

# Residential Time of Use Electricity Pricing in NSW

## Discussion Paper

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*Australian energy companies and regulators claim that introducing Time of Use pricing will benefit consumers and move their consumption to times when the network is less congested. On closer examination, further adoption will impose increased costs on households and appears more likely to increase the profits of electricity companies than to assist consumers.*

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March 2019

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# Summary

Australian households have traditionally faced a simple electricity pricing structure, with basic peak and off peak rates. However, as the costs involved in providing consumers with electricity vary through the day, electricity companies and regulators have pushed for further tiers of rates under 'time of use' (ToU) pricing arrangements. They hope this would "encourage customers to reduce or move their consumption to times when the network is less congested."

In theory, customers would avoid the higher prices and use electricity more consistently through the day, reducing peak loads on networks. By reducing peak loads, less investment in the system is required and "reduced network investment will mean lower prices for customers".

Unfortunately, despite this theoretical benefit, ToU pricing is unlikely to change consumption patterns and will result in significantly higher electricity costs for households.

The responsiveness of customers' electricity use to a price change is known in economic theory as the (own) price elasticity of demand. For example, if a 10% increase in the price of peak electricity is found to lead to a 1% reduction in the use of peak power the elasticity is  $-0.1$ .

Australian electricity companies claim that demand for peak electricity is elastic – ie that consumers make relatively large changes in consumption in response to price changes. They estimate the elasticity at between  $-0.1$  and  $-0.3$  in the short term and from  $-0.6$  to beyond  $-1$ , in the long term. In other words, they claim that consumers can almost offset entirely the effect of a peak price increase under ToU by reducing peak demand.

However, analysis of data on the National Electricity Market (NEM) shows that demand for electricity in Australia is likely to be very inelastic, with estimates over a decade of between  $-0.06$  and  $-0.137$ . This suggests consumers have little ability to change consumption and avoid higher prices.

Based on ToU price offers from a major retailer and the electricity consumption of average NSW 1-person and 4-person households, this paper estimates changes to annual electricity bills, with results summarized below:

**Table 1: Household annual electricity cost summary**

Cost	1-person household	4-person household
Current rates	\$ 1,403	\$ 2,254
ToU no change	\$ 1,666	\$ 2,684
ToU -0.1	\$ 1,627	\$ 2,615
ToU -0.3	\$ 1,555	\$ 2,485



These estimates show:

- If households cannot shift consumption at all, the introduction of ToU pricing would increase bills by 19%. This would cost an extra \$263 per year for the 1-person household and \$429 per year for the 4-person household.
- If consumers can shift peak to shoulder periods at electricity company elasticity estimates of -0.1, costs still increase by 16%, or \$224 for a 1-person household and \$361 for the 4-person household.
- Even assuming elasticity of -0.3, a 1-person household still faces an increase of \$152 per year while the increase to the 4-person would be \$231 per year.

The higher elasticity estimates appear less likely as the last 15 years has seen considerable household investment in the easiest energy efficiency options such as LED lighting. If the scope for relatively inexpensive change is now limited it follows that further changes in consumption will impose larger costs on households.

Part of the justification for ToR pricing is that peak loads are increasing. While peak loads increased substantially during the early years of this century, data from the Australian Energy Regulator shows that peak loads have declined since around 2009, undermining the case for ToR pricing.

In conclusion, further adoption of ToU pricing will impose an additional financial burden on households and especially low-income households that cannot make the potentially expensive adaptations to significantly modify the volume or time of electricity use. The push for ToU pricing appears more likely to increase the profits of electricity companies than to assist consumers. This conclusion will come as no surprise to observers of Australia's privatised/corporatised energy system.

# Introduction

This short note provides a brief explanation of Time of Use (ToU) electricity pricing as it applies to residential customers in NSW, its rationale and estimates its effect on household residential electricity costs.

Due to the difficulty of accessing key data, such as the actual distribution of current consumer use of electricity by time of day, several simplifying assumptions have been made to arrive at its possible impacts. There is also considerable uncertainty regarding the scale of response residential consumers will and, can make, to the new electricity pricing structure. Because of these caveats the cost estimates should be regarded as approximate and indicative only. (Appendix 1 details these modelling assumptions).

## BACKGROUND

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Following privatisation of the NSW electricity system over several decades the system has been subject to varying forms of regulation (for a description of the complex regulatory agencies and rules governing the system see Australian Energy Market Commission (AEMC) <https://www.aemc.gov.au/regulation/national-energy-governance>). In simple terms, in NSW the cost of poles and wires (transmission and distribution systems), which carry power from generators to business and residential users, is regulated by the Australian Energy Regulator (AER). The poles and wires are regulated since they are a natural monopoly, i.e. it is more efficient to have just one supplier).

The AER sets maximum long term revenue targets for transmission and distribution companies, typically of five year duration. The targets are met by annual changes to approved pricing. The changes are designed to ensure the cumulative revenue targets are neither exceeded nor deficient due to events such as fluctuations in demand or storm damage to the system.

The transmission provider in NSW is Transgrid. There are several distributors such as Ausgrid, Endeavour and Essential Energy, each having a local geographic monopoly. Unlike transmission and distribution, other parts of the NSW electricity system are not regulated. Both the generation sector and the retailers are deregulated in terms of their price setting. These sectors are regarded as competitive by electricity regulators,

though, in the case of retailers this assumption is open to question.<sup>1</sup> Electricity retailers were deregulated by the NSW government in July 2014.

