International and domestic electricity tariffs and tariff structures
DRAFT

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1 Executive Summary

This report investigates the use of variable electricity tariffs as an incentive to generate demand response. Demand side response describes electricity consumers' propensity to respond to variations in market prices. In particular it looks at the likelihood that the spread of smart meters or advanced metering intelligence will result in any great incentive for demand response being made to residential consumers.

Demand response can take different forms and come from different motivations. For example a consumer might be motivated to behave differently because of a desire to simply be less wasteful, as a contribution to environmental sustainability or in an effort to reduce their costs.

The incentive to change demand for any purpose is signalled through the retail tariff. The composition of that signal can be based on two-step metering arrangements (e.g. night and day rates) or smart time-of-use (TOU) capable two way meters.

In any event, the incentive doesn't automatically come from the meters or any other enablers. It comes from the retailers or the distributors. Retailers and distributors have different commercial drivers. A lines business is most likely to target peak demand through its network charges. The retailer is more likely to target the real time cost of energy required to meet their retail commitments. Neither may be especially motivated commercially to reduce overall consumption

In NZ tariffs are composed by the retailer so it is up to them to decide the extent to which they reflect the network charges to consumers. The breakdown of retail tariffs follows:

Breakdown of retail tariffs	
Energy c/kWh	39%
Lines charges c/kWh	43%
Other c/kWh	18%

A breakdown of retail tariffs shows that 39% of the tariff is energy, 43% is lines charges and 18% is the retailers' fixed costs. In addition we know that the network charge is required by law to have a minimum fixed charge component. This breakdown of retail tariffs illustrates the point that any signalling via tariffs for energy or network charges has to have taken the shape of the other components into account.

International case studies show that the enabler for demand response isn't confined to the metering arrangements. It was also a function of publicity and information. International case studies[1] also show that tariffs can be effective in getting the consumer to act, as demonstrated below:

Aggregated demand elasticity results			
Type of ratio	**Price ratio**	**Load shifting**	**Load shedding**
Peak/off peak	2.83	3.20%	3.67%
Critical peak/peak	2.89	8.15%	4.02%

Smart meters or advanced technology do widen the possibilities in terms of the incentives retailers might signal to consumers to better manage their electricity demand. This is the case whether the retailers are passing on the signals generated by distributors or signals that fit with their own business.

Smart metering technology does provide electricity retailers with a way to significantly reduce operational costs through remote meter reading, more efficient data collection and other actions made possible by remote communication. Commercially this is a sufficient basis for the introduction of smart metering

Survey result in New Zealand indicate that even with smart meters the NZ retailers don't seem especially likely to change the signalling to consumers much in the early years.

There is not indication at all that the consumers will be empowered in terms of receiving more information.

Retail competition has been present in the New Zealand market for a number of years Competition exists in so far as different retailers offer different branded products. From a consumers' perspective though they are offered slight variations on a theme and the costs difference between retailers is not a huge inducement to switch. Evidence is that switching activity is quite passive with most switching takes place in response to being directly approached (door knocking or telemarketing) or by people shifting house.

The extent to which retailers compete may be a function of the way the industry is organised. Retailers are, in fact, vertically integrated generator retailers and they earn their margin predominantly from their wholesale margins as opposed to their retail margin. In addition, the main retailers have very similar business drivers so the incentive to differentiate in a retail competition sense is not great.

[1] See section 5.2

One of the changes that smart meters may herald is more cost reflective tariffs. With the ability to better target tariffs by sculpting the prices to reflect the actual cost of delivery comes the possibility that retailers will compete for the more desirable consumers.

There is scope for greater variation in retail products generally, especially in the area of demand response and particularly with the heightened awareness of a potential link between electricity consumption patterns and climate change. This scope might be greater if competition was more intense.

In New Zealand there is the added awareness amongst consumers here that we are hydro dependent. The public are aware that from time to time supply is cheap and conservation campaigns may be called (such campaigns occurred in 1992, 2001and 2008). Consumers know that current tariffs protect them from price signals during tight supply conditions but they may be susceptible to products that have a critical peak pricing type mechanism in it, for periods of extreme demand.

There is the potential for competition, greater choice and augmented awareness with the arrival of smart meters or advanced technology. There is also the potential that not much changes because retailers continue to decide what information is provided whether it is via the meters or through and other medium. They continue to decide the style of tariffs are offered and whether the signals continued in theme are their signals, the signals that come from distributors or the signals that consumers want to be able to respond to.

If there is a policy response warranted by the lack of demand response in the New Zealand market it would be to consider the nature of the information regime in respect of retail electricity tariffs. . That means information available on the monthly bill, information on the link between consumption and the environment, information on the link between consumption patters and cost and more advanced information on what consumers might do when the system gets tight.

The arrival of smart metering provides an ideal opportunity for policy makers to investigate this possibility.

2 Introduction

LECG have been engaged by the Parliamentary Commissioner for the Environment (PCE) to investigate the use of variable electricity tariffs and smart meters as an incentive to generate demand response. Demand side response describes electricity consumers' propensity to respond to variations in market prices.

From the PCE's perspective demand response has an important role in improving New Zealand's security of supply and emissions reduction. Demand response is also a way that consumers can reduce the cost of their electricity consumption. Whichever motivation is at the fore there must be some incentive or, at the very least, some form of enabler in order to generate a response.

This report focuses on the role of retail tariffs in encouraging or discouraging demand response. It also looks at the role of enablers such as smart meters in eliciting more demand response.

In preparing this report the author has reviewed demand response and the composition of retail tariffs in New Zealand and a number of other jurisdictions,

3 Context for this project

3.1 Demand Response

Changes to residential electricity consumer patterns might be motivated by all or any of:

- Energy efficiency – the desire to be less wasteful
- Climate change – the desire to consume in a way that is more environmentally sustainable
- Cost – the desire to have lower energy charge

These goals might be achieved through

- Changes to the installed appliances, electrical fittings and building practices
- Changes to consumption patterns

Consumers could be encouraged to make these changes by providing

- Incentives
- Information

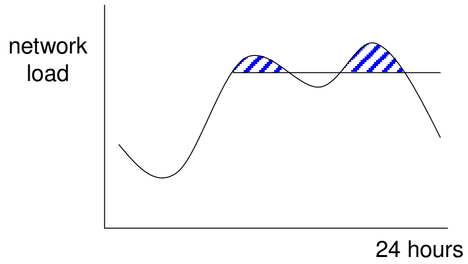
Whatever the motivation there might be for consumer behaviour to change, any change will often contribute to realising all three motivations simultaneously. The question asked by the PCE revolves around the role of electricity tariffs in driving changes in consumer behaviour and the prospect that retailers will change electricity tariffs in a way that would encourage such activity, especially with the adoption of smart metering technology.

There are three main ways that changes in consumption patterns manifest themselves

- Peak lopping – cutting consumption over the demand peaks
- Load shifting – shifting consumption from the peak demand period to the off peak demand period.
- Reduced consumption – consuming less energy throughout the day or consuming less regardless of the time of day

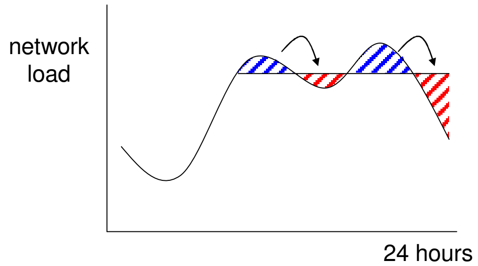
These three primary approaches to demand response on an intraday basis are illustrated below. They can be viewed as individual profiles. However, they also represent collective load shape (aggregated across a specific consumer group). If a significant number of consumers change their behaviour the benefits discussed above may be enjoyed by the whole community.

Peak Lopping



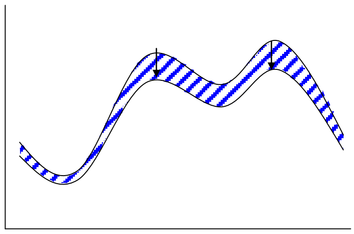
Peak lopping reduces peak demand and reduces overall demand. This has the potential to contribute to lower capacity requirements for infrastructure, if it can be relied on, and lower energy requirements for the day. It will most likely result in lower energy costs for consumers because less is consumed. If it coincides with peak prices it will save retailers or other direct wholesale purchasers purchasing costs. To the extent that removing the peaks reduces the need to run thermal generation (gas or coal) this will also result in CO_2 emissions reductions.

Load shifting



Load shifting like peak lopping reduces the need for generation capacity and transmission capacity if the reduced peak demand is reliable. For consumers or retailers purchasing electricity from the market on an arm's length basis, it will reduce their daily average cost if the peaks coincide with their "peak" prices[2]. This is how load control works. Distributors switch off water heating across the peaks then switch it on again later. The water has to be reheated so there is not much of a net saving in electricity but the peak demand is lowered. CO_2 emissions may or may not be reduced, depending on the generation mix at peak periods relative to off-peak periods.

Load reduction



Reducing demand evenly throughout the day has some of the benefits of cutting or shifting the peaks but adds the reduced requirement for overall energy production. For consumers on tariffs or retailers purchasing form the wholesale market this should result in lower electricity cost for the day. Reducing overall demand in the New Zealand market will reduce thermal running (gas or coal) and thereby reduce CO_2 emissions in most circumstances.

