which is under a revenue cap) was increased, which results in TUOS tariffs being decreased.
    ii. higher when the DNSP is under a revenue cap because the DNSP's income was decreased, which results in DUOS tariffs being increased.
- Placing the 'Responsible customer' on a demand charge tariff (rather than a Standard tariff) results in 'Other customers' bills being:
    i. lower when the DNSP is under a revenue cap because the DNSP receives significant income from the demand charge, which results in DUOS tariffs being decreased.
- The costs to the 'Responsible customer' are also lower on a demand charge tariff (compared to a TOU tariff), making it preferable from both the 'Responsible customers' and 'Other customers' point of view. Only for the retailer is a TOU tariff preferable.

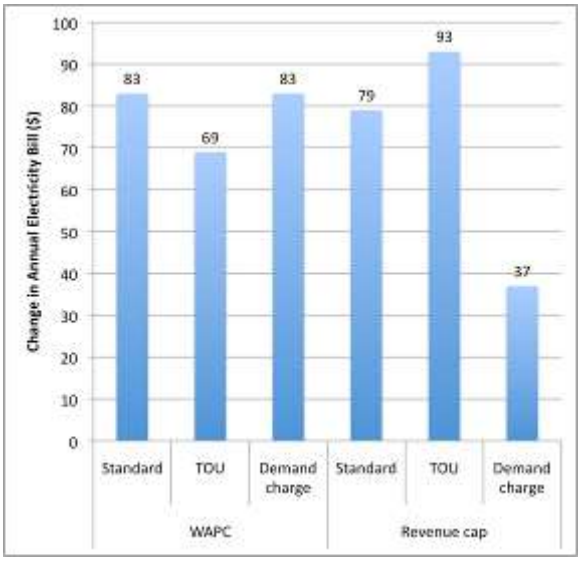

Figure 2. Third order (total) annual bill impacts on 'Other customers', by tariff type, where 20% of households install an average AC

AC + Photovoltaics

In order to illustrate the financial impacts of a technology such as PV, which can reduce demand peaks, we have superimposed it on the impact of installing an air conditioning system (which can increase demand peaks). Here we assessed the impact of 20% of households installing both an average sized AC unit and a net-metered 2.5kW PV system.

Figure 27 shows the first, second and third order impacts on both the 'Responsible customer' and the 'Other customers', where the 'Responsible customer' is on a Standard tariff, and the DNSP is regulated under a WAPC, as is currently the case in most states. The main points to note here are that PV reduces the 'Responsible customers' bills considerably, and after the third order impacts are taken into account, also reduces the cost impact of AC on 'Other customers'. This is possible because the bulk of the 'Responsible customers' savings are made through reduced payments to the wholesale generator and retailer, whereas savings for the 'Other customers' are due to peak demand reduction.

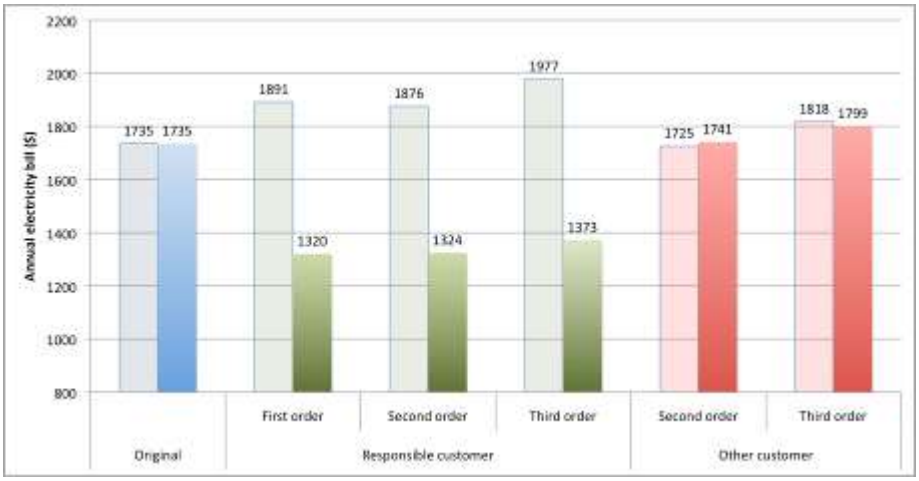

Figure 3. First, Second and Third order annual bill impacts under a WAPC: Standard tariff, 20% households install both AC and 2.5kW PV (semi transparent columns are AC alone)

