Electricity lines charges

Economic impacts on residential consumers and businesses in the Ruapehu District

Report to Ruapehu District Council

May 2011

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Executive summary

Purpose

This report prepared at the request of Ruapehu District Council and the King Country Energy and Power Trust (KCEPT) examines the economic and social impacts of electricity lines charges as practised by the The Lines Company that provides the distribution network in the district. There are concerns in Ruapehu District that recent changes to charges are damaging the attraction of the district for business and residential investment, calling for closer examination of the effects of the charging.

Electricity consumers in Ruapehu District have seen some major changes in electricity lines charges in recent years. The basic changes have involved:

- Direct billing for lines charges separate from retailers' bills introduced in 2005
- From 2007, replacing a variable charge based on kWh consumption to a "demand charge" at a constant monthly rate based on each customers' assessed contribution to demand loading during the winter peak
- From 2009 roll out of demand meters to give more accurate measures of load
- An increase of aggregate revenues collected from customers on lines charges.

Together these changes will have made customers more aware of lines charges than in the days when they were combined on the same bill as power consumption. The change in charging will have led to some redistribution of liability for costs of the lines network, which on its own would have left some customers better off and others worse off than they were before. But this has been masked by the general increase in costs and revenue requirement that lines charges are set to recover.

Approach

Our approach in preparing this report has involved

- Canvassing Ruapehu residents about their experiences with the lines charges, in their capacity as residents and business owners
- Reviewing international literature on the theory and practice of demand charging for electricity lines and similar networks
- Examination of published material on TLC's charging and revenue requirements
- Analysis of data on electricity use in Ruapehu District over the period of recent changes
- Examining the effect of such charge increases on a model of the Ruapehu District economy
- Interpreting the results against a framework for considering the equity, effectiveness and efficiency of the lines charges.

Findings

There is a sound economic basis and economic precedent for charging for a lines network by pricing loads at peak times, as it these loads that drive the need for new capacity and additional cost. The purpose of such pricing is to incentivise restrained use in the peak, or shifting of consumption to off-peak periods when there is capacity to spare. However, the flat charge used by TLC in Ruapehu District provides little guidance for customers as to when the peak occurs or how to avoid it – in particular the formula applied to old mechanical meters does not reward load shifting, and with demand meters it is difficult to anticipate when critical load assessments occur.

Analysis of aggregate data suggests that effects on restraining demand since the demand charges came in have been small and confined to Turangi and Taumarunui, but growth in skifield activity may mask restraint at individual level. Our analysis of individual level billing data from TLC suggests there may have been some restraint in demand, but this varies across sector and the response may be due to the rise in electricity price as well as in lines charges.

Modelling of inter-industry transactions in the district's economy suggest the impact of the lines charges increase is modest because of the adjustments between sectors responding to the charge. But such modelling provides an aggregate picture and does not pick up the effect on individual businesses and residential consumers who may face difficulties or threats to their viability from increased charges, for instance:

- Seasonal tourism operations and accommodation, whose peak season coincides with the network peak demand and face a mobile clientele who may relocate to other districts if they raise their prices to recover higher lines charges
- Pastoral farming also has multiple demand charges for multiple connection points that may be used for short periods in the year
- Owners of rented accommodation face particular impacts from "legacy" bills of departed tenants and TLC's shifting liability from the tenant to the property owner.

Our assessment of the current lines charges is

- By international standards its approach is unusual, not to say unique, and cannot be regarded as best practice in terms of the incentives it creates
- Equity or fairness is not a matter that economics provides firm guidance on beyond noting the distribution of impacts, but the unpredictability of charge-setting process suggests it would not score highly on this criterion
- There is some tentative support for the charges' effectiveness in reducing loads at peak times, but there are shortcomings in the data used for analysis and the effect may be reflecting changes in electricity price as well as lines charges
- The current charge is not efficient in terms of the signals it gives consumers of impending peak loads, or in giving them a feasible means of responding by reducing or shifting consumption away from those peak periods.

What can be done about the impacts?

With a relatively sparse population, low incomes, an extensive but old electricity lines network and an unusual demand pattern with winter-sports driven peaks, a lines operator in Ruapehu District would face challenges in raising revenue in the district to self-fund renewal and upgrade of lines to maintain system reliability and accommodate growth. Internationally there is a trend towards using differentiated pricing focused on peak periods to encourage “demand side participation” in electricity load management and obtain more efficient use of the network.

The metering infrastructure in Ruapehu District is currently limited in its ability to provide critical peak price signals, but it would be feasible to provide a seasonal surcharge to reflect the additional costs of use in the peak. This would have negative impacts on particularly vulnerable groups like those on low or fixed incomes. Such a surcharge would only be an approximate indication of peak costs to provide some additional incentive for constraint in the peak use period.

In the longer term efficient pricing requires improvement of metering infrastructure and a roll out of meters that facilitate customer response to pricing signals. Studies from USA, Canada, Scandinavia and the UK suggest that new meters with a user-friendly display of real time power use improve feedback to customers. The current course with existing demand meters suits TLC for billing purposes but provides little assistance for customers to participate in managing demand.

While the changes to charges have redistributed costs across customers, the impact has been compounded by the marked increase in costs to be recovered from the network charges. Review by independent experts on electricity system management could show whether the planned cost increases are appropriate for system upgrade.

For the Ruapehu District Council a number of potential courses of action emerge from this report

- Establish the extent of the problems in the district with a more representative survey of residents and the impacts of charges on them
- Commission an assessment of the electrical system and the renewal programme which is contributing to the increase in costs recovered by lines charges
- Engage with The Lines Company on alternatives to the current course, including a time-varying peak charge or roll out of new meters that give customers greater ability to manage load than with current meters
- Engage with the Electricity Authority and other regulatory bodies to investigate the efficiency effects of the current lines charges rather than viewing it as a matter of pure distribution.

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1. Introduction

This report examines the effect of electricity lines charges on businesses and the local economy within the Ruapehu District. It aims to inform the debate around lines charges by considering the level of impact of the current charge structure on residential and business consumers in the district, and on what might be feasible alternatives to the current system.

There are three parts to this examination:

- Establishment of the rationale for the current charging regime, what it is meant to achieve, and whether there are other practical ways of structuring the line charging which could help assure the viability of the power supply but with lower impact on businesses in the local economy
- Analysis of the charging regime and the response of electricity customers to the current regime's introduction, to identify if it has been effective in curbing peak demand that drives the need for new investment in line network upgrades
- Examination of the depth of impact on different types of customer in the local economy in Ruapehu District, taking account of the characteristics of the businesses and the local markets they serve, through a mix of interviews with selected businesses and analysis of the industry composition in the district.

Ruapehu District occupies an area served by The Lines Company (TLC) Ltd of Te Kuiti, bordering the areas served by Powerco in the south and by Unison in the east. In 2005 TLC introduced direct billing of lines charges, separate from the billing of power consumption by electricity retailers. This was preparatory to 2007, when TLC replaced its traditional practice of charging using a combination of a daily fixed network fee plus a charge per kWhs consumed, with a customer "demand charge" set at a constant monthly rate each year based on each customer's assessed contribution to KW loading during the network's winter peak use period. This change was intended to give a market signal to consumers of the costs their use imposes on the peak and to restrain their demand on the network. In 2009 TLC made a further change by rolling out to some properties demand meters that enabled more accurate recording of half-hourly based loads over constrained periods.

The succession of changes to the billing system, combined with the apparent effect of these changes on some customers, has generated concern in Ruapehu District about the impacts of the price rises and the fairness of bills being set on different bases depending on the type of meter on the property. Estimating the effects of these changes on electricity customers in the District, and what that might mean for the local economy, is the subject of this report.

The recent changes have drawn attention to TLC's business practices and caused some to question the company's strategy with respect to the customers in the southern network in Ruapehu District. This report is not, however, a critique of TLC's business model or operations. It considers these to the extent they directly affect the charging mechanism and its effect on electricity customers, but to consider TLC's direction and the adequacy of its network management requires a different range of electrical systems expertise than is assembled here. The focus of this report is on the impacts on customers, economy and communities within the Ruapehu District, which for purposes of this study is taken to also include Turangi but to exclude Waiouru which is outside the TLC network.

The report proceeds through the following sections:

- Background to the issue, customer experience in Ruapehu district
- The rationale, theory and practice of lines charging
- The effect of charges on electricity consumption in the district
- The effect of charges on inter-industry activity across the local economy
- Conclusions.

While this study is primarily concerned with assessing the effects and scale of impacts of the lines charges in Ruapehu District, it also applies three criteria in the economic assessment of the impacts. These are:

- Effectiveness of the current charge mechanism in achieving what it is intended to achieve
- Efficiency of the current charge mechanism in managing network demand without undue costs, with reference to the three well-beings of the Local Government Act
- Equity in managing demand in a manner that is perceived to be fair across the community.

It also includes

- An outline of long term tends of electricity usage as a fuel and implications for TLC policies, to provide context for developments in electricity supply
- A review of international practice on lines charging, for comparison against TLC's current practice
- An informal, qualitative canvassing of affected customers in the Ruapehu district, to illustrate the scale of impacts for different types of customer
- Analysis of recent consumption data in the Ruapehu district, to see what appreciable difference can be associated with TLC's new charging procedures.

2. Background – pricing the peaks

Electricity is an essential input for modern lifestyles and commercial and industrial activity, and for many uses there are no effective substitutes that provide the same quality of service at reasonable cost. At least in the short run, demand is unresponsive to price rises and unanticipated “outages” incur high costs to the community. New Zealand is a long thin country which has to be self-sufficient in electricity, and it does this by collecting power from dispersed hydro-, geothermal, wind and thermal power stations on the national transmission grid, and by supplying individual properties through local lines networks that draw power off grid exit points. That inter-connection comes at a cost in terms of the grid infrastructure and power losses incurred in transmitting electricity over long distances. But it also confers benefits in enabling its main urban load centres to access lower cost power sources in remote rural locations, and also by conferring greater resilience against failures of individual power plant than is possible with a localised stand-alone system.

2.1 Paying for network infrastructure

Networks of fixed infrastructure like power lines, pipelines and roads are problematic for economic efficiency, because once they are built the cost of using them is very low until use rises close to full capacity, at which point congestion raises the risk of network failure and loss of service. In such circumstances the standard economic prescription for efficient pricing, setting price equal to short run marginal cost, would not cover the full cost of providing the network (many of which are costs “sunk” in the construction that have little or no value in other use) or provide sufficient return to maintain or develop the network further. Basing price on the higher long run marginal cost would discourage use that could be accommodated with the result that available capacity is likely to be under-utilised

As networks need to meet demand when it occurs they are susceptible to fluctuating use with peaks in demand and they are built with a level of “headroom” capacity over what is needed for usual demands to accommodate peaks. A balance needs to struck between bearing the risks of occasional overloading and provision of additional capacity which will not be used much of the time. Hence peak demand loads, rather than the average load carried most of the time, are the drivers of infrastructure capacity.

In order to break even network providers commonly resort to “second best” pricing in which the price consists of a component of short run marginal cost plus a mark up to provide for the fixed costs of providing the network. A common approach is to determine a fully distributed cost in which the fixed component is averaged across some measure of consumption (e.g. the number of consumers, or each consumer’s share of total consumption). This is not economically efficient because it can result in some consumers facing a higher (or lower) price than the marginal value of the consumption to them, which results in them lowering (or raising) their consumption relative to what they would consume with efficient prices.

An approach which is less distorting of consumption (and more efficient) is therefore to vary the mark up according to the price sensitivity of different users i.e. raising the mark up on the least price sensitive and reducing the mark up on the most price sensitive. Such pricing based on so-called "Ramsey principles" requires detailed information on consumers' price sensitivity. An easier to implement alternative that is still more efficient than a fully distributed cost approach is to apply a two part charge in which there is a fixed charge for access to the network which covers the fixed costs, and a variable charge reflecting usage of the network. This is a familiar approach to charging for "club facilities", in which a membership charge (for example, of a squash club) confers access to general club facilities but specific services such as use of courts, bar etc incur a usage charge.

2.2 Options for pricing networks

Networks commonly have club charge structures in which there are various components:

- A fixed network charge which is common to all network customers, which in the case of lines companies would cover such things as general company overheads and repair of weather-related damage
- A variable charge related to use of the network, which in the case of a lines network could be rather small, reflecting the wear and tear of conveying power across the network
- When networks approach capacity and face increased risk of over-loading which could cause network failure and loss of service, it is also common to levy a congestion charge or demand charge at those specific locations and periods to both discourage some price-sensitive use or shift it into the off-peak period and provide revenue for upgrading capacity.

There is international precedent for use of demand charges, which are described in more detail in this report's Appendix B. But none of them in the literature reviewed here operate as a flat rate through the year based on a customer's single assessed peak loading. Norway, which is a long thin country with challenging terrain and climate, has a demand charge at a higher rate in the winter peak than the rest of year, based on an average of highest kW loadings during the three month winter peak season. This provides more of an incentive for customers to shift consumption out of the peak season than a flat rate through the year.

