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Submission to SAPN's Tariff Structure Statement for 2020-25 and their Pricing Proposal for 2019/20

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About CEEM

The UNSW Centre for Energy and Environmental Markets (CEEM) undertakes interdisciplinary research in the design, analysis and performance monitoring of energy and environmental markets and their associated policy frameworks. CEEM brings together UNSW researchers from the Faculty of Engineering, the Australian School of Business, the Faculty of Arts and Social Sciences, the CRC for Low Carbon Living, the Faculty of Built Environment and the Faculty of Law, working alongside a number of Australian and International partners.

CEEM's research focuses on the challenges and opportunities of clean energy transition within market oriented electricity industries. Key aspects of this transition are the integration of large-scale renewable technologies and distributed energy technologies – generation, storage and 'smart' loads – into the electricity industry. Facilitating this integration requires appropriate spot, ancillary and forward wholesale electricity markets, entirely re-envisaged retail markets that suitably facilitate distributed resources, efficient network regulation that also supports beneficial innovation and incentivises distributed resources to provide competitive network services, and coherent and comprehensive wider energy and climate policies that can deliver the low carbon energy future required to address dangerous global warming.

Distributed Energy Resources (DERs) are a vitally important set of technologies, with vitally important stakeholders, for achieving low carbon energy transition and CEEM has been exploring the opportunities and challenges they raise for the future electricity industry for over a decade. A key issue is, of course, network tariff arrangements for consumers choosing to deploy these technologies. More details of this work can be found at the Centre website. We welcome comments, suggestions and corrections on this submission, and all our work in this area. Please feel free to contact Associate Professor Iain MacGill, Joint Director of the Centre at i.macgill@unsw.edu.au.

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Introduction

We welcome the opportunity to make a submission in response to the South Australia Power Network's (SAPN's) Regulatory Proposal and Tariff Structure Statement. We commend SAPN for the level of detail provided in this Tariff Structure Statement. We make some general comments here, and then address some key specific details of the TSS and Pricing Proposal.

The SAPN TSS Overview notes:

Why we have tariffs: "… Tariff reform is proposed to help to keep future distribution network costs down by improving customer use of the existing network and reducing the need to increase network capacity in the future."

We agree on the importance of highlighting this key role of the tariff reform process. However, proposals to increase fixed (daily) charges clearly work against this objective by reducing incentives for customers to 'improve' their use of the existing network. This vexed issue is not properly addressed in our view.

What our tariffs do: "… Our pricing needs to signal, via more cost-reflective tariffs, the cost of building and maintaining a network to better manage customer demand peaks and troughs. Increasingly the troughs are being formed by surplus energy generated by solar on South Australian rooftops."

We are agreed on the importance of tariff reform addressing the growing impact of distributed PV on demand troughs. Of course, utility PV is now also growing in South Australia and is driving this midday demand reduction further as well. At the State level, certainly, this is not just a rooftop PV issue and what 'responsbility' does SAPN believe households and businesses with PV should take for these impacts?

It would be useful to also explicitly flag here the role that rooftop PV is playing in reducing demand peaks on the network. CEEM analysis using SA scheduled demand and estimates of 30 minute distributed PV generation based on the APVI Solar Map[1] over May 2018-April 2019 suggests that PV reduced the State peak by over 13% on 24 January, while shifting it from 2pm to 7pm (Figure 1). Much of the tariff analysis in the TSS doesn't appear to properly account for the very valuable role that PV is playing in reducing peak demand which remains, certainly in the longer term, a key driver of total network costs. It could be argued that truly cost-reflective tariffs should properly reflect this contribution rather than effectively taking it for granted and focussing on the 'new' peak period after sunset, that PV doesn't help reduce.

1. *Haghdadi, N., Bruce, A., & MacGill, I. (2015). Assessing the representativeness of 'Live' distributed PV data for upscaled PV generation estimates. In Power and Energy Engineering Conference (APPEEC), 2015 IEEE PES Asia-Pacific. Brisbane, QLD: IEEE. doi:10.1109/APPEEC.2015.7380908*

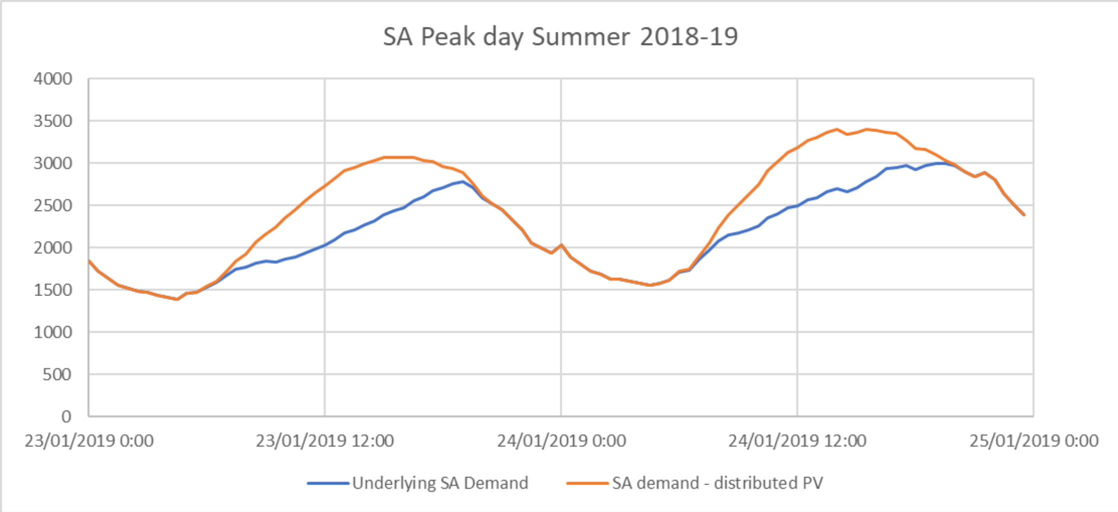

Figure 1: Peak reduction from distributed PV in SA 24th Jan 2019

Overall, we estimate that distributed PV reduced highest South Australian peak demand for some 23 hours over seven days last summer.