## RATIONALE FOR TOU

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ToU is a price system described by the AER as a:

Tariff incorporating usage charges with varying levels applicable at different times of the day or week. A time-of-use tariff will have defined charging windows in which these different usage charges apply. These charging windows might be labelled the 'peak' window, 'shoulder' window, and 'off-peak' window.<sup>2</sup>

ToU is a pricing method used internationally to send 'price signals' to residential and business consumers to shift their consumption of electricity from peak to non-peak periods.<sup>3</sup> Australian electricity regulators have, for some years, advocated distributors and retailers adopt 'cost reflective pricing' like ToU pricing. For example,

Time-of-use tariffs tend to more closely resemble the cost of customers' decisions to utilise the distribution network at times of congestion. Such tariffs encourage customers to reduce or move their consumption to times when the network is less congested. Reducing consumption during times of peak network congestion means less network investment is necessary to provide reliable electricity supply during those peak times. In the long run, reduced network investment will mean lower prices for customers.<sup>4</sup>

Network congestion occurs when the grid is:

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<sup>1</sup> The NSW Independent Pricing and Regulatory Tribunal (2018: 7) observes that the NSW 'retail electricity market remains concentrated, however there is a consistent trend of smaller retailers slowly gaining market share at the expense of the big three retailers in NSW (Figure 3.1). As at the end of June 2018, the big three retailers had around 85% share of the NSW electricity market for small customers, made up of: AGL (23%) Energy Australia (28%) and Origin Energy (33%). While the combined market share of the 21 smaller retailers only sits at 15%, it has doubled from 7%, when prices were first deregulated in NSW'

<sup>2</sup> AER (2017) *Final decision: Tariff structure statements – Ausgrid, Endeavour and Essential Energy*, [https://www.aer.gov.au/system/files/nsw%20final%20decision%20-%20consolidated%20version%20%28D2016-00169120%29\\_1.pdf](https://www.aer.gov.au/system/files/nsw%20final%20decision%20-%20consolidated%20version%20%28D2016-00169120%29_1.pdf)

<sup>3</sup> There are many different price and non-price schemes for 'demand management' to alter the level or timing of peak electricity consumption of which ToU is only one (Crossley 2010).

<sup>4</sup> AER (2017) *Final decision: Tariff structure statements – Ausgrid, Endeavour and Essential Energy*, [https://www.aer.gov.au/system/files/nsw%20final%20decision%20-%20consolidated%20version%20%28D2016-00169120%29\\_1.pdf](https://www.aer.gov.au/system/files/nsw%20final%20decision%20-%20consolidated%20version%20%28D2016-00169120%29_1.pdf)

unable to accommodate all required load during periods of high demand...Grid congestion...impacts reliability [and causes a] decrease in efficiency...If lines are congested and operating at or near their thermal limits, they would be exhibiting significant line losses during high load conditions... [Also] electricity retailers may not have access to the least expensive source of electricity, which can 'artificially' drive consumer prices up to very high levels.<sup>5</sup>

Grid congestion can also occur due to any reduction in grid capacity such as storms damaging some poles and wires imposing higher current load on the remaining operating system.

In addition, data on 'network load duration' reveals that maximum peak demand occurs for a very short period of time; a small fraction of the total time the network operates. For example, Endeavour Energy experiences demand within 20% of its maximum for just one percent of the year.<sup>6</sup> This reinforces the argument that devoting resources to increasing grid capacity to meet this relatively short duration of peak demand is inefficient.

In short, ToU pricing is designed to avoid or defer investment in grid capacity:

If customers are given the opportunity to respond to these price signals...network investment requirements will be lower than they otherwise would be. This reduces upwards pressure on electricity prices for everyone.<sup>7</sup>

The claim that peak demand has continued to increase is examined later.

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<sup>5</sup> Bryant, Dave (2013) *Power Grid Congestion*, Electricity Today July/August  
<https://www.electricity-today.com/overhead-td/power-grid-congestion>

<sup>6</sup> AER (2017) *Final decision: Tariff structure statements – Ausgrid, Endeavour and Essential Energy*, page 124, [https://www.aer.gov.au/system/files/nsw%20final%20decision%20-%20consolidated%20version%20%28D2016-00169120%29\\_1.pdf](https://www.aer.gov.au/system/files/nsw%20final%20decision%20-%20consolidated%20version%20%28D2016-00169120%29_1.pdf)

<sup>7</sup> Ibid, page 26-27

# Smart Meters and ToU

Put simply, there are two types of meter used in NSW to record residential consumption of grid current. These are ‘accumulation’ meters that record total usage over a given period and ‘smart’ meters which are “capable of measuring electricity usage in specific time intervals and enabling tariffs that can vary by time of day.”<sup>8</sup> Smart meters are also known as ‘interval’ meters, since they record electricity use over specific time intervals during the day. ToU pricing relies on the installation of smart meters.

Smart meters make the implementation of cost reflective network tariffs possible because they measure both total consumption and specific times when this consumption occurs. In NSW from 1 December 2017, it has been compulsory to install smart meters in all new buildings and in replacing older malfunctioning meters.<sup>9</sup> Smart meters are also essential for connecting residential solar to the grid to receive a feed-in tariff. (A payment from electricity retailers to householders that export current to the grid).

All meters in Australia, regardless of what type, are given a unique National Meter Identifier (NMI), a 10 digit number. The NMI is used by distributors and retailers to determine what type of meter is installed within any Australian residence. In NSW the type of meter installed at a residence determines the type of electricity ‘tariff’, or pricing system that is assigned by distributors and retailers to a particular residence. A smart meter is assigned to ToU pricing and accumulation meter is assigned to a flat rate tariff. (There are actually many different types of pricing system and tariffs but these are both very common and used for simplicity).

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<sup>8</sup> AER (2017) *Final decision: Tariff structure statements–Ausgrid, Endeavour and Essential Energy*, page 5.

<sup>9</sup> *Australian Energy Market Commission (2014) Rule Determination National Electricity Amendment (Distribution Network Pricing Arrangements) Rule 2014, November* <https://www.aemc.gov.au/rule-changes/distribution-network-pricing-arrangements>



# Transitional Pricing

At present in NSW it is not compulsory for ToU pricing to apply to a residence, despite the presence of a smart meter and the residence being assigned to a ToU tariff. This follows a 2017 decision by the regulator to permit NSW ‘customers...to opt-out to...transitional residential and small business tariffs’ (AER 2017: 11). Customers can elect to remain temporarily on their previous flat tariff despite having a smart meter and being assigned to ToU pricing. The reason for introducing this ‘transitional’ system is explained by the regulator:

[w]e understand from consultation with the NSW distributors that moving from current tariff levels to fully cost reflective levels would have significant customer impact. To manage this impact, they proposed to transition towards more cost reflective tariff levels with each round of tariff structure statements.<sup>10</sup> (AER 2017: 96).