Figure 33 summarises the impacts on 'Other customers' when the 'responsible customer' installs either AC or AC plus a 2.5kW PV system. The key points are:

- When the DNSP is regulated under a WAPC, PV reduces the increase caused by AC when the Responsible customer is on any of the three tariffs.
- When the DNSP is regulated under a revenue cap:
  i. when the Responsible customer is on a standard tariff, PV sightly increases 'Other customers' costs (by $10 per year). This is simply because it reduces electricity use and DNSP's expected revenue – which they seek to recover from all customers.
  ii. when the Responsible customer is on a TOU tariff, the PV has little impact on 'Other customers' costs – because the additional impacts that PV has on revenue for TNSPs (increase) and DNSPs (decrease) cancel each other out.
  iii. only when the Responsible customer is on a demand charge tariff does PV reduce the increase caused by AC (by $9). This is because, on a demand charge tariff, more of the DNSPs expected revenue comes from the demand charge and less from the DUOS charge. Since PV's largest impact on demand is outside the times when a demand charge tariff applies, DNSPs receive their expected revenue and so the 'Other customers' DUOS tariff is increased by a smaller amount.
- In this case the costs to the 'Responsible customer' are highest on a demand charge tariff, followed by the TOU tariff then the Standard tariff.

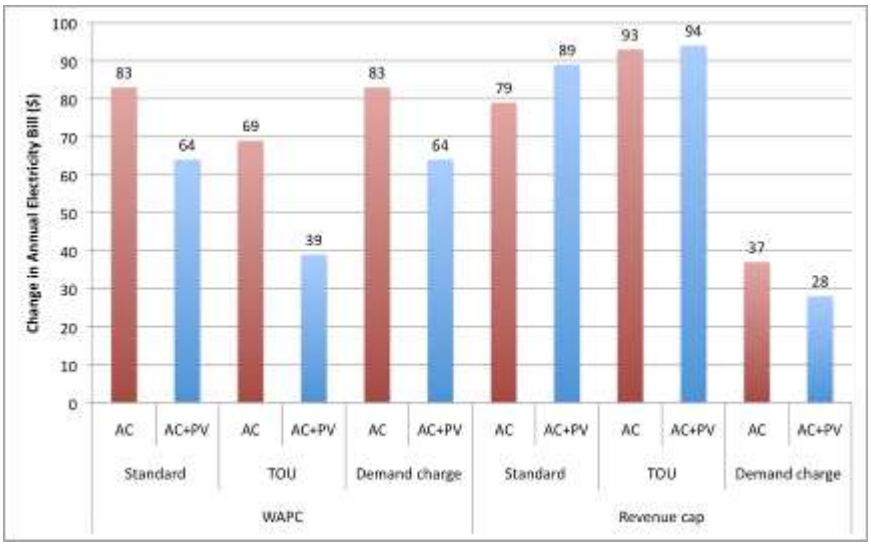

Figure 4. Third order annual bill impacts on 'Other customers', where 20% of households install both AC and 2.5kW PV

AC + PV + battery

It is assumed that the PV owner has a battery system that captures any PV electricity that would otherwise have been exported to the grid. The 'battery electricity' is then used to offset electricity use during the peak demand period, assuming only 80% of the electricity is available because of battery losses.

Figure 40 summarises the impacts on 'Other customers' when the 'Responsible customer' installs either AC or AC and a 2.5kW PV + battery system. The key points are:

- When the DNSP is regulated under a WAPC, PV+battery reduces the increase caused by AC when the Responsible customer is on any of the three tariffs.