Who will benefit from the tariffs: "We already have cost-reflective 'demand-based tariffs' for our largest customers. The tariff reform process is now looking to influence how households and small businesses use energy…"

The first part of this statement is incorrect. The complexity and necessary simplifying abstractions (eg. Long Run Marginal Cost) of network economics means that 'cost-reflective' tariffs are extremely difficult to define, let alone calculate. What we do know is that true cost-reflective network tariffs would require very significant locational variation. Particular tariffs smeared over significant network regions as seen even with larger SAPN customers definitionally can't be considered truly 'cost-reflective'. This statement is reflective of a missing aspect of the current Australian NEM discussion around more cost-reflective tariffs. It seems that some cross subsidies such as those between households with and without PV are problematic, yet significantly larger cross subsidies between households in different regions aren't. There are certainly reasons why governments might wish to retain cross subsidies between city and country, but equity considerations need to be considered holistically, or they risk becoming discriminatory.

We are, however, agreed on the importance of reforming tariffs to influence how households and small businesses use energy. Again, increases in fixed (daily) charges clearly work against this objective as there is nothing that these consumers can do to change that aspect of their bill. While flat volumetric tariffs are potentially problematic it is notable that when teamed with low 'export' PV tariffs, they do encourage households with PV to move the operation of flexible demand, such as dishwashers and washing machines, into the middle of the day, hence assisting in reducing morning and evening peak demand as well as reducing solar export. By comparison, peak demand tariffs can often have a rather 'random' impact on household bills due to the inevitable variability of household demand, which may not reflect the systemic pattern associated with a household's demand during peak demand windows. There are good reasons why many consumers do not support their use given these uncertainties.

When the tariffs will apply: "About 13% of residential customers and 15% of business customers now have interval meters. We expect this to grow to 45% by 2025 as all new and replacement meters must be of the new interval meter type including small business starts. All existing customers with interval meters will be assigned to the new cost-reflective tariffs as will all new customers. Other existing customers will be assigned when they get a new or replacement meter."

We support the universal use of interval meters across all consumer sectors in the Australian NEM, although there are concerns regarding the costs of provision of these, how these costs are covered, and access to data that still need to be addressed. Until there is universal deployment, however, there is a risk of unfair discrimination between existing and new consumers, or between consumers who don't or do undertake some action that requires a new meter (for example, the requirement for new interval meters for households that install PV) depending on their metering. Equity considerations are very important here, and creating a class of legacy customer who stays on favourable flat tariffs due to retained accumulation meters is problematic in this regard.

How customers will benefit: "If retailers pass these tariffs through to customers, some customers will be motivated to change consumption patterns and reduce their individual bills. Other customers will incorporate these pricing changes into possible investments in equipment including more efficient plant and distributed energy resources (DER)…"

This is a very big 'if' on which to base these reforms. While it can be argued that cost-reflective tariffs are more efficient and equitable (causer pays) even if they are not passed through in cost-reflective form, this assumes an efficient retail market – a laughable assumption in the present retail market arrangements of the NEM as noted by the ACCC and others. It seems extraordinary that all this tariff reform effort lies in the hands of a highly dysfunctional retail market dominated by a small number of large incumbents with what would seem to be very little interest, indeed antagonism, towards efficient retail market outcomes.

On the issue of network tariffs signalling efficient 'investment' in DERs, it should be noted that investment really requires some certainty around future tariff structures and specific charges. Indeed, it seems likely that SAPN's proposed tariff structures might adversely and unfairly impact on prior DER investments, for example in rooftop PV, by making these investments less valuable. It would be helpful for SAPN to address the issue of how DNSPs can create a lower risk environment for consumers considering DER investments – certainly their current actions seem to be adding to rather than reducing these risks.

As a final point, we would prefer that SAPN and all DNSPS use the term consumer or energy user rather than customer. While definitions vary, many would argue that we can consider users as customers only when they have the choice on whether to interact with the organisation, and have meaningful opportunities to take action if they are unhappy with the goods and services delivered. More generally, the DNSPS should be consumer, indeed citizen, oriented given their privileged position of regulated returns and key role in delivering societal welfare through affordable, reliable and environmentally sustainable energy services.

Summary views on the proposed TSS and Pricing Proposal

Fixed charges

- As discussed above, and in further detail below, this increase in the fixed supply charge is regressive and will reduce the ability of SAPN tariff reform to drive cost reductions through changed consumer behaviour.

Inclining block tariff

- Removing the inclining block component of residential tariffs will almost certainly make the tariffs for households with accumulation meters less cost-reflective given that there is a relationship between monthly demand and their coincident contribution to network peak demands.

TOU tariff

- The TOU morning peak is unnecessary (since there is no network peak at that time) and the evening peak is far too broad (since the TSS makes the case for the peak window to be 4pm to 9pm, not from 3pm to 1am). Having such a broad evening peak period will likely reduce the beneficial impact of battery systems reducing demand during the network peak - although according to the TSS there is no longer a need to reduce the evening peak, so it is not clear why this is needed.

- The solar sponge is in theory an excellent approach, but will target solar households, that already have a far greater incentive to move their loads to the middle of the day, so will likely have little impact on the trough. This price signal should be applied to all households.
- Thus, the TOU tariff appears to be designed to financially discriminate against solar households, despite them being responsible for reducing network demand peaks and placing significant downward pressure on wholesale spot prices, and therefore costs for all households, and of course, reducing greenhouse emissions. They are also the households most likely to take up batteries, which will place further downward pressure on network peaks and thereby increase network asset utilisation, further reducing costs for all households.

Demand tariff

- Although the demand charge window theoretically appears to be reasonable, according to our analysis (see below) it may not actually result in increased bills for households with high demand during network peak periods (such as owners of air conditioners (A/C), and vice versa.