More bluntly, the regulator is concerned that customers will suffer ‘bill shock’ without this transition. It notes that one distributor’s

approach to adopt a time-of-use structure with peak, shoulder and off-peak windows and to apply the same rate across all windows for a transitional period will provide customers with important information about their time-of-use consumption patterns, but without imposing bill shocks. We consider this will help customers make a decision as to whether they want to opt-in to the more cost reflective time-of-use tariff. It also allows customers time to adjust their consumption patterns without any price impacts before transitioning to the more cost reflective time-of-use tariff (AER 2017: 61).

The regulator is also of the view that, to achieve network efficiency over time, ToU pricing could be compulsory. ‘In the long run, we consider this should be facilitated by assigning all customers to cost reflective network tariffs...We are also open to considering mandatory tariff assignment arrangement proposals (i.e. no opt-out

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<sup>10</sup> Ausgrid, *Revised tariff structure statement*, 4 October 2016, pp. 43–45; Endeavour Energy, *Response to information request*, 9 December 2016; Essential Energy, *Tariff structure statement*, 4 October 2016, p. 21.

provisions), as long as distributors have addressed the customer impact principle in the Rules' (AER 2017: 61).<sup>11,12</sup>

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<sup>11</sup> A search of the National Electricity Rules Version 119 (February 2019) finds no mention of the term 'the customer impact principle'. These Rules cover the operation of the NEM and comprise 1672 pages. The Rules do however make reference to the National Energy Customer Framework (<https://www.energy.gov.au/government-priorities/energy-markets/national-energy-customer-framework>). This Framework is part of the National Electricity Rules but not included in the legislation referred to above. The Framework covers issues to do with minimum terms in retail contracts, information on billing, disconnections and hardship. It does not appear to make any prohibitions to price increases by retailers, such as the large increases for peak power in NSW for residences with smart meters. This is consistent with the deregulation of retailers in NSW since 2014.

<sup>12</sup> Advice to the author received from the AER dated 28th February 2019 is that the 'current structure statements for NSW distributors will expire on 30 June 2019, and no decision has yet been made on their revised proposals that (once approved) will apply from this date'.

# Consumer Response to ToU

ToU pricing is intended to either reduce total peak household electricity consumption and/or divert it to other times. The key assumption is that, should households seek to diminish the effect of rising prices, they have considerable flexibility in either the total quantum of their electricity consumption and/or its time of use.

The responsiveness of customers' electricity use to a price change is known in economic theory as the (own) price elasticity of demand. For example, if a 10% increase in the price of peak electricity is found to lead to a 1% reduction in the use of peak power the elasticity of demand for peak electricity is thus  $-0.1$ . A related concept is the cross price elasticity of demand, which measures the change in demand for peak (or off peak) power in response to a change in the price of off peak (or peak) power.

Where the change in the volume of commodity in percentage terms is less than the percentage price change demand is known as inelastic. The example above shows inelastic demand. Where the demand change, in percentage terms, is greater than the percentage change in price, the demand is described as elastic. Firms use knowledge of the elasticity of demand for their products and services in their pricing strategies.

Some of the factors that determine the price elasticity of demand of a commodity include:

- Is the commodity discretionary or essential to the consumer?
- Are there substitute commodities that reasonably match the qualities of the original commodity? What is the price difference between the original and substitute product?
- How much of a consumer's total income does the commodity consume? (A commodity representing a small fraction of a consumer's income may be quite price inelastic).
- What is the cost of acquiring information about substitutes?
- Are there any impediments to the consumer changing their behaviour or investing in substitutes?

A general conclusion in the economic literature is that elasticity of demand is likely to change as the price increases. Thus higher price increases elicit a larger proportional change in demand than a smaller price change. In addition, it would be expected there is a difference in the elasticity of demand in the short-run and the long-run. In the short-run customers can change behaviour, like turning off lights and shifting demand from peak to off peak. In the long-run consumers can make investments which change

their total demand and/or time of use of electricity. Examples of the latter include consumers installing home insulation to lower consumption; solar panels to generate their own electricity to substitute for grid power, or replacing electrical with gas appliances if these appliances deliver a net cost reduction.

Ausgrid (2015: 18) undertook a comprehensive review of national and international studies quantifying the residential consumer elasticity of electricity demand with respect to a change in the price of electricity. The main findings were:

- ‘the common range for short run estimates of the own price elasticity of electricity (peak consumption) is  $-0.1$  to  $-0.3$ . Estimates may be as low as  $-0.025$  and as high  $-0.6$ ’
- ‘long run estimates of the own price elasticity of residential demand exceed the short run measures, as consumers purchase more energy efficient appliance stock. The long run value can be around  $-0.6$ , although some studies have placed this value above 1’
- ‘although even the typical higher end of these estimates (e.g.  $-0.3$  range) is still considered to be relatively inelastic in economic terms, it is sufficient to defer enough demand to save a substantial amount in avoided costs<sup>13</sup> (especially when all upstream and downstream benefits are factored into the analysis)’
- ‘the substitution effect associated with peak price rises dominates the conservation effect (positive cross price elasticities of off-peak consumption with peak price)’
- ‘Elasticities in warmer climates can be as much as double those in cooler climates. High air conditioning penetration rates drive higher elasticities’.