The approach used in Norway is known as **Critical Peak Pricing** in that it provides a surcharge for use in the peak periods. Such approaches raise concerns about affordability but they can be addressed through other measures, for instance special tariffs for those on low incomes, or rising tariffs that provide a low cost on the first block of consumption but increasing rates on higher consumption. An alternative to Critical Peak Pricing is **Peak Time Rebates** in which customers are rewarded with rebates for restraining their use in peak load periods.

More commonly encountered is **Time Of Use** pricing, in which prices vary according to a pre-notified fixed schedule on a recurring basis – for instance with higher prices during the daily morning and early evening peaks, or during the seasonal peak. Such pricing has been used in New South Wales, Queensland and Victoria and also in Ontario, Canada and it has been found to be effective in shifting some use off the peak periods. However, in Ontario they were found to result in higher electricity bills for customers because people used more power in the off-peak periods. In the Australian states they have been criticised for not being family friendly because of the inconvenience of adjusting family consumption patterns around them.

A theoretically more favoured method is **Real Time Pricing** in which prices vary closely with variations in loading and in wholesale market prices for electricity. Prices change from hour to hour on the basis of a schedule issued a day ahead, thus giving consumers notice and time to adjust their consumption. Such pricing schemes remain relatively uncommon, largely because implementing them requires relatively sophisticated metering infrastructure.

Much of the recent literature on network pricing is tied to improvements in metering technology, which promises to enable much greater refinement in how prices are set for networks and the encouragement of "demand side participation" – i.e. giving incentives to customers with which they can respond to better manage the loads on the network. So-called "smart meters" provide much greater functionality than conventional electromechanical meters that simply measure the cumulative consumption of electricity between meter reading dates. This functionality may include real-time readings of power use for both the network operator and the customer, and also perhaps communication with smart appliances to adjust the loads they place on the network at critical times. There is as yet no universally agreed definition of what a smart meter is, and various types of advanced meter could be fitted within the rules set by the Electricity Authority in its Part 10 of the Electricity Industry Participation Code. The ability to price is constrained by the characteristics of the metering infrastructure.

In short, across networks such as that managed by The Lines Company,

- Peak loading is a major driver of overall costs of the network
- Peak pricing to shift load off the peaks is a common response internationally to managing load and the accumulation of cost
- International trends are towards use of increasingly sophisticated smart meters that provide information to both network operators and customers to enable them to better manage their electricity loading on the network.

The questions to be examined now are how The Lines Company's charging is applied in Ruapehu District, whether this charging is effective, efficient and equitable and what impacts are the charges having on the economic and social life of the District.

3. State of play – Lines charging in Ruapehu District

Following the 1998 electricity reforms that split local electricity retailing from network businesses, The Lines Company (TLC) took over the assets of two relatively old and rural distribution lines networks, a northern one in the Waitomo-Te Kuiti area and a southern one acquired from King Country Energy which covered Turangi and most of Ruapehu District (with the exception of the areas around Waiouru and Raetihi). The Waitomo Energy Services Customer Trust (WESCT) has 90% of the shares in TLC and the King Country Energy and Power Trust (KCEPT) has the remaining 10%.

Since the two networks came under common management TLC has been planning to renew the networks and reduce anomalies in pricing. Prior to 2007 the lines charges in Ruapehu District consisted of a variable charge tied to kWh consumption, and flat monthly charges for network costs and for metering and control. One such anomaly identified by the company is holiday homes, which comprise about 25% of connected properties in the southern network, contribute to the winter demand peak, but have low use and yield little revenue from a charge based on kWh consumption. The former operator of the southern network, King Country Energy, had a philosophy of cross-subsidising the rural peripheral areas, but recent changes to charging may be seen as a harmonisation of the two networks' approaches, converging on that of the northern network that has had user pays principles since the early 1990s.

The context in which recent changes in lines charges have occurred include an requirement for increased revenue to cover asset renewal and upgrade at a time when the number of customers of Inter-connection points (ICPs) has been static or declining resulting in an increase in the average cost to be recovered per ICP. An outline of these trends for TLC is provided in Appendix C.

3.1 Recent changes in lines charges

TLC's new pricing strategy was influenced by focus group research that expressed a preference for more predictable charges than the variable charge per kWh. In the southern network it has had a number of staged components:

- Direct billing of lines charges from October 2005, separate from the electricity retailer bills
- From March 2007, replacement of the charge per kWh with the demand charge based on an assessed KW load contribution at a time of maximum peak load
- Roll out of demand meters that provide half hour demand data to selected properties from 2009, to provide more accurate assessments and provide a dataset against which to calibrate assessments from other properties
- Increase in the level of charges collected to fund network renewal and upgrades.

Another change in pricing is shifting responsibility for billing on rental properties from the tenant or current occupier to the landlord, introduced in new terms and conditions supply issued by TLC in 2009.

3.1.1 Charge setting process

The principal components of TLC's pricing now consist of a capacity charge and demand charge to cover the following elements (The Lines Company Limited, 2010):

- "Investment and maintenance costs of the assets that are either dedicated to, or are significantly influenced by, the capacity requirements of the customers
- Investment and maintenance costs of the common network
- The cost of transmission services
- Customer related costs e.g. data reconciliation, billing, individual queries"[page 1].

For the around 1,000 ICPs that currently have a demand meter fitted, the demand level is measured by selecting a period when TLC is load controlling in the winter peak and taking the ICP's highest consumption over any 3 hour period (i.e., composition of 6 half hourly usage) and dividing that by 3. This information is downloaded from the demand meters by meter readers at the property and used to calculate each property's kW load for the subsequent year's billing. A standard rate per assessed kW is then applied to set the monthly demand charge. TLC only requires data from the June-September winter peak for this calculation and a property's demand charge is only revised once a year.

For the majority of TLC's ICPs that do not have demand meters, TLC applies a formula to total recorded consumption between meter readings at the property over a 92 day period. For 2011 TLC's formulae for different types of user were:[1]:

- Less than 777kWhrs of uncontrolled consumption over a 92 day period (June - September): (0.1567*consumption^0.5259)/3
- More than 777kWhrs of uncontrolled consumption over a 92 day period (June – September): ((0.0024*consumption)+3.3359)/3
- Dairy sheds whose uncontrolled consumption is metered over a 92 day period between 1 September – 31 December: (0.0009*consumption)+2.3364.

These formulae, the coefficients of which change from year to year, impose a standard profile onto the aggregate consumption reading over the 92 day period. A customer could shift consumption away from peaks (for instance the daily morning and evening peaks) but get no benefit in reduced demand unless they reduced their total consumption over the period.

A third price setting process occurs for those with the time and ability to challenge the company's demand loading assessment, which in some cases has resulted in a reassessment and ad hoc adjustments to the demand charge for that property. Hence the possibility arises of three similar properties with similar usage patterns

[1] Source: http://www.thelinescompany.co.nz/docs/2011%20Formulae.pdf

having three different demand charge assessments because they are based on the different methods.

Customers may reduce their assessed loads by:

- Shifting more of their electricity use onto controlled circuits which TLC uses to activate ripple control at times of high loading to manage load on the network – however, there are limits to which it is feasible for customers to do without power during controlled load periods which can last several hours in some locations
- Fitting devices such as a Switchit, a plug adapter with a light that signals when load controlling occurs, or a Centometer linked to their current meter (demand meter or conventional meter) to give a read out of their real time electricity use, each of which is available at cost to the customer from TLC for about $125, to assist them in controlling the timing of their load – but these do not assist the majority of customers without demand meters who only gain relief from reducing total consumption over the 92 day period across both peak and off peak periods
- Converting to alternative energy sources where it is feasible to do so, for instance wood stoves for heating, LPG for space and water heating and cooking, solar water heating and so on.

3.2 Sapere review of TLC's pricing method

TLC recently commissioned Sapere Research Group to review its pricing method.[2] Sapere's review found it broadly consistent with the Electricity Authority's Pricing Principles and also with the Commerce Commission's Information Disclosure Guidelines. It also, however, found that much of the data held by TLC "may be inadequate in its current form to support, in a transparent manner, the demand charging method" [p14]. The report is silent on whether the pricing mechanism actually provides customers with an appropriate incentive to limit their peak time usage, and its recommendations for improving the mechanism do not address whether customers face a price that they can actually respond to, or their impact on well-being across the district.

The Sapere report makes recommendations for improving the system, including:

- Improving the measurement of demand charges for TOU customers (i.e. those with demand meters):
  - Moving from a reading on a single 3 hour peak to the average of six 2 hour periods for determining load
  - Refining the processes and data bases for calculating demand for each TOU customer, and clarifying allocation of customer readings to particular control periods
- For estimating demand charges for customers without demand meters:

[2] Sapere Research Group "Review of The Lines Company's Pricing Method" by Stuart Shepherd and Patrick Harnett, March 2011

  - Transitioning to demand formulas for each geographic area using TOU meter data as it becomes available
- Improve TLC's pricing disclosures by:
  - Changing the pricing methodology document to make it more accessible from a customer perspective, including descriptions of impacts on consumer classes.

Sapere finds the TLC pricing method generally consistent with Electricity Authority Pricing Principles, with a few reservations over the transparency of the method. However, it would be hard to conclude that TLC's demand charge in its current form meets the Authority's Principle a)iii in signalling the impact of additional usage on future investment costs when the charge is levied at a flat monthly rate through the year, that rate is changed only once a year and the rate is based on a limited period of readings retrospectively, with customers given little indication of when the readings that will determine the next year's rate will be taken. As customers with demand meters only see TOU data in retrospect if they ask for it from TLC, the signalling of peak use to users is weak to non-existent and cannot result in an efficient response.

As the time-related readings of new meters are only available to TLC some time after the use has occurred, they do not inform customers who want to know when to avoid adding to load that contributes to their demand charge. Compared to the Electricity Authority's recent discussion documents on advanced metering infrastructure with advanced meters and wide functionality, the demand meters have limited capability in improving customer awareness of power use and potential impacts on the network that affect the price they will pay.

Sapere's recommendation of moving from a single three-hour peak reading to an average of 6 two hourly peaks would address the complaint of unfairness from customers with demand meters that a year's restraint could be wasted by a single period of heavy demand that coincided with the peak controlling period from which readings are taken. However, choosing shorter two hour peaks generally means moving further up the peak so it is unlikely to provide much relief to many customers facing disproportionately large kW load readings.

4. Economic and social impacts in Ruapehu District

The impacts on electricity customers in the Ruapehu district of recent changes in lines charges can be examined at two levels. First is the experience of individual customers in facing the bills over the past 5 years since direct billing came in. Second is an analysis of changes in consumption and demands in peak periods, which is indicative of whether the new charging arrangements are equitable, effective in achieving what they are intended to do, and efficient in the way they do it.

This report has benefited from discussions with, and material provided by, a cross section of affected people across Ruapehu District and Turangi about the impacts of lines charges over the past five years. These discussions involved about 30 residents of the Ruapehu District and a few others from outside the district who have an interest in the area. They included those with interests as electricity customers in the residential sector, property rentals, farming and tourism, including accommodation providers, ski clubs and Ruapehu Alpine Lifts.

Survey participants were largely self-selected and do not provide a statistically representative sample of customers as a whole. However, their experience provides illustrations of a range of impacts of the charging mechanism. Concerns raised by respondents can be summarised under a few recurring themes.

The first is a straightforward **concern about rising costs** for an essential service and input to consumption and production activities. Next is **concern about the transparency** of the processes for setting the charges and seeking reassessments, reflecting uncertainty in the charging procedure and the timing of when assessments are taken. The last two bullets are **concerns about failings in the regulatory oversight** of the company's activities arising from its position as monopoly supplier of lines services in its area. The following section looks at the issues under these headings, and highlights experiences in particular sectors.

4.1 Impacts on electricity consumers

4.1.1 Themes from reported impacts

a) Rising costs

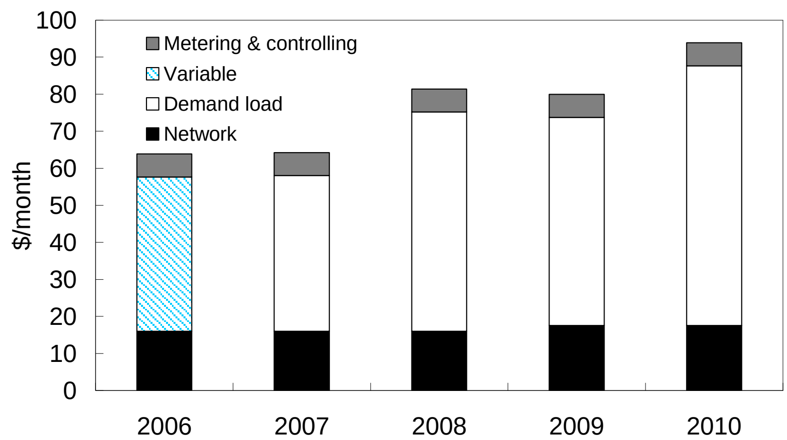
Customers across a range of sectors have reported steep increases in the lines charges over the past 5 years. Common concerns raised were:

- The rapid rise in electricity lines bills in recent years
- That lines charges now exceed electricity consumption bills for some properties, and continue at their high level even when no power is used
- Variation in bills according to which method is used to set charges, with the installation of demand meters commonly being accompanied by a steep increase in assessed peak load and associated bill throughout the year.