Batteries

- We are concerned that the TSS underestimates the ability of battery energy storage systems (BESS) to reduce both network demand and solar export peaks.
- Using real BESS data we have found that between 37% and 55% of residential BESS capacity was being discharged during the network-wide and zone substation peaks.
- We have found similar outcomes for BESS reducing solar exports.

Controlled load

- We agree that shifting the time of controlled load is a good idea. Otherwise, SAPN will be in the rather contradictory position of having a peak demand window within which a substantial amount of controlled hot water systems turn on.

Analysis undertaken using the UNSW Tariff Tool

- Income impacts
    - The Block and TOU tariffs do not appear to have inequitable impacts on different income households.
    - The demand and Prosumer tariffs increase bills for low income households and decrease bills for high income households.
    - Converting the demand and Prosumer tariffs into coincident demand charge tariffs avoids these equity impacts.
- Air conditioning
    - None of the TOU, Demand or Prosumer tariffs significantly increase the bills of households with A/C compared to the Block tariff, and so do not send an effective price signal to customers most responsible for increasing network peaks and therefore costs.
    - The only tariffs that resulted in a significant difference to the Block tariffs were the tariffs with a coincident demand component.
    - Note that we are not providing this analysis in the expectation that coincident demand tariffs will be implemented. It is likely that cost-reflective tariffs will only be effective when systems, such as distributed household batteries and Home Energy Management Systems, allow automated responses to price signals. In these cases, accurate price signals are critical.

- Solar PV
  - The most interesting result here is that all three Demand tariffs result in the greatest bill increase for households with PV, with the coincident and Prosumer options resulting in a slightly greater increase.

Tariff Structure Statement 2020 to 2025

We commend SAPN for undertaking a detailed and transparent analysis of the various impacts relevant to their Tariff Structure Statement (TSS). We do, of course, have some concerns, as discussed below.

After discussing the structure of the TSS' proposed tariffs, we use the UNSW Tariff Tool (described below) to assess the tariffs in the 2019/20 Pricing Proposal because our concerns regarding the TSS tariff structures apply to these also. Here we focus on the residential tariffs. We then use the Tariff Tool to assess the tariffs proposed in the TSS to see if they result in improved outcomes compared to those in the Pricing Proposal. We then suggest some modifications to these tariffs. We should flag that the absence of publicly available South Australian household interval metering data means that our analysis must use NSW data. We invite, indeed urge, SAPN to make suitably anonymised household interval data sets available for this type of tariff analysis. In the absence of such data, we are forced to use less appropriate datasets.

1. Daily fixed charge

At the risk of sounding like a broken record,[2] although fixed charges may be more reflective of the costs faced by networks (i.e. large amounts of capex and small opex), they don't better reflect the extent to which different households are responsible for those costs. As noted by many others, such tariffs are also regressive. The TSS states (p35) that "We believe that this improves the cost reflectivity of smaller and medium-sized customers and is more equitable between customers with and without DER such as solar." As stated above, it is not clear that solar households are in fact being subsidised by non-solar households when the benefits from reduced network augmentation costs, reduced spot prices and reduced GHG emissions are taken into account.

What is clear however, is that owners of A/C systems are being cross subsidised by households who do not own them, with the level of cross subsidy being proportional to the size of the system (meaning that even owners of small A/C are subsiding owners of large A/C). This was estimated by the Productivity Commission to be in the order of $350 per year,[3] and has been confirmed by our own analysis.[4] Increasing the fixed charge increases the cross subsidy further because the usage charges are reduced.

2. Block tariff

Our only comment here is that removing the inclining block component of residential tariffs will almost certainly make the tariffs for households with accumulation meters less cost reflective given that there is a relationship between monthly demand and their coincident contribution to network peak demands.

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[2] An ancient technology used to record music.

[3] 'Electricity network regulatory frameworks', Productivity Commission Inquiry Report, No. 62 Vol. 1, (2013), p. 9. April 2013.

[4] Passey, R., Watt, W., Bruce, A. and MacGill, I. (2018) 'Who pays, who benefits? The financial impacts of solar photovoltaic systems and air-conditioners on Australian households', *Energy Research and Social Science*, 39, p198-215.

3. TOU tariff

The TSS makes a very clear case for the price signals used to reduce residential and broader network peaks to be in the range 5pm to 9pm. It is unclear then why the time-of-use (TOU) tariff charges a higher rate from 6am to 10am and from 3pm to 1am. The morning peak period is unnecessary and the evening peak is far too broad. We note that the demand charge peak window correlates well with the 5pm to 9pm network peak, so why doesn't the TOU peak period correlate to the same window?

Having such a broad TOU evening window will encourage households to reduce their demand over this entire time, rather than during the 5pm to 9pm network peak. This is especially relevant to owners of battery systems, whose batteries are likely to discharge early in the window or could be programed to spread their output over this entire period (and so make a reduced contribution during the network peak itself).

We agree that the 'solar sponge' component of the TOU tariff, with reduced rates in the middle of the day, is an excellent approach. However, we note that households with PV already have a strong incentive to move their demand to the middle of the day (because their usage tariff is much greater than their solar FiT), and providing a lower usage rate in the middle of the day is unlikely to make any further difference. Thus, non-solar households are likely to be far more responsive to a lower mid-day rate, and so should be the primary target of such a tariff. However, according to the TSS (p11), the households to be assigned to tariffs such as the TOU tariff are the existing households with interval meters as well as all new households. Given that solar households (who are the households that are most likely to have interval meters) now make up about 33% of the total,[5] this tariff will be predominantly applied to the households least likely to respond to it. Indeed, it might be that this proposed tariff change could actually reduce load in that period from households with PV as there is now less value in moving flexible demand into that time of day once there is no PV export.

Further, the TSS states (p14) "Whilst peak demand is still a consideration in building network to respond to customer needs, it is no longer a key driver for how we manage our network and the associated costs we incur to provide SCS" and (p122) "SA Power Networks expects co-incident demand to be relatively flat over the period to 2025". So according to the TSS there is no pressing need to reduce the evening peak.