There is some reason for scepticism regarding the relatively high elasticity proposed by the distributor. First, the most obvious point is that it is in the self-interest of a commercial electricity operator advocating for the introduction of ToU to suggest that the elasticity is moderately high. Certainly the long- run price elasticity of demand estimates ranging from  $-0.6$  to above 1 imply that consumers can almost offset entirely the effect of a price increase by reducing demand. Of course, the short-run estimate of  $-0.1$  to  $-0.3$  imply, as one would expect in the short-run, that consumer have less capacity to offset price increases. Distributors and transmitters can seek quite large price increases from the regulator on the basis that, because consumers have a moderate to large ability to reduce their electricity demand in response to a price

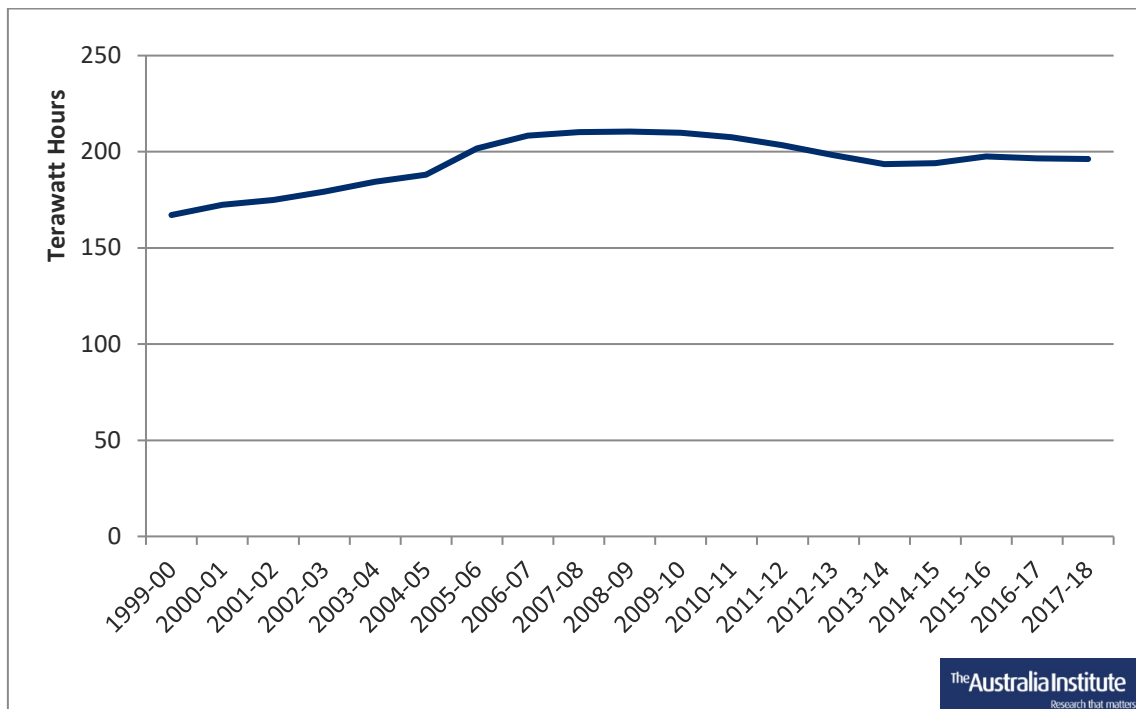
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<sup>13</sup> The term ‘avoided costs’ refers to the lower investment in electricity infrastructure when consumers respond to price increases by reducing the rate of growth of electricity demand. The ‘costs avoided’ apply to both electricity providers, who lower investment below that otherwise required to meet rising peak demand, and consumers, who pay for this higher investment.

increase, the net cost burden on consumers will be relatively minor. Further, suggesting moderate to large elasticities also implies that by permitting large price increases the regulator will achieve its objective of minimising peak grid congestion.

Second, the very high rate of price inflation for electricity associated with privatisation of the electricity system in Australia serves as a ‘natural experiment’ to gauge how electricity consumption has adjusted in response. The trend in Australian long run electricity consumption on the National Electricity Market (NEM), which includes only the wholesale electricity market, is given in Figure 1.

**Figure 1: National Electricity Market Consumption (TWh)**



Source: AER 2019a

The NEM data excludes Western Australia and the Northern Territory and certain categories of electricity generation and consumption, notably self-consumption of power such as that generated by residential PV. The NEM represents around 80% of the total electricity market. Figure 1 shows that over the full period 1999-2000 to 2017-18 electricity consumption increased and peaked in 2008-09, and since then has fallen by 6.8% (Australian Electricity Regulator 2019a). The Australian Bureau of Statistics (2018) electricity price index in June 2008 was 64.3 and by June 2018 it was 139.8, an increase of 117%.<sup>14</sup> This implies an electricity price elasticity of -.06. In other words a 100% increase in electricity prices led to a reduction of just 6% in electricity

<sup>14</sup> Over the same period that total CPI increased by just 23%.

consumption. This estimate is a fraction of the .3 offered by Ausgrid and strongly suggests that electricity consumption is highly price inelastic.

Similar patterns are observed for total NSW electricity consumption, (which includes the NEM and other sources such as domestic PV), with consumption peaking at 80.5 terawatts in 2010-11 and falling to 75.4 terawatts in 2016-17 (latest data available) (Department of the Environment and Energy 2018: Table L). Controlling for population growth by using trends in average electricity consumption per capita in NSW reveals a low elasticity. Electricity consumption in NSW per capita peaked in 2006-07 at 10.9 megawatts but then declined to 9.11 megawatts per capita in 2016-17, a decline of 17% (Department of the Environment and Energy, 2018 Table B). Over the same period the ABS electricity price index increased by 124%. This gives an elasticity of  $-.137$ . A more than 100% increase in electricity prices reduces per capita demand by 14%.

Importantly, the estimates of  $-.06$  and  $-.137$  may be regarded as long-run elasticities since the data spans at least a decade. Long run elasticities are, as noted earlier, generally regarded as higher than short-run estimates since they permit households to take action such as installing more efficient appliances or PV.

Hugh Saddler (2015: 18) investigated some of the factors behind the trend to flat or declining total electricity consumption. These include the closure of energy intensive industrial plants, notably aluminium smelters. For residential customers 'demand for electricity is being significantly reduced by regulated increases in the minimum efficiency levels of household appliances and equipment, and also by minimum energy performance requirements for new dwellings...Behind the meter consumption of electricity generated by rooftop photovoltaics is also significant' (Saddler 2015: 18). The scope for continued sustained reductions in NSW residential electricity consumption is examined later.

# How Does ToU Affect Consumer Costs?

As noted earlier there is considerable uncertainty regarding the price elasticity of demand for residential electricity. Therefore, two approaches were made to quantify some effects of ToU pricing. Data for this exercise, the data sources and the assumptions are detailed in Appendix 1. The key pricing data was derived from a large representative retailer's pricing schedule and this was applied to annual consumption data for 1 and 4 person households in the Parramatta post code. Since there is considerable variation in average household electricity consumption for the same household size across NSW regions, for simplicity Parramatta was selected as it is 'the geographical centre of Sydney, 24 kilometres west of the CBD' (ABC 2014).