Demand response may also take the form of reduced demand across a season or in response to a campaign driven by security of supply concerns.

3.2 Retail tariffs

Electricity retailers in New Zealand tend to be vertically integrated generator/retailers. That is that they rely on their earnings from a wholesale margin on their production as much as they rely on a retail margin above that. Commitments to supply a retail customer base serve to stabilise the price the energy companies receive as much as they provide a retail margin. The wholesale price on which the retail margin is added includes a margin for the risk that the generator is taking. Principally the risk is that they over commit to the retail side and face having to buy from the wholesale market to meet

[2] For a consumer this will depend on the style of tariff. If it is time dependent and prices line up where energy is taken from and to it will result in lower overall cost. Similarly, for purchasers exposed to spot it will lower the cost of electricity if the shift coincides with the pattern of spot prices in the day.

those commitments at a time when prices are acutely high. In this section, where we refer to retailers we mean vertically integrated generator/retailers.

Tariffs offered by electricity retailers tend to be:

- single rate tariffs: or
- controlled tariff, or
- day night tariff.

In any event the residential tariff includes energy cost, lines charges, metering costs, retail operating costs, and a return on retail assets

Network charges include transmission charges. The network companies calculate their charge on quite a different basis than the retailer computes the energy component. Essentially it is based on the consumers' contribution to network peaks as that is what capital expenditure is based on.

The retailer adds a charge that includes allowance for the raw estimated energy cost, the load factor of the generator/retailer's retail portfolio, location factors for generation sources, ancillary services and levies. The energy cost, in turn, includes the hedging, risk management and transaction costs have to be added to that to get the full energy cost. Clearly this component is calculated with quite different drivers in mind to the network component.

The consumer only sees the bundled electricity tariff. I.e. none of these component parts is broken down in their retail tariff.

In section 6 these figures are detailed as part of a discussion around the link between demand response and retail tariffs in New Zealand.

Also in section 6, the prospect of tariffs being more shaped or sculpted is discussed. The underlying proposition is that higher prices in one part of the day and lower tariffs in another part of the day would encourage consumers to shift consumption from one time period to the other. This is borne out by our study of other markets and the evidence from the case studies

Sculpted tariffs would still be set having taken into account the risks the retailer faces of having to buy from the pool if they were unable to cover their commitment and had to go to the spot market when prices were high. The difference is that this assessment has to be made for each of the time zones offered in the sculpted tariff.

Questions also remain about the propensity for consumers to shift consumption around and the incentives on retailers or distributors to encourage less over all consumption.

Leaving those questions aside, clearly the potential introduction of metering technology capable of capturing consumption data by time period raises the very real possibility that tariffs will be able to be more sculpted. This heralds the possibilities that tariffs become more targeted at specific consumers by region or consumption type. That also raises the possibility of greater competition in some sectors, possibly in all sectors.

This paper addresses all of these issues. It considers these issues from the perspective of what it is possible to achieve and what might be done to improve the chance of these goals being achieved.

3.3 Metering and other enablers

If consumers are to change their demand patterns, as discussed in section 3.1, they require some key information. The main piece of information required is an understanding of the relationship between the pattern of their consumption and the cost to them. This requires information on the pattern of prices[3]. As discussed in the previous section the prices seen by consumers are domestic tariffs as opposed to the wholesale spot prices the retailer sees.

Metering

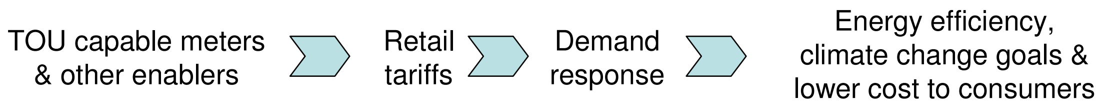
For the purpose of this report the following table demonstrates the four broad types of meters used for electricity. It groups common terms for these four meter types and explains the typical tariff structure and demand response possible from the use of these meters, as well as their relevance to this project.

Table 1 Electricity meter types and their corresponding tariff structures and demand response mechanisms

Type of meter	Tariff structure	Demand response	Relevance to project
Cumulative meter	Single rate or split rate i.e. fixed and variable	Demand response is achievable by raising prices and reducing demand	Cumulative meters are the status quo in New Zealand
Separate meter **Dedicated circuits**	Two rates or discount for people who take it up	Mainly load control on hot water/air con, overnight heaters.	Separate meters or dedicated circuits allow for differentiated tariffs but the tool for differentiating is very blunt and therefore the consumer's role is relatively passive
Time of use (TOU) meter **Interval meter**	Direct exposure to spot or fixed prices up to 48 time periods in a day	Tends to be larger consumers i.e. not residential	TOU meters typically used for commercial customers, TOU capability is the key for advances in retail tariffs
Smart meter **Advanced meter** **Intelligent meter**	May be as per TOU. Residential consumers will be offered sculpted tariffs	A useful but not a minimum condition for encouragement of residential demand response	Smart/advanced/intelligent meters will provide the ability for TOU sculpting of prices and improved communications

[3] Other information that might assist consumers to better understand the impact of their consumption patterns includes distribution charges as opposed to simply the retailers charge. That, in turn, includes energy, metering and the cost to serve.

The relationship between retail tariffs, demand response and the wider context is illustrated below:



This diagram shows that the relationship being discussed here is more than just the relationship between tariffs and demand response. Demand response has several different forms as discussed earlier. The enabler of metering arrangement is also a key variable.

For the purpose of this paper we are especially interested in the arrival of smart meters or advanced metering infrastructure. The key elements of that technology in this context are the TOU capability and the ability to send other communications to consumers. The issue of the specifications and capability of the metering technology is the subject of another paper. However, a mandated roll out of smart meters is underway and the following passages are a useful description o one jurisdictions' definition of what they are and what they should be capable of.

Smart meters or advanced metering infrastructure

Advanced Metering Infrastructure (AMI) is made up of two key components:

- A meter that is able to measure electricity usage by time of use (e.g. half hour intervals); and
- A communications infrastructure, that provides remote or local monitoring and control of the meter.

Each component can vary in terms of its functionality and therefore the type of activities that the AMI supports.

Application

The introduction of "smart meters" may prove to be a significant step forward in unlocking the benefits of demand response. They provide retailers the ability to measure consumption by half hour. That means they can construct tariffs that differentiate the price to consumers by time period up to 48 half hour periods in a day.

This doesn't remove the issues of accounting for all costs and estimating the energy price for the time period. It just means that they can be more precise. It also means they can use price differentiation by time period to send signals to consumers. Tariff prices are still fixed prices for the time periods chosen so the risk of volatility in the wholesale market remains with the retailer. The outcome is that smart meters will allow retailers to offer sculpted tariffs

Initially the main change to retail pricing smart meters will facilitate will probably be peak periods, off peak periods, possibly a shoulder period will be defined and in some markets a critical peak pricing (CPP) mechanism. Prices set would reflect periods where an incentive to reduce consumption is required and a message of a preferable time to have intense electricity consumption signalled.

Currently many network businesses sculpt their network charges in an attempt to send a signal through to consumers. For consumers with accumulation meters and fixed tariffs these are not necessarily reflected so the signal is lost. The introduction of TOU capable meters will enable retailers to reflect these charges on to all consumers.

The intra day sculpted fixed price tariffs may be varied over time. They may be set differently for different seasons of the year. Smart meters (further described in the next section) might communicate the electricity tariff and any changes via an in-house display but that is not a pre requisite for their introduction.

What may also develop is an offering of a floating rate type tariff. Here the consumer might elect to have tariffs at part of the day or right across the day move periodically to reflect spot market conditions. It may result in an offering whereby residential consumers could elect to be exposed to the full and direct wholesale spot price. There is no indication that this will necessarily eventuate.

Based on evidence from other markets the CPP mechanism is likely to be an early innovation. Whether an in-house display is used or some other medium like newspaper, radio, SMS messaging or the internet the presence of CPP could be signalled so consumers on the differentiated tariffs could take action. Smart meters enable any response to be properly measured and rewarded.

However, it should be noted that meters and other enablers are not a sufficient condition for demand response. Simply providing a consumer with a smart meter and a varying electricity tariff does not mean that consumers will adjust their demand for electricity. For example, a consumer's demand for electricity is relatively inelastic because it is an essential good. This limits the changes to consumer's behaviour that might result from adjustments in prices.

3.4 Tariff and consumer-oriented benefits and opportunities

The table below looks at some of the benefits and opportunities that smart meters or advanced metering technology might herald in terms of demand response. This table is indicative as this is the subject of separate and full reports to the PCE.

None of these benefits are guaranteed by the introduction of this technology. Sculpted tariffs are likely but indications are that New Zealand generator/retailers are introducing the technology based on operational gains. Those are considered in the following section.