In summary, the TOU tariff targets periods where there is little or no need to reduce demand and are likely to be ineffective in doing so anyway. The reason for the design and method of assignment of this TOU tariff seems to be well illustrated in 17.45 and 17.46 of the TSS – to simply increase revenue from households with solar PV. This is despite the fact that, as stated a number of times throughout the TSS, and as highlighted in our analysis above, these households have been responsible for reducing network demand peaks, and therefore costs for all households (not to mention placing significant downward pressure on wholesale spot prices, and of course, reducing greenhouse emissions). As discussed below, they are also the households most likely to take up batteries, which will place further downward pressure on network peaks and thereby increase network asset utilisation,[6] further reducing costs for all households.

We recommend that the TOU tariff be redesigned to at least target periods that are at risk of becoming a peak (i.e. the same 5pm to 9pm window as targeted by the demand charge tariff), that it include a

[5] http://pv-map.apvi.org.au/historical

[6] On a more general level, looking ahead out to 2030, it is likely that the best way to decrease network costs to consumers is to combine the use of BESS with the uptake of electric vehicles – with their charging controlled in such a way that volumes are increased while demand peaks are not. Under revenue cap regulation, this increased network utilisation will place downward pressure of network tariffs for all end users.

solar sponge rate in the middle of the day (any lost revenue should be compensated by the evening peak tariff), and be opt-in. This tariff design is assessed below.

A minor point: why is the solar sponge component of the off-peak tariff during a different time window (from 9:30am to 3:30pm)?

4. Demand charge

The residential demand charge component appears to be reasonable, targeting an appropriately sized window in the warmest months (although we note that p58 of the TSS refers to the peak period being 5.30 to 9.30pm, not the 5pm to 9pm used in the demand charge window). However, as discussed below, compared to a Block tariff it may not actually result in increased bills for households with high demand during network peak periods (such as owners of air conditioners (A/C)), and vice versa.

Another concern is that it appears to only be available through the 'Prosumer tariff', which combines the demand charge with the TOU tariff (which as discussed above appears to have serious design flaws). We recommend that it be available as a stand-alone tariff and/or as part of the modified design for the TOU tariff we recommend above, both on an opt-in basis.

5. The impact of batteries

We are concerned that the TSS underestimates the ability of battery energy storage systems (BESS) to reduce both network demand and solar export peaks. Although batteries are discussed in Appendix F 'Evolution of the customer', they are not mentioned at all in Appendix D 'Peak demand window identification', nor in Appendix E 'Tariff Philosophies (Watching brief on future tariffs)', apart from being part of an electric vehicle (V2G) and as part of a microgrid. They are also not expected to have an impact until the following regulatory period (p113).

Network demand peaks

We are currently undertaking detailed analysis of the operation of BESS during both network-wide and zone substation (ZS) demand peaks. Although we are using a small sample (15 BESS) from the Energex network, the results are consistent across different peaks and across different types of batteries (AC-coupled and DC-coupled). Using 1 min data for the 2017 year, we have assessed the BESS operation during the two highest network-wide peaks and during the four highest ZS peaks. We found that, where the BESS are functioning as designed, on average 37% (peak 1) and 55% (peak 2) of the BESS capacity was being discharged during the network-wide peaks (a combined average of 46%). The equivalent values for the ZS peaks were: on average 55% (ZS peak 1), 41% (ZS peaks 2), 53% (ZS peak 3) and 41% (ZS peak 4) (a combined average of 47%). These BESS were not part of a virtual power plant and so were operating in load-following mode.[7] As such, if the household's demand was high and so contributing more to the network peak at the time, the BESS output would also be high, and vice versa.

The average household peak demand is given as about 2.2kW in the TSS (p58) and there are about 784,000 residential customers (p120). Thus, the residential peak is about 1,725 MW. Residential BESS capacity in SAPN's network is estimated to increase to 165MW by 2021 (p121), and increase slightly thereafter. Assuming a combined average BESS contribution at the time of the peak of 45%, they would reduce the network-wide demand by about 74MW, or 4.3%, and the ZS peaks by an equivalent amount.

Although this is a relatively small reduction, when combined with the expected low growth in peak demand (as discussed above), this could significantly reduce the need for any network augmentation

[7] This is the standard mode of operation of BESS as it maximises the financial outcomes for the customer by minimising both exports to the grid and imports from it.

over the regulatory period. It is of course also possible that, like solar PV, BESS uptake will be far greater than expected.

Solar trough and export peaks

The TSS identifies the solar trough and export peaks as significant issues in the coming regulatory period. The TSS states (p30) "Without more cost-reflective pricing, and other mechanisms we will need to increase network capacity to cater for the localised coincident peak of extra solar generation during the 'solar trough', rather than the air-conditioning demands of the past." The network capacity referred to here is not so much a MW-based capacity to deal with a solar export peak, but the capacity to deal with issues such as voltage rise and reverse power flow. These are indeed real issues, and are being observed in distribution networks throughout Australia.

However, there seems to be no acknowledgement that BESS operating in load-following mode will reduce both solar export and by extension the solar trough (during the time of solar generation the household demand will still be zero, but it won't be negative).

As part of the same research project discussed above, and in research already published, we found that BESS are very effective at reducing solar export peaks.[8] Thus, DNSPs should be actively pursuing actions to enable the uptake of BESS, which will not only help to defer network augmentation (and, as discussed above, increase asset utilisation and so decrease household costs), but help to reduce the 'solar trough' impact as well.

6. Shifting Controlled Load

The TSS states that (p32) "We are also proposing incentives and time clock adjustments to shift some hot water away from the 11:00pm spike in demand and into the solar sponge." We agree that this is a good idea, and in fact all DNSPs should really have done it some time ago. Without this, SAPN will be in the rather odd position of having a peak demand window within which a substantial amount of controlled hot water systems turn on.