Under the flat rate tariff the peak rate is 31.4 c/kWh; off peak 15.9 c/kWh and the supply charge is 91.7 cents per day. Under ToU the peak rate is 58.3 c/kWh; shoulder rate 26.2 c/kWh and the daily supply charge is 106.5 cents. (Off peak remains the same). The peak rate increases by 86% and the daily supply charge by 16%.

The first approach to quantifying the effect of ToU is a base case and simply examines the effect on total cost of a 1 and 4 person household shifting from a previous flat rate to a ToU following installation of a smart meter. (The total cost is usage + increased daily supply charge. It is assumed the household has no solar PV and/or a battery). In the base case there is no change in the volume of electricity used or its time of use. Its purpose is to measure the pure price effect of ToU keeping these two factors fixed.

## BASE CASE. PURE PRICE EFFECTS

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Tables 1 and 2 provide the base case results. The key points are that shifting from a flat rate to ToU increases the total annual electricity cost of a one person household by \$263. This is an increase of 19%. This is comprised of a \$209 increase in annual usage cost and \$54 increase in the annual supply charge.

For the four person household shifting from a flat rate to ToU increases the total annual electricity cost by \$429. This is an increase of 19%. This is comprised of a \$375 increase in annual usage cost and \$54 increase in the annual supply charge.

**Table 1: One Person Household. Annual Consumption 3997kWh. No Change in Total Use or ToU**

	Annual Usage \$	Annual Supply charge \$	Total \$
<b>Flat rate tariff</b>	1068	335	1403
<b>ToU tariff</b>	1277	389	1666
<b>Increase \$</b>	209	54	263
<b>Increase %</b>	20%	16%	19%



**Table 2: Four Person Household. Annual Consumption 71847kWh. No Change in Total Use or ToU**

	Annual Usage \$	Annual Supply charge \$	Total \$
<b>Flat rate tariff</b>	1920	335	2255
<b>ToU tariff</b>	2295	389	2684
<b>Increase \$</b>	375	54	429
<b>Increase %</b>	20%	16%	19%



## AUSGRID ELASTICITY APPROACH

The second approach uses Ausgrid’s preferred short run residential price elasticity of demand estimate of  $-0.1$  to  $-0.3$  to estimate the effect on residential electricity costs.<sup>15</sup> This was derived from their international review of the literature. The review also found that in response to price rises, rather than reduce total electricity consumption (conservation effect), householders mainly shifted electricity use to cheaper times (substitution effect). They concluded ‘the substitution effect associated with peak price rises dominates the conservation effect (positive cross price elasticities of off-peak consumption with peak price)’ (Ausgrid 2015: 18). Either ‘effect’ can play a role in reducing peak grid congestion.

We use these results to estimate the effect of ToU on residential prices. For simplicity we assume the ‘substitution’ effect is total, so that the volume of electricity consumption remains constant but an increase in unit price of peak power leads consumers to shift a proportion of their peak use to shoulder use. (We assumed that the level of off-peak consumption remains constant. This was based in part on the fact that off-peak power in most residential settings is primarily used for hot water storage heating and this use will not change under ToU pricing). Further, because peak rates

<sup>15</sup> An example of how these elasticities are applied is that the price of peak power moving from the flat rate to the ToU has increased by 86%. Using a one person household this is multiplied by the assumed rate of change in quantity in response to the change in price, which is given by the price elasticity of demand of  $.1$ , to arrive at the new volume of week day peak use under ToU of 1004 kWh.



under ToU are only charged on weekdays it is assumed that substitution occurs only during weekdays.

**Table 3: One Person Household. Annual Consumption -.1 and -.3 Price Elasticity**

	peak *	shoulder **	Total \$***
<b>Flat Rate Consumption kWh</b>	1103	827	
<b>Flat Rate Cost \$</b>	346	260	1403
<b>ToU Consumption kWh</b>	1103	827	
<b>ToU Cost \$</b>	643	217	1666
<b>ToU Consumption kWh (-.1)</b>	1004	902	
<b>ToU Cost \$ (-.1)</b>	585	236	1627
<b>ToU Consumption kWh (-.3)</b>	816	1042	
<b>ToU Cost \$ (-.3)</b>	476	273	1555



\*Weekdays only \*\* Shoulder Flat rate is the same price as peak \*\*\* Total Annual

The main results from Table 3 are that for a one person household:

- moving from a flat rate to ToU Tariff with no change in volume or time of use increases annual electricity cost by \$263 or 19%
- a price elasticity of .1 in substituting peak for shoulder use cuts the total ToU cost by \$38 or 2.3%
- even after assuming a -.1 elasticity under ToU annual electricity costs are \$224 or 15.9% higher under ToU than under the flat rate tariff.
- a price elasticity of -.3 in substituting peak for shoulder use cuts the total ToU cost by \$111 or 6.7%
- even after assuming a -.3 elasticity under ToU annual electricity costs are \$152 or 10.8% higher under ToU than under the flat rate tariff.

**Table 4: Four Person Household. Annual Consumption -.1 and -.3 Price Elasticity**

	peak *	shoulder **	Total \$***
<b>Flat Rate Consumption kWh</b>	1983	1487	
<b>Flat Rate Cost \$</b>	622	467	2254
<b>ToU Consumption kWh</b>	1983	1487	
<b>ToU Cost \$</b>	1156	389	2684
<b>ToU Consumption kWh (-.1)</b>	1804	1621	
<b>ToU Cost \$ (-.1)</b>	1052	424	2615
<b>ToU Consumption kWh (-.3)</b>	1467	1874	
<b>ToU Cost \$ (-.3)</b>	856	490	2485



The main results from Table 4 are that for a four person household:

- moving from a flat rate to ToU Tariff with no change in volume or time of use increases annual electricity cost by \$429 or 19%
- a price elasticity of .1 in substituting peak for shoulder use cuts the total ToU cost by \$69 or 2.6%
- even after assuming a -.1 elasticity under ToU annual electricity costs are \$361 or 16.0% higher under ToU than under the flat rate tariff.
- a price elasticity of .3 in substituting peak for shoulder use cuts the total ToU cost by \$199 or 7.4%
- even after assuming a -.3 elasticity under ToU annual electricity costs are \$231 or 10.2% higher under ToU than under the flat rate tariff.

