# MAJOR ELECTRICITY USERS' GROUP

3 May 2005

Mr Richard Longman
The Secretariat
Gas Industry Company Limited
PO Box 10 646
WELLINGTON
By email to richard.longman@gasindustry.co.nz

Dear Richard

**Submission on follow up consultation for GIC Levy Proposal**

1. This is a submission by the Major Electricity Users' Group (MEUG) on the Gas Industry Company (GIC) discussion paper, *The GIC Levy Proposal for 2005/06 – follow up consultation*, dated 22 April 2005.

2. The preliminary budget for 2005/06 set out on page 3 of the discussion paper is an improvement compared to the 1st GIC levy discussion paper of 19 March. MEUG note:

   a) MEUG accept the commentary in appendix A.2 of the discussion paper in response to the MEUG submission of 15 April that the ERL and Gas Levy have no direct link to GIC activities and therefore compensating savings from those are not relevant.

   b) MEUG still consider more detail is required to comply with sub-sections (1)(a) to (1)(h) of section 43ZZC of the Gas Amendment Act 2004. However, to be pragmatic, MEUG recognise that this is the first year of operation of the GIC, and therefore the abbreviated indicative budget is sufficient this year subject to the GIC providing further information on items 2. c) and d) below.

      In future years the budgets that the GIC consult on should be more detailed in order to meet the requirements of the Act.

   c) The largest single item cost of the total GIC budget is for "Working groups" totalling $1m, ie 28% of total budget. Further details of costs expected for this activity should be disclosed by the GIC before finalising levies. For example if all external advisor costs are already covered in the separately disclosed budget cost of $0.6m, then is the $1m for Working groups only needed for room hire and payment for working group members time and disbursements? If so, then the budget looks excessive. If not and there are other items, then those should be disclosed.

d) Further details are still required of the "Partial recovery of expenses since 22 December 2004" of $0.6m. For example:

i) Full disclosure of the amounts and parties being compensated for partial recovery of expenses. The GIC should disclose the methodology to allocate between acceptable prior costs third parties will be compensated for and costs not recoverable through the levy. The GIC should disclose if an independent audit was made of those cost allocations or if not, why not?

ii) Details of the interest rate, if any, to be used in compensating for prior costs.

iii) Is this cost a one-off lump sum this year or an amortised sum that will be levied over a number of years and if so how many years? The GIC should also disclose how it decided between making either a lump sum or amortised recovery of acceptable prior costs.

3. The discussion paper proposes an even split for recovering the retail levy using a c/GJ and $/ICP basis. MEUG agree this is an improvement compared to the GIC 19 March discussion paper proposal to fully recover on a c/GJ basis. However MEUG still regard a full $/ICP basis as the pricing approach that best achieves an efficient price signal. This is because a fully fixed cost basis is the least distortionary approach to recover sunk or fixed costs. If some of the retail services the GIC will be providing are truly variable, then those should be recovered on a c/GJ basis, but no more than those truly variable costs. In the view of MEUG the GIC compromise will still lead to larger households and commercial gas consumers subsidising small gas consumers.

4. It is very disappointing that the second GIC discussion paper has not even mentioned the alternative options and factors suggested in the MEUG submission of 15 April when considering who to tax for the wholesale related costs. One of the factors MEUG raised previously was the tax incidence on the wholesale supply and demand curves (refer paragraph 3. a) of MEUG submission 15 April 2005). The importance of this has been highlighted in a recent report to the NZ Climate Change Office by *e-dec* Limited, *Emissions charge cost pass-through*, 15 April 2005. In that report *e-dec* estimate the short-run and long-run demand elasticity's for gas and the pass-through proportion of a proposed Carbon tax. In the long-run they estimate 36% of a carbon charge will be passed through to consumers, the balance of the tax incidence falling on the supply chain. The GIC in designing a robust levy structure for the wholesale related costs should have considered this type of impact. By failing to undertake a more robust analysis of tax incidence effects, the latest GIC proposal may not be the most efficient for the economy as a whole or least cost for consumers in the long-run. A copy of the *e-dec* report is appended to this submission.