Table 2 Consumer-oriented benefits and opportunities			
BENEFITS & OPPORTUNITIES	**Retailer**	**Distributor**	**Consumers**
Time sculpted tariffs	Signal real cost of consumption Signal CPP	Time specific congestion charging	Basis for demand response. Possibly greater competition Financial incentives Future innovations
In home display	Communicate price and other information (weather for example)	Line status advice	Immediate information on consumption and cost. Information on emissions implications of consumption Other product information
Lower barrier to competition	Consumers better able to appreciate their true cost	Consumers better able to appreciate their true cost	Downward cost pressure
Reduce cross subsidisation	Ability to target desirable consumer sectors	Ability to target peaky consumers	Tariffs that reflect the true cost of consumption may encourage cherry picking of consumer sectors
Load control	Manage energy costs	Greater detail and control Ensure load control signals received	The value of the service more clear
Control of all appliances	Enhanced energy cost management	Access to more load control	Greater control, greater choice and possibly greater competition
Micro Distributed Generation	Better monitoring	Better monitoring	Greater visibility on net load

3.5 Operational improvements to existing process

As raised previously the business case for smart meters may come from a completely parallel set of benefits. These may not necessarily be passed on the consumer although in a competitive market one would expect that they would be once the cost of the meters had been accounted for.

Table 3 Operational benefits to parties

BENEFITS & OPPORTUNITIES	Retailer	Distributor	Consumers
Remote meter reading	Regular and accurate readings No estimates – greater revenue certainty	Outage detection & isolation	Regular and accurate readings Bills based on metered data rather than estimates that require correcting Possibly choose when billed
Efficient data collection	Fewer errors, improved settlements. Better able to optimise contractual positions	Greater certainty over network activity	More accurate bills
Two way communication	Ability to send signals as well as receiving data Potential to communicate with appliances	Ability to send signals and other information to consumers or appliances directly. Also receive data	Improved service More services
Remote disconnect/reconnect	Limited use	Restoration confirmation	Better customer service on fault detection and restoration
Remote meter reconfiguration	Ability to change product offering	Local QOS monitoring	Greater choice possible
Reduced non-technical losses	Reduce theft, fraud and vacant premise consumption		
Cost to serve	Reduced cost to serve		Retailers may pass through reduced cost to serve
Network reliability and asset loading	Better customer service	Outage monitoring Optimisation of network Identify points of failure Identify voltage limits Manage network losses Monitor meter tampering	Better service from retailers and distributors Reduced line charges may be passed on

4 The demand response promise

Regulators in a number of markets are enthused by the possibilities that smart meters afford in terms of demand response. Our finding is that smart meters are an enabler and that they do not of themselves result in demand response. For that to occur there has to be some communication and some incentive. As discussed earlier that may not necessarily require a smart meter but it is clearly easier and more likely to happen with smart meters in place.

The Electricity Commission (Commission) has released an Advanced Metering Policy[4] that sets out the promise of smart meters or advanced metering technology. The Commission "views Advanced Meter Infrastructure (AMI) systems as an important enabler to further the Government Policy Statement on Electricity Governance ((GPS), see paragraph 3.2.1)). In particular, AMI systems have the potential to significantly increase demand-side participation in the electricity market."

"The limitations imposed by earlier generations of non-communicating meters are expected to progressively disappear with the spread of AMI systems. This potentially ***opens the way***[5] to demand-side participation in the electricity market. By providing more cost reflective pricing options, supply side industry participants ***will be able*** to effectively empower much larger numbers of electricity users and assist them to make more informed purchasing decisions closer to real time. This, in turn, has ***the potential*** to moderate consumption during periods of high demand, leading to continuing downward pressure on generation, transmission and distribution costs. In addition, savings can be achieved through remote meter reading, enhanced data management and remote disconnection and connection of vacant premises."

Smart meters or AMI do not provide information to consumers. Smart meters mean that more information is collected. Retailers decide what information will be made available to consumers, they decide how that information will be made available to them and they determine the construction of the tariffs. The Commission's comments reflect this fact.

The amount and form that information is provided could change with smart meters. The level of information made available may be driven by the wishes of consumers or by the level of competition in the retail electricity market. . It is beyond the scope of this paper to comment on the level of competition in electricity retailing New Zealand except to observe that the companies operating as electricity retailers are all vertically integrated and have broadly similar business drivers. They offer slight variations of a similar product. It remains to be seen whether those organisations differentiate their offering much with the addition of smart meters.

For competition to flourish it is reasonable to assume that consumers need access to a full array of information around the impact of their electricity consumption. It may also

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[4] Electricity Commission, Advanced Metering Policy May 2008
http://www.electricitycommission.govt.nz/pdfs/opdev/retail/ami/Advanced-metering-policy.pdf

[5] Emphasis added

require competing retailers to be able to see information on a target consumer's consumption pattern. Better still, for consumers to gain access to tariffs that encourage demand response they might behave a say in the design of the tariff structure.

The introduction of smart meters will create an environment where all of this information is created. If competition in electricity retailing is desirable the benefit of "empowering large numbers of consumers' may outweigh the cost. Waterman[6] observes that in industries like energy and telecommunications, policies are demonstrably required in order that such markets do indeed become competitive.

Based on the studies discussed in section 5 and the answers received from New Zealand retailers, the promise of consumers doing something different may not even appear in the rationale of a retailer or the meter supplier wishing to install smart meters. The business case for introducing smart meters tends to be based more on remote billing, outage observation, more accurate data and the ability for two way communications.

5 International electricity tariffs and tariff structures

We looked at a number of jurisdictions to determine how their tariffs were structured.

- Australia: New South Wales, Victoria
- Canada: Alberta, Ontario
- Italy
- Sweden
- UK

5.1 Survey of jurisdictions

New South Wales, Australia

In New South Wales, population 7 million with 8.6 people per km^2, 70% of all customers are on regulated tariffs. These tariffs are regulated by the Independent Pricing and Regulatory Tribunal (IPART), who set retail tariffs in the absence of a negotiated

[6] Michael Waterson, Department of Economics, University of Warwick *The role of consumers in competition and competition policy* accepted for the International Journal of Industrial Organization April 2002

contract with a retailer (the three large retail-distributors are Country Energy, Energy Australia and Integral). Transmission and distribution charges are also both regulated.

Generation in NSW depends heavily on the burning of coal, with this source providing around 90% of all electricity.

IPART are involved with encouraging demand management through allowing NSW distributors to recover the costs of implementing approved tariff and non-tariff based demand management measures through an increase in the weighted average price cap.

Increasingly, time-of-use and smart meters are being adopted in NSW. For example, the retailer and distributor Energy Australia have 160,000 smart meters with variable tariffs depending on the time of day that energy is consumed (peak, shoulder, off-peak). Country Energy and Integral have also either undertaken or are currently undertaking smaller scale pilots with smart meters and variable tariffs.

Victoria, Australia

Victoria has a population of greater than 5 million at 22.92 people per km^2.

60% of consumers in Victoria are on competitive electricity contracts, with a choice of approximately 12 different retailers. In the absence of such a contract, 'nominated' retailers (AGL, Origin Energy, or TRUenergy) offer electricity at fixed tariffs. The Victorian Government has reserve powers to regulate retail prices for electricity customers consuming less than 160MWh/year.

Currently, most Victorian electricity supply points are metered with electro-mechanical accumulation meters that only record total consumption and are subject to manual reading every three months. These accumulation meters are owned by the distributors.

If a customer has a two-rate meter or a dedicated circuit meter (e.g. hot water cupboard) than there is a differentiation between 'peak' and 'off-peak' charges. However, for most customers in Victoria, there is no such distinction made.

There are plans starting at the end of 2008 for more than 2.5 million new smart meters to be installed over a 4 year period. This rollout is mandated by the Essential Services Commission.

Like NSW, generation in Victoria depends heavily on the burning of coal, with this source providing around 90% of all electricity.

Alberta, Canada

Alberta has a population of around 3.5 million at 5.38 people per square kilometre. The electricity generation mix is strongly weighted towards thermal generation, at around 90%, although hydro is also relatively important.

In Alberta, the distinction is made between 'competitive providers' and 'regulated rate providers'. If a consumer does not choose a provider, of which there are approximately seven options, then they are allocated their local regulated rate provider (City of

Lethbridge Utilites, EPCOR, Direct Energy and ENMAX). EPCOR and ENMAX dominate the Alberta market with around 70% of consumers combined.

Long fixed term rates are often used and have come about since deregulation in 2001. For example, Enmax has 72% of customers on 5 year plans, 10% on one year and 18% on floating plans. Floating plans are set in the same manner as regulated rate plans and are currently comprised of 40% monthly market prices and 60% long-term prices (increasing to 100% monthly market prices by 2010).

Meters are owned by retailers and any smart metering initiatives are their responsibility. For example, ENMAX has plans to implement smart meters over the next few years as a priority, while EPCOR has no plan to implement smart meters at this stage.

Ontario, Canada

Ontario has a population of around 14 million with 13.9 people per square kilometre.

Generation is 50% nuclear, 22% coal and gas and 22% hydro, with the remainder being made up of other renewable sources, which the Ontario Government are committed to increasing. The marginal generation units are usually hydro, coal or gas.

Ontario is a relatively advanced jurisdiction in terms of smart meter usage and variable tariff structures. By the end of 2007, over one million smart meters had been rolled out for Ontario residential customers. These meters are owned and operated by the distribution companies, unless a consumer has made provisions to procure their own meter.

Competing retailers, of which there are several, offer contracts to residential customers, but tariffs are set by the Ontario Energy Board. The prices are reviewed every six months and are based on three tiers: on peak, off peak and mid peak. Residential customers not on a smart meter plan pay a rate between the mid peak and off peak rates.

Italy

The population of the country is approximately 60 million, with a density of 196.9 people per square kilometre.