- When the DNSP is regulated under a revenue cap, PV+battery *increases* the increase caused by AC when the Responsible customer is on any of the three tariffs – although again, the cost to 'Other customers' is lowest when the 'Responsible customer' is on a Demand charge tariff, and highest on the TOU tariff.
- Thus, although using a battery to, in effect, have more PV capacity available during peak periods does reduce demand peaks, it also increases the amount of PV electricity that is used on-site. When the DNSP is regulated under a revenue cap, they are able to recover any reduction in revenue through higher network charges, and so costs increase for 'Other customers'.
- The costs to the 'Responsible customer' are again higher on a demand charge tariff, followed by the Standard tariff then the TOU tariff – making the TOU tariff particularly ineffective at providing an effective and fair price signal.

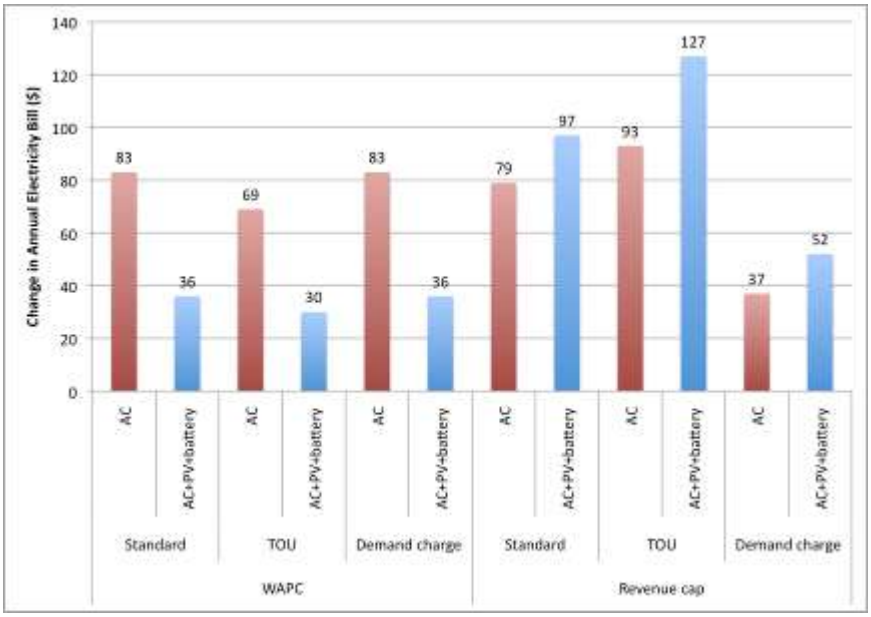

Figure 5. Third order annual bill impacts on 'Other customers', where 20% households install AC and 2.5kW PV and a battery

AC + Solar Water Heaters

Although SWHs do not reduce demand peaks, to make the results more comparable to the other technologies, we have still used AC to form the baseline. Thus, to assess the impact of SWHs, we modelled 20% of the 50% of households that have electric storage water heaters (leaving 30%) installing SWHs and taking up AC. 'Other customers' are taken to be those who have electric storage water heaters but don't install a SWH or AC.

Figure 43 summarises the impacts on 'Other customers' when the 'responsible customer' installs either AC or AC and a SWH. The key outcome is:

- When the DNSP is regulated under either a WAPC or a revenue cap, SWHs increase the increase caused by AC. This is because SWHs reduce both TNSP and DNSP income but do not reduce demand peaks.