Yours sincerely

Ralph Matthes
Executive Director

Attachment:
Report to the NZ Climate Change Office by *e-dec* Limited, *Emissions charge cost pass-through*, 15 April 2005

# Emissions charge cost pass-through

Report to

New Zealand Climate Change Office
Ministry for the Environment

by

*e-dec* Limited

15 April 2005

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## Preface

The original report on the Emissions charge cost pass-through was delivered to the New Zealand Climate Change Office on 29 October 2004. Review of this original report gave rise to several issues regarding the analysis of electricity, petrochemical gas and coal.

The electricity analysis was carried out from first principles using publicly available information. In fact, NZCCO is coordinating a modelling project covering aspects of the New Zealand electricity sector. This NZCCO work covers, although is not limited to, the fuel mix in generation and the likely increase in electricity prices resulting from the carbon tax. Future analysis of the emissions charge (carbon tax) pass-through will incorporate the conclusions of the NZCCO electricity work. The electricity demand paragraphs in Sections 5.6, Demand for pipeline gas in the long run, and 7.3, Demand for coal in the long run, should be read with this in mind. Changes to elasticities that result from incorporating the NZCCO electricity work might affect the conclusions in Sections 5.7, Pass-through proportion for pipeline gas in the long run, and 7.4, Pass-through proportion for coal.

The analysis of petrochemical gas was based on extremely limited information. Future development of the cost pass-through analysis will revisit the area of petrochemical gas, seeking out further and better information. As a result, it is possible that the analysis and conclusions on the cost pass-through for petrochemical gas might change. Sections 5.3, Use of gas in petrochemicals in the long run, and 5.4, Pass-through proportion for petrochemical gas in the long run, should be read with this in mind.

The Ministry of Economic Development (MED) made constructive comments on the coal section in the October 2004 report. The report used the latest available statistics on coal (taken from the July 2004 Energy Data File) but it appears that there are problems in these statistics. Future development of the pass-through analysis for coal will use improved statistics that are expected to become available by mid-2005. Initial information from MED is that the new statistics will differ substantially from those used in this report. As a result, the analysis and conclusions for coal might change significantly. Accordingly, a caveat needs to be attached to the conclusions on coal in the present report – substantial change to the information base could lead to a significant change in the conclusions regarding the cost pass-through for coal. Section 7.4, Pass-through proportion for coal, should be read with this in mind.

Finally, this revision of the October 2004 report incorporates a number of minor changes to reflect detailed, editorial points made by MED and NZCCO.

## Table of Contents

# 1 The Question of Incidence

## 1.1 The carbon charge

The carbon charge or emissions charge is a tax on fuels. It is akin to an excise tax. The tax is a specified dollar amount per physical unit of the fuel purchased and sold (although the amount may differ between fuels). For example, the tax might be 3.5 cents per litre of petrol and 3 cents per litre of diesel.

The tax amount is calculated as the tax rate multiplied by the tax base. The tax rate is the tax per tonne of $CO_2$ emissions-content of the fuel. The tax base is the $CO_2$ emissions-content of a standard physical unit of the fuel. For example, the tax rate might be $15/tonne of $CO_2$, the tax base for petrol might be 0.0023 tonnes $CO_2$ per litre, so the tax amount would be 3.5 cents per litre of petrol.

## 1.2 Incidence of the charge

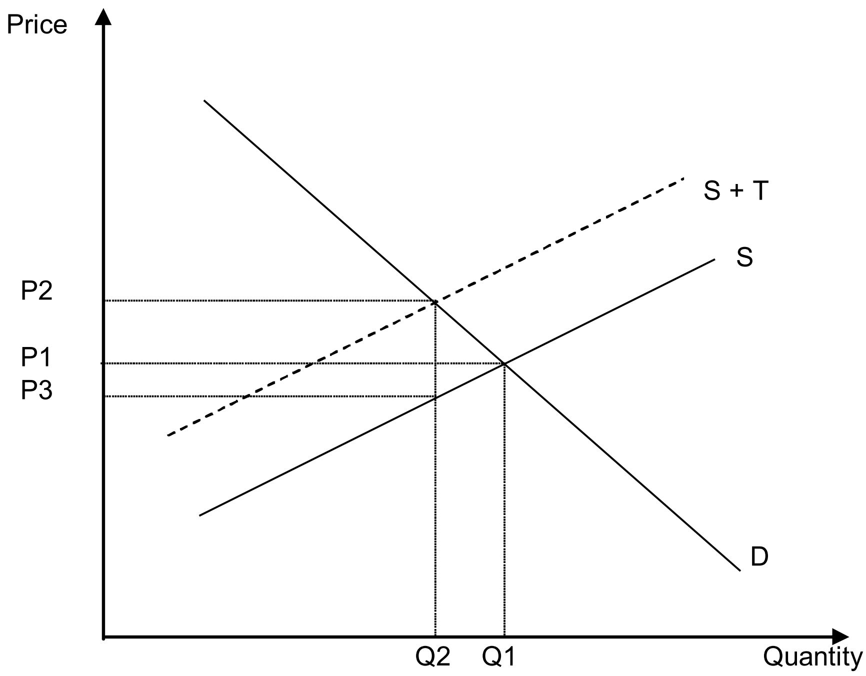
It is essential to distinguish between collection and payment of the carbon charge. Collection occurs at the point in the supply chain at which the tax revenue is collected by the Crown. Payment, in contrast, refers to which parties in the supply chain end up paying more (for purchasers) or receiving less (for suppliers) than they would in the absence of the carbon charge.

