Improving the utilisation of network assets and the affordability of electricity for customers is the challenge ahead for distributors.

Electricity costs have risen steadily in recent years. A contributing factor to these increases is growth in electricity demand at peak times, which was strong over the period 2001 to 2006, but has stabilised in recent years. In proportional terms, demand has increased significantly more than energy consumption. This is illustrated for South East Queensland in Figure 1.

Household consumption accounts for less than one-third of total electricity use but has important implications for peak demand mainly owing to the growth of residential air conditioning.

Demand management is one of the mechanisms being used to address this challenge.

Demand management involves using price and non-price measures to reduce customers’ use of electricity during peak demand periods. Currently there are over one million customers, both residential and business, participating in Energex and Ergon Energy’s long running hot water load control programs. Other active residential demand management initiatives include pool pump and air conditioning load control programs.

A number of international and national studies have identified that time varying tariffs can be an effective tool in managing electricity demand at peak times. However, the question remained, were these findings applicable to the Queensland situation? Would someone experiencing winter in Toowoomba respond in the same way as someone living through the tropical Cairns summer?

**KEY FINDINGS**

- Participants reduced their usage during peak periods by an average of 19% on event days, with a slightly weaker response on the second day of consecutive events.
- Trial tariffs provided reductions of around 0.2kW to 0.4kW per household. These reductions were in addition to those achieved from load control via retail economy tariffs.
- Participants did a range of activities to respond on event days - they were generally more careful about their electricity use and commonly shifted consumption to after 8pm.
- Reductions came from households of all demographics, incomes and energy consumption bands.
- Response to time-of-use under the Consumption tariff was small - the greatest increase in proportion of night time use was 4% in Cairns.
- The majority (89%) of Participants reported an understanding of peak demand, and a small reduction (1.8%) in peak period usage was observed even on non-event days.
- Most participants easily understood the tariffs and favoured state-wide implementation.

**FIGURE 1: SOUTH EAST QUEENSLAND PEAK DEMAND GROWTH (ENERGEX)**

![Figure 1: South East Queensland Peak Demand Growth (Energex)](image)
To find out, Energex and Ergon Energy conducted the most comprehensive tariff trial in Queensland. Commencing in January 2011 and running for 27 months, around 3,700 households in three different climate zones volunteered to be involved in the Reward Based Tariff (RBT) trial (refer to Figure 2).

2.1 Objectives of the trial

The RBT trial had five core objectives:

1. Create community awareness and discussion around alternate electricity pricing models.
2. Improve understanding of customer attitudes towards alternate electricity pricing models.
3. Understand the actions taken by participants in response to the alternate price signals.
4. Use trial findings to guide Queensland distribution network policy development regarding further network pricing models.
5. Estimate the network benefits that can be attributed to new models.

This report meets the first four objectives. The analysis required to meet the last objective is outside the scope of this report.
2.2 Trial design

To ensure confidence in the trial findings, expert resources were consulted for both the trial design and statistical analysis. Queensland University of Technology (QUT) was engaged to provide the experimental design for the project, ensuring internal and external validity of results. Deloitte was engaged to provide advice on the appropriate statistical analysis as well as verification of the results reported.

At commencement, a total of 3,104 households were enrolled in the trial. Additionally 611 households were used a Control group.

For the trial, households across the regions were randomly allocated to three groups, the Consumption group, the Capacity group and Control group. The trial locations were chosen to represent the more extreme climate zones in Queensland and households were recruited to ensure the trial sample was representative of the general population. In this report the Consumption and Capacity group collectively are referred to as participants.

2.3 Consumption group

The Consumption group trialled a combination time-of-use (TOU) and dynamic peak pricing (DPP) tariff that consisted of a day rate, a 20% cheaper night rate and a peak rate. The day rate was the same as the default residential tariff. The peak rate only applied on event days. On event days, the peak rate applied if their electricity usage exceeded a threshold during the 4pm-8pm period. Three different peak rates were trialled. These ranged from 5 to 8 times the usual electricity rate. Refer to Figure 3.