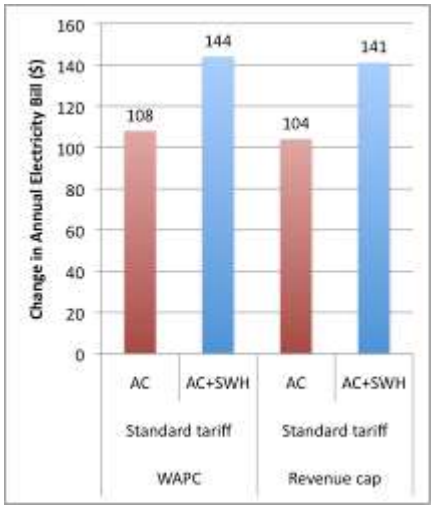

Figure 6. Third order annual bill impacts on 'Other customers', where 20% households install both AC and a SWH

AC + 20% Demand Reduction

In this scenario, it is assumed that 20% of customers use a combination of energy efficiency measures to reduce their demand by 20% spread evenly across the day i.e. each half hour period is reduced by 20%. Figure 50 summarises the impacts on 'Other customers' when the 'responsible customer' installs either AC or combines AC with a 20% demand reduction. The key points are:

- When the DNSP is regulated under a WAPC, a 20% demand reduction reduces the increase caused by AC when the Responsible customer is on any of the three tariffs
- When the DNSP is regulated under a revenue cap, a 20% demand reduction *increases* the increase caused by AC when the Responsible customer is on any of the three tariffs – although again, the cost to 'Other customers' is lowest when the 'Responsible customer' is on a Demand charge tariff, and highest on the TOU tariff.
- 'Other customers' bills are significantly increased (relative to AC alone) when the Responsible customer is on a Demand tariff because the assumed 20% demand reduction is very effective at reducing their demand charge payment.
- In this case, the costs to the 'Responsible customer' are highest on a TOU tariff, followed by the Demand charge tariff then the Standard tariff.

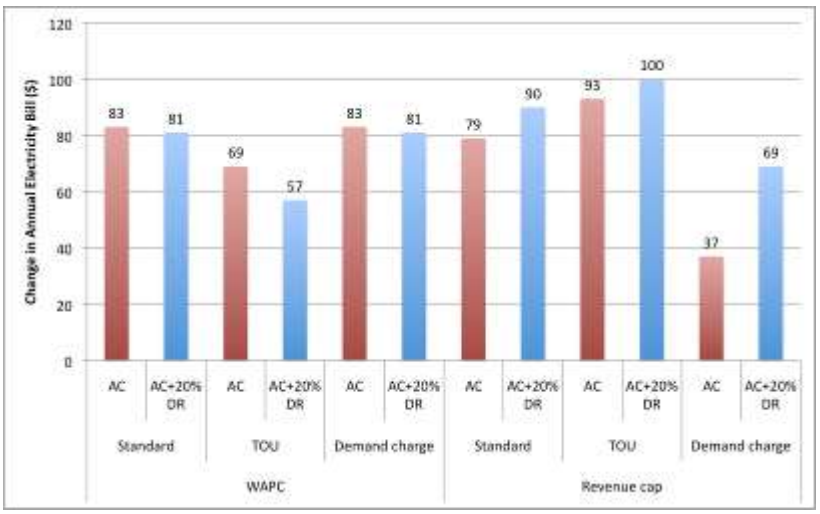

Figure 7. Third order annual bill impacts on 'Other customers', where 20% households install AC and undertake a 20% demand reduction

Confirmation Using Second Dataset

The following key findings from the analyses above have been confirmed using a different dataset of 270 houses obtained from Ausgrid:

1. That under a TOU tariff, DNSPs receive less income than they would under a Standard tariff
2. That PV reduces the price impact of ACs on 'Other customers' under a WAPC
3. That, under revenue cap regulation, placing a 'Responsible customer' that has AC on a Demand charge results in the lowest costs for 'Other customers', whereas a TOU tariff results in the highest costs
4. That PV reduces the impact of AC on 'Other customers' if the 'Responsible customer' is on a Demand charge tariff, under both WAPC and revenue cap regulation.

Discussion

The impact of different technologies installed by 'Responsible customers' on the costs faced by 'Other customers' is very dependent on whether the DNSP is regulated under a WAPC or a revenue cap. Under a WAPC, where a technology reduces electricity use, the cost is incurred by the DNSP. Under a revenue cap, this cost is passed through to all customers in the form of higher tariffs.