Some discussants have provided power and lines bills from before and after the recent changes, which show change in the level well above the rate of general inflation and also changes in the composition of lines charges. Rates of increase are commonly in the range of 8-10% per year on average, similar to the average annual rate of just under 9% growth in TLC's lines revenues from the southern network.

Charges increased most on introduction of the demand charge in 2007/08, with a further big increase in 2010. For individual properties this could reflect both increase in assessed kW load contribution and increase in the TLC rate. However, similar variation is reflected in TLC's annual reports so this figure need not be far from a typical experience.

Figure 1 Progression in charges over time



Source: NZIER

b) Transparency

Customers' concerns about transparency of the charging mechanism appear to be centred on three sources:

- Uncertainty around the basis for setting the demand charge, and when the critical load periods occur at which peak loads are assessed
- Frustration at TLC's communication with customers and difficulty in explaining how the generalised approach to charging is translated to individual properties
- Lack of confidence in the equity of the method and the equivalence of charges that arise from the method applied to customers with demand meters, the method applied to those with old meters, and the ad hoc adjustments that some have received on the basis of challenging the initial assessments.

Uncertainty over when customers should manage demand reduces efficiency of the current pricing method. TLC notes with some justification that it cannot predict precisely when loading becomes critical, but it will know better than most of its customers when critical loads are most likely to occur and when restraint will assist in managing the system. Those periods are the ones that should bear the highest charge to be truly cost-reflective, and if conveyed to customers would enable them to cut or switch power use more efficiently than at present when any time during a 3 month peak season is potentially at risk of recording a critical peak reading.

Lack of transparency in explaining the charge setting mechanism and its application to particular properties is also a commonly voiced concern. The Sapere report acknowledges this in recommending TLC revises its pricing methodology document and its pricing schedules to make them more accessible from a customer perspective (page iv).

Improving the clarity of explanation would serve to redress the lack of confidence expressed around the equivalence of the different bases for setting charges. That some customers experience a sharp increase in assessed load and charges when moving from volumetric to demand meter basis is indicative that the current formulae applied to volumetric meter readings are not representative of all properties in their class and the potential for "bill shock" would be reduced if customers had a clearer idea of the transition from one basis of charging to another.

c) Regulatory oversight

TLC is a regulated lines company subject to a number of restraints on activity administered by the Electricity Authority, Commerce Commission, and the Electricity and Gas Complaints Commission (see Appendix C). None of the recent changes to lines charges by TLC, and the rise in costs to be recovered, have triggered a response from the main regulatory agencies. The Electricity and Gas Complaints Commission has upheld one complaint brought before it, but its jurisdiction is being challenged by TLC.

Regulatory agencies may be reluctant to intervene because this is seen as a unique case (which it is, given TLC is the only lines company direct billing in this manner) or primarily an issue about distribution of costs and hence more concerned about equity than efficiency matters. However, compared to international practice in peak pricing the current demand charge appears at odds to the time-reflective pricing of peak loads in international practice, and also of questionable consistency with the Electricity Authority's Distribution Pricing Principle a(iii) which is about signalling to the extent practicable the impact of additional usage on future investment costs.[3] That principle is fundamentally about the efficiency of the pricing signal and it is one where the demand charge and the manner of its assessment bear closer consideration.

4.1.2 Impacts on sectors

Many of the businesses interviewed are not well placed to absorb increased lines costs, invest in alternative energy sources or pass on costs to their customers. Many

[3] Electricity Commission (2010) "Distribution Pricing Principles and Information Disclosure Guidelines ", Wellington, February 2010

tourism and accommodation businesses have a weak cash flow dependent on business concentrated in the four months of the ski season. If they do seek alternative energy they may find the TLC charges change little. Businesses in nearby areas like Raetihi and Taupo which are not on the TLC network or subject to its charge increases appear to have a competitive advantage.

a) Tourism and accommodation sector

Tourism and farming are two of the principal industries for generating revenues and bringing wealth into the Ruapehu District. Two characteristics of tourism in the district are:

- Highly seasonal demand, with most activity concentrated in the 4 months of the winter ski season that coincides with TLC's peak demand, and for some tourism businesses perhaps one or two months of heightened activity in the summer
- A high proportion of relatively small tourism operators and accommodation providers, with low turnover and high potential impact from an increase in fixed costs like lines charges.

Another characteristic is that, although the mountains and skifields of Tongariro National Park are major visitor draw-cards, accommodation businesses within the Ruapehu District face competition from outside the district in places like Taupo, and a proportion of visitors come as day visitors from Hamilton or Rotorua, which constrains the ability of local accommodation providers to pass on cost increases that are not shared outside the district. In summer visitors commonly make short visits passing through to other places, and spend proportionately more of their visit inside the National Park using basic accommodation provided by Department of Conservation.

Rooms and accommodation units can be converted to low wattage economy heaters to help control the load, but cannot eliminate the risk that tourism behaviour creates spiked demand that increases the lines charge for future years. Camper vans present a recurring risk to motor camp operators, and removing the power from camper van sites is not a useful business strategy for attracting customers who may just as well drive down the road to another site. One camp operator traced the high loading that increased their demand charge to a single party of overseas tourists who came with electronic devices.

Bottled LPG gas can be a substitute for heating and cooking appliances, but requires substantial capital investment. At least one tourism business is planning to go off-grid altogether, installing solar water heating and a diesel generator to provide power for appliances. Such conversions involve substantial costs, and affected businesses have faced additional expenses such as $30,000 for LPG installation to almost $100,000 for an off-grid make-over. Resorting to self-sufficient generation runs the risk of susceptibility to system breakdown, and loses the resilience conferred by connection to a network with a mix of contributing suppliers. In general, LPG heating with fixed flued heaters is around 3 times more expensive per kWh equivalent than modern electric heat pumps, but heat pumps contribute to assessed load which LPG avoids.[4] Reliance on diesel generators does not fit well with businesses trying to achieve accreditation on sound environmental management.

The smaller businesses that lack the capital to lessen their liability for lines charges by investing in energy alternatives may engage in counter-productive activity, such as shutting down high loading appliances like drying rooms or hot tubs that skiers might expect to need after a day on the mountain. Some have also reported changing the hours of meal times or cutting back on meals altogether. A combination of small size and low occupancy due to seasonality increases the difficulty of managing a year-round charge based on the winter season peak. Lines charges can amount to a substantial proportion of the revenues of these small enterprises – for instance over 10% of the gross revenues of small rented accommodation – lowering the viability of what are already marginal enterprises. By reducing the net rental stream increased lines charges also erode the value of these enterprises, which detracts from the wealth of their owners but benefits future purchasers.

b) Farming

In Ruapehu District, the principal farm enterprises are pastoral sheep and beef production, with smaller presence of other livestock like deer. Dairying is relatively less significant than on the area served by TLC's northern network, and much of the country in Ruapehu District has a terrain that limits the scope for future dairy conversion, leaving forestry as a more likely alternative to the current pastoral production. Forest growing and harvesting makes relatively little demand on electricity, and wood processing can be undertaken outside the Ruapehu District if cost differentials make that worthwhile.

Sheep-beef farms commonly retain properties that are used for only part of the year, but now face a monthly charge based on a peak load calculation that bears no relation to total electricity consumption at that property. These include farm cottages, which may be used for temporary accommodation for shearing gangs and other workers, and woolsheds that need power mainly for the intense use over a couple of weeks for shearing. Farmers have multiple ICPs and may face "legacy bills" from the high use of previous tenants. Some have been choosing to disconnect properties from the lines network to avoid paying high lines bills. Some have incurred costs to re-orient their electricity circuits on the farm around fewer ICPs or transformers to reduce the number of bills they pay, or have installed alternatives like solar power for electric fencing or generators for temporary accommodation. Some have reported achieving little relief from this, because their remote location on low density lines means that much of the line cost is simply reallocated to the lines bills on their remaining properties that share the same line.

[4] See NZIER (2010) "Review of unflued LPG cabinet heaters"; Report to Ministry of Economic Development (Energy Safety), page 23 comparisons http://www.energysafety.govt.nz/upload/74836/NZIER%20LPG%20cabinet%20heater%20review%2025%20May%202010.pdf

Farmers report a cost of $1200-$1400 per ICP to be common on these properties. This may be small in the context of farm turnover measured in the hundreds of thousands of dollars, but with multiple ICPs has resulted in noticeable increases in a fixed component of cost.

c) Rental property sector

Owners of rental properties are also concerned by the practice of "legacy charging" in which they are faced with a demand charge imposed by the previous tenant's usage when taking over a vacated property; and by specific moves by TLC to make landlords responsible for the peak charges incurred by their tenants. Reviews only happen once a year, so even closing down a shop and reducing power use can leave them with a sizable bill to pay from no revenue in the months after closure, and the risk of disconnection if bills of previous tenants remain unpaid. The Electricity and Gas Complaints Commission has found in favour of the landowner in one such case, but TLC is challenging this in the courts.

d) Other

Residential customers have faced similar issues with bill shock, lack of transparency and no avenues for redress as businesses, but as end use consumers have no prospect of recovering increased costs by passing them onto their customers. The impact is particularly hard for those on fixed incomes, such as pensioners: there have been cases of small households making frugal use of electricity through the year facing a legacy of high bills from the effect of visitors on a single weekend. As with landlords, residential customers face legacy bills based on the previous occupant's usage when first moving into a property, whether rented or owner occupied. The effect of an increase in line charges is to detract from their disposable income and their ability to pay for consumption of other goods and services.

Increases in line charges can be expected to fall hard on those on fixed incomes such as the retired and elderly, but also those with high demands on their incomes. According to the last Census Ruapehu District has a small and young population, with a median age below the national average pulled down by a large proportion of under 15 year olds and median income levels are also below the national average.

4.2 Equity of the current lines charges

Unlike efficiency, which has well-defined measures of assessment such as minimising costs per unit output or maximising net present values over time, there are no well-defined economic criteria for what is equitable or fair. Economics can identify distributional consequences of particular actions, and categorise them in terms such as horizontal equity (equal treatment for equal entities), vertical equity (unequal treatment according to some distinguishing characteristic) or inter-temporal equity, but whether a particular distribution is considered fair or equitable depends on socio-political judgements of what is reasonable under the circumstances. Equal treatment of entities may be considered "not fair" if they have vastly different abilities to pay, or different responsibilities for, or control over, the costs which are being distributed.

The way the current demand charge mechanism is applied has some resemblance to local authority rates, in which a certain cost needs to be recovered from a collective of beneficiaries and is allocated across them on a proxy measure of their individual contribution to them. With rates that proxy measure is a property's share of the total property value in the district. With the demand charge that proxy measure is a share of the total demand loading in the peak period when the network is constrained. That resemblance to rates is reinforced by TLC's change in conditions of supply to make property owners responsible for unpaid lines bills of tenants in their properties.

Given the similarity to property tax, lines charges might apply similar principles to those laid down in 1776 by Adam Smith in his *The Wealth of Nations* and amended by Henry George in the late 19th Century (NZIER 2007), particularly with regard to the timing and amount to be paid being certain to the payer; bearing as lightly as possible on production; and bearing equally so as to give no individual an advantage over another.

The timing and amount of demand charge to be paid may appear certain once the constant monthly charge is set, but the uncertainty as to how much the charge will be before it is set and inability to reduce until another year's assessment pass provides little ability for businesses and other customers to plan for the year ahead or determine means of reducing the charge in future. It is also arguable that the charges do not bear lightly on some types of production and the chance element in setting the level of the demand charge gives the appearance of unfairness.

Because of this lack of precision, fairness is not as high on the economic scale of economic criteria as efficiency. But unless arrangements are seen as fair, people will not self-comply, detracting from efficiency by increasing transaction costs in enforcement and compliance.

If a company is going to impose itself on its customers by introducing onerous or restrictive requirements, it needs a sound justification for its actions. TLC makes a reasonable case that providing for replacement of assets requires some increase in prices and a focus on peak loading, but its demand charge based on a single assessed peak and set at a uniform monthly charge through the year is hardly giving customers a better awareness of the "true costs" they are imposing on the system or when they occur. If the company cannot do what it needs to do – namely apply cost-reflective time-varying charging in which variable prices are signalled and customers have incentive to avoid the peak periods – it is not efficient devising some partial alternative and passing it off as the real thing. This undermines the trust between company and customers and creates costs in trying to resolve this.

The company can gauge from the number of complaints whether its actions come across as fair. Beyond some threshold it should admit that they don't and change the approach accordingly.