The group started the year with a performance bonus of $75 that was increased to a maximum of $125 or decreased to a minimum of $25, depending on their performance against the trial tariffs.

The DPP rate that applied beyond the threshold varied as follows:

- **2 tier high** – Each hour where the total hourly consumption exceeds 2.7kWh is charged at 8 times the Tariff 11 rate.
- **3 tier high** – Each hour where the total hourly consumption exceeds 2.7kWh is charged at 5 times the Tariff 11 rate, or 8 times the tariff rate if hourly consumption exceeds 4.5kWh.
2.4 Capacity group

The Capacity group was asked to limit consumption below a threshold between 4pm-8pm on event days. At all other times the default residential tariff applied. The group started the year with a performance bonus of $75 that was progressively reduced (to a minimum of $25) if they exceeded the threshold on an event day. Refer to Figure 4.

**FIGURE 4: CAPACITY TARIFF STRUCTURE**

---

**Capacity tariff**

In the first period after Kate entered the RBT trial, there was one event day. On this day Kate’s consumption between 4pm-8pm exceeded the threshold of 4.5kWh for two of the four hours. Her performance incentive at the end of the period is calculated as:

\[
$75 - (2.50 \times 2 \text{ hours}) = $70
\]

---

“ON PEAK DAYS WE’VE COME IN UNDER THE LIMIT BY CHANGING OUR HABITS.”
2.5 Control group

Control groups were enrolled in each region to provide a benchmark to compare the response from the Consumption and Capacity groups. Following installation of the meter and payment of their sign-on incentive no further contact was made with these households during the trial.

2.6 Trial operation

Remotely read advanced electronic meters were installed in all homes. These installations were required as interval meters for residential customers are not commonly used in the Queensland market. Participants were issued with trial performance statements throughout the year to help them track their usage, and a performance cheque was given at the end of each year. Refer to Image 2. The value of the performance cheque varied based on their performance against the trial tariffs. These were issued separately to their normal electricity bill which was issued by their electricity retailer.

A survey was conducted at the end of the first and second year of the trial. The survey provided insights into what participants did as well as their perceptions and attitudes towards the trial tariffs. A 92% response rate was achieved for both years of the survey. Payment of the end of year performance bonus was dependent on completion of the survey.

2.7 Data analysis

During the trial, to see how people responded, the meter readings of the Control group, Consumption group and Capacity group were compared. Data analysis was undertaken using interval consumption data, weather data and survey data. Refer to Figure 5.

Analysis was only conducted on those households that completed the entire trial and for which there was a complete demographic dataset (2,228 households). The trial analysed consumption on the default residential retail tariff (Tariff 11) only, and did not look at consumption on retail controlled load tariffs (Tariff 31, 33). Households with solar photovoltaic (PV) systems and customers with a medical condition that required the use of life support equipment were excluded from the trial.

**Figure 5: Data Sources for Analysis**

A range of statistical tests and analytical methods were used to determine participants’ response and how this varied with weather, demographic attributes and location. The response of trial participants was measured as the difference between the average participant group usage between 4pm-8pm to that of the Control group on event days.

In order to make statistically meaningful comparisons between the participant and Control groups, tests were undertaken to ensure that there were no statistically significant differences between Control and participant group pre-trial annual consumption. The average load profiles of participant and Control groups on non-event days were also compared and found to be similar.

The objective during trial enrolment was to recruit Control and participant groups that were similar to the broader Queensland population. This was largely achieved, however there was a slight over-representation of detached dwellings and home owners. At the end of the trial there were some differences between participant and Control group demographics. As a result, these results should not be interpreted as being representative of the broader Queensland population. However, it should be noted that the trial was designed, so that if desired, the results could be extrapolated to other target populations. In such a case, this analysis would need to account for differences between the participant groups and proposed target population demographics.