Tariff Assessments Undertaken Using the UNSW Tariff Tool

We have analysed the residential tariffs in the Pricing Proposal and the tariffs proposed for 2020/21 in the Tariff Structure Statement, as well as some proposed modifications to these tariffs. We have done this using the UNSW Tariff Tool.[9] It is an open source modelling tool to assist stakeholders in assessing the implications of different possible network tariff designs, and hence facilitate broader engagement in the relevant rule making and regulatory processes in the NEM. We do not have access to residential load data for South Australia so have used load data from the Smart Grid Smart Cities (SGSC) database[10] and from the Ausgrid 300 database[11], which we believe are acceptable proxies.

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[8] Young, S., Bruce, A. and MacGill, I. (2019) 'Potential impacts of residential PV and battery storage on Australia's electricity networks under different tariffs', *Energy Policy*, 128, p616-627.

[9] Information on the Tariff Tool, and the Tariff Tool itself, can be found here http://www.ceem.unsw.edu.au/cost-reflective-tariff-design.

[10] https://data.gov.au/dataset/ds-dga-4e21dea3-9b87-4610-94c7-15a8a77907ef/details

[11] https://www.ausgrid.com.au/Industry/Innovation-and-research/Data-to-share/Solar-home-electricity-data

The SGSC database includes metadata that allows the households to be subdivided into a number of different categories. Here we have compared the impacts of different tariffs on households in different income groups and on households with ducted A/C and without any A/C.

Income

Figure 2 shows the annual bills for households in different income groups under different tariffs in the 2019/20 Pricing Proposal. It can be seen that, as expected, as income increases, so does the annual bill. Under the demand tariff, the annual bill for low income households increases slightly compared to the TOU tariffs, but for high income households it decreases. The slight increase for low income households may not be significant, given that the residential profile in SAPN's network may be somewhat different to that in Ausgrid's network. The decrease for high income households may reflect the low demand charge component as discussed below.

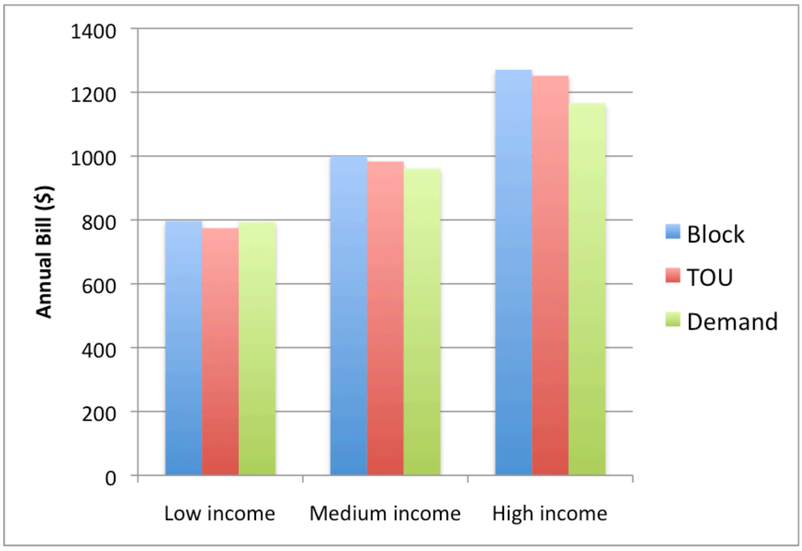

Figure 2. Impacts of Tariffs on Households of Different Incomes

Air conditioning

Figure 3 shows the annual bills for all households in the SGSC database, and for those without any A/C and those with ducted A/C.[12]

As expected, households with A/C have higher bills than households without A/C. Also as expected, households without A/C have lower bills under TOU and lower still under Demand tariffs. However, given that the ducted A/C households have significantly higher demand during the TOU evening peak period and during the Demand Tariff peak period (Figure 7 and Figure 8), they would be expected to have higher bills on TOU, and higher again on Demand charge tariffs, but they do not. As discussed below, this is in part because the values of each component (the TOU peak rates and the demand charge rates) are not high enough to compensate for the lower rates in other components of the tariffs.

[12] The SGSC database also separates out other types of A/C, such as split systems, but we have use the ducted A/C customers because they have a greater A/C impact (high peaks), and so should illustrate the most extreme impacts of tariffs on these types of customers.

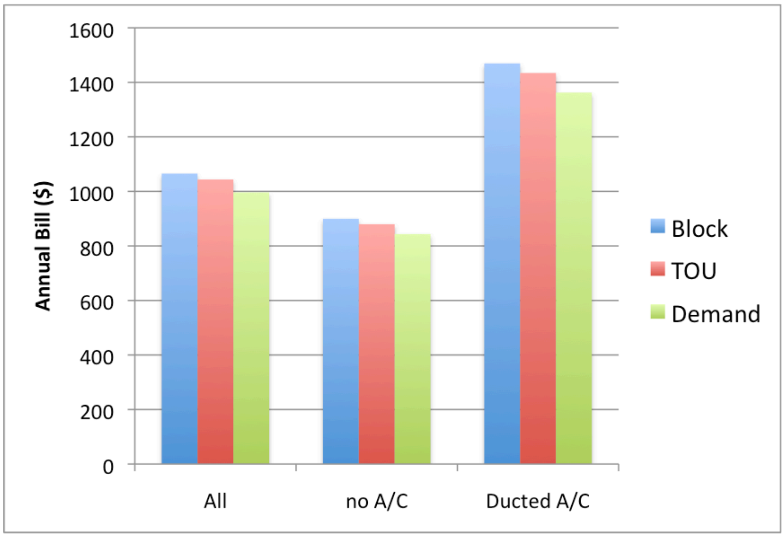

Figure 3. Impacts of Tariffs on Households with/without A/C

Solar PV

To compare the impacts of different tariffs on households with and without PV we have used the Ausgrid 300 database. For households with PV, their bills increase slightly going from block to TOU to demand – see Figure 4. The impacts of refining these tariffs are discussed further on the following section.