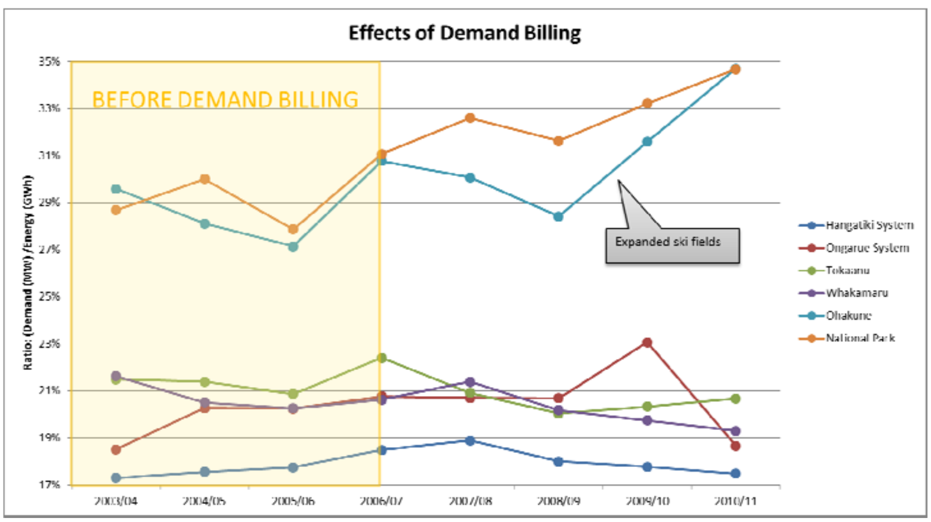
4.3 Effectiveness of the current lines charges

4.3.1 TLC assessment of effectiveness

TLC justifies its recent charging changes by its requirement for new capacity at peak times growing faster than the revenue it receives, so curbing the peak should also reduce capital expansion costs. In trying to sheet the costs home to those responsible for adding to peak demands it also has a stated aim of reducing the amount that gets spread across a wider population of users, many of whom have low income and can ill-afford to pay for new capacity necessitated by the peak use of others.

In its Asset Management Plan (AMP), TLC analyses the effects of the new charges after 3 years of operation by developing a ratio of the overall demand divided by the total amount of energy used for that year, which should be low in a system that can control its peak loads effectively. TLC regards it as a better indicator to analyse demand billing than demand itself that can be influenced by load growth and the current economic situation. The AMP's Figure 5.8 below plots this ratio for each of TLC's supply areas for the period 2004 to the current year.

Figure 2 The ratio of demand to energy for TLC's supply points



Source: TLC Asset Management Plan 2011, Figure 5.8

The results to date are mixed (Figure 2). The figure shows Ohakune and National Park peak demands increasing each year relative to their increase in energy. "It illustrates the dilemma TLC has in these areas... with respect to trying to recover revenue for these from energy based charges. Prices would become very expensive and have to be funded from all energy users, not just the ones creating the peak."(TLC AMP 2011) The AMP suggests ski operators increased capacity during late 2008 before the 2009 season, which both increased ski field use of power and attracted more people into power-using accommodation. It asserts that, due to demand billing, many of the residents have changed to non-electric hot water heating, reducing both demand and energy requirements. However, it has not yet been able to draw firm conclusions from data at this time on how much the load would have increased without the demand billing.

TLC's AMP further claims that Taumarunui and Turangi achieved 0.7% and 0.6% reductions in demand in response to the changes. Although the charge changes have no visible effect in Ohakune and National Park, the counter-factual without charge changes could have been even higher demand growth.

4.3.2 Effects on aggregate consumption

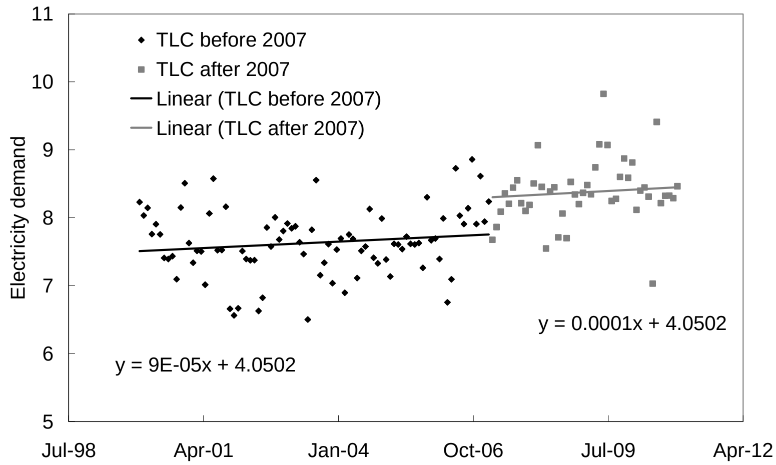
One indication of effectiveness of the change in charging would be to compare electricity demand in the Ruapehu district before and after March 2007 when the demand charge came in. Data used in this section is from the Electricity Authority online database (centralised dataset). TLC demand is calculated as the sum of the four Grid Exit Points (GXPs) in the Ruapehu District and is seasonally adjusted. Data covers the time period from January 2000 to December 2010.

There are four GXPs feeding the TLC network in Ruapehu District, at Ongarue (Taumaranui), National Park, Ohakune and Tokaanu (Turangi). Locations connected to the Grid gain resilience from the ability to obtain power from more distant generators and even out variability in supply from localised generation (such as when dry spells constrain hydro generation). The cost of supplying electricity to any location therefore encompasses the cost of electricity consumed (which varies with supply and demand conditions in the wholesale electricity market), a share of the cost of the national transmission grid and a share of the cost of the local distribution lines network.

The plot below shows how the electricity consumption has changed before (black dots) and after March 2007 (grey dots). Fitting a regression line through these dots and treating the before and after 2007 periods as separate suggests there was a step up in electricity consumption after 2007. The regression line after 2007 has a slightly steeper slope, which indicates an increase in the use of TLC electricity after 2007 when the meters change came in.

This is contrary to what would be expected with an increase in price and is suggestive of demand shifting in response to other influences. TLC has pointed to extra electricity consumption on the skifields and to increased uptake of heat pumps as possible causes for consumption increase and increased load on the network in the peak season

Figure 3 Ruapehu electricity use over time



Source: NZIER from Electricity Authority Centralised Data Base

4.3.3 Analysis of TLC data

The justification for TLC's charge changes has been to provide appropriate incentives for shifting demand off the peak winter period. Analysis of TLC's own billing data over the 5 years since direct billing began might show whether the changes have been having their desired effect.

Aggregating the data at meter level to ICP level, then linking the individual ICPs through the 5 years as much as possible, a fixed effect model has been used to estimate the peak demand changes over the 5 year period for a typical customer, distinguishing by customer type and by location. The results presented in the tables below suggest that the peak demand has decreased since 2007 in general. The table should be read as follows, for example, in regard to residential customer, peak demand in 2007 decreased by 3.4% compared with that in 2006, peak demand in 2008 decreased by 4.4% compared with that in 2006, etc.

Table 1 shows that across customer types, the hospitality industry and to lesser extent industrial and commercial customers have been unable to reduce their peak-time demands in some years, consistent with the difficulties expressed by affected electricity consumers in tourism and accommodation businesses. It also shows the individual data shows demand has decreased across all areas within Ruapehu District.

Table 1 Changes in individual peak time demand

Demand Changes (%) over 2006 by Customer Type					
	Residential	Commercial	Industrial	Hospitality	Dairy
2007	-3.4%	-10.9%	-13.4%	-12.0%	-6.3%
2008	-4.4%	-3.8%	2.8%	15.1%	-4.0%
2009	-3.0%	0.3%	-0.6%	3.0%	-4.6%
2010	-6.9%	-3.0%	-21.2%	-5.2%	-12.5%

By location

	NPK	OKN	ONG	TKU
2007	-12.4%	-12.6%	-4.0%	-5.9%
2008	-6.6%	-10.5%	-6.4%	-6.1%
2009	-6.5%	-2.4%	-3.2%	0.0%
2010	-14.1%	-12.1%	-7.8%	-7.1%

Source: NZIER from TLC data

These results differ from those in TLC's analysis in Figure 2 because whereas that figure looks at the aggregated level peak demand and hence reflects the effect of adding new customers, the analysis in this table looks at a representative individual customer's peak time demand over the 5 years. The individual level data suggest there has been reduction in peak time demand in all parts of Ruapehu district, whereas aggregate level data suggest that in two areas, Ohakune and National Park, that individual restraint is more than offset by growth in the aggregate loads driven by new customers or new loads. However, given the quality of the data, which contain many omissions and errors in their raw form and need to be cleansed for analysis, the results need to be interpreted with caution.

If peak demands have gone down in Ruapehu since the charge changes, the question arises as to what is the price elasticity (or price responsiveness) of demand in the District. Analysis of TLC's winter peak billing data suggests a relatively high price elasticity of around -1. However, customers respond to the total price of delivered electricity, not just to changes in one component of that price.

Four electricity retailers currently deliver energy to customers over TLC's southern network in Ruapehu District, and there is no central record of the average retail price across all of them. Using results of a Ministry of Economic Development survey of lines and energy retail prices in the TLC area, and scaling these by national relativities between lines and energy costs across residential, industrial and commercial sectors, it appears the electricity component will have contributed slightly more than the lines component to the total increase in electricity retail price, so the elasticity with respect to lines price alone would be less than -1.

Issues around data quality mean these results need to be treated with caution. Even if the demand charge is effective in curbing demand at peak times, that does not necessarily mean it is being done in an efficient manner.

4.4 Efficiency of the current lines charges

Efficiency refers to the ability of a policy or action to achieve its effect at lowest resource cost. It requires setting clear and unambiguous price signals that customers can respond to, and minimising the transaction costs of implementing the charging regime for both those collecting and those paying the charge. In principle there is an economically efficient optimum at which it would not be possible to change the distribution of costs to make one person better off without an offsetting loss incurred by someone else. Conversely, starting from a point of inefficiency it is possible to make changes where the gainers gain more than the loss to those who lose out, so the gainers could in principle compensate the losers and all would end up no worse off than before, while at least some end up better off.

Methods of supply and charging for electricity services, both power consumption and lines charges, are likely to change as suppliers seek to manage growing demands on the systems and technology improvements allow refinement in charging. On any network infrastructure there is solid economic grounding for pricing peak use, as this is what drives the requirement for new capacity. Improving the efficiency of electricity systems, improving pricing signals and increasing demand side participation are all common features of electricity supply across countries.

TLC's method of demand charge, which is collected at a flat monthly rate through the year along with other charge components, appears unique among demand charges in use around the world in not having a time variable component to it. This has some counter-productive effects:

- **Pricing signalling is weak or inadequate**: Our review of theory and practice suggest that TLC's lines charges do not provide a price signal that customers can respond to in a sensible way. Firstly, it is clear that consumer demand response was the main driver behind introducing the demand charge and demand meters. Consumer demand response requires a pricing signal that the consumer can detect and act upon. For the TLC consumers, the only pricing signal is through the lines bill, which may be an estimate and which provides information that is retrospective and will probably not reflect the actual resource (or economic) cost of their consumption over the billing period. Secondly, the demand charge does not vary with the peaks, is changed only once a year, and uncertainty as to when the load reading on which it is based will be taken provides little basis for customers to respond rationally to it. Additionally, customers without demand meters have little access to their daily usage data that would allow comparisons to demand-meter-customers, and even if they did they have limited options to respond, because TLC's formula applies a standard profile to total consumption and does not recognise, for instance, deliberate actions to shift demand from the daily peaks to off-peak periods. These factors are additional obstacles to implementation.

- **Uneconomical for consumers who have inelastic demand**: TLC coverage areas have strong seasonal/timing elements, for example, electricity in the skiing season, and woolsheds are provided with power for short shearing seasons. If certain electricity consumption needs to take place at particular times, a high peak demand charge will have strong impact on commercial activities and may contribute to some eventually exiting the market. One potential solution for those who have inelastic demand is to invest in alternative energy resources. The alternative energy resources can directly feed electricity into commercial usage. Another issue is that some residential consumers have favourable consumption patterns. Implementation of TLC's peak load pricing will cost them more in maintaining their consumption pattern. Thus, the current method only favours customers who can manage their usage to be high during the off-peak period and low usage during the peak period.
- **Problem with asymmetric information**: In principle, a smart meter's advanced communication between users and operator can be useful for overcoming asymmetric information between supplier and consumers. Under the assumption of full information, consumers have the ability to change their consumption by knowing when and how to shift. However, TLC uses demand meters with limited functionality as a tool to determine its charging levels. More importantly, 95% of TLC customers have not had demand meters installed, which limits consumers' confidence in the reliability of charge setting and also their ability to anticipate peak loads and change their demand. Demand meters do not provide enough information for consumers to monitor their peak loading and charging method.

The ability of meters to convey a meaningful price signal is a constraint on the application of such charges. In Ruapehu District, where 95% of meters give simple consumption volume readings, TOU differential pricing could not be introduced, except through a simple peak season surcharge. That would be a fairly crude pricing measure that could raise issues of affordability. But the current demand charge gives little signal to customers of when to restrain demand for the benefit of the network. The adverse publicity generated by the charges may instil a fear of power use that may cause some customers to reduce the demand but without a clearer link to when demand needs to be reduced that will not be an efficient market signal and could result in needless disruption from customers applying restraint at times when they do not need to.

The current charge system creates a double jeopardy of high charges for consumers because most customers:

- have no real time information on when high use is occurring
- have no indication of when the critical peaks on which charges will be based will occur.