The APVI supports the transition of DNSPs to revenue cap regulation. However, this is only one of the steps needed to enable distributed energy to fully contribute to least-cost energy services. For a fully functional distributed energy market to be established, regulatory changes are required that will result in equal competition between supply and demand side options at all levels: generation, networks and retail. This is likely to require Integrated Resource Planning for network augmentation and replacement, as well as a range of other changes to enable equal competition on a day-to-day basis.

Under both WAPC and revenue cap regulation the installation of ACs increases costs for 'Other customers' because of increases to demand peaks and therefore network costs. We estimate AC cross subsidies to be about $250/yr for each customer that does not have AC, excluding possible higher generation costs to meet peaks. Had the merit order effect now evident from PV and wind generation been included in this modelling, the impact of AC on 'Other customers' would have been even greater.

Under the TOU tariff used here, the DNSP receives less income than under a Standard tariff, even when AC is installed. Given that ACs are responsible for a significant proportion of distribution network peaks, and TOU tariffs have been proposed to pay for the network costs driven by AC, this is an unexpected outcome.

Under the current WAPC regulation, our research indicates it is likely that PV has been reducing the cost increases for 'Other customers' that have been driven by high AC uptake. However, this means that PV has been reducing revenue for DNSPs. Under revenue cap regulation, PV only minimally increases costs for 'Other customers' where the 'Responsible customer' is on a Standard tariff. Where they are on a TOU tariff, the increase is likely to be insignificant and, when on a demand charge tariff, PV actually reduces costs for 'Other customers', without reducing revenue to DNSPs.

PV's ability to reduce costs is entirely dependent on its ability to reduce demand at the annual peak. In the modelling used here, the peak demand reduction was based on actual customer load data where 20% of the PV's rated capacity was available during the distribution network peak and 54% was available during the transmission network peak. In some cases PV will be providing less value and in some cases more than the customer base used for this analysis.

The need for PV to provide value to 'Other customers' by meeting demand peaks should be minimised as much as possible. This can be readily achieved where the 'Responsible customer' is on a Demand charge tariff, simply because in this case PV has little impact on DNSP's expected income.

When DNSPs are regulated under a revenue cap, the Demand charge tariff results in the lowest costs for 'Other customers' for all technologies. Although TOU tariffs result in the lowest costs for 'Other customers' for all technologies when DNSPs are regulated under a WAPC, this is only because the DNSPs receive less revenue.

A Demand charge tariff is most effective at reducing the cost impacts of AC and PV because it is capacity based (it provides a price signal to smooth or reduce annual demand peaks), whereas TOU tariffs are volume based (they increase DNSP revenue if demand increases during peak periods, but don't have a particular emphasis on the annual peak).

Thus, this research recommends a demand charge component be used in electricity bills, rather than the blunt instruments of fixed levies which have been proposed for PV customers. Such fixed charges provide no price signal for people to reduce demand peaks and are discriminatory. Demand charges will provide a more equitable outcome and will also cater for the full range of distributed energy options likely to be available in future, including demand management, energy efficiency, storage and electric vehicles.

The demand charge tariff used here applied the charge across a very broad time period – from 2pm to 8pm, which is the same as the peak period for the TOU tariff. This could result in customers whose peak demand does not coincide with the network peak being penalised. While this would nevertheless serve to minimise customer peak demand generally, targeting a shorter time period could be more efficient. Ideally this time period would be network-specific, although this would also increase administrative costs for network operators. As discussed, the demand charge a DNSP needs to apply to offset the LRMC of meeting the annual peak will be significantly less than the LRMC, and so will be less than the demand charge used in this report.

If demand charges are to be used, it is critical that they are accompanied by an education campaign that lets households know how their bills will be impacted and, most importantly, what options they can use to reduce their demand peaks and therefore their bills.

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