The carbon charge represents a given dollar amount of tax per unit of fuel. This tax will be collected by the Crown. Collection will be from suppliers early in the supply chain of each fuel. But the tax affects the net amount received or paid by parties in the supply chain. The matter of who pays the tax – how much is paid by suppliers, how much by purchasers – is known as the incidence of the tax. This concept of payment is the difference between the price paid/received with the tax in place compared to the price in a world without the carbon charge.

The carbon charge will be collected from sellers but collection is different from incidence. Incidence compares the with-tax situation to the without-tax situation. The tax paid by purchasers is the purchase price, including the tax, less the price that purchasers would have paid if there were no carbon charge. Similarly, the tax paid by sellers is the price received by sellers, net of the tax, less the price sellers would have received if there were no carbon charge.

The distinction between collection and incidence is shown graphically in Figure 1. This shows a generic demand curve, D, and a generic supply curve, S. The tax of T (in $ per unit of the fuel) is collected from suppliers so that purchasers are facing a market supply curve of S + T. The market equilibrium without the tax is at price P1 with quantity Q1 purchased and sold. The market equilibrium with the tax is at price P2 and quantity Q2, where P2 is higher than P1 and Q2 is lower than Q1.

Figure 1
Illustration of tax incidence




In the with-tax situation, purchasers pay a price of P2 but suppliers receive, net of tax, P3 where P3 = P2 – T. The various components of collection and payment are, in dollars per unit purchased/sold:

Tax collected = P2 - P3
= T

Tax paid by purchasers = P2 – P1

Tax paid by suppliers = P1 – P3

Tax paid = (P2 – P1) + (P1 – P3)
= P2 – P3
= T

The tax paid, summed across purchasers and suppliers, is T, the same as the tax collected. But the tax paid, compared to the no-tax situation, is split between suppliers and purchasers. This split is the incidence. In general, all that can be stated is the tax will be shared in some way between buyers and sellers. As the split depends on how responsive to price is demand and on how responsive to price is supply, knowledge of the actual market is needed in order to calculate the numerical incidence.

### 1.3 Calculation of the pass-through

The definition of tax incidence involves two market situations – one with the tax, the other without the tax. However, only one of these situations is actual or observable – the market outcome with the tax. The comparator situation, that without the tax, is hypothetical. Accordingly, the examination of tax incidence must be done by analysis, it cannot be done by observation.

In Figure 1, above, the only points that are observable are P2 and Q2, the market situation with the tax imposed. Also, the tax amount, T, is known. P3, the price received by suppliers, net of tax, can be calculated directly from actual information and the known relationship P3 = P2 - T. The no-tax situation, defined by P1 and Q1, is hypothetical, it is not observable. Therefore, the tax incidence is not observable. And in particular, what is of concern to NZCCO, the carbon charge pass-through to purchasers, corresponding to P2 – P1, cannot be observed.

It is not possible to observe P2 and P1 and from these to calculate the pass-through as the difference, P2 – P1. How, then, can the pass-through of the carbon charge be calculated?