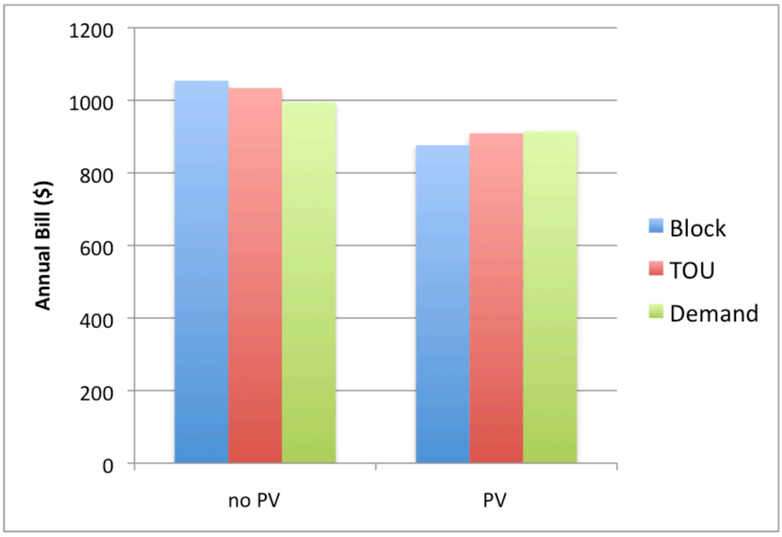

Figure 4. Impacts of Tariffs on Households with/without PV

2020/25 Tariff Structure Statement

In this section we assess the impacts of the proposed TSS tariffs on the same household groups as above. We also assess the impacts of suggested modifications to these tariffs. The modifications are described in Table I. In all our modified tariffs the average bill was the same as for the TSS proposed Block tariff (Type 6). This allows for an easier comparison and helps to normalise for differences between our dataset and that used by SAPN. The rates for the TSS tariffs are as proposed on page 69 of the 2020/25 TSS.

Table I. Differences Between Tariffs in the Pricing Proposal, the TSS and our revisions

2019/20 Pricing Proposal	2020-2025 TSS	Suggested Modifications
2 stage block	Block	No change
TOU	TOU	Modified TOU (TOU 1.88): Removed morning peak, made evening peak 4-9pm, and needed to increase rate of evening peak rate by 1.88x (to 37.2c/kWh) to result in same bill for average household. Left other rates the same as for 2020/21 version.
Demand	No Demand tariff	Demand tariff (Demand 1.145): Daily charge same as for TSS Block. NUOS charges increased by same % as TSS Block. Demand charges increased by 1.145x compared to PP Demand charge (to $16.16/kW/month summer and $7.98/kW/month winter), to result in same bill for average household.
		Coincident demand tariff (Dem coinc 3.01): As for Demand charge except that the demand charges are applied to the coincident demand, and were increased by 3.01x compared to PP Demand charge (to $42.49/kW/month summer and $20.99/kW/month winter), to result in same bill for average household.
		Coincident demand tariff, half daily (Dem coinc 0.5 3.52): As for Coincident demand charge except that the daily charge was halved and the demand charges were increased by 3.52x compared to PP Demand charge (to $49.69/kW/month summer and $24.54/kW/month winter), to result in same bill for average household.
	Prosumer (Demand + TOU)	Modified Prosumer (Prosumer 2.83): As for the Modified TOU, Removed morning peak, made evening peak 4-9pm. Daily charge unchanged. Demand charges increased by 2.83x compared to Prosumer (to $28.50/kW/month), to result in same bill for average household.
		Modified coincident Prosumer (Pros coinc 7.19): As for Modified Prosumer except that the demand charges are applied to the coincident demand, and were increased by 7.19x compared to Prosumer (to $72.50/kW/month), to result in same bill for average household.

		Modified coincident Prosumer, half daily (Pros coinc 0.5 8.38: As for Modified Prosumer except that the daily charge was halved and the demand charges were increased by 8.38x compared to Prosumer (to $84.50/kW/month), to result in same bill for average household.

Income

Figure 5 shows the annual bills for households in different income groups. Compared to the Pricing Proposal tariff analysis in Figure 2, the first point to note here is that the modified TOU tariff has a very similar impact to the Block tariff across income groups. The second point to note is that the Demand tariff (modified slightly to result in the same average bill as the Block tariff as described in Table I) increases bills for low income households and decreases them for high income households. Converting the Demand tariff into a coincident Demand tariff (especially with a lower daily charge) avoids this inequitable impact on different income groups. These coincident Demand tariffs are discussed in more detail in the following section. The proposed Prosumer tariff results in a much lower average bill when applied across all the SGSC households, so have been increased as described in Table I, and like the Demand tariff has inequitable income impacts. Again, converting this into a coincident demand charge avoids such impacts, especially where the daily charge is halved.

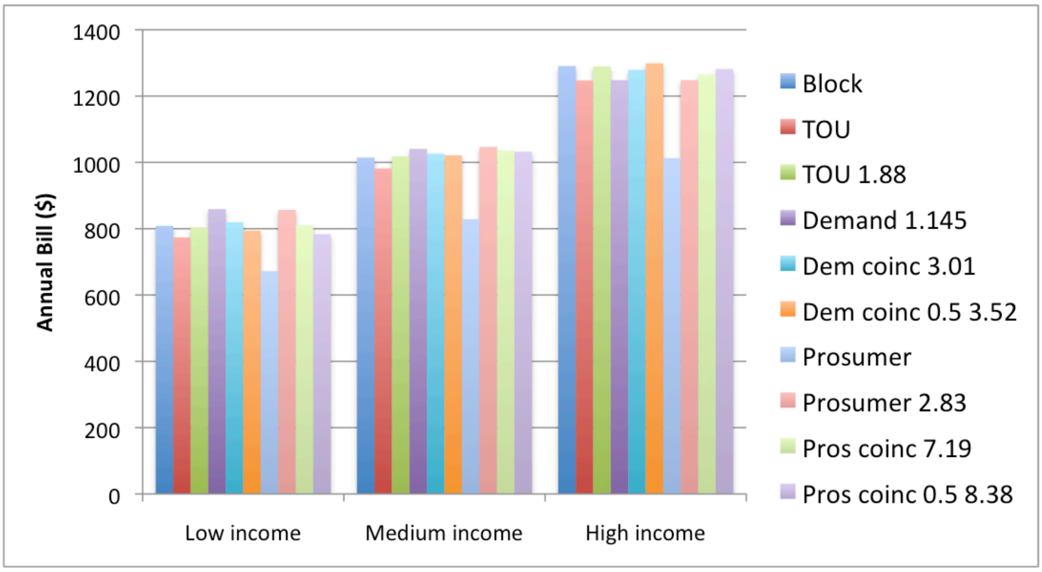

Figure 5. Impacts of Tariffs on Households of Different Incomes (TSS)