Italy is a world leader in the adoption of smart meters and associated variable tariffs. The 'Telegestore' project has seen 23 million smart meters installed since 2003. The project was undertaken by Enel, a former vertically integrated monopoly that still dominates the market in generation, distribution and retailing, despite the gradual introduction of retail competition, and was funded by the Italian government.

Companies must offer a 'base tariff' to consumers and may also offer their customers other tariff options. Both base tariffs and alternative tariff options are subject to the regulator's (Autorità per l'energia elettrica e il gas) approval. Alternative options to the base tariff include tariffs differentiated by time (peak, high, medium, off-peak) according to a customer's meter's ability. Furthermore, retailers must comply with the EU's 'White Certificate Scheme' to encourage energy savings.

Approximately 16% of generation in Italy is from renewable sources.

Sweden

The population of Sweden is 9 million, with a density of 20 people per square kilometre.

Generation is approximately 49% renewable, while emergency reserves are generally non-renewable.

Sweden has a competitive retail market for electricity where electricity prices are not regulated, although the regulatory body Energy Markets Inspectorate (EI) does follow general pricing developments. The three large retailers with market shares over 5% are Vattenfall, E.ON and Fortum, whose combined share is around 50% of the market. Other elements that comprise the retail electricity price, such as network charges, are regulated.

Current pricing options include fixed prices over periods ranging from 3 months to 3 years. Variable tariffs also exist, which vary with the time of the year, amount of rain and water reservoir levels, winter cold, amount of snow, spring flooding, and other weather conditions. However, prices are passed through to consumers on a monthly basis, as opposed to real-time.

There have been information campaigns from the government and retailers on reducing electricity consumption, although these have not been specifically targeting demand response according to the EI.

Distributors own the residential meters in Sweden, which traditionally have not been smart. However, with the Swedish Government's requirement that all meters be accurately read monthly by 2009, new emphasis has been placed by distributors on smart metering initiatives.

United Kingdom

The UK population is just over 60 million, with a population density of 249 people/km^2.

The UK electricity market is characterised by six large vertically-integrated retailers and a number of smaller retailers. Generation is overwhelmingly non-renewable. In 2006, only 4.1% of electricity generated was from renewable sources, while peak demand at 9.2% of total demand was met by a combination of oil and advanced gas turbine (4%), pumped storage (3%), open cycle gas turbines (1%) and hydro (1%).

Retail tariffs are not regulated by the regulator Ofgem, although some of its components, such as transmission and distribution costs, are regulated. Meter provision costs are not regulated as Ofgem considers the market competitive.

Residential meters are not smart, although there are 10 year plans by Ofgem to have all consumers serviced by smart meters. Recent trials have been undertaken by Ofgem, in conjunction with four retailers, to determine the potential of smart meters. This information is contained in the case study section below.

Although most tariff arrangements are currently constant regardless of when electricity is consumed, where separate meters are present, UK retailers do offer pricing plans that allow for day and night rates through 'Economy7' and 'Economy10' plans.

Moving from country-wide experience to specific case studies
As part of this research we came across a number of case studies that reported demand response activity, some of which involved smart meters, but not necessarily so. As shown in section 3, demand response can potentially be pursued without the introduction of smart meters. We note that in many cases smart meters are still something that are being rolled out rather than there being a useful history. A great deal of literature focused on the promise afforded by the tariff and consumer orientated benefits and opportunities highlighted in section 4.

5.2 Demand response case studies

The table below presents price and demand response findings from a number of case studies, where information was available:

Table 2 Demand response case studies

Country	Programme	Critical Peak Pricing (CPP)	Peak	Shoulder	Off-Peak	Flat rate	Pricing type 1 (peak/off-peak)	Pricing type 2 (critical peak/peak)	Demand response
USA	Puget Sound		6.25	5.36	4.7	5.36	1.33		The average residential customer shifted 13 kilowatt hours out of peak periods and into off-peak periods (four percent). Control group also shifted load similarly, despite having no price incentive to do so. Also load shedding of 1-2 percent.
	Anaheim Critical Peak Pricing Experiment	Rebate of 35c/kWh if savings made during CPP				6.75 up to 240kWh then 11.02			12% peak load shedding on CPP days than control group
	California Statewide Pricing pilot	61	22.5		9.4	13.3	2.39	2.71	On critical days 13.1% reduction in peak energy use for those consuming less than 20 kW with Programmable Communicating Thermostats (PCTs) and 0% for those without. For those consuming 20-200 kW, there was a 10% reduction with PCTs and a 5% reduction without. Not peak shedding. Use of enabling technology matters as it improves response. Also, control group with purely information and no price incentives did not respond.
	Public Service Electric and Gas Company (PSE&G) myPower	77.1	17.1	9.1	4.1	9.1	4.17	4.51	On-peak period demand cut by 47 percent on summer peak days (shift/shed). Program participants also reduced their total summer energy use by 3 to 4 percent compared to a control group (shed), and most customers saw lower energy bills.
	AmerenUE (sponsored by	Up to 36	Hourly			Average over summer of			4.7 percent demand elasticity. Load shedding of 3-4% in summer. 15% DR on days with highest

	Commonwealth Edison)					8.25			prices.
	Pacific Gas and Electricity (PGE)		29.84 (summer) 9.7 (winter)		8.763 (summer) 9.070 (winter)		1.28-2.57		
Canada	Ontario Smart Pricing Pilot	30	10.5 (summer) 9.7 (winter)	7.5 (summer) 7.1 (winter)	3.5 (summer) 3.4 (winter)		3.00	2.86-3.09	6% shedding from time of use participants, 4.7% from critical peak participants, 7.4% from critical peak rebate participants. Shifitng also occurred to the extent that consumers saved 3% on their bill. 2.4% shifting from peak (11.9% and 8.9% from CP and CPR).
	Hydro Ottawa		Time-of-use pricing						88% made changes to their use as a result of pilot. Even without a price incentive to participate, customers conserved or shifted their electricity usage.
	Quebec		14.41						Customers found that prices were rising and dropped out of pilot
	Ontario		8.7	7	3	5 (<1000kWh), or 5.9	2.9		Targeting 5% peak reduction by end of 2007.
Australia	Country Energy	38	19	13	7		2.71	2.00	Critical peak occurred twice and load shifting/shedding of peak amounted to 30% reduction.
	Energy Australia		27.61	9.79	5.61		4.92		83% of customers use less electricity (shed), saving 10% on bills. Average residential customer consumed only 21 per cent of their electricity during the peak period, compared with about 25 per cent for customers on a flat tariff (shifting).
New Zealand	Christchurch (Orion)		23.77 (M) 21.765 (C)		10.15 (M) 9.256 (C)	19.86	2.34		
	Dunedin (Aurora)		15.72-20.39 (summer and winter – M) 15.747 (C)		8.99-10.25 (summer and winter – M) 9.168 (C)		1.72		

There were essentially two types of pricing across the pilot studies. The first pricing methodology involves different rates for peak, off-peak and potentially shoulder periods. The second pricing method involves critical peak pricing, where prices rise significantly in response to extreme demand levels. This method seemed particularly common in California, which has experienced an energy crisis in the recent past. These pricing methods are not mutually exclusive and were frequently used in conjunction with each other. Furthermore, some pilots adopted rebates for those that saved electricity during critical peak periods.

In these case studies, the ratio of peak price over off-peak prices ranges from 133% to 492%. What is important to consider is how much demand response was achieved from the tariff structures and whether other conditions had a material impact on the outcome.

All pilots presented demonstrate some level of demand response, whether load shedding or shifting. In terms of load shifting, most pilots that reported on this determined some level of shift from peak to off-peak periods, ranging from 2.4% in Ontario to 13.1% in the California Statewide Pricing Pilot.

In terms of load shedding, most pilots reported some degree ranging from 1-12%, although the California Statewide Pricing Pilot saw no such shedding.

Critical peak pricing also generated demand response in those jurisdictions that adopted it of up to 47% load shifting and/or shedding on critical peak periods. The critical peak price/peak price ratio ranged from 2.00 to 4.51.

Although all trials use price incentives, control groups without price incentives were often also used within the trial. In Puget Sound, demand response was similar across the control group and group presented with price incentives. Anaheim Critical Peak Pricing Experiment, Public Service Electric and Gas Company and Hydro Ottawa had control groups that did respond purely to information, although not to the extent that those with price incentives did. The California Statewide Pricing Pilot, on the other hand, saw no demand response from those consumers presented strictly with information.

The aim of the pilot studies varied. Some, such as the Puget Sound, Anaheim Critical Peak Pricing Experiment and Pacific Gas and Electricity trial, were implemented in response to an energy crisis. Some were implemented to encourage energy efficiency, such as the Ontario Pilot and subsequent state-wide rollout. Others focussed on curbing capital costs for generators and distributors. E.g. EnergyAustralia. And some programmes set out to target demand response in itself, such as Country Energy and AmerenEU. Different aims led to different pricing methods.

The sample sizes for the pilots presented vary greatly, from 123 in the Anaheim Critical Peak Pricing Experiment to 400,000 in Puget Sound. The majority of pilots involved a few hundred or a few thousand participants. The caveat is that not too much should be read into the results of specific studies with limited participants. Rather, lessons should be drawn from the overall trends that emerge from such studies.

Finally, the list of trials presented here is by no means exhaustive. In particular, many more trials are currently underway or proposed for the future. For example, the UK currently has a pilot scheme involving 40,000 households receiving either state of the art smart meters or simpler electronic display devices, funded jointly by the government and four energy firms. However, trials presented here are those where some results have been published and the results are publicly available.