The indicators of concern for NGA purposes are not the with-tax and without-tax prices, P2 and P1, but the price difference, P2 – P1. This difference is the pass-through. Equivalently, the indicator of concern is the pass-through proportion, (P2 – P1) / T. (These are equivalent because, as T is known, the pass-through can be calculated from the pass-through proportion, and vice verse.) Therefore, the objective, for NGA purposes, is to develop an analytical method for calculating the pass-through proportion, PTP:

$$\text{Pass through proportion} \quad = \quad (P2 - P1) / T$$

The approach followed in this report is to develop a model for calculating this pass-through proportion. This is referred to as the pass-through model or the incidence model. Then, the report applies this model to the case of introducing a carbon tax on hydrocarbon fuels in New Zealand to estimate the numeric pass-through proportions that can be expected for the various fuels.

This model provides a framework for analysing the pass-through of the carbon charge. Several important conclusions can be drawn directly from this framework. We then populate the model with initial empirical estimates of parameters, drawn from international experience and preliminary New Zealand information. We note, though, the considerable further work remains to be done to refine the empirical parameters to match the New Zealand situation.

# 2 The Incidence Model

## 2.1 The approach

This chapter develops a incidence model. It models the distribution of the tax amount between fuel suppliers, on one side of the market, and fuel purchasers, on the other side. It examines the market for a specific fuel, market behaviour by suppliers and purchasers, and adjustments of market prices and quantities to the tax. As the model allows for adjustments until the price, quantity demanded and quantity supplied in this market are all consistent, it in known as a partial equilibrium model.

## 2.2 Tax collected from purchasers

Consider first the case in which the carbon charge is collected from fuel purchasers.

Notation

| | | |
|---|---|---|
| P | = | price received by suppliers |
| T | = | Tax (carbon charge) per unit quantity of the fuel |
| P + T | = | price to purchasers |
| QD | = | quantity of fuel demanded |
| QS | = | quantity of fuel supplied |

Market behaviour – the partial equilibrium model

| | | |
|---|---|---|
| QD | = | a – b * Price to purchasers |
| QS | = | m + n * Price to suppliers |
| a | = | numerical parameter affecting the level of demand |
| m | = | numerical parameter affecting the level of supply |
| b | = | response of quantity demanded to price, $b \geq 0$ |
| n | = | response of quantity supplied to price, $n \geq 0$ |
| QD | = | QS the condition for market equilibrium |

The market situation without the charge is:

$$QD1 = a - b * P1$$
$$QS1 = m + n * P1$$
$$QD1 = QS1$$

and the market equilibrium without the carbon charge is:

$$P1 = (a - m) / (b + n)$$
$$Q1 = (a * n + b * m) / (b + n)$$

The market situation with the charge is:

$$QD2 = a - b * (P2 + T)$$
$$QS2 = m + n * P2$$
$$QD2 = QS2$$

and the market equilibrium with the carbon charge is:

$$P2 = P1 - b * T / (b + n)$$
$$Q2 = Q1 - b * n * T / (b + n)$$

The effects of the carbon charge on prices and quantity are:

$$\Delta P = P2 - P1$$
$$= - b * T / (b + n)$$
$$<= 0$$

is the effect on the price received by suppliers.

$$\Delta PD = (P2 + T) - P1$$
$$= n * T / (b + n)$$
$$\geq 0$$

is the effect on the price paid by purchasers.

$$\Delta Q = Q2 - Q1$$
$$= - b * n * T / (b + n)$$

$\leq 0$

is the effect on the quantity purchased and sold.

The pass-through proportion, PTP, is:

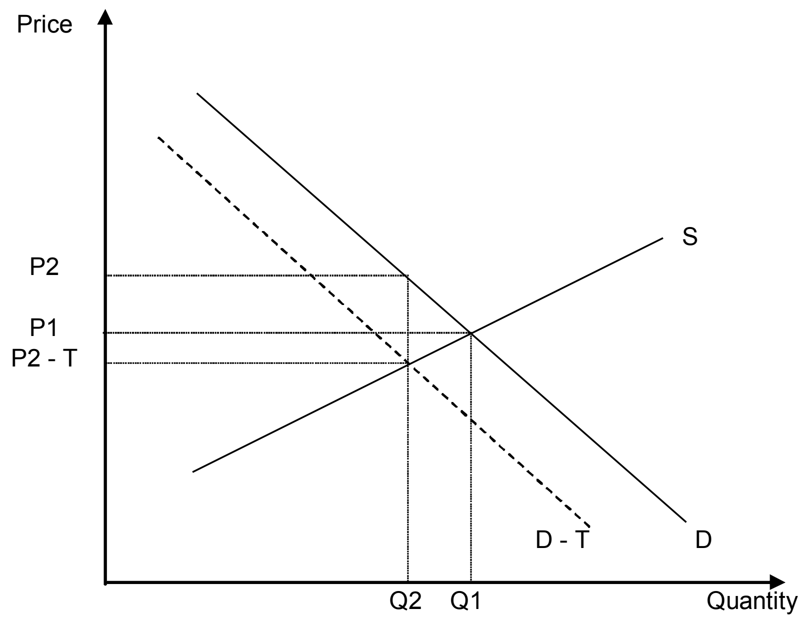
$$PTP = \Delta PD / T$$
$$= n / (b + n)$$
$$\geq 0$$