1 During the trial, 1454 households exited the trial. 39% were due to solar PV being installed and 45% were due to change of occupants.
3. Key findings

Overall the trial found that households were willing and able to change their behaviour in response to the trial tariffs.

Both the survey responses and energy consumption data show participants across all three regions reduced their consumption during peak times on event days. Very few participants (15%) reported they “did nothing differently” on event days.

With the exception of the Brisbane Capacity group, reductions of 17% to 23% were achieved when comparing average energy use between 4pm-8pm on event days to that of the Control group (refer to Table 1). These findings are consistent with other Australian tariff trials which found average reductions in peak demand were between 13% and 40%.²

<table>
<thead>
<tr>
<th>Trial group</th>
<th>No. of event days</th>
<th>Mean 4pm-8pm reduction¹ (%</th>
<th>kWh / hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brisbane</td>
<td>36</td>
<td>20</td>
<td>0.24</td>
</tr>
<tr>
<td>Cairns</td>
<td>37</td>
<td>17</td>
<td>0.24</td>
</tr>
<tr>
<td>Toowoomba</td>
<td>36</td>
<td>17</td>
<td>0.21</td>
</tr>
<tr>
<td>Capacity group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brisbane</td>
<td>36</td>
<td>8</td>
<td>0.10</td>
</tr>
<tr>
<td>Cairns</td>
<td>37</td>
<td>21</td>
<td>0.29</td>
</tr>
<tr>
<td>Toowoomba</td>
<td>36</td>
<td>23</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Notes:
¹ when compared to the Control group 4pm-8pm usage in their region
All results are statistically significant (p<0.01) unless otherwise noted

The majority of participants reported that there was “nothing” preventing them from responding on event days.

Of those surveyed 71% found it easy to respond on event days, 21% were neutral and 8% found it difficult. Participants engaged in a range of behaviours on event days and these actions were similar between year 1 and year 2 of the trial (refer to Figure 6).

A mix of customers were able to respond.

Generally, all participants within all energy consumption and income bands responded to price signals on event days. Those participants in low income and low annual energy consumption groups demonstrated they were able to reduce their consumption during peak times. In some cases, they achieved the greatest kilowatt reductions of all groups.

Trial tariffs have demand management potential.

Trial tariffs provided reductions of around 0.2kW to 0.4kW per household during times of highest network demand. Participants’ responses to the tariffs remained consistent over the life of the trial. On consecutive event days there was a small fatigue effect with participants’ second day response being 7% to 8% less than their first day response.

The trial tariffs were found to be complementary to load control and alternative energy sources (eg gas). While over half of participants were connected to regulated economy tariffs (Tariff 31, Tariff 33), they were still able to reduce their general usage (Tariff 11) during peak times on event days. Toowoomba participants also achieved significant reductions during peak times (19% to 26%) on winter event days compared to their Control group, despite the majority being connected to gas (an alternate heating source).

Participants understood the tariffs and peak demand.

The majority of participants found the trial tariffs easy to understand (75%) and easy to implement (71%), despite minimal education and information being provided as part of the trial. Trial participants had a good understanding of peak demand, with 89% claiming to know what the term meant.

The vast majority of participants (70%) supported implementation of trial tariffs throughout Queensland and 20% were neutral. Only 10% of participants opposed the implementation of the tariffs. Perceived financial benefit was closely related to support for the tariff, with 91% of those participants who believed they would be better off, supporting implementation.

“WE HAD A BBQ INSTEAD OF USING THE OVEN.”

“I THINK THAT THE IMPLEMENTATION OF THE TARIFF WOULD CHANGE THE WAY QUEENSLANDERS USE ELECTRICITY”
4. Tariff design insights

4.1 Consumption tariff

Consumption participants reduced their peak period energy use by 17% to 20% on event days in response to DPP pricing. This can be seen as the divergence between the ‘event days’ load profile of the Consumption group and Control group between 4pm-8pm (refer to Figures 7 to 9). The higher pricing variations had the highest response ranging from 16% to 26%.