This creates uncertainty for customers and the likelihood of inefficient responses. Although TLC's pricing method aims to reflect to customers the costs that their usage imposes on the operations and expansion of the TLC network, the reliance on single peak readings or standardised formulas for imposing use profiles for setting a charge that applies through the year makes it unlikely that the charge will reflect the true cost of the individual ICP, leading to capriciousness in application and appearance of unfairness amongst the customers affected by the system.

5. Implications of the current lines charges

The changes in price and consumption resulting from TLC's decision to move to a peak-pricing rule have been explored so far. The next stage of our investigation is to ask what impact that would have on the district's economy. To estimate that effect we used our computable general equilibrium (CGE) model of the New Zealand economy, customised for the Ruapehu district.

CGE modelling is a highly-respected and well-developed technique that has a rich history for assessing policy, regional and industry questions. It captures the various inter-linkages between sectors, as well as their links to households (via the labour market), the government sector, capital markets and the global economy (via imports and exports). More technical detail on the model is presented in Appendix A.

5.1 Modelling approach

5.1.1 The electricity sector

The rule change directly affects only the lines component of the electricity price. Our model separates the electricity sector into two parts: the generation side and the transmission side (which in the terms of the model includes both national grid transmission and distribution lines networks). For this simulation we focussed on the price charged by the transmission industry to both consumers and industries.

5.1.2 Shocks

To simulate the effect of the rule change we simply use estimated price and value changes and impose them on the electricity transmission sector. We assume that the price rise is generated by increased profit margins at the transmission level.

Annual reports indicate that TLC's profits across its entire network have risen by $5.8 million between 2007 and 2010. We assume that the profits attributable to the southern network are responsible for half of the increase and use that value of $2.9 million as the shock in our modelling. Note that these assumptions mean we are calculating the cumulative effect of the increased charges over the three year period, not an average annual impact.

5.2 Impact of the price change

In this section we review the impact of implementing the price rise as discussed in Section 5.1.2. For technical details on the results and their interpretation see Appendix D5.

5.2.1 Direct effects

The direct effect in the simulation is the increase in TLC's profits by $2.9 million, all of which is extracted from households and industries in the Ruapehu region. That generates electricity prices that are nearly 7% higher for households and businesses in the Ruapehu region and reduces the quantity of electricity consumed as people decrease their consumption in the face of the price rise.

Lower demand for electricity in the Ruapehu region also flows through the electricity sector and marginally decreases the price received for electricity by transmission companies and generators across the nation.[5]

5.2.2 Indirect effects

While much of the impact is borne by households, the price rise has flow-on effects on numerous other industries. Initially, it generates additional costs for industries that use a lot of electricity such as the paper manufacturing and sawmilling sectors. The sawmilling sector in Ruapehu uses about $710,000 of electricity per year and the increased costs contribute to a rise in the prices they charge. That reduces their sales and sees their revenues decline by $83,000 per year (see Table 2). However, since electricity costs are less than 1% of most firms' expenses the impact on downstream industries is eclipsed by the decline in household expenditure.

The increased cost of electricity reduces discretionary incomes in the region, which then reduces households' consumption spending. Firms that sell services directly to households are the worst affected in the region. Those who, additionally, see their costs rise due to higher electricity prices are doubly affected. Food service providers, such as bars and restaurants use $160,000 of electricity per year in the region but also sell directly to consumers. That makes them particularly vulnerable to electricity price rises and that is reflected in the $44,000 cost to that industry from the rule change.

[5] This is a simplification of the electricity market and assumes no frictions and continuous supply curves. Nonetheless, we have no evidence to suggest that the impact on the upstream supply chain would be zero, although it would doubtless be extremely small given the magnitude of the shock.

Table 2 Indirect impacts on selected industries

Cumulative percentage change in output from baseline, selected industries

Industry	Type	Cost of rule change	Reduction of output
Paper production	Downstream	-$130,000	-0.11%
Forestry	Downstream	-$38,000	-0.11%
Beef farming	Downstream	-$65,000	-0.06%
Accommodation	Household expenditure	-$78,000	-0.31%
Sport and recreation	Household expenditure	-$46,000	-0.52%
Bars and restaurants	Household expenditure	-$44,000	-0.33%

Source: NZIER

It is important to note that the small percentages in Table 2 do not indicate that the impact on any one business is small. Within each sector there may well be many businesses for whom a rise in electricity prices is the difference between survival and bankruptcy. Unfortunately, the available data does not allow us to examine the impact at such a disaggregated level.

5.2.3 Overall impact on Ruapehu region

The overall regional results flow logically from the direct and indirect impacts. We focus on key macroeconomic variables such as employment and Gross Regional Product (GRP). In addition, we report the impact on household consumption, which indirectly shows how the price rise has affected disposable incomes.

Table 3 summarises the overall regional impacts. The change in GRP is the sum of the indirect effects on businesses that are described above. The drop in household spending is a consequence of the drop in incomes, as reflected by the jobs lost as a result of the price rise. That drop in discretionary income carries through to the lost household spending, which shows that the price rise has reduced household spending by over $2 million in the Ruapehu region.

Note that this is an aggregate figure and doesn't show the costs borne by individuals. There are likely to be some households for which the price rise is particularly difficult and others who hardly notice it in the weekly budget. Our modelling does not capture these individual differences.

Table 3 Regional impact of rule change

Cumulative percentage change from baseline

Indicator	Percentage change	Real value change
GRP	-0.44%	-$1.9 million
Employment	-0.32%	-16 jobs
Household spending	-0.78%	-$2.1 million

Source: NZIER

6. Conclusions

This report has examined the economic and social impacts in Ruapehu District of recent changes in electricity lines charges.

The lines charges in the Ruapehu district have increased over the past 5 years, reflecting two compounding effects:

- Change in the charging mechanism from a variable charge per kWh to a demand charge set at a flat monthly rate based on assessed contribution to KW peak loading in a single period in the peak
- Increase in the revenue sought to recover the fully distributed costs of the network, which have risen to reflect renewal and upgrade of an aging lines network and upward revision of the asset valuation.

Normally a change in pricing structure results in redistribution of liability for costs which results in some people ending up better off than before and some people worse off. In Ruapehu district the public clamour on recent changes in lines charges appears predominantly negative. Most of those consulted for this report have experienced substantial increase in their lines charges and difficulty in understanding and predicting how the charge will change in future. There may be some who have received a lower charge under this – but that benefit may have been overshadowed by the revenue increases required to meet costs of renewal and upgrade.

6.1 Findings

International literature shows there is widespread interest in demand charging as a means of shifting loads off the peak periods, often in conjunction with introduction of smart meters. Such shifting has the economic benefit of deferring the date when new capacity needs to be installed, and is efficient as long as the marginal benefit of shifting (upgrade deferment) is greater than the marginal cost incurred in making the shift. That marginal cost is largely borne by customers who pay more for energy or bear the cost in inconvenience in changing power use patterns. But it also has effects beyond immediate customers to the extent that their increased costs lower the transactions they generate with other businesses.

All examples found of these demand charges include an element of time varying charging – time of use pricing, critical peak pricing, real time pricing etc. Setting a demand charge as a flat charge on the basis of a single peak load reading appears to be unique to TLC. Much of the literature is linked to discussion of the use of smart meters to enable greater "demand-side participation" in the electricity market, an essential part of which is that such meters make customers better informed of their electricity use and better able to respond reasonably to price signals. The demand meters being rolled out by TLC do not have the features of such smart meters.

It is clear that some customers have faced substantial increase in their lines charges, well above the rate of inflation. It is not clear how "representative" these are. A combination of an old network needing renewal, a highly peaked demand around the winter ski season and some relatively small business enterprises with strong seasonality in power use and revenue flows makes line charge increases of recent levels a threat to the continued viability of some of these enterprises.

Data analysis shows some mixed results:

- Analysis of the power taken off the four grid exit points into the local network in Ruapehu District over a 10 year period shows a step *increase* in electricity consumption following introduction of the demand charge – despite the increase in lines charge component and decline in the number of ICPs/customers in the district, implying a demand shift for reasons other than price. TLC has attributed such changes in aggregate consumption and load to increases in consumption on the district's skifields and ancillary businesses and among residential properties installing heat-pumps under recent government-sponsored schemes.
- Analysis of TLC's billing data at the individual level, which is confined to the 3 month winter peak period over the 5 years since direct billing was introduced, suggests there has been some reduction in the peak, but not evenly across customer types or areas within Ruapehu District.

Modelling the effects of lines charge increases on the district-wide economy of Ruapehu District shows some modest adverse effects on the district's economy as a whole. This is because in the context of a general equilibrium model of economic activity that allows for resources to change price and reallocate across sectors there will be offsetting gains and losses across sectors. Such analysis looks at the overall effect and does not pick up all the effects at the margin on the individual businesses which exit or attempt to enter the local market.

6.2 Assessment

6.2.1 Equity in the setting of charges for collective services

Equity refers to the fairness of the charges in distributing costs and benefits across the community. Although economics can identify distributional consequences of particular actions, and categorise them in terms such as horizontal equity (equal treatment for equal entities), vertical equity (unequal treatment according to some distinguishing characteristic) or inter-temporal equity, whether a particular distribution is considered fair or equitable depends on socio-political judgements of what is reasonable under the circumstances.

There is clearly a deeply held sentiment in Ruapehu District that the recent lines charges are not fair in terms of the level of charge being levied on some properties (even those empty and yielding no income), the difficulty of predicting them and taking steps to reduce them, and the perception of uneven treatment of similar properties according to what kind of meter they are operating. Unless arrangements are seen as fair, people will not self-comply and efficiency gets detracted by increasing transaction costs in enforcement and compliance.

6.2.2 Effectiveness of the current lines charges

Effectiveness refers to the extent to which a policy or course of action achieves what it set out to do. The changes to lines charges in Ruapehu District are intended to give customers a signal of the costs their use imposes on the network and to lower demand at peak periods.

The evidence to date is mixed. While TLC's AMP shows some improvement in the ratio of demand to energy for the Turangi and Taumarunui areas, demand continues to rise relative to energy consumption in National Park and Ohakune, driven by activities on the ski-field and associated businesses. Across the district power off-take from the national grid appears to have risen over the same period that the charges have been increased, suggesting a demand shift driven by a factor other than price. And while analysis across the district by customer type suggests that peak consumption reduced in face of rising charges, the estimated price elasticity is improbably high and suggests increases in the price of power will have affected the result as well.

6.2.3 Efficiency of the current lines charges

Efficiency refers to the ability of a policy or action to achieve its effect at lowest resource cost. It requires setting clear and unambiguous price signals that customers can respond to, and minimising the transaction costs of implementing the charging regime.

While it can be efficient to increase prices at peak times on a network in order to defer the date at which network expansion is required there are multiple reasons to expect the current lines charges in Ruapehu District to not be efficient.

- The demand charge does not provide a time-differentiated charge that signals the actual peak periods when restraining consumption would be most valuable
- Customers have no way of anticipating critical peak periods, so are likely to restrain use when it is not necessary to do so and fail to restrain as much as they could when it is important to do so
- Lack of transparency over the application of the charge creates transaction costs for the company and its customers in challenges and calls for reassessment of bills

- The lack of signalling of when the load assessments that determine the demand charge are to take place creates uncertainty for customers and causes them to respond with inefficient behaviours.

Recent suggestions to change some of the processes around charge setting address some of the perceived inequities but do not correct the inefficiencies inherent in the current charges.

6.3 Implications for Ruapehu District

TLC has an aging network in Ruapehu District in need of renewal, but no great capacity to spread costs of upgrade across the population at large. But impacts on the community would be less if they avoided the mystery load lottery that causes undue uncertainty for customers as to when to use power during the peak and causes difficulties for forward planning ahead of the next year's charge coming in.

Metering infrastructure is currently quite limited in its ability to provide critical peak price signals. Possibilities include:

- Seasonal surcharge on lines charges during the peak winter period, with a return to a charge component per kWh. A number of customers seem comfortable with the idea of paying for what they use, and prefer to handle the variability this would introduce to their charges to the one off uncertainty of how the annual charge will be set.
- Seasonal surcharges could fall heavily on certain vulnerable groups of customers, the elderly or those on low incomes with limited options for heating. This could be addressed by introducing a rising tariff that increases with increases in consumption, so that the heaviest users face the highest charges and have the greatest incentive to economise or find substitutes at the margin.

As with networks the world over, in the longer term TLC needs to encourage demand side participation to improve the efficiency of managing its network. This includes rolling out meter technology with the capability of informing customers of their power use and load contribution so they can better manage it. The current course with existing demand meters may suit TLC for its billing purposes but is not helping its customers, and is locking the district into limited-capability meters until the current stock of demand meters is due for replacement, which may be 15 years ahead.

For the Ruapehu District Council a number of potential courses of action emerge from this report

- Commission a representative survey of residents to identify impacts of the new charges on affordability and economic consequences and establish the extent of the problems in the district
- Commission an assessment of the electrical system across the network and the renewal programme which is contributing to the increase in costs recovered by lines charges

- Engage with The Lines Company on alternatives to the current course, which may include resorting to an element of time-varying peak pricing or the use of alternatives to the demand meters that give customers greater incentive to manage the load than the fear of an unpredictable load assessment
- Engage with the Electricity Authority and other regulatory bodies to investigate the efficiency effects of the current lines charges rather than viewing it as a matter of pure distribution.