# Consumer Adaptation Constraints

Not only is there considerable uncertainty regarding the residential price elasticity of demand there is also a real question regarding the future scope for maintaining the past rate of reduction in residential electricity use. There are reasons for believing that the observed rate of decline in per capita electricity use in NSW will not continue. Given the unprecedented scale of electricity price increases over the period of electricity market privatisation, which are much larger than that flowing from ToU, one would expect that most households have already made basic behavioural changes. Examples of these 'low hanging' and inexpensive 'fruit' from behavioural change include installing timers on appliances to run at non-peak times; installing LED bulbs; running air-conditioning at higher or lower temperatures in summer and winter respectively and restricting the space to be heated or cooled to essential areas. It is simply unknown how much relatively inexpensive behavioural change remains to be made. If the scope for relatively inexpensive behavioural change has been substantially exhausted across households it follows that a further step change reduction in per capita consumption will impose large costs on households.<sup>16</sup> These expensive adaptations would be for example installing solar PV and/or batteries; solar hot water and retro-fitting insulation into established residences. As far as can be determined these important issues have not been extensively examined by electricity retailers or the regulatory authorities.

Hugh Saddler (2015: 20-22) provides some guidance on these issues by suggesting there are three distinct limits to sustaining the past rate of decline in residential and business electricity consumption. First, households are becoming saturated with more energy efficient appliances implying a slowing in the rate of decline in per capita energy consumption from this source.<sup>17</sup> Second, there is ideological and political opposition, based on 'cutting red tape', to mandating further energy efficiency measures on household and business appliances and enhancing building standards

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<sup>16</sup> The alternative response is that households simply cut their electricity consumption well below levels they would otherwise need. This will reduce the quality of life of these households and/or impose health and safety costs due to inability to achieve required levels of internal lighting or safe temperatures.

<sup>17</sup> Although not noted by Saddler there are also technological limits to the continued increased efficiency of these appliances. This is especially the case with major appliances like electric stoves, air-conditioning, refrigeration and water heating, whose basic physics have been understood and design relatively fixed, for well over a century. The scope for continued energy efficiency in such appliances will, in the absence of a major technological breakthrough, be incremental. The type of break-through for these appliances, equivalent to the enormous efficiency gains achieved by replacing incandescent with LED lighting, does not appear to be on the immediate horizon.

Third, there is 'widespread and widely acknowledged non-compliance with the energy efficiency regulatory requirements of the National Construction Code...energy efficiency aspects of building regulations are not at present being enforced'.

Aside from the issue of non-compliance with building energy efficiency standards, there is also severe criticism of the adequacy of current standards for certain types of residential building, specifically mid-rise residential buildings 4-8 stories high. These structures are increasingly common in housing urban populations. One engineering review found that Australian building energy efficiency standards for such structures have been 'demonstrated to be aspirationally low at the global level' (Heffernan et al 2017: 298). Further, at a state level, NSW has adopted its own building energy efficiency targets known as BASIX (Building Sustainability Index). The same study found that BASIX is 'failing to effect significant energy savings within mid-rise residential apartments' (Heffernan et al 2017: 298).

On a more positive note the continued rapid decline in the cost and rapid increase in efficiency of residential solar PV will continue to aid consumers adjust to high electricity prices. Households that can significantly cut their peak grid consumption and/or shift a substantial share of their time of use to more affordable times will be those best able to cope with ToU pricing. In the first category are obviously households with rooftop PV and this benefit is greatly amplified if they also have battery storage, since this group will be able to frequently displace daytime grid supplied peak use, when solar output is at its maximum, and store excess power for peak times on cloudy days or in the early evening when PV output is reduced or ceases.

However, according to the Australian PV Institute (2019) in 2018 only 18% of homes in NSW have solar PV. This is less than one in five. A much smaller proportion have solar linked batteries. Not only are there are limits to consumer affordability of devices such as PV and batteries there are also restrictions on the type of residential buildings that can feasibly install PV or install a sufficient area of PV to make a meaningful contribution to offsetting the rise in ToU prices. The obvious example is high rise apartments or heavily shaded residences. In addition, rental accommodation is subject to the well known problem of 'split incentives' where the renter has a disincentive to invest in energy efficiency and/or measures such as PV because they do not own the structure to which these items are permanently attached. Further, the average duration of rental tenure is low. Equally, landlords will not pay for renewable energy and energy conservation measures as it is renters who reap the rewards of lower energy bills. According to the latest Census data around 31% of all housing (free standing, apartments, town houses etc) in Australia is rented (ABS 2017). In other words, given the current structure of incentives, and in the absence of government measures to redress these market failures, a high share of Australia's housing stock will

not receive significant investment to adapt to higher ToU pricing. (Renters and high-rise apartment dwellers can elect to use renewably generated electricity from the grid but this does not affect the issue of grid congestion; since congestion can occur whatever the actual source of power fed into the grid).

Finally, the AER and retailers do not appear to have considered the effect of climate change on consumer costs, and in particular, the prospect of more extreme weather events such as hot days. The latter will arguably reduce the price elasticity of demand and constrain consumers' capacity to adapt to rising ToU prices.

# Alternative Approaches to Grid Congestion

The rationale for ToU pricing is to avoid further large scale investment in the grid due to peak grid congestion. At present in many jurisdictions across Australia the regulatory system does not reward distributors and transmitters to pursue measures to reduce per capita consumption or improve energy efficiency. Put simply revenue for transmitters and distributors is determined by a regulated rate of return on the value of the capital stock in ‘poles and wires’ known as the Regulated Asset Base.<sup>18</sup> Retailers in NSW are deregulated and their revenue model is one effectively based on maximising electricity consumption by business and households.