PTP is the proportion of the carbon charge per unit of fuel that is passed through in the form of a higher price to purchasers. This equation provides a formula for calculating the pass-through proportion. Note that only the b and n parameters enter this formula.

## 2.3 Graphical presentation from the purchasers' side

The incidence model with the tax collected from purchasers can be illustrated in graphical form. This is done in Figure 2. Figure 2 does not reveal the incidence formula but it clearly shows the qualitative nature of the effects of the tax.

Figure 2
Carbon charge collected from purchasers



## 2.4 Tax collected from suppliers

The incidence model can be developed from the point of view of suppliers as opposed to purchasers. This section considers a carbon charge collected from the suppliers of fuel into a market.

Notation

P = price paid by purchasers
T = Tax (or carbon charge) per unit quantity of the fuel
P - T = price received by suppliers
QD = quantity of fuel demanded
QS = quantity of fuel supplied

The model of market behaviour is the same as in the previous section. The market situation without the charge is the same as above but the market situation with the charge is different as the tax is collected from suppliers::

$$QD2 = a - b * P2$$
$$QS2 = m + n * (P2 - T)$$
$$QD2 = QS2$$

and the market equilibrium with the carbon charge is:

$$P2 = P1 + n * T / (b + n)$$
$$Q2 = Q1 - b * n * T / (b + n)$$

The effects of the carbon charge on prices and quantity are:

$$\Delta P = n * T / (b + n) \geq 0$$

is the effect on the price paid by purchasers.

$$\Delta PS = -b * T / (b + n) <= 0$$

is the effect on the price received by suppliers.

The pass-through proportion is:

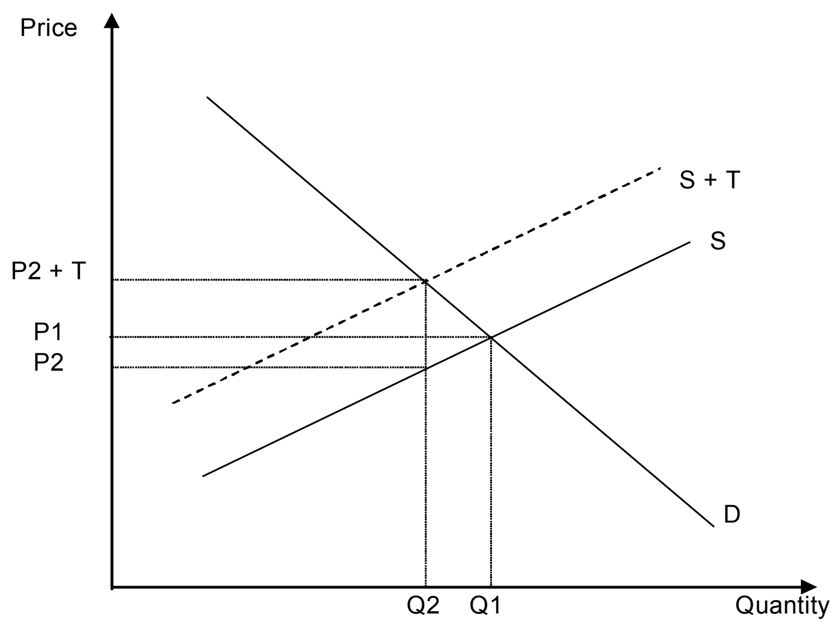
$$PTP = \Delta PD / T = n / (b + n) \geq 0$$

This is the proportion of the carbon charge per unit of fuel that is passed through in the form of a higher price to purchasers. This is the same as PTP in the previous section, viewing the market from the purchasers' point of view.