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Appendix B Economics of electricity systems

To give some perspective on the issues around lines charging in Ruapehu District, it is useful to consider the context of trends in electricity supply and consumption in New Zealand, how TLC's actions respond to those trends, and what theory and international practice would suggest as responses to those trends.

B.1 Trends in electricity supply and consumption

Electricity is an essential input for modern lifestyles and for commercial and industrial activity. In recent years it has accounted for just over 25% of consumer energy in New Zealand, second only to oil.[6] For many uses, there is no effective substitute for electricity, such that, at least in the short run, demand is unresponsive to price rises and unanticipated "outages" incur high costs to society. Secure supply of electricity at low cost therefore has widespread benefits.

New Zealand is a long thin country in which major hydro generation and storage capacity is located predominantly in the South Island whilst major demand centres and thermal generation are concentrated in the North Island. Generation plant and markets are linked by the national transmission grid, operated by Transpower, from which power is taken from Grid Exit Points for distribution on local lines networks to consumers in each locality's markets.

Electricity consumption has historically moved more or less in track with growth in national economic activity. Between 1979 and 2009, New Zealand's net generation grew from 22,175 GWh to 42,010 GWh.[7] This almost doubling in electricity supply over 30 years is equivalent to a compound growth rate of 2.2% per year, similar to New Zealand's economic growth over the period.

Recent electricity forecasts, such as an average of 1.3% per year to 2030[8] or of 1.4% per year over the period to 2040,[9] suggest growth rates that are low by historical standards, reflecting assumptions about energy efficiency improvements, but actual growth rates could be somewhat lower or higher than these forecasts. In particular consumer behavioural responses to changes in the price and reliability of electricity or new sources of demand (like new household appliances and automation) make future demands inherently difficult to predict.

The historic link between electricity and economic growth poses some challenges in the foreseeable future for sustained growth in economic activity and incomes:

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[6] Ministry of Economic Development (2010) *New Zealand Energy Data File*, http://www.med.govt.nz/templates/StandardSummary____15169.aspx

[7] Ministry of Economic Development (2010) *New Zealand Energy Data File.*

[8] Ministry of Economic Development (2006) *New Zealand's Energy Outlook to 2030*, http://www.med.govt.nz/templates/MultipageDocumentTOC____21862.aspx

[9] Electricity Commission (2010) *Statement of Opportunities*, http://www.electricitycommission.govt.nz/opdev/transmis/soo/2010SOO/index.html/?searchterm=SOO

- Most of the best sites for renewable generation are already in use and new generation faces increasing costs from technical and consenting requirements
- There is uncertainty over gas supply with doubts over the size and timeliness of new gas discoveries to replace the run-down of the Maui gasfield
- International obligations on curbing greenhouse gas emissions are increasing the cost of generation from fossil fuels and are being expressed in New Zealand through the emissions trading scheme
- Awareness of threats to energy security has been heightened by recent experience of dry years limiting hydro generation or failures in parts of the transmission network.

These threats to continued electricity supply at reasonable cost are increasing interest in improving the efficiency of electricity use. Energy efficiency or energy security have now been explicitly written into the *Resource Management Act*, the *Government Policy Statement on Electricity Governance*[10] and the *New Zealand Energy Strategy.* It is also an explicit motivation for energy efficiency initiatives such as the *Warm Up New Zealand* programme of subsidised insulation and clean heating upgrades, and the *Draft New Zealand Energy Efficiency and Conservation Strategy*.[11] It is also apparent in explicit changes in Part D of the Electricity Governance Rules (now replaced by Part 10 of the Electricity Industry Participation Code) to facilitate the introduction of Advanced Metering Infrastructure comprising smart meters and the monitoring and control systems to utilise their full functions.

Other countries face similar energy challenges and have responded with moves to improve the efficiency of the electricity sector. Part of this response has been an interest in using the capabilities of new metering technologies for both improving the price signalling of electricity use to consumers, and providing information that consumers can use to better manage their electricity use. Although recognised as essential in improving the overall efficiency of energy markets, “demand side participation” – incentivising consumers to be responsive in managing their electricity use – has to date been limited by the economics of available technologies. But there is growing interest in innovative forms of metering to allow for more detailed information to be collected on electricity consumption, and for communications technologies to allow end-users to become more actively involved in electricity markets by responding to price signals and information on consumption patterns.[12]

So economic factors and technological capabilities are moving towards changes in the way electricity services are supplied and paid for. The question is whether the lines charge changes in Ruapehu District are moving with, across or against that tide.

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[10] http://www.med.govt.nz/templates/ContentTopicSummary____21482.aspx

[11] http://www.med.govt.nz/templates/ContentTopicSummary____19431.aspx

[12] Haney, Jamasb and Pollit (2009) “Smart metering and electricity demand: technology, economics and international experience” Working Paper EPRG0903 www.eprg.group.cam.ac.uk

B.2 Economics of network provision

Networks of fixed infrastructure like power lines, pipelines and roads are problematic for economic efficiency, because once they are built the cost of using them is very low until use rises to near capacity, at which point the risk arises of congestion and network failure, which incurs costs in loss of service or in provision of additional capacity. Infrastructure service needs to be provided at any time when there is a demand; accommodate variations in demand across different time periods; and its output is non-storable. Hence peak demand loads, rather than the average load carried most of the time, are the drivers of infrastructure capacity. A cost reflective pricing method can assist in achieving economic efficiency by ensuring upgrades are only installed when demand is sufficient to justify their costs.[13]

Internationally there is growing interest in setting up tariff structures to encourage reduced electricity consumption during peak demand or shifting it to off-peak periods. The challenge of such a tariff strategy is to ensure its effectiveness and accuracy in terms of price signalling. Price signalling needs to:

- Ensure the consumer uses electricity in the most efficient way for the system as a whole
- Be sustainable in the short term and long term.

Due to the nature of a distribution network, capacity is fixed unless an upgrade of the grid takes place. This creates different marginal costs of peak and off-peak consumption. During peak demand periods, the marginal cost of each electricity unit conveyed is high due to capacity constraint and the risk of over-loading and loss of service. Demand that is insensitive to price (price inelastic) tends to cluster in the peak. At off-peak times, there is plenty of spare capacity and marginal costs of consumption are lower. Demand is more price sensitive (elastic) during the off-peak time, whereas supply is relatively inelastic. So it is more expensive to supply a secure lines service during peak demand periods compared to off-peak demand periods.[14]

The standard economic prescription for efficient pricing would set price at the marginal cost of supply, but this would not cover the full cost of providing a network (many of which are costs "sunk" in the construction phase and have little or no value in other use). Nor would it provide sufficient return to maintain or develop the network further. So in order to break even network providers commonly resort to "second best" pricing in which the price consists of a component of marginal cost plus a mark up to provide for the fixed costs of providing the network.

[13] Economic efficiency is about maximising the value of benefits obtained from available resources, and achieving an optimal resource allocation across the economy from which it is not possible to change to make one person or group better off without making someone else worse off.

[14] "Demand" here is used in its economic sense in defining the relationship between consumption of a good or service and its price: other things being equal, the higher the price the lower the consumption (and vice versa) as depicted in a demand schedule signifying quantity consumed at successive price levels. This is distinct from demand in the electrical sense, which describes the maximum consumption loading on a system at any point in time.

A common approach is to determine the fully distributed cost (FDC) in which the fixed component is averaged across some measure of consumption (e.g. the number of consumers, or each consumer's share of total consumption). This is not economically efficient because it can result in some consumers facing a higher (or lower) price than the marginal value of the consumption to them, which can result in them lowering (or raising) their consumption relative to what they would consume with efficient prices.

An approach which distorts consumption less (and is more efficient) is to vary the mark up according to the price sensitivity of different users i.e. raising the mark up on the least price sensitive consumers and reducing the mark up on the most price sensitive. Such pricing is based on the so-called "Ramsey principles" and requires detailed information on consumers' price sensitivity. An easier to implement alternative that is still more efficient than a fully distributed cost approach, is to apply a two part charge in which there is a fixed charge for access to the network which covers the fixed costs, and a variable charge reflecting usage of the network. This is a familiar approach to charging for "club facilities", in which a membership charge confers access to general club facilities but specific services such as use of courts, bar etc incur a usage charge.

Networks commonly have club charge structures in which there are various components:

- A fixed network charge which is common to all network customers, which in the case of lines companies would cover such things as general company overheads and repair of weather-related damage
- A variable charge related to use of the network, which in the case of a lines network could be rather small, reflecting the wear and tear of conveying power across the network
- A congestion charge: when networks approach capacity and face increased risk of over-loading which could cause network failure and loss of service, a congestion charge levied at those specific locations and periods encourages some price-sensitive use to refrain or shift consumption to off-peak periods and provides revenue for upgrading capacity. This is broadly the role identified by TLC for the demand charge to make consumers aware of the "true costs" they impose on the system.

The charges set by electricity distribution businesses (EDBs) aim to reflect the cost of installation, operation and maintenance of their electricity networks. Due to the variations of geographical features in urban or rural areas, the cost of electricity investment in different areas show wide variation. Attribution of costs across the electricity networks' different user types can be problematic in term of equity. For TLC's service region, consumers are located across varying geographic zones with variable and changing characteristics that include weather patterns, the mix of rural or urban land, residential, commercial or industrial customers and specific constraints in the existing network.

EDBs are intermediaries in the supply chain between the producers (generators) and retailers serving the ultimate consumers, and their networks create a type of natural monopoly that would be prohibitively costly to replicate. They can also be considered a "bottleneck" industry, collecting revenue by charging system users who have no practical alternative for receiving delivered electricity. Hence they are commonly subject to regulation to reduce the likelihood of taking advantage of the monopoly.

B.2.1 Pricing options

The broad options for pricing network services lie between collecting contributions through:

- a flat rate charge, which is a single price for a day, week, month or year,
- variable charges or
- some combination of the two.

Time varying pricing (also called dynamic pricing strategy) is an important means of improving efficiency in price signalling. The logic behind using price signalling is to reduce customers' electricity consumption during peak periods, which requires a differentiated charge in the peak. Such a charge can flatten the overall consumption pattern as consumers respond to the marginal payment for additional usage in the peaks. As a result, it can reduce grid costs and postpone the potential need for expanding grid capacity.

Dynamic pricing would convey the true cost of electricity generation and network provision to electricity customers and provide them with a price signal that more accurately reflects variation in energy costs over the course of the day or year. It could also reduce electricity bills through reductions in peak period consumption.

There are two fundamental issues to consider when designing dynamic retail electricity prices (Borenstein, 2005):

- Granularity of prices: the frequency with which retail prices change within the day or week.
- Timeliness of prices: the time lag between when a price is set and when it is actually effective.

The main variants of dynamic pricing are outlined in the table below.

The main variants of dynamic pricing are outlined in the table below.

Table 4 Characteristics of dynamic pricing

Dynamic Pricing	Description	Discussion
Time of Use (TOU)	Prices vary across periods within a day or seasonally but are predetermined. In other words, the price varies in a preset way within certain blocks of time; It includes Peak, Partial-peak, Off-peak. Peak period is the most expensive time interval. It aims to reflect the average cost for each different block of time period. It is static and predictable.	Reflecting average cost for each period. In comparing to RTP, it has less degree of granularity and timeliness which can not capture any of the shorter-term variation in supply or demand balance. It does provide some certainty for consumers on the price they will face, enabling them to respond accordingly.
Real time price (RTP)	Consumers track the price in the power market. They are normally the day-ahead prices, but some allow real-time announced prices. The prices change hour to hour. Technology advances in electricity meters have enhanced, and continue to enhance, the customers' ability to respond to real-time price changes.	High degree of granularity and price timeliness reflects the actual supply/demand situation in the market. However, there is an issue in whether prices should be set a day ahead or an hour ahead. Choice of this has a large impact on the efficiency of RTP. Additionally, consumers need to bear the high volatility in retail price. It may be feasible for large industrial or commercial users, but not small residential users.
Critical Peak Pricing (CPP)	A time-variant rate structure (similar to TOU) with a high or "critical" price during peak demand periods. "Critical" price sometimes called a demand charge. It is a compromise between the static properties of TOU and the variability of RTP. It is getting more popular.	More closely reflects the short-term cost of use during the peak than is possible with conventional TOU pricing. It is not as economically efficient as RTP but has practical advantages for consumers that are not well equipped to monitor varying real time prices and adjust their demands accordingly; - it provides some certainty and ability to manage use in critical peaks.
Peak time rebates (PTR)	Similar to CPP, instead of paying a high price during peak demand period, customers receive rebates for not using the power during peak period.	It is similar to CPP. But consumer behaviour suggests stronger response on how much they need spend.