Given the incentives facing transmitters, distributors and retailers the regulatory system has only one mechanism to reduce network congestion, that is, price.<sup>19</sup> There is no incentive and no regulatory scope for these companies to use alternative approaches to grid congestion such as subsidising the uptake by residential and business customers of PV and/or batteries. The use of so-called ‘non-network’ technologies and strategies to reduce network congestion is however under investigation by the regulator.<sup>20</sup> The widespread application of this would however, require a radical change to the present regulated funding model of transmitters and

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<sup>18</sup> ‘Under the revenue cap model currently in place across the NEM (which is really a revenue guarantee), the value of network assets (the regulated asset base or RAB) is rolled forward every five years and adjusted for inflation, depreciation and the value of new assets’ (Byrne and Parmenter 2018 :19).

<sup>19</sup> The following advice to the author was recently received from the AER.

‘The AER has limited discretion in approving tariff structure statements (TSS) and pricing proposals. The AER must approve:

- a proposed TSS unless the AER is reasonably satisfied that the proposed tariff structure statement does not comply with the requirements of the National Electricity Rules (which are about making sure network prices reflect the costs of particular network usage, while also specifically considering the impact of changing tariffs on consumers).
- annual pricing proposals if the proposal complies with the National Electricity Rule requirements and the applicable distribution determination, and all forecasts associated with the proposals are reasonable.

As a result, it is not within the scope of our role in approving a TSS to require distributors to use signals other than pricing signals’.

<sup>20</sup> For example the AER is funding research by Ausgrid into demand management systems that shift appliance or equipment use from peak to non-peak periods (this can also be done remotely with agreement of the business or householder); converting the appliance energy source from electricity to other sources; and power factor correction (<https://www.ausgrid.com.au/Industry/Innovation-and-research/DMIA-Research-and-trials>).

distributors. Secondly, it will almost certainly require re-regulation of retailers so that the profit motive is aligned with the objective of lowering consumer electricity grid consumption and prices.

The Australia Institute (2018) has strongly advocated for the adoption across all Australian jurisdictions of Demand Response (DR) which ‘provides the opportunity for consumers to receive payments for reducing their power usage during periods of peak demand - creating ‘negawatts’.<sup>21</sup> Rather than the current system which penalises households to reduce grid congestion by dramatically increasing the price of peak power, DR provides incentives for households to moderate their energy consumption. DR has for several years operated in the Queensland wholesale electricity market and for example, utilises technologies to remotely control household air-conditioning units (to raise the temperature settings) and pool pumps (to shift their operation to non peak times) during extreme peak loads. Households receive a payment for participating in these schemes. Similarly, large industrial energy users, such as Blue Scope Steel, have agreed to moderate their electricity consumption to avoid grid ‘blackouts’.

## IS PEAK DEMAND INCREASING IN NSW?

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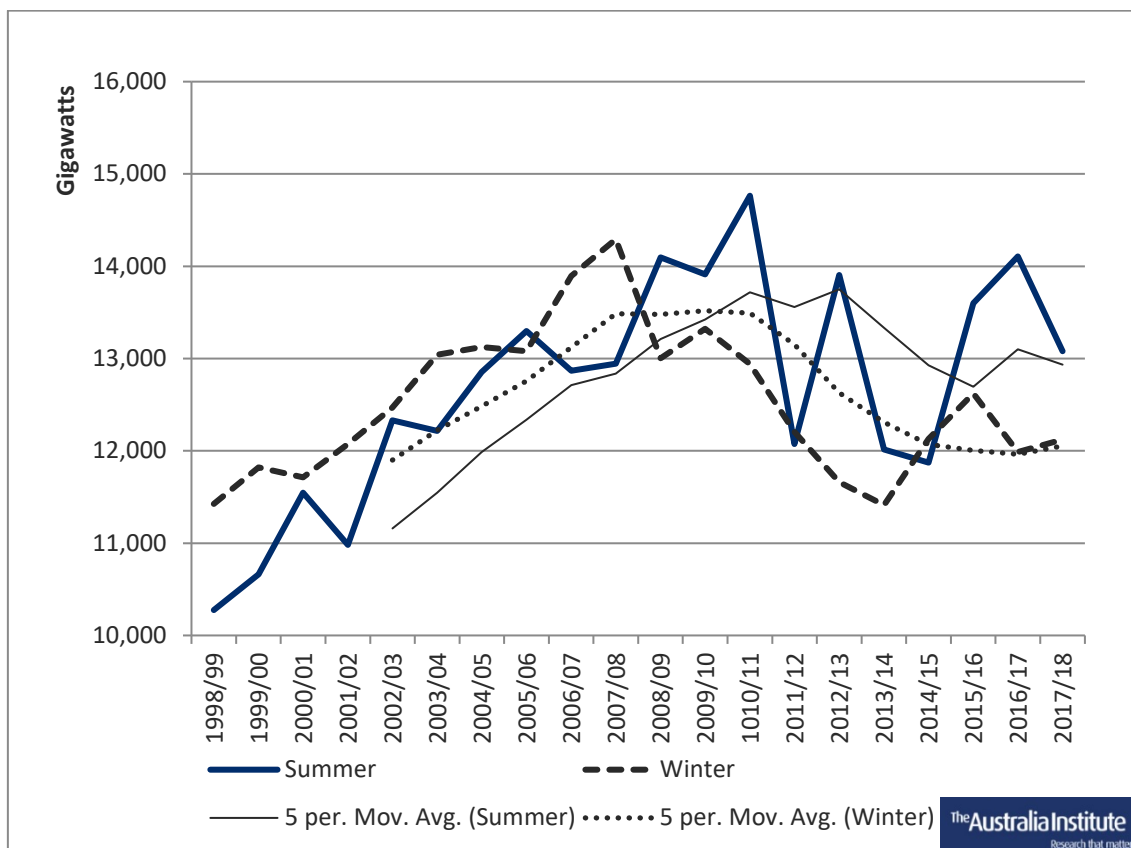
The key assumption in the introduction of ToU is that peak residential electricity consumption in NSW will continue to rise. ‘Network costs have increased over the last decade as distributors invest in additional infrastructure upgrades to meet the higher peak demand. This increased investment has been a factor driving electricity price rises in the last decade’ (AER 2017: 26).