## 2.5 Graphical presentation from the suppliers' side

The graphical presentation of the model from supply side is given in Figure 3.

Figure 3
Carbon charge collected from suppliers



## 2.6 Incidence formulas

The proportion of the carbon charge per unit of fuel that is passed through in the form of a higher price to purchasers is:

$$PTP = n / (b + n)$$

The complement to the pass-through proportion is the proportion of the carbon charge remaining with suppliers. By definition, this is (1 - PTP). This proportion is:

$$1 - PTP = b / (b + n)$$

The ratio of the tax incidence on purchasers to the tax incidence on suppliers, i.e. the ratio of the price increase carried by purchasers to the price reduction carried by suppliers, is:

$$PTP / (1 - PTP) = n / b$$

Note that all these incidence formulas involve only the b and n parameters.

## 2.7 Convert to elasticities

The pass-through proportion is

$$PTP = n / (b + n)$$

It will be more convenient, when applying this incidence model to practical situations, to express the formula in terms of elasticities rather than the slope coefficients, b and n. The relevant elasticities are:

Price elasticity of demand = ed
Price elasticity of supply = es

A price elasticity measures the responsiveness to a price change, it is the percentage change in demand or supply resulting from a one percent change in the price of the good or service. The demand and supply elasticities are defined:

$$ed = |(\Delta QD / QD)| / (\Delta P / P)$$
$$es = (\Delta QS / QS) / (\Delta P / P)$$

The vertical lines surrounding the quantity response in the demand elasticity are the notation for absolute value. This operation removes the negative sign of $\Delta QD$ (this is negative because the quantity demanded moves in the opposite direction to price). The effect is that the elasticity of demand is a positive number even though the price – demand relationship is negative.

The slope coefficients of the incidence model can be expressed in terms of these elasticities by applying the elasticity formulas. The resulting expressions are:

$$b = ed * Q / P$$
$$n = es * Q / P$$

The pass-through proportion can now be expressed in terms of elasticities:

$$PTP = es / (ed + es)$$

Similarly, the proportion that is carried by suppliers can be expressed:

$$1 - PTP = ed / (ed + es)$$

## 2.8 Position of a purchasing firm

NGAs will be negotiated with individual fuel-purchasing firms. This gives rise to the question of how an individual firm relates to the incidence model and the pass-through conclusions flowing from this model.

The carbon charge will be introduced onto all fuel supplied into the New Zealand market. All suppliers and all purchasers will be affected. The distribution of the tax between the supply side of the market and the demand side of the market is described by the pass-through formulas derived above. The proportion of the carbon charge passed-through to purchasers depends on the price elasticity of demand and the price elasticity of supply.

The response of an individual firm to the carbon charge, say of a purchasing firm to the rise in the price it pays for the fuel, does not matter in calculating the pass-through. What matters is the overall response of supplying firms and the overall response of purchasing firms. The totality of responses is the only relevant factor; the response of any one purchaser will be buried within this totality.

In short, the relevant behavioural information in calculating the pass-through proportion is the average elasticity of supply across all suppliers into the market and the average elasticity of demand across all purchasers in the market; the behaviour of an individual firm is not relevant. Furthermore, knowledge of the response or likely response of an individual purchasing firm adds no useful information to assist in calculating the likely pass-through of the carbon charge.

## 2.9 Core results

The core results of the incidence model can now be set out.

(1) The proportion of the tax passed-through to purchasers is

$$\text{PTP} = \text{es} \ / \ (\text{ed} + \text{es}).$$

(2) The incidence of the charge does not depend on which side of the market the tax is imposed on, i.e. the incidence is the same whether the tax is imposed on/collected from suppliers or purchasers.

(3) The effect of the tax on the price paid/received by an individual purchaser/supplier in the market reflects not that party’s response but the

totality of responses of all purchasers in the market and of all suppliers in the market.

(4) The ratio of the price increase to purchasers to the price reduction to suppliers is:

$$PTP / (1 - PTP) = es / ed$$

The proportion of the tax borne by purchasers (suppliers) is inversely related to the elasticity of demand (supply). The more price-responsive side of the market shifts more of the burden of the tax to the less price-responsive side of the market.