5.3 Demand elasticity summary

By using the available demand response figures from the pilot studies covered, we can crudely determine demand elasticity figures (in terms of load shifting and shedding) for peak/off peak pricing and critical peak/peak pricing. Calculating such figures necessarily requires the aggregation of prices and results that have come from pilots in different jurisdictions, with different pilot study and wider market conditions. Furthermore, there are not a lot of data points. Thus it is important that the resulting elasticity figures, set out below, are interpreted carefully and that the weaknesses inherent in arriving at these figures are fully recognised.

Table 3 Aggregated demand elasticity results

Type of ratio	Price ratio	Load shifting	Load shedding
Peak/off peak	2.83	3.20%	3.67%
Critical peak/peak	2.89	8.15%	4.02%

For peak/off peak pricing, a 2.83 ratio will lead to 3.2% load shifting and 3.67% load shedding. Therefore there is material demand response to a ratio of 2.83, with demand response occurring through similar levels of shifting and shedding.

For critical peak/peak pricing, a 2.89 ratio will lead to 8.15% load shifting and 4.03% load shedding. During critical peak periods we see greater degrees of load shifting, where consumers defer consumption to non-critical periods than under standard peak/off peak pricing. This relatively greater response is likely due to the high absolute price adopted during critical peak periods, as well as a probable disproportionate amount of marketing targeted at the critical peak, which does not occur very often. Shedding remains similar to levels under peak/off peak pricing.

6 Retail tariffs and demand response in New Zealand

6.1 Profiling

Retailers buy the electricity they supply to consumers on a half hourly basis. With accumulation meters they don't know when each consumer actually consumes i.e. they don't know the pattern of individual household's consumption. This is dealt with by a system of deemed profiles.

A deemed profile is defined in the Electricity Governance rules as a "fixed or variable electricity consumption pattern assigned to a particular group of meter registers or unmetered loads". Consumption pattern means the way in which total electricity use for a certain period and group of users would be allocated across half hourly time periods. Profiles used by retailers must be approved by the Electricity Commission

Profiling[7] "involves estimating consumers' half hourly electricity usage and can use typical consumption 'shapes' built up over time by looking at a representative sample. The retailer then uses this information in the reconciliation process".

Profiles can be either network supply point (NSP) derived profiles or statistically sampled or engineered profiles. Profiling is a statistical way of getting around the problem of not knowing exactly what electricity is purchased and consumed in each half hour by the mass market residential consumers with cumulative meters. Retailers use the profiles when designing retail tariffs.

Invoices to retail customers are based on the retail tariff times the total consumption through the billing cycle[8] regardless of the time of consumption during that period.

6.2 Cost reflective tariffs

The draft Government Policy Statement on Electricity Governance released February 2008 notes that the Electricity Commission "should promote and facilitate the efficient use of electricity by end users. It should pursue this objective in multiple and mutually – reinforcing ways including:

- by promoting cost-reflective pricing

7

8 Billing cycle normally coincides with the meter reading cycle. However, many retailers invoice on estimates and actuals alternatively.

- by seeking innovative ways to enable residential and other consumers to respond to pricing incentives to use electricity more efficiently"[9]

So, all retailers pay the same wholesale price for the delivered energy (after adjustments are made for losses at each node), irrespective of the tariff for the delivered energy for individual customers, or groups of customers. Residential consumers who happen to have consumption patterns more weighted toward lower wholesale price periods cross subsidise consumers whose consumption patterns happen to be weighted towards higher priced periods.

With smart meters, retailers will be able to offer tariffs that are sculpted to reflect the price patterns in the wholesale market.

For some consumers it will be more expensive. For others it will be cheaper as illustrated in the Energy Australia example below. If that is the case with sculpted tariffs there may be some changes in behaviour simply as a result of more cost reflective tariffs.

Another change that is likely to occur with sculpted tariffs is that retailers are more likely to target consumers with a desirable load shape. The possibility of using tariffs to provide incentives for a change in load shape is discussed in the next section.

In its submission to the Australian Ministerial Council on Energy (MCE) Smart Meter Working Group Energy Australia provides evidence of the extent of the cross subsidisation in its residential customer base[10]. The figure below shows this as the error in calculating the core costs of goods sold (COGS) based on bundled energy and network purchase costs using deemed (or average) COGS instead of actual COGS based on interval meter data[11]. The flat line represents the deemed (or average) cost, while the red line represents the "true" cost.

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[9] Draft Government Policy Statement on Electricity Governance February 2008 para 46

[10] EnergyAustralia, Energy Australia Comments on cost-benefit analysis of smart metering and direct load control; Final report for the Ministerial Council on Energy Smart Meter Working Group April 2008

[11] The data is drawn from a representative sample of approximately 200,000 customers in EA's network with interval metering. Customers are ranked according to the cost of supply based on interval data settlement going left to right from the lowest to the highest cost. Because of the commercial sensitivity of the data it has been normalised. In this example, there is no difference between overall retail settlement prices and hence the under and over-recoveries cancel each other out. Wholesale electricity prices in the two cases are identical and relate to the NSW physical market. 2007 NSW pool price data was not used but if they were the settlement error would be greater than represented here because of the high incidence of high pool price events. Wholesale network prices in the two cases are different in that in the accumulation data example flat network prices are used whereas under the interval data example EnergyAustralia's time of use network prices are used.

In this example for 75% of customers, under deemed settlement, the retailer is subject to an over-recovery relative to actual cost. However, for the remaining 25% of customers, the retailer is subject to an under-recovery. The two sides cancel each other out in total.

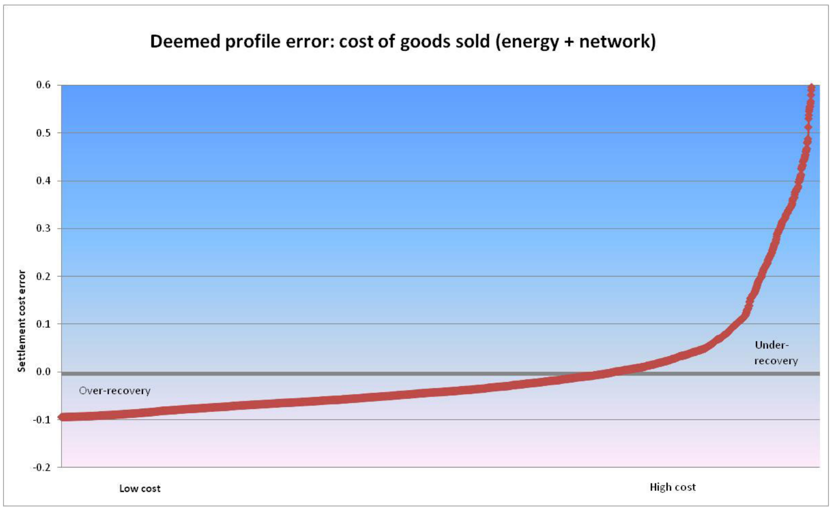

Figure 1 Deemed profile error for retail electricity customers

Sculpted retail tariffs will expose customers to the true cost of their consumption to the extent that retailers reflect actual intraday price shape and the true cost of network charges in them. In the example from Energy Australia 75% of customers are paying too much and should see a lower retail charge. The other 25% of customers are paying too little and should find themselves paying more.[12]

This will be less pronounced in New Zealand because prices in the wholesale market do not spike as often or to the levels evident in the NEM. It does lend some support to the fact that the retail market will change with smart meters.

6.3 Variability in wholesale prices and demand

. It is not clear whether sculpted retail tariffs will result in more load shifting or peak lopping. In the evidence from case studies we looked at the price differentials in tariffs and the response in other jurisdictions. Those tariffs were set by integrated lines and energy businesses unlike New Zealand. The implications of this are discussed in the following section. Those case studies were also accompanied by information and other

[12] There could be the unintended consequence that the 75% of consumers who end up with cheaper electricity demand more electricity once its price falls.

communications campaigns. This is also discussed in alter sections. Before turning to lessons for New Zealand from the international experience it is worthwhile looking a brief look at the volatility in the New Zealand wholesale market.

We have to assume that the current load shifting will remain in place so the goal is incremental load shifting or peak lopping. To consider the scope for this we looked at the volatility in load shape and the volatility in prices.

6.3.1 Intraday load shape

The peakier the load the greater the benefits are for load shifting. Transmission capacity, network capacity and generation capacity has to be built to meet the peaks. In many markets the peaks are met by thermal generation. That is less the case in New Zealand but the point remains that a flatter load shape means that non-thermal generation can be spread across the day more evenly. This would educe the need for base load thermal generation

The extent to load can be shifted from peak periods to off peak depends on what load there is with the discretion to shift it. Thai incentive becomes a matter of the price differentials but that is discussed separately.

In a paper prepared by the New Zealand Treasury[13] on electricity demand-side Management an analysis of the scope for load shifting was conducted. The findings were based on data on Auckland, Northland, Canterbury and Nelson-Marlborough load in from 2004.

The conclusion this study reached was" the load curves in the regions in question are relatively flat suggesting that there is limited scope for further peak management in these areas. Our analysis revealed that peak trimming could only be achieved by load shedding for four or more hours a day over winter months. This clearly raises issues of acceptability and practicality to consumers".