Source: (Borenstein, 2005; Herter, 2007; Stokke, Doorman, & Ericson, 2010)

Demand charging is one component of Critical Peak Pricing (CPP). Demand charges are usually static as they generally charge the highest demand peaks at a predetermined rate. They may also be commonly based on each consumer's peak rather than the system peak, and hence may not convey the correct marginal pricing signals for network efficiency. However, they can provide an incentive to reduce "needle peaks" and allow EDBs to postpone further investment in upgrading grid capacity.

There are three ways for consumers to avoid high demand charges:

- Consumers can reduce their consumption at peak periods if they know when higher charges apply: an effect of this option is temporary loss of enjoyment of power use.
- Another option is to substitute an alternative energy which may be gas, firewood, or off-grid electricity such as micro-generation: an effect of this is that consumers lose resilience and supply security that comes from connection to networks.

- Shift electricity consumption from peak periods to off peak periods: an effect of this option is inconvenience.

In practice, there are two different types of decision making consumers: active and passive. Active consumers are those who can quickly adjust their electricity consumption by closely monitoring their usage according to the marginal prices they pay. These are the consumers who drive changes in consumption behaviour when shifting from flat charges to dynamic pricing. Passive consumers are those who play little attention to their usage or the price structure they face, and thus may need a third party (e.g., EDB) to assist in controlling their usage.

B.2.2 International experience with smart meters and pricing methodology

Technology advances in electricity meters have enabled more refined implementation of time varying pricing. The traditional electromechanical meter contains no information on real time electricity consumption but merely records changes in cumulative consumption of electricity units between meter readings. In comparison, smarter meters provide real time[15] consumption information, and may also come embedded with other features and capabilities. Details of the other advanced functions are listed in the table below.

Table 5 Comparison of conventional and smart meters

Conventional meter	Smart meter
No information of when the electricity was consumed	Provides real time information of electricity consumption, in hourly / half hourly intervals
Limited ability to remotely control power use (e.g. ripple control on New Zealand hot water circuits)	Allows remote control of contact and disconnections which save service costs
Not applicable	Bi-directional communications
Not applicable	Detects service outage
Not applicable	Detects unauthorised use of electricity
Not applicable	Able to change the maximum amount of electricity that a customer can demand at any time

Source: NZIER

Internationally, there is no universal standard of smart meter, but installation of smarter meters has been widely accepted among European countries, Northern America and Asia Pacific[16]. For example, the Ontario Energy Board in Ontario installed 800,000 smart meters by the end of 2007. The Department of Energy and Climate Change in the United Kingdom has plans to install smart meters for all British customers by the end of 2012, and the Essential Services Commission of Victoria in Australia aims to install 2.6 million smart meters by the end of 2013.

[15] Real time: time interval size down to hourly or half-hourly.

[16] Countries in the process of installing smart meters: Netherlands, Nordic countries, Italy, United Kingdom, United States, Canada, Australia, New Zealand, Japan.

Haney et al (2009) note that residential demand tends to fluctuate more than commercial and industrial demands and that residential consumers tend to have more peaky loads at times when system load factor is high. Residential and small commercial customers are those who are generally last to have their meters upgraded, yet collectively they can have a large influence on system loading at certain times. The main barriers to increasing end-user participation in electricity markets are commonly ascribed to inelasticity of demand (i.e. consumption is insensitive to price signals) and information asymmetry between customers and electricity supply companies. Interest in improved metering, therefore, has had the twin purpose of improving the accuracy of price signalling in reflecting the costs imposed by use of electricity, and of providing information to customers to enable them to better manage their electricity use.

Upgrading metering may be a simple as retrofitting traditional electromechanical meters that measure cumulative kWh consumed with sensors and relays feeding information to remote displays indicating power use. More costly are smart meters which, linked with advanced communications, can provide a platform for automated demand responses by connecting with smart appliances such as thermostats which can adjust to control loads. They also allow remote monitoring and operations by network operators, who thus have a direct interest in providing smart meters.

While international literature and practice points to increasing possibilities for energy management by consumers and what is known as “demand side participation” from the use of smart metering, the demand meters being rolled out by TLC are not being provided as smart meters: they have no read-out to give customers real time information on consumption, and TLC relies on downloads of data series on historic use downloaded from the meters rather than current readings through the peak. One of the main conclusions of studies undertaken in the USA, Canada, Scandinavia and the UK is that a user-friendly display should form part of any new meter specification to improve the level of direct feedback to customers.[17]

Norway

Norway, which is a long thin country with challenging terrain and climate, has a demand charge (DC) at higher rate in the winter peak than the rest of the year, providing more of an incentive for customers to shift their consumption from the peak period. Stokke, Doorman and Ericson (2010) conducted an econometric study on Norway’s demand charge electricity grid tariff in the residential sector, and found the demand charge tariff could result in a 5% reduction for all hours in all month and 12% for critical peak hours. The reduction is almost equivalent to 0.7% of total electricity load of the area. The data was obtained from Norwegian grid company Istad Nett AS (INAS) who introduced DC in 2000. Formulas for both tariff options are below:

[17] Haney et al (2009) *op.cit.* page 9

Table 6 Results from a demand charge in Norway

Tariff Option		Tariff Component: Fixed monthly charge	Variable charge	Demand charge
Flat rate	Monthly Tariff	191.66NOK	0.3366 NOK/kWh * q_i	
CPP (with demand change)	December or January or February	63.75NOK	0.1789NOK/kWh *q_i	0.1789NOK/kW * Q_i *where i is Dec or Jan or Feb*
	Tariffs for other months	63.75NOK	0.1789NOK/kWh *q_i	0.1789NOK/kW * $[(Q_{dec} + Q_{Jan} + Q_{Feb})/3]$
q_i is monthly energy consumption Q is highest consumption on working days between 7 A.M. and 4 P.M.				

Source: Stokke, Doorman & Ericson 2010

Ontario, Canada

The Ontario Energy Board uses three different pricing regimes for households who use an interval meter. They are TOU, TOU with CPP and TOU with PTR. After a year, Navigant Consulting (2008) found 66% of people in the Newmarket region paid more under the TOU regime when compared to the two tier system. Another study conducted in the Milton region also found 55% of customers had higher electricity bills using TOU rather than the two tier system (Rowlands & Furst, 2011).

Taking Milton Hydro Distribution Inc., as an example, two different price strategies are used for customers with smart meters and conventional meters respectively. For a customer with a smart meter, TOU pricing is applied. It has on-peak, mid-peak, off-peak pricing. During weekdays, three rates are applied to different time blocks across the day. An off-peak rate is applied for weekends and holidays.

Table 7 Time-varying rates in Ontario

	2010-2011		On-peak (0.099/kWh)	Mid-peak (0.081/kWh)	Off-peak pricing (0.051/kWh)
Weekdays	Winter: Nov 1-Apr 30	7am-11am and 5pm-9pm	Y		
		11am-5pm		Y	
		9pm-7am			Y
	Summer: May 1- Apr 30	7am-11am and 5pm-9pm		Y	
		11am-5pm	Y		
		9pm-7am			Y
Weekends & Holiday					Y

Source: Milton Hydro Distribution Inc [18]

For customers with conventional meters, the Ontario Energy Board reviews the pricing plan every 6 months. Their tariffs include both a winter-time peak surcharge and a rising tariff on higher consumption to encourage restraint. Current charges are:

Table 8 Variable tariffs from Ontario

Residential customer	November 1, 2010 to April 30, 2011	First 1000 kWh at $0.064/kWh	Balance of KWh at $0.074/kWh
	May 1, 2011 to October 31, 2011 (subject to change)	First 600 kWh at $0.064/kWh	Balance of KWh at $0.074/kWh
Non Residential Low Volume	November 1, 2010 to April 30, 2011	First 750 kWh at $0.064/kWh	Balance of KWh at $0.074/kWh

Source: Milton Hydro Distribution Inc., [19]

NSW, Queensland and Victoria, Australia

Australia recently offered both regulated single rate tariffs and TOU tariffs (Johnston, 2010). The companies believe TOU could deliver a demand response and thus result in broader societal benefits. However, households from NSW, Queensland and Victoria found it was not "family friendly" as households needed to change their consumption patterns which created inconveniences to daily life (e.g. doing the washing late at night, or reducing air conditioning). From a money wise point of view, there are "winners" and "losers" depending on the flexibility of households' consumption patterns.

[18] http://www.miltonhydro.com/pdf/residential_rate_info/elec_rate_card_2010_update.pdf

[19] http://www.miltonhydro.com/pdf/residential_rate_info/elec_rate_card_2010_update.pdf

Appendix C Recent history of TLC

Table 9 shows TLC is not New Zealand's smallest network company or the one with the lowest density of Inter-Connection Points (ICPs) per kilometre, but in recent years it has been distinguishable from other network operators by its high loss percentage, a reflection of the age of network assets which were installed with government assistance after World War II and are now in need of renewal. TLC has assessed 39% of assets will need to be replaced by 2020, and system renewal needs to be funded by users without government assistance.

The table also contrasts the figures for the neighbouring lines companies of Powerco and Unison. They both have many more ICPs, higher revenues and encompass sizeable urban centres that enable economies of scale and more scope for spreading the common costs of network operation than would be possible for TLC with its smaller centres of Taumarunui and Te Kuiti.

Past editions of PWC's business disclosure compendiums show that from 2006 to 2010 TLC achieved substantially larger increases in variables such as lines charge revenue, regulated profit and ODV value of assets than the average of New Zealand lines companies. For example its earnings before interest and tax per ICP increased by an annual average of 30% to surpass in 2010 the national average for all lines companies, which had averaged EBIT growth of 7.5% per year over the same period. Between 2006 and 2010 the number of ICPs in TLC's area fell from 26,180 to 23,351, and Ruapehu District accounts for about half of ICPs and half that decline.

Table 9 Characteristics of small lines companies

Company	ICP/km	ICPs	Total km	Load %	Loss %	Net line charge revenue	Regulatory EBIT
						$'000	$'000
Unison	11	108,212	9,571	59.6	4.0	103,734	39,408
Powerco	11	317,489	30,035	64.1	5.9	291,866	121,244
Buller Energy	7	4,422	617	67.4	9.7	5,364	1,886
Scanpower	7	6,786	905	62.0	7.3	4,678	1,511
Network Waitaki	7	12,257	1,714	58.4	7.7	10,259	2,311
Marlborough Lines	7	24,073	3,334	62.2	6.0	25,720	4,058
Eastland Network	7	25,432	3,662	60.1	6.7	27,653	9,457
Alpine Energy	7	30,615	4,106	69.7	3.1	33,163	9,837
Mainpower New Zealand	7	33,793	4,518	69.9	5.3	35,196	12,778
Westpower	6	12,782	2,130	66.6	4.7	18,299	4,147
Electricity Ashburton	6	17,452	2,933	48.0	7.8	24,696	11,033
The Lines Company	5	24,435	4,491	64.0	12.4	27,367	9,208
Centrallines	4	7,976	1,837	65.0	7.7	7,860	1,525
The Power Company	4	34,050	8,603	64.2	6.8	38,832	8,110
Otago Net Joint Venture	3	14,768	4,357	78.0	7.1	25,337	11,186
New Zealand average	13	68,862	5,186	59.4	5.1	65,932	25,308

Source: PWC Electricity Lines Business 2010 Information Disclosure

The northern network has around 48% of ICPs, but tends to have over 50% of costs and revenues. Table 10 shows that since 2007, neither the northern nor southern networks have been gathering enough revenue to cover the fully distributed costs in their respective areas, with the exception of 2009, when the southern network had revenues just exceeding its costs. TLC's pricing methodology papers attribute this to a "price path effect", implying that the regulated price path has restrained prices rising enough to enable revenues to match full costs.

Table 10 Split of revenues & costs across the northern & southern networks of TLC

Fully distributed costs attributed to areas and aggregated

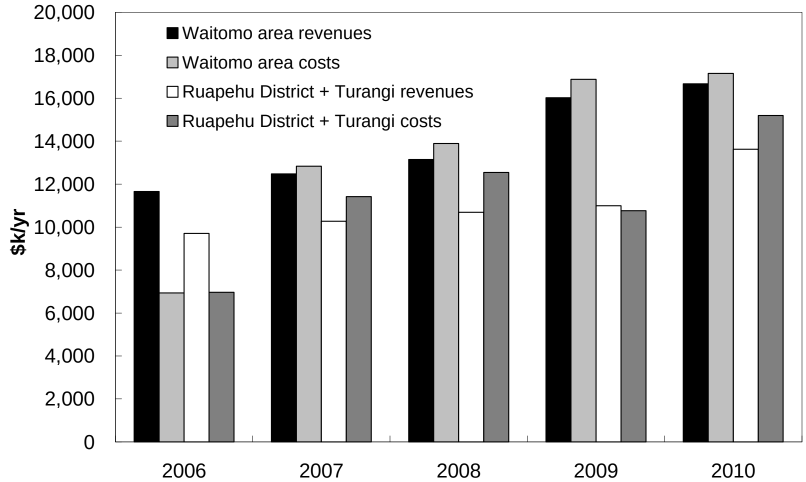
Revenue	$	$	%	%
2006	11,658	9,708	54.6%	45.4%
2007	12,474	10,275	54.8%	45.2%
2008	13,146	10,693	55.1%	44.9%
2009	16,025	10,997	59.3%	40.7%
2010	16,671	13,629	55.0%	45.0%
Costs	$	$	%	%
2006	6,933	6,965	49.9%	50.1%
2007	12,839	11,423	52.9%	47.1%
2008	13,897	12,544	52.6%	47.4%
2009	16,876	10,767	61.0%	39.0%
2010	17,155	15,199	53.0%	47.0%

Source: NZIER from TLC's Pricing Methodology papers, various years

Since 2006 the revenue collected from TLC's network services has increased by an average annual rate of 9.1%, compared to average annual change in the CPI of 2.7%. In National Park and Ohakune the annual increase has been 14.8% and 12.2% respectively, but lower than the average in Taumarunui and Turangi. Costs have increased by an annual average of 23.5% over the same period over the whole TLC area, with rates as high or higher in each of Taumarunui, National Park and Ohakune and 14.8% in Turangi. For both revenue and costs the biggest year on year increases were between 2006 and 2007, and between 2009 and 2010.[20]

[20] TLC Pricing methodology papers, various years

Figure 4 Revenues and costs in TLC networks



Source: NZIER from data in TLC Pricing Methodology papers, various years

The value of company assets increased by 11% between 2007 and 2008 and 29% between 2008 and 2009. So the change in pricing structure has coincided with both increasing renewal and upgrade requirements and changes in underlying accounting for assets which feed into an increased full cost distribution.