TOU pricing had very little effect in shifting usage with the exception of Cairns, where participants increased their proportion of night usage by 4%. This is consistent with other Australian studies that found that the extent of response depends on the strength of the price signal and customers’ ability to adapt. These studies found that ‘flatter’ TOU pricing resulted in a quarter of the response found from critical peak pricing.3

Around half of Cairns participants reported shifting some appliances to after 8pm. The top three appliances they reported shifting were the dishwasher, dryer and washing machine. This can be seen as the increase in the Cairns ‘Consumption, normal days’ load profile after 8pm (refer to Figure 8).

How to read a load profile

Load profiles represent the pattern of electricity usage over a day. The profiles are based on ½ hourly meter reads (kWh). Energy consumed over one hour can be determined by adding two consecutive ½ hourly readings.

---

3 Australian Productivity Commission, 2013, Electricity Network Regulation: Peak Demand & Demand Management, pp 356.
4.2 Capacity tariff

Capacity participants reduced their peak period energy use by 8% to 23% on event days. This can be seen as the divergence between the ‘event days’ load profiles of the Capacity group and Control group between 4pm-8pm (refer to Figures 10 to 12).

The Brisbane Capacity group had the highest proportion of participants reporting they had not changed their usage on event days as they knew their usage was below the threshold. This may explain the smaller response from this group.

4.3 Energy conservation

The majority (91%) of participants believed the trial made them more aware of their electricity. An average 1.8% reduction was found when comparing participants’ energy consumption on non-event days to that of the Control group. This reduction predominantly occurred between 4pm-8pm (refer to normal day load profiles of Figures 7-12). This ‘conservation effect’ is comparable to findings from other studies which found reductions of 2% to 4%.

4.4 Notification, In-Home-Displays and performance statement frequency

Most participants reported they were satisfied with one day notice before an event day. One difficulty encountered during the trial was event day selection. Event days were selected based on 48 hour weather forecasts and sometimes the weather on the day was milder than predicted.

The presence of In-Home-Displays (IHD) and higher frequency of performance statements did not conclusively result in a greater response. Participants reported finding the IHD useful at the start of the trial, but they soon became redundant. While the majority of participants said they read their performance statements, they did not act as a strong motivator for behavioural change.

5. Conclusions

The trial provided an invaluable source of information and learning on the response, behaviours and attitudes of Queensland residents to dynamic peak pricing, Time of Use and Capacity tariffs. Overall the trial found that participants were willing and able to change their behaviour in response to trial tariffs.

They engaged in a wide range of behaviours on event days to shift their electricity usage outside of peak periods. While findings were generally consistent with other trials, additional in-depth and wide ranging insights were gained. These shed light on and challenge some long held industry views.

It was never intended for the trial tariffs to be rolled out. Rather Energex and Ergon Energy will use trial findings to inform the development of future electricity tariffs and will work in consultation with customers and other affected stakeholders in their implementation. Work is already underway to ensure future residential tariffs allow for the integration of peak pricing and capacity components as well as ensuring price resilient signals continue to be passed to customers.

Work has also commenced on investigating network areas that would benefit from the introduction of these tariff types, provided they could be cost effectively deployed alongside the current suite of demand management products. Trial results will be shared with government and fellow distributors to help improve their understanding of customer attitudes toward alternate electricity pricing models.

ACKNOWLEDGEMENT

Energex and Ergon Energy gratefully acknowledge the role of participants in the RBT trial. We wish to extend our thanks to members of the Control, Consumption and Capacity groups for their contribution to advancing research in time varying tariffs and demand management.

We extend our thanks to all the people in Energex and Ergon Energy that have made this trial possible from metering installation, data management, data analysis tariff design and pricing advice and customer contact centre staff.

We also acknowledge the contribution of the Queensland University of Technology and Deloitte in providing robust, independent advice on the trial design, statistical analysis and verification of results.