6.3.2 Intraday price volatility in the wholesale market

The greater the differential between high prices and low prices the more incentive there is to try and shift what demand can be shifted from high price periods to low price periods. The more predictable the volatility is the more retail tariffs are able to be set to give incentives to load shifting.

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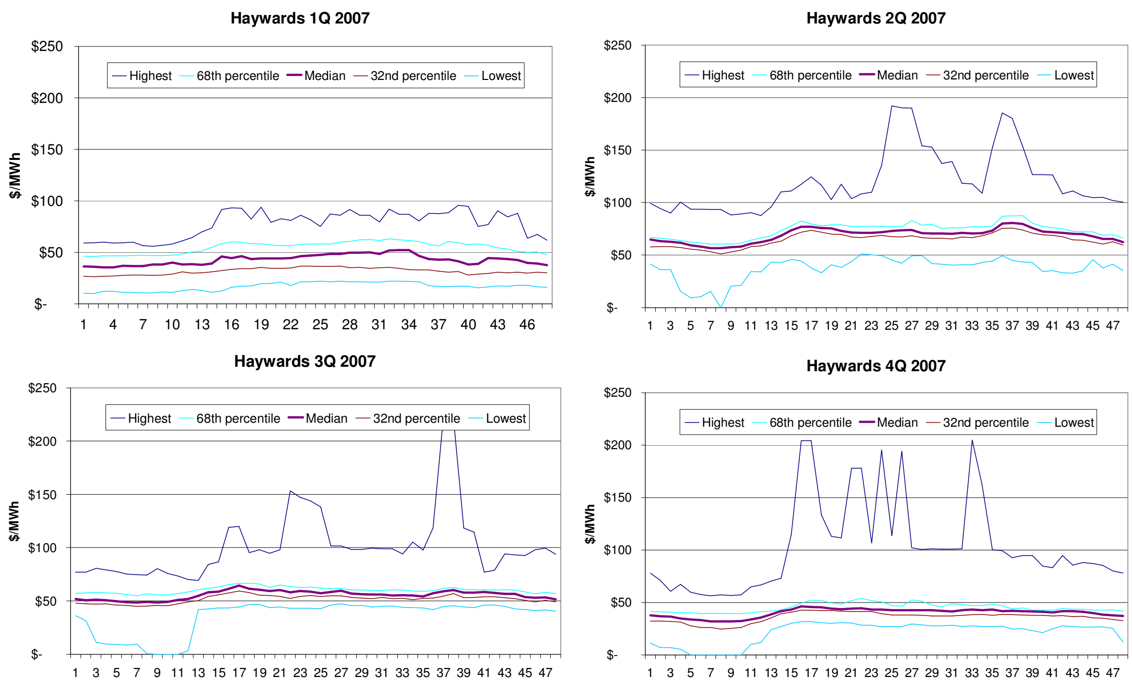
[13] Electricity Demand Side Management Prepared for the Treasury October 2005

Conventional wisdom is that wholesale prices are volatile though so this should provide some scope for retailers to sculpt tariffs in a way that encourages greater load shifting without taking undue risks.

The charts below plot 2007 wholesale prices by quarter. Each chart shows the highest and lowest prices in each half hour through the quarter. These look dramatic but these are not necessarily reflected in retail tariffs and may not be in sculpted tariffs.

The charts also show the median prices. They also show prices one standard deviation above median and one standard deviation below median. So a third of prices lie between the maximum and one standard deviation above median. A third of prices lie between the standard deviation lines and a third between the lower standard deviation and the minimum prices shown.

Figure 2 2007 Haywards wholesale prices by quarter

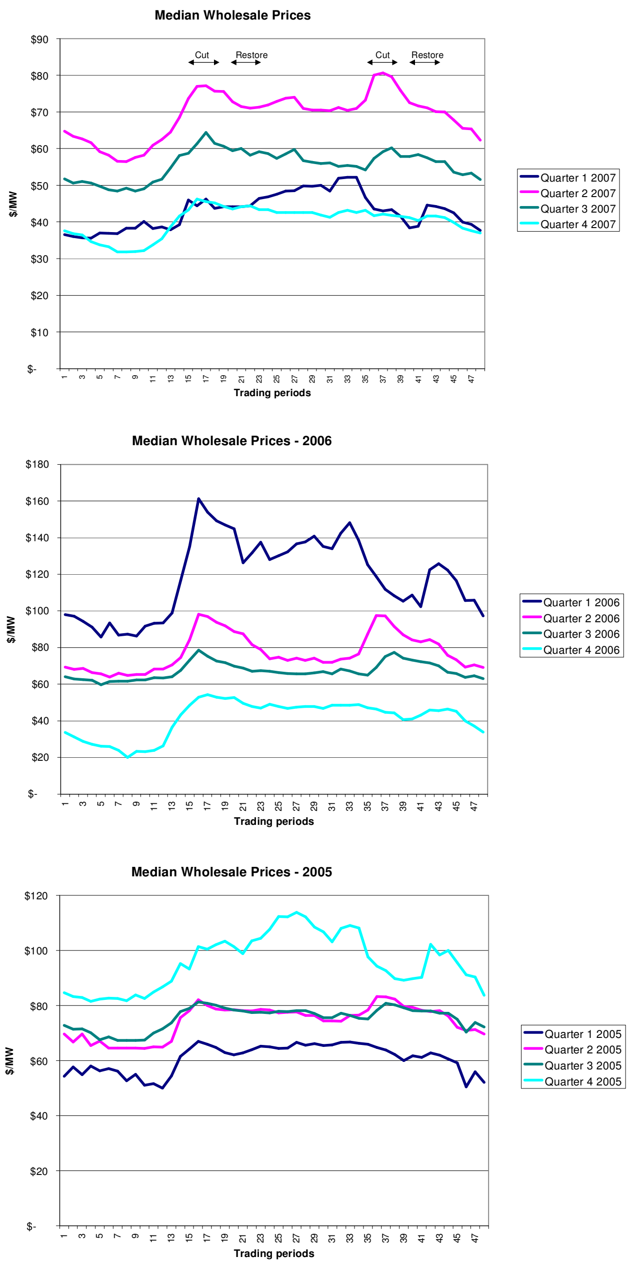


For 2007 we see that the distribution of prices between the standard deviation lines is very tight. The spread to the minimum and maximum series is very wide. The charts don’t show that the incidence of these is quite random.

For the purpose of load shifting and setting tariffs what is important is the differential between the prices when load is cut and prices when load is restored. When tariffs in the respective periods are calculated the retailer has to be reasonably confident that a positive differential will prevail. These differentials have to be reasonably reliable

The chart below shows just the median prices for each quarter of 2007, 2006 and 2005. On the 2007 chart the points where load shifting in response to price would be applied is indicated. This is a more clear view of the wholesale [price series that would be the basis for shifting load in the wholesale market.

Figure 3 Median wholesale prices by quarter



For load shifting to be effective those differentials have to be pretty reliable and based on the 12 quarters shown they do not appear to be. Account has to be taken of days when the differential doesn't exist at all. Some days it could even be the reverse and we see that the median prices in the fourth quarter don't really lend themselves to load shifting.

We have not done further statistical analysis on these differentials. That is partly because of another factor that has to be taken into account when considering the prospects for shifting energy, based on price and doing so profitably.

If multiple retails are triggering load shifting the price differentials would soon flatten out and any financial reward would be eroded.

If a retailer wishes to price a sculpted tariff that reflects wholesale prices and their risks they will have to go through the same exercise albeit in more depth.

6.4 Tariff breakdown

Between the years 1998 and 2008 retail electricity charges have risen 64.7%[14]. Residential electricity demand between 1998 and 2007 rose 17.6%. Growth was 4.1% between 2006 and 2007. There is no indication the recent growth rates are slowing up.

Retailers have made some effort to educate consumers about the energy efficiency implications of the way homes are set up. The next step is to make consumers more aware of the implications of their consumption patterns. Ideally, changes to price signals in tariffs would be accompanied by "Switch it off" and "leave it off if it is not required" type campaigns so consumers fully understood the rationale for the pricing.

It is not clear that much will happen with tariffs in the near term. It will take some time for smart meters to be rolled out and then it may take some time before retailers really focus on differentiating tariffs to target desirable consumer groups. It may be some time after that before we see retailers really use tariffs to encourage any sort of change in behaviour. Nevertheless it is instructive to look at the composition of retail tariffs.

Energy is only one component of the bundled retail tariff and will continue to be with the introduction of sculpted tariffs. Section 5.3 included a discussion on demand elasticity. The response discussed there was based on the difference in tariffs between intraday time periods. If the energy or lines component only is being changed to create a differential in a sculpted tariff it has to be differentiated much more to create the tariff differential required than if the tariff was one single function.

In the table below we distinguish between energy, the lines charge and other cost components. This gives an estimate of how much of the retail tariff is energy. Note that no breakdown is given for the proportion of line charges being a direct pass through of transmission charges. Note also that figures are nominal 2005 dollars.