Air conditioning

Figure 6 shows the average annual bill for all households in the SGSC database, as well as for those without any A/C and those with ducted A/C, using the same tariffs as described in Table I.

As for the income groups, the TSS TOU tariff results in a slight drop across all categories. The modified TSS TOU tariff results in no significant difference for all three household groups (all households, 'no A/C' and 'with A/C') compared to the Block tariff. It is very slightly lower for 'no A/C' households and very slightly higher for 'with A/C' households. Thus, neither TOU tariff sends a more effective price signal than the Block tariff to households on average. As described in Table I, the modified TSS TOU tariff has the morning peak period removed and the evening peak period tightened up to 4-9pm and the peak rate is almost doubled – so it is surprising that it sends the same price signal as a Block tariff.

Similarly, the adjusted Demand (1.145) tariff and the adjusted Prosumer tariff resulted in little difference for all three household groups compared to the Block tariff – and so again do not send an effective price signal to households on average.

The reason for this lack of effective price signals, for the data used here, can be seen in Figure 7 and Figure 8. These show the average load profiles for households with and without A/C in summer and winter. It can be seen that although the sizes of the peaks (and in fact the total demand) is greater for households with A/C, the shapes of the loads averaged across these periods are in fact quite similar. The TOU tariff is applied across all days and so averages out the loads and so is no more able to distinguish between loads of such similar shapes than is a Block tariff. The conventional Demand charge tariffs used here face a similar problem, with the demand charge averaged over a 5 hour period, over 12 months of the year. Unfortunately we do not have access to SAPN residential household data categorised according to ownership of A/C and so cannot test the results on those households. However, we see no reason for the results to be significantly different.

The only tariffs that resulted in a significant difference to the Block tariffs were the coincident demand tariffs. Halving the daily service charge and increasing the demand charge rate improved its effectiveness, as did moving to the Prosumer structure – presumably because of the higher usage tariff during the A/C peak. Thus, the tariff that combined these two attributes was the most effective.

As we have discussed in detail in previous submissions, and in a peer reviewed journal paper,[13] tariffs that target coincident demand (i.e. the household's demand at the time of the network peak) will be more cost-reflective than those that target a broad area. However, here we are not providing this analysis in the expectation that coincident demand tariffs will be implemented – only to highlight the fact that it is very important that the correct price signals are given. It is likely that cost-reflective tariffs will only be effective when systems, such as distributed household batteries and Home Energy Management Systems, allow automated responses to price signals. In these cases, accurate price signals are critical. For example, as discussed above, inappropriate time windows for high TOU tariff rates and for peak demand charges can result in batteries being exhausted or operating at low capacity during network peaks.

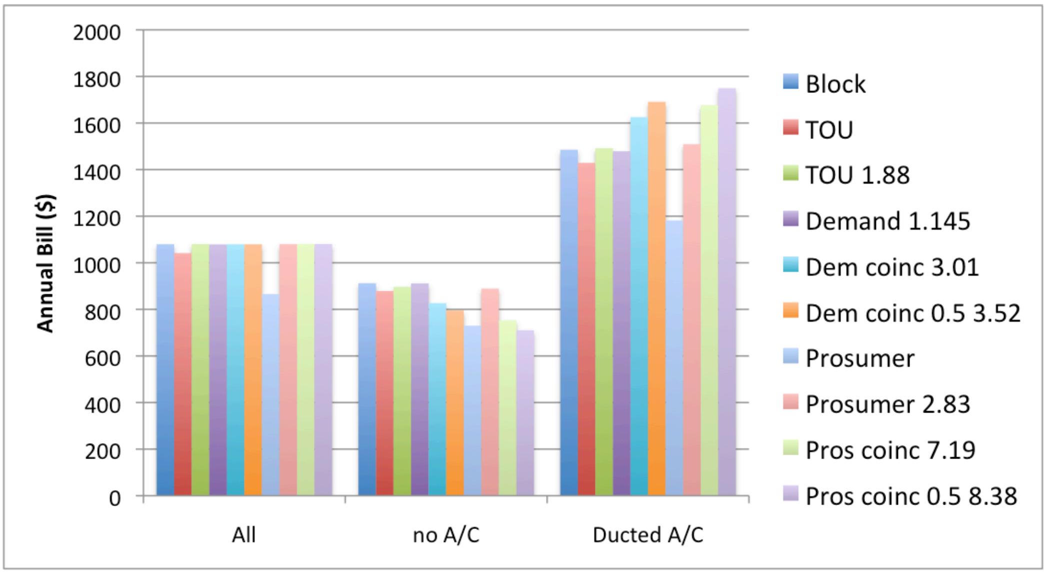

Figure 6. Impacts of Tariffs on Households with/without A/C (TSS)

[13] Passey, R., Haghdadi, N., Bruce, A. and MacGill, I. (2017) 'Designing more cost reflective electricity network tariffs with demand charges', *Energy Policy*, 109, p642-649.