TLC is a regulated lines company subject to the following restraints

- Conformity with distribution pricing principles and Information Disclosure Guidelines overseen by the Electricity Authority
- Subject to an electricity default price quality path set by the Commerce Commission under subpart 9 of Part 4 of the Commerce Act 1986 – TLC's current projections are just under the maximum allowable estimated by the Commission
- Subject to limit on rate of return set by the Commerce Commission – at 6.03% TLC's ROI is well below the average of 8.4% achieved across all lines companies
- Subject to the Fair Trading Act administered by the Commerce Commission – although the Commission has found no reason to intervene under this Act
- Subject to the Electricity and Gas and Complaints Commission findings on individual cases, the validity of which may be challenged in the courts.

The Electricity Authority interprets its statutory objective as exercising its functions in ways that provide long term benefit for electricity consumers, by facilitating increased competition, managing security and reliability in ways that minimise costs, and increasing the efficiency of the electricity industry.[21] The Act defines consumers as "any person who is supplied, or applies to be supplied, with electricity other than for resupply", and this definition includes commercial and industrial firms as well as residential consumers. The Authority takes account of indirect effects as well as the

[21] Electricity Authority "Interpretation of the Authority's statutory objective", February 2011

direct and more obvious effects on consumers, focusing on consumer benefits in aggregate in which intra-community payment transfer payments are netted off and only efficiency gains count as benefiting consumers.

The Authority is not allowed to intervene in the electricity industry to address fairness and equity issues, as a result of deliberate cabinet decision to narrow its functions and shift the consideration of equity and fairness issues to the Minister of Energy and Resources.

The Ministry of Economic Development has an interest in policy towards energy and the electricity sector. It is unlikely to change policy or legislation in response to an issue with a single company, which implies that it would not intervene to address TLC's unique approach to demand charging.

Appendix D CGE modelling framework

D.1 ORANI-NZ

Our results were produced on a model of the New Zealand economy based on a tried and tested generic model (ORANI) that has been found effective for policy analysis in Australia and around the world. The model has been calibrated to the local setting and loaded with New Zealand data. The assumptions needed are based on consultation with industry specialists and reflect best practice.

The model has been developed with considerable assistance from CGE modelling experts at the Centre of Policy Studies at Monash University in Melbourne Australia.

D.2 Database structure

The model is based on a large database containing the value flows of the economy. The database defines the initial structure of the economy, which by definition is assumed to be in equilibrium in all markets. The structure of the database is similar to traditional input-output tables; for example commodities may be used as intermediate input for further production, utilised in investment, exported or consumed by households and the government. Industry costs include the cost of intermediates, margins, taxes and primary factor costs for labour, land and capital. As per the accounting identities in input-output tables, the total value sum of producers' input costs (including margins, taxes, returns to factors and other costs) equates to the total value of output production (the 'MAKE' matrix in the database).

The ORANI-NZ model consists of:

- 131 industries
- 210 commodities
- 1 household
- 15 regions

The database has been sourced initially from Statistics New Zealand 1995/96 Inter-Industry tables, updated using the subsequently released 2003 Supply and Use tables, and finally 'up-scaled' to 2010 levels using latest Statistics New Zealand macroeconomic data.
We modified the database by adding a new region that reflected the geographic area of operations for The Lines Company (TLC). This new region spans the Ruapehu District (without Waiouru) and Turangi-Tongariro. In the model the new region is essentially created as a sub-set of the Manawatu-Wanganui region.

Regions in the CGE model are differentiated based on that region's share of national:

- Output by industry
- Investment by industry

- Consumption by commodity
- Export by commodity
- Government spending by commodity
- Inventories by commodity.

Official statistics are not available at a sufficiently disaggregated level to calculate these shares for the TLC region. The TLC region's employment share by industry was used as a proxy for the output share for each industry given output data is unavailable at disaggregated regional level. The TLC region's employment level is the sum of the employment in Ruapehu and Turangi-Tongariro deducting Waiouru.

Employment by industry for the Ruapehu District was obtained from the latest Business Demographic Survey by Statistics New Zealand for 2010. Missing data in the original dataset due to confidentiality was estimated based on the total employment as well as the industry rank in the Manawatu-Wanganui region.

Employment data by industry for Turangi-Tongariro and Waiouru is not available given the small employment numbers in these areas. Therefore, the employment numbers in Turangi-Tongariro and Waiouru is estimated by scaling the Ruapehu employment by their population share over Ruapehu while keeping the composition of industries constant.

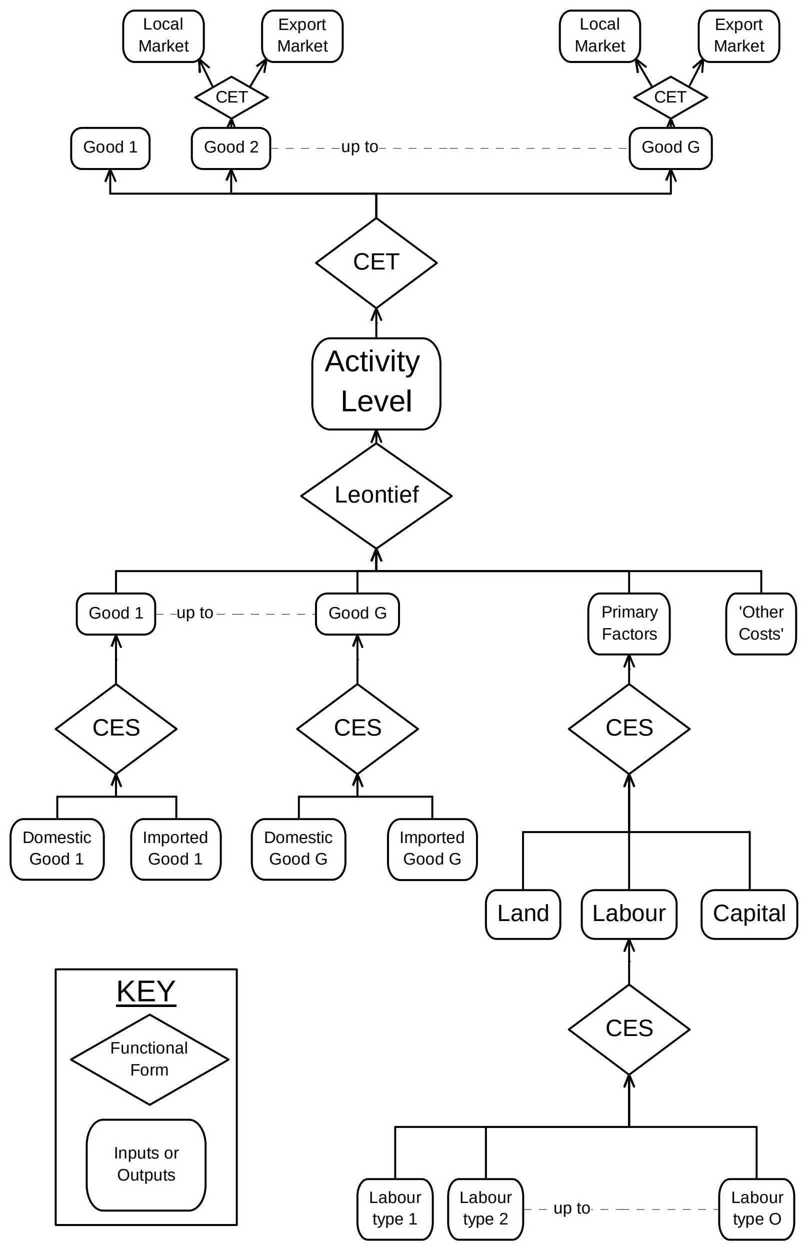
The estimates for output and investment shares were based on the TLC region's share of Manawatu-Wanganui's employment. Shares of consumption, government spending, and inventories were based on the TLC region's share of Manawatu-Wanganui's population. Export shares were calculated by determining the percentage of industrial output that was exported. The TLC region's share of this exported output was determined by its original output share. This level of exports was then determined by total exports to obtain the TLC region's export shares.

D.3 Production structure

The production structure of the model is presented in Figure 5.[22] Each industry can produce a number of different commodities. Production inputs are intermediate commodities, both domestic and imported, and primary factors labour, land and capital. Working from bottom to top, we see constant elasticity of substitution (CES) production nests for occupations, primary factors and the choice between imported and domestic commodities. In this case, an increase in price moves sourcing towards another input, for example, if the price of imports increases, more domestic commodities are demanded in the intermediate sourcing CES nest.

[22] Mark Horridge, Monash University. Centre of Policy Studies, and IMPACT Project (Australia), *ORANI-G: A General Equilibrium Model of the Australian Economy* (Centre of Policy Studies, 2000).

Figure 5 Production structure



Source: Horridge, 2000

At the activity level, intermediate goods, primary factors and other costs are combined using a Leontief production function. This means the proportion of production inputs does not change. On the output side, there are two further constant elasticity of transformation (CET)[23] nests. The production mix of each

[23] A CET function is identical to a CES function except that the transformation parameter has the opposite sign (i.e. increasing price increases output in a CET; in a CES, increasing price reduces demand).

industry is dependent on the relative prices of each commodity. Similarly, the export nest determines local and export market shares depending on relative prices.

D.4 Shocks

We assume that the price rise is generated by increased profit margins at the transmission level and proxy them with a tax on the transmission industry. Our previous data analysis suggests that this increased profit is due primarily to the rise in network charges so levying a tax of $2.9 million on the TLC lines network is equivalent in its regional impact to increasing the price of the delivered electricity by 7% (the rise over the same three years).

An important consideration in taking this approach is the equivalence between increased taxation and increased profits. While the national impact of a tax is undoubtedly different from the impact of increased profit margins due to market power, the regional impact is likely to be similar: the price of the electricity rises and the revenues are not returned to the local community. The latter is an important qualifier and, in order to ensure that the effects of the tax are not felt across the Ruapehu region through increased government spending, we fix the level of government spending in the region for the duration of our simulation.

Similarly, the difference between a tax and profits is likely to affect the level of investment in the industry. However, that effect is only significant in the medium-run when capital is mobile. Consequently, we restrict our simulation to estimating the short-run effects and fix the industry's capital stock for the duration of the simulation.

Finally, our simulation required us to specify the percentage of the national impact upon firms' intermediate usage that fell within the Ruapehu region. Lacking a regional input-output table for the TLC lines area we were forced to estimate this percentage based upon previous regional studies. A brief survey of regional input-output analysis suggests that about 80% of the impact on firms' input prices is usually contained within the region. We used that percentage in our simulation but better data on inter-regional trade would allow us to more accurately specify the parameter.

D.5 Reporting

D.5.1 Change from baseline

The CGE technique used by NZIER calculates impacts as changes from a baseline level. For this simulation we are estimating the impact of a historical price effect. Consequently, the impact can be thought of as the cost that Ruapehu has borne over the last couple of years as a consequence of the rule change.

We report impacts as percentage changes in most cases because the model is essentially atemporal. However, for key variables we assume that the duration of the simulation is 2-3 years[24] and convert the percentages to dollar values using 2010 levels.

D.5.2 Direct and indirect effects

In analysing the modelling results we track the impacts as they flow through the economy, beginning with the direct impacts on the electricity transmission industry itself. We then analyse the flow-on or indirect impacts. It can aid understanding to split indirect impacts into the following categories:

- **Household expenditure industries** – industries that households spend money on are likely to suffer from the lower disposable incomes of households as their electricity expenditure rises. Such industries include housing and real estate (which takes a large share of households' budgets), and those for consumption goods like retail trade.
- **Downstream industries** – industries that suffer from the lines company's increased profits as they face rising electricity prices.

[24] The duration for which our fixed capital assumptions remain valid has been econometrically estimated to be about this timeframe.