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14 Bundled retail electricity charges (i.e. lines plus energy plus retailers charges) have risen 64.7% from 13.58 c/kWh to now 22.36 c/kWh between April 1998 to February 2008. Lines charges have risen 18.2% while non-lines charges (predominantly energy charges) have risen 110.2% in the period. Source MED

Table 4 Generator/retailers broken down bundled retail prices							
Vertically integrated generator/retailer	**G/R 1**	**G/R 2**	**G/R 3**	**G/R 4**	**G/R 5**	**Weighted average national retail charge**	**%**
Energy c/kWh	6.47	6.36	6.49	6.46	6.28	6.48	39%
Lines charges c/kWh	7.06	7.76	6.09	6.77	7.11	7.12	43%
Other c/kWh	3.22	2.16	2.85	2.96	4.11	2.97	18%
Total (2005 nominal) retail prices	16.74	16.27	15.43	16.19	17.50	16.57	**100%**

This table shows that 57% (i.e. 38% + 18%) of bundled retail charges go to the retailer. Of that one third covers cost to serve, metering and the retail margin leaving 39 % of the tariff going to energy. Of the remaining 43% some covers the regulated network charges and some covers the regulated transmission charges.[15]

In New Zealand lines charges tend to be flat so for a differentiated tariff to be introduced (given the appropriate metering arrangements) it would tend to be the energy component. One conscious example of a network company offering a differentiated tariff is Orion (or Southpower as it was). Prior to the reforms of the 1990s when Orion was an integrated retailer distributor it introduced a two step tariff using meters that had a double register. The switch from one register (peak) to the other register (off-peak) could be made by the control room. This mechanism allowed Orion to provide an incentive to consumers to shift load from peak to off-peak.

That metering arrangement remains in place and is the basis for Orion's lines charging regime to retailers on its network, which is mentioned in the demand response case studies. However it is unusual. These types of charging regimes are not especially forthcoming while retailers determine the bundled tariffs that consumers see.

In this section we have shown that sculpting tariffs means sculpting one of two key components or both. To deliver the sort of demand responses discussed in section 5.3

[15] The energy component is only one part of the retail tariff, but it is this component that is likely to vary where the aim is cost reflective retail tariffs. See for example LECG, *SA Standing Contract Electricity Prices Price Path Review and Inquiry*, August 2007 & IPART, *Promoting retail competition and investment in the NSW electricity industry*, April 2007.

based on the tariff differentials discussed in that section the difference one of the competent parts has to be magnified.

Mathematically, if energy charges are differentiated 185 % between day and night that results in a differential in the bundled rate of 127%. To achieve a differential of 185% in the bundled rate would require the energy only price to have a differential of 758%

These results are illustrated in the table below.

Table 5 Sculpting energy charges within tariffs

	Weighted average national retail charge	185% differential on energy charge alone		185% differential on retail price	
Energy c/kWh	6.48	8.42	4.54	11.5	1.5
Total retail prices (2005 nominal)	10.57	18.51	14.63	21.5	11.6
High rate over low rate	Energy only Bundled rate	186% 127%		758% 186%	

7 Lessons for New Zealand

7.1 Why aren't tariffs currently encouraging DR?

Demand response in New Zealand tends to take the form of:

- 2 part (day/night type) tariffs
- expenditure on energy efficient appliances and fittings

Otherwise little demand response is evident currently occurring in New Zealand in response to signals created by retail electricity tariffs. This is understood to be due to the lack of enablers and blunted incentives for both consumers and retailers.

7.1.1 Questions were posed to industry participants

In preparation for this report the five largest generator/retailers were asked "What are you doing now to encourage demand response across your residential customer base?" Their responses are set out in the following table:

Table 6 Responses from Generator/Retailers and Lines Businesses	
Genesis Energy	Where possible, Genesis Energy offers its residential customers: 1. Reduced tariffs in return for the customer allowing a portion of their load to be controlled by another party. Typically, the controllable load would be cylinder-based hot water heating. This option is normally available to our residential customers where: a. the customer uses electricity to heat and store water; and b. the distribution network uses load control signalling equipment (typically 'ripple control'); and c. the customer's home is configured to receive and respond to load control signals from their distributor; and d. the customer's distributor offers a tariff for controlled load. 2. Basic time-of-use tariffs where the customer pays less for energy consumed during low demand periods. The structure of these tariffs depends on the capability of the meters at the customer's premises. Typically, basic time-of-use tariff are limited to simple 'night' and 'day' periods – with lower charges at night.
TrustPower	TrustPower offer a number of tariff options to both its residential and commercial customer base that encourage demand side response. From a Domestic customers perspective these include various controlled load options for storage heating, Day/Night or Night only tariff options, Interruptible load options, Weekend/Weekday peak off-peak saver options.
Contact Energy	Currently Contact's direct encouragement of demand side response is limited to our retail pricing structures based on existing meters: the Day price of the Day/Night tariff, for instance is significantly more expensive than the Night rate.
Mighty River Power	Currently undertaking a study with Otago University and the National Energy Research Institute (NERI) to explore the issue of whether prices, information or other drivers affect consumer consumption decisions.
Meridian Energy	Meridian did not address the question other than to say: "Meridian is very committed to the use of advanced metering in New Zealand."

Genesis appears to be speaking for all of the generator/retailers when they referred to the issue of tariff based initiatives as follows:

Genesis Energy	In the absence of advanced metering infrastructure, the ability for retailers to encourage demand response through pricing is largely a function of factors outside the retailer's control, including: 1. metering and load control infrastructure available in each electricity lines area; and 2. Tariff structures offered by electricity lines business. It has not been economic for retailers to make use of conventional time of- use metering on other than high consumption (commercial and industrial) sites.

The reference to tariff structure offered by electricity lines businesses is clearly an issue with the generator/retailers who answered the questions in full all referring to it. Vector makes a valid point about industry arrangements as faced by the lines businesses.

Vector	Currently there are a number of rules and regulations that have been enacted on an ad hoc basis with the intention of resolving perceived energy market issues ranging from energy affordability to connection of distributed generation. These regulations in most cases have not considered the wider impacts that they have had on the energy market and as such create a number of perverse outcomes. For the demand side to work effectively, all rules and regulations that affect or influence pricing need to be reviews with the goal of ensuring that all are consistent, well thought out and provide the market with the correct investment and development incentives. responses

Other lines companies focus more specifically on the composition of tariffs in their response to the question: "What are the barriers for you to encourage demand response?" as follows:

WEL	Ability to convey pricing signals to customers, Transpower pricing is all but fixed, which means a large incentive to reduce demand is lost to customers. The low fixed charge regulations inhibit our ability to introduce smarter tariffs for higher volume users. Technology barriers exist – in being able to control or manage load within the home (e g heat pump and freezer controls).
Northpower	Northpower considers the most significant barrier to encouraging demand response is the continuing erosion of the pricing differentials between the retail tariffs for 24-hour availability and for controlled load. Because Northpower operates on an "interposed" contractual arrangement with the electricity retailers for all ICP's (apart from a few very large industrial sites), Northpower has no control on how the electricity retailers re-package Northpower's line charges in their retail tariffs to the mass-market.
Scanpower	In regard to pricing, the differentiated day/night rates captured in Scanpower's line charges is often largely diluted by retailer rebundling of line charges.
Electra	Electricity retailers not offering enough price differentials between peak and off peak tariffs and competitive night rate tariffs. Without significant differentials users will not install the appliances to make use of the cheaper tariff rates e.g. larger hot water cylinders with the bottom (main element) on the night or thrifty tariff and a top element on the day rate to heat the top of the cylinder if required during the day. Also current retail tariffs do not give enough encouragement to install night stores and underfloor heating.
Waipa Networks	A significant barrier to encourage demand response is that as a network company with conveyance agreements we are dependent on the Retailer for marketing (e.g. promotional material, price signals). As some retailers are also in the gas market they may not market electric hot water storage systems for example. (These retailers market dual fuel as a one stop shop advantage over other retailers for example).
Buller Electricity	The major barrier to encourage demand response is retailers' inability to add value to our demand response tariffs. For example, the retailers add no further "discount" to our controlled tariff and further, add expense for the relay and second meter which totally cancels our discount. As a result consumers no longer choose the controlled tariff options and we now insist load control be offered on suitable load.
Network Tasman	The current metering stock does not facilitate sculptured time differentiated tariffs other than in the broadest possible terms e.g. day/night meters, controlled load meters, night only meters etc.

Most of these lines companies focus on the dynamic that seems to exist between retailers with their customer interface and the way network charges are passed onto consumers. Network Tasman brings the matter back to the possibility that things will improve with TOU capable meters.

7.1.2 Barriers to tariffs that encourage demand response in NZ

What we learn from the full responses to the questions submitted by the PCE to industry participants is that that institutional arrangements and technology limit the potential for demand response in New Zealand. In many ways this is unsurprising. The New Zealand Energy Strategy states "cheap and abundant energy – particularly gas and electricity – has been one of the foundations of the New Zealand economy's competitive advantage." Increased demand has been accommodated by the supply of energy and infrastructure until very recently.

Real electricity prices in New Zealand rose from 10 cents/kWh in 1979 to 15 cents/kWh in 2004 (March 2004 dollars), according to the MED.[16] As of February 2008, retail electricity prices were around 22 cents/kWh in today's dollars.

Furthermore, electricity bills make up a relatively small share of a household's expenses. According to the Statistics NZ Household Economic Survey for the year ended June 2007, New Zealanders had an average household income of $67,973 and spent $956 per week on average on expenses. Approximately 3.17% of total net expenditure went on electricity.