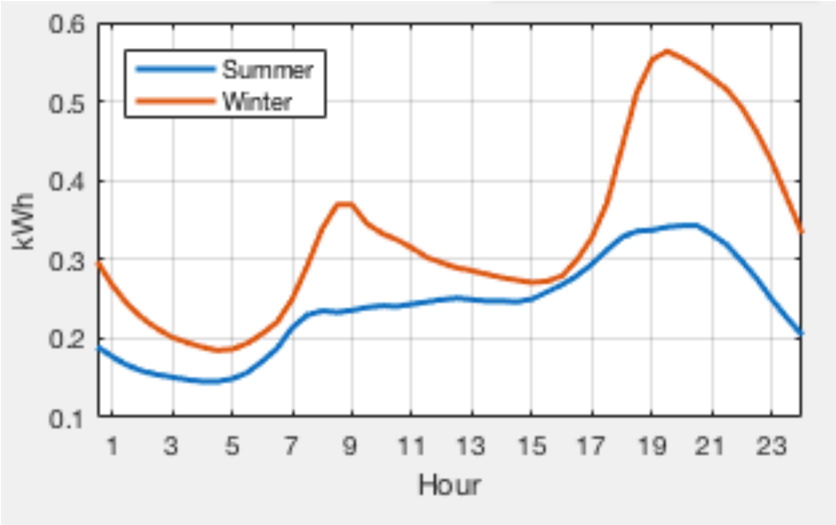

Figure 7. Average Load profiles of Households Without A/C

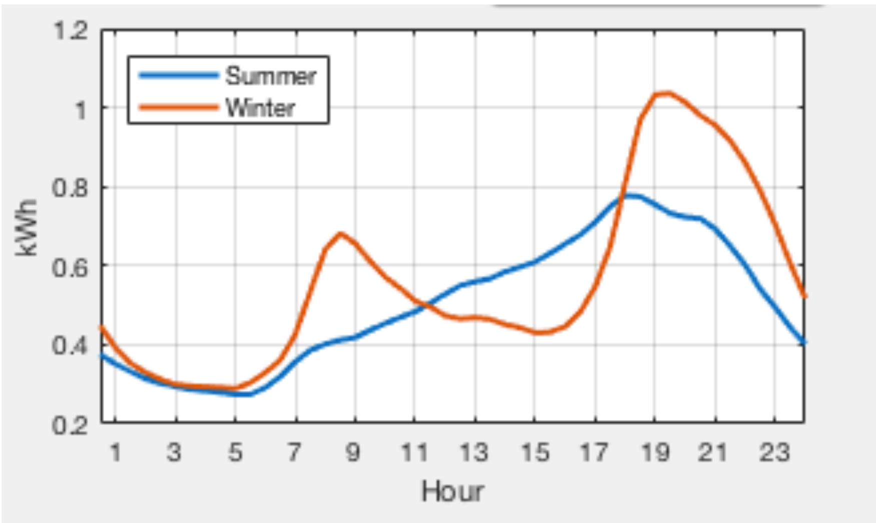

Figure 8. Average Load profiles of Households With A/C

Solar PV

Here, for the sake of consistency, we have applied the same tariffs as were applied to the SGSC data (so the TOU and Demand tariffs have not been normalised to result in the same average bill, although the Demand tariffs come pretty close). The most interesting result here is that all three Demand tariffs result in the greatest bill increase for households with PV, with the coincident[14] and Prosumer options resulting in a slightly greater increase.

[14] On a slightly technical point, the Tariff Tool applies the coincident demand tariff to the network peaks, which is taken to be the sum of all the customer demand profiles. For the SGSC data, this is just the sum of all the SGSC households. However for the Ausgrid 300 data, the same houses are analysed with and without PV, which effectively creates two different network profiles, which may have peaks at different times. However this impact should be immaterial for the purposes of illustrating the impact of the coincident demand charges here.

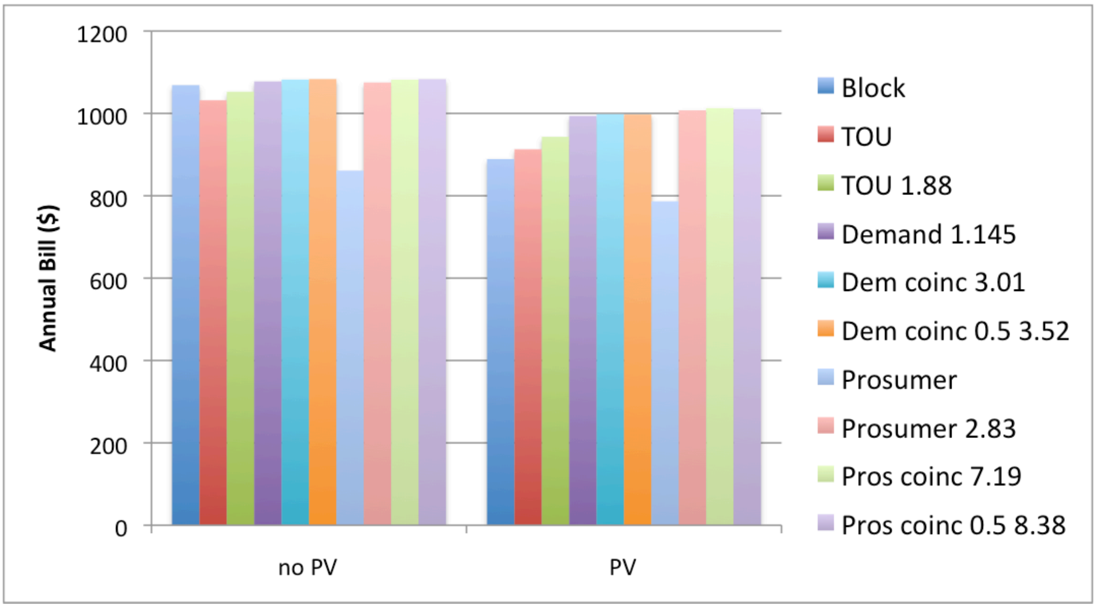

Figure 9. Impacts of Tariffs on Households with/without PV (TSS)