It was noted earlier that total per capita electricity consumption in NSW has declined for several years and the data suggests that similar trends of declining peak consumption are also underway. Figure 2 shows peak wholesale electricity consumption for NSW for summer and winter seasons over two decades from 1998-99 to 2017-18. Five year moving average trend lines are also provided. Excluded from the data is self-consumption of PV electricity as this does not enter the grid or wholesale market.

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<sup>21</sup> Crikey (2017) *How aggregated demand response could reduce cost impact of electricity price spikes*, <https://www.crikey.com.au/2017/07/14/how-aggregated-demand-response-could-reduce-cost-impact-of-electricity-price-spikes/>

**Figure 2: NSW Peak Wholesale Electricity Consumption**



Source: Australian Energy Regulator (2019)

The key trends are first, the steep increase in both winter and summer peak consumption from beginning of the series for most of the decade followed by a significant trend decline. Winter consumption peaked in 2007-09 at 14.3 GW and tracked down to stabilise at around 12.1 GW. This is a fall of around 15%. Summer consumption peaked in 2010/11 at 14.7 GW and fell to 13 GW at the end of the series. This is a decline of 12%.<sup>22</sup> Clearly there is considerable variation in the data but the trend in the second decade of the 2000s is one of sustained decline in the level of peak seasonal consumption but it is too early to tell if this level or rate of decline can be sustained.

Offsetting the efficiency gains and increased use of non-grid power, which account for the reduced level of peak consumption, are factors such as increased population level and likely increase in electricity intensive devices such as electric vehicles. On the other hand there is also the trend in electric vehicles to give them ‘bi-directional’ flows

<sup>22</sup> This summer peak decline over the last decade is all the more remarkable as this was a period of sustained above average summer temperatures in NSW. Similarly, since 1998 in NSW every year has had winter temperatures higher than the long run average (Bureau of Meteorology 2019).



so that vehicle batteries can also supply a residence for self-consumption during peak periods or when PV is not working (AEMO 2018: 38).

There is thus some uncertainty regarding trends in future residential peak consumption. Official peak demand forecasts from AEMO (2018a: 46) for NSW show peak summer and winter demand below that already observed in the first decade of the 2000s and not reaching similar levels until 2038. This is under the 'neutral' scenario which assumes a continuation of recent trends regarding factors such as population and economic growth and uptake of PV.

# Conclusion

We conclude this paper by pointing out that while retail suppliers have chosen to introduce ToU pricing they appear to have also taken the opportunity to increase the profit they extract from households who fail to seek out better deals or who cannot make very large changes in their pattern of use.

The highly probable mandated future extension of smart meters and ToU pricing will impose an additional financial burden on households and especially low-income households that cannot make the necessarily expensive adaptations to significantly modify the volume or time of electricity use. (These adaptations will be expensive since it can reasonably be assumed that these households have already taken the least cost behavioural changes to adaptation in response to unprecedented increases in electricity price that occurred over the last decade). The average family of four is likely to be worse off by \$429 with a 19% increase in their electricity bill unless they opt out of ToU pricing. Even if households manage to substantially change their pattern of electricity usage it will be very hard to avoid some additional costs. For example, the above four person household will still be \$231 or 10 % worse off even if they manage to switch 30 per cent of their peak usage to shoulder pricing.

It is also concluded that, at least over the medium term, given past and projected trends in peak wholesale electricity volumes, there is no sound justification for the large increase to both peak pricing and the daily supply charge. Further, even accepting the need to deal with peak congestion in future years, other methods should have been detailed and evaluated by regulated electricity entities and by the regulator, the AER. If current rules do not allow the regulator to consider alternatives to simply increasing prices to moderate peak congestion, then the regulatory rules must be reviewed.

## Appendix 1. ToU Modelling Assumptions

1. There are two tariff types, ToU and flat rate. The latter has just peak and off peak.
2. Neither household has solar PV and/or battery.
3. The daily pattern of use was based on the earlier Canstar (2017) study of electricity prices which assumed households use '30% of their energy during off-peak times...remaining usage is split between shoulder periods (30%) and peak periods (40%)'. (This pattern of use is similar to the recent NSW Independent Pricing and Regulatory Tribunal (2018: 46) study which assumed '20% and 35% for the average and high peak usage').
4. Based on a of major retailer's offer it was assumed that ToU peak prices only applied on working days with the pattern of use described above being applied. On weekends when peak rates do not apply a ratio of 70% shoulder and 30 % off peak was applied. To distribute this usage through the year (365 days) in NSW there were 252 working days with 104 weekend days and 9 public holidays.
5. Consistent with the national policy shift to 'cost reflective pricing' NSW electricity retailers have significantly increased peak electricity rates. Tables A and B show the cents per kilowatt hour and daily supply charges for ToU and flat rate from a large representative retailer.

**Table A: Representative Retailer ToU Pricing\***

	ToU Pricing c/kWh			Daily Supply Charge
	Peak	Shoulder	Off- peak	Cents
<b>Working days</b>	58.311	26.169	15.862	106.535
<b>Weekend/Public Holidays</b>		26.169	15.862	106.535

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\*(Excludes discounts but includes GST)

**Table B Representative Retailer Flat Rate Pricing\***

	Flat rate Pricing c/kWh		Daily Supply Charge
	Peak	Off- peak**	Cents
<b>Working days</b>	31.372	15.862	91.729
<b>Weekend/Public Holidays</b>	31.372	15.862	91.729

The Australia Institute  
Research that matters.

\*(Excludes discounts but includes GST \*\* Under flat rate pricing off peak is formally known as Controlled Load 1 (CL1) and is used primarily for hot water storage heating. The CL1 rate is actually somewhat cheaper, by about 2 c/kWh,

than the off- peak but to simplify the tables and aid comparisons the off peak rate was used.

6. Annual household electricity consumption data was derived from the Australian Energy Regulator, (<https://www.energymadeeasy.gov.au/benchmark>). This shows usage benchmarks by post code. The benchmark selected excluded pool, gas mains and gas heating at the residence. The Parramatta post code was selected with calculations using benchmarks for 1 and 4 person households. The 1 person household at this post code used 3997 kWh p.a. and the 4 person household 7184 kWh p.a.

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