Consumers therefore have not had, and do not have, strong incentives to respond to electricity prices as the cost of electricity is, on average, relatively small when compared to income.[17] Nor have they had especially strong incentives to call for more innovative tariff structures.

The responses repeated in the previous section tell a story of two step tariff arrangements based on a two meter arrangement. This has support ripple control of hot water heating overnight and this has been a key feature of retail tariffs for some 50 years.

A number of elements have converged now that make the need for greater demand response more urgent. Rising energy costs and an emerging desire for environmental

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16 MED, *New Zealand Energy in Brief*, March 2006.

17 Given that electricity prices are widely forecast to increase over the near future due to effective bans on new thermal generation in NZ requiring new, more costly renewable generation to be brought online, consumers might become more incentivised to respond to electricity price increases as the proportion of income devoted to electricity increases.

sustainability and a desire to simply be less wasteful have generated a greater urgency for retail electricity tariffs to provide incentives for demand response.

The barriers appear to be a function of:

- The split between lines businesses and energy retailing. This has created two different outcomes:
    - Energy companies supplying most of the electricity market are vertically integrated energy companies who make the bulk of their income from the wholesale margin rather than the retail margin. A retail base is as much a hedge against price volatility as it is a source of revenue. Tariffs have evolved accordingly.
    - Supply is delivered by regulated Electricity lines businesses who manage their infrastructure investment with quite different drivers. Their costs are absorbed into the tariffs i.e. there is little visibility for consumers on the competition of retail tariffs.
- Legislation such as the low fixed tariff obligation that lines companies have to meet.
- The stock of accumulation meters.
- Retail electricity is a low involvement commodity. It is a relatively small proportion of household budgets, it is (for the most part) an essential good, the retail offerings are very similar and it is complicated to switch. A recent survey[18] on retail competition notes that "a clear majority (63%) have not researched what other retail electricity companies charge in their local area.” Other findings lead the researchers to conclude “this strongly suggests that approaches from companies are a key factor in informing people about electricity price differences.”

We are seeing few attempts to encourage demand response from generator/retailers with current arrangements. We have learnt from the survey questions that generator/retailers are conducting appropriate research and, in most cases, advancing plans for the roll out of smart meters.

Advances in technology and the availability of cost effective smart meters may have arrived at the right time. However the institutional arrangements remain in place and it is

[18] Electricity Commission Retail Competition A qualitative and Quantitative Study (March 2008) section 3.

not clear whether the arrival of these meters will fulfil their promise in terms of demand side response in the near term.

There is a progression of steps required before consumers will be invited to modify their consumption in response to tariffs. This fact seems to be borne out by one generator/retailer who said: "at this time out focus for smart metering is around improved customer service and for the company's own bill reconciliation processes – not directly for other purposes like demand side management".

7.2 What do tariffs need to be like to encourage DR?

International experience suggests that different tariffs for different periods will likely generate demand response to some degree, although there are also other non-price incentive options, such as advertising campaigns and other information that may be appropriate.

7.2.1 Overseas evidence on tariffs encouraging DR

Overseas experience tells us that differentiating peak and off-peak rates typically does elicit demand response from consumers, in the form of both load shifting and shedding. Our aggregate figures from section 6 suggest that a price ratio of 2.83 leads to 3.2% load shifting and 3.67% load shedding. Similarly, a critical peak pricing ratio of 2.89 will lead to 8.15% load shifting and 4.03% load shedding. Therefore, there is a benefit to be gained from implementing a tariff structure that differentiates between periods, dependent on the implementation of enabling technology such as smart meters.

We know that there is likely to be a benefit in terms of demand response from a varying tariff structure, so the relevant question becomes weighing up the cost of enabling such a scheme. Costs must be taken into account by policy-makers before any decision on how best to elicit demand response is made.

Variable tariffs require enablers such as smart meters, which are not inexpensive. In New Zealand a smart meter without an in-house display is expected to cost in the order of $70 - $80 versus new accumulation meters which cost around $30 (excluding installation costs). Indeed, the cost of smart meters has led to Hydro Quebec shelving plans for a smart meter roll-out, as prices to consumers would have to rise significantly to recover the costs of the technology. Consumers may not be willing to partake in a pricing structure where they perceive the costs to be too great to them, which has implications for the design of such pricing.

Inequity is one other possible cost from variable tariffs. For example, in California, Towards Utility Rate Normalisation (TURN) have opposed variable rates through the use of meters, claiming that lower-income households have less ability to reduce peak consumption and thus lower-income households will be disproportionately affected by such rates.

If variable tariff structures, and the infrastructure necessary to allow for them, are too costly relative to the benefits they bring, other alternatives might be considered.

7.2.2 Non-tariff incentives and information to encourage DR

There is a great deal of activity in New Zealand aimed at reducing electricity use. Two agencies in particular have a mandate to address non-tariff incentives and energy efficiency information[19]. It is clear that information or publicity campaigns have a greater role in encouraging consumers to modify their consumption patterns (i.e. demand response) for the greater good as well as their own.

We saw in the case studies evidence of control groups that did not have price incentives, such as variable tariffs, who achieved similar levels of demand response as those that did have those price incentives. This was achieved through the provision of information to consumers about the merits of changing their behaviour. E.g. Puget Sound and Hydro Ottawa. The findings from these two studies do raise the issue of whether variable tariffs are necessary, although it should be noted that in the California Statewide Pricing Pilot the sole provision of such information did not elicit demand response from consumers.

Advertising campaigns providing information to consumers have been adopted in other jurisdictions, such as the 'Beat the Peak' campaign in Western Australia. Beat the Peak is a Western Australian Government initiative to increase energy awareness and to provide tips on how to reduce energy use between 3pm and 6pm, such as through setting the air conditioner onto a higher temperature.

Such centralised advertising overcomes issues of individual generator/retailers being reluctant to promote non-price incentivised demand response, a possible problem in the current regime. Individual generator/retailer campaigns do not currently occur, possibly due to the inability of the generator/retailer to capture fully the benefits of such a campaign. In other words, if one generator/retailer targeted consumers to load shift through advertising, other generator/retailers' consumers might also load shift after being exposed to the advertising, which would limit the ability of the advertising generator/retailer to sell excess peak generation to others.

What is noticeably absent in New Zealand is good quality information on the links between consumption patterns and the overall cost of electricity. If the generator/retailers offer cost reflective sculpted tariffs there may be some demand response. The introduction of TOU capable metering will assist this a great deal. The addition of broad publicity on the need to be more efficient will continue to be worthwhile.

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[19] Good progress is being made with roll-out of new electricity efficiency programmes. The Commission has contracted 19 parties to deliver efficient lighting and commercial buildings programmes. Compressed air audits have commenced, with eight completed and another six given approval to proceed. Excluding the CFL programme, the contracts entered into for programmes provide for savings of up to 450 GWh per annum

The last remaining information barrier is an understanding of the issues discussed in this paper such as the composition of tariffs. Some consumers may not want to see this much information but if a consumer wants to make informed decisions they have to be able to access this more easily than at present. If consumers are to be able to secure the genuinely best deal in the market place a competing retailer must be able to see or at least confirm a consumer's consumption pattern and price to them accordingly. This is the way the retail insurance industry works for example.

7.3 Conclusion

This report has not investigated the net benefit or public benefit of introducing smart meters (I.e. time-of use and two way communication capable). It has not considered specifically whether in home displays are the essential means of communication with consumers. Nor has it considered who should own the smart meters.

This report has focussed on the relationship between retail electricity tariffs and demand response. The discussion on this relationship has been expanded to include all enablers of demand response rather than just retail tariffs in isolation. It notes that the drivers for demand response are different for retailers and distributors and may differ from consumer to consumer.

International studies showed that demand response in electricity consumption is not a well developed phenomenon. This may simply be because electricity has been a relatively cheap commodity for some time and is seen as an essential good. Recent hikes in fuel input costs in many markets have given electricity costs a higher profile. More recent acknowledgement of the potential effect of the way we consume electricity on the climate have raised the profile of electricity consumption patterns further.

Where electricity markets have been established any policy response to outcomes sought from the market have to be well considered. With respect to areas that a policy response might be considered or even warranted in respect of demand response we make the following conclusions:

- Consumers do not appear to have access to good information about the way they consume electricity. They do receive the information the retailers choose to provide but they do not see unbundled information on their energy, lines charges, transmission and fixed costs.
- Cost reflective tariffs will become possible with the introduction of time of use capable metering. This may result in greater competition, possibly downward pressure on prices for some consumers and hopefully greater diversity on the retailers' offerings.
- Research into the New Zealand situation highlighted the ambiguity around the ownership of consumption information. It is not completely clear whether a consumer can release their file to another retailer to support a request for competitive quote. This may become more of an issue with time of use capable

meters. It is akin to the insurance industry where customers transferring (or switching) from company to company are required to make a declaration on their claims record. If retailers do not support files being available to consumers, intervention may become warranted.

- Demand response is clearly not solely a matter of tariffs. Campaigns with messages around the theme of “switch it off” and “leave it off if it is not required” also address electricity consumption patterns and energy efficiency. Development in tariffs, messaging and information go together in encouraging demand response.
- Research into the New Zealand market detected consumers have little say, if any, into the tariffs, products and communications offered around their electricity supply. Marketing functions in the retail departments of the electricity companies are sure to do market research but no evidence of large consumer input came to the fore. It seems extraordinarily one sided.