(5) All these pass-through conclusions depend on just two parameters – the price elasticity of demand and the price elasticity of supply. These results provide a framework for empirical analysis that is extremely efficient in terms of information. Furthermore, these results provide precise guidance as to the empirical information that is needed to apply the model to actual market situations.

### 2.10 The pass-through

The incidence model provides the key formulas needed for a practical investigation into the pass-through of the carbon charge.

The pass-through proportion, the proportion of the charge that is reflected in an increase in the price paid by purchasers, is:

$$PTP = es / (ed + es)$$

It is important to note the meaning of the price increase underlying this expression. The increase is relative to the price that would have applied in the absence of the carbon charge. The price increase does not refer to an increase over time, for example from this year to next year; the price increase refers to the with-tax situation relative to the without-tax situation.

The pass-back proportion is the proportion of the carbon charge that is passed back to fuel suppliers in the sense of reducing the price, net of the carbon charge, received by suppliers, compared to the no-charge situation. The pass-back proportion and the pass-through proportion must sum to one, or 100 %. Therefore, the pass-back proportion, PBP, is given by one less the pass-through proportion, so:

$$PBP = ed / (ed + es)$$

The pass-through amount is the increase, resulting from the carbon charge, in the price paid by purchasers. This is measured in dollars per unit of the fuel whereas the pass-through proportion is a ratio. The pass-through and pass-back amounts are:

$$\text{Pass-through} = T * es / (ed + es)$$
$$\text{Pass-back} = T * ed / (ed + es)$$

The sum of the pass-through and pass-back amounts is:

$$\text{Pass-through} + \text{Pass-back} = T$$

which is as it should be – the amount of the charge passed forward to purchasers plus the amount of the tax passed back to suppliers is the amount of tax.

## 2.11 Central and limiting cases

This section examines the pass-through proportion in a central case, in which the elasticities of demand and supply are equal, and in limiting cases.

If the demand and supply elasticities are equal, and the particular numerical value of the elasticities does not matter, then the pass-through proportion has a known value:

$$\begin{aligned} PTP &= es / (ed + es) \\ &= 1 / (1 + ed/es) \\ &= 1 / (1 + 1) \\ &= 0.5 \end{aligned}$$

If the elasticities are equal then exactly half the carbon charge will be passed through to purchasers. Accordingly, the pass-through formula gives rise to these results:

If ed > es then PTP < 0.5
If ed = es then PTP = 0.5
If ed < es then PTP > 0.5

Thus, the pass-through proportion is 50% if demand and supply are equally responsive to price changes, it exceeds 50% if demand is less responsive than supply, and it is less than 50% if demand is more responsive than supply.

The analysis can be extended to the limiting cases of no price-responsiveness (elasticity is zero) or extremely high price responsiveness (elasticity is infinite).

If ed is 0 or es is infinite then the pass-through proportion is one or 100%. In practical terms, if demand is vastly less responsive to price than is supply, purchasers will bear all the carbon charge.

Conversely, if ed is infinite or es is 0 then the pass-through proportion is zero. Thus, if supply is vastly less responsive to price than is demand, suppliers will bear all the carbon charge.

## 2.12 Graphs of limiting cases

There are four limiting cases – the combinations of demand elasticity and supply elasticity being either zero or infinite. These are shown in Figures 4 to 7.

Figure 4 shows the case in which supply is fixed, i.e. es = 0. As the supply is fixed, all the burden falls on suppliers. As quantity is fixed, the only possible adjustment is

Figure 4
Case of fixed supply

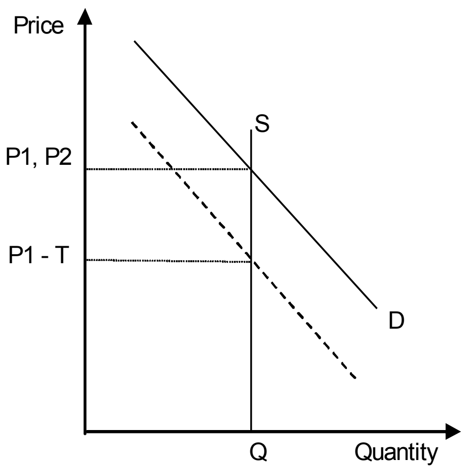



Figure 5
Case of highly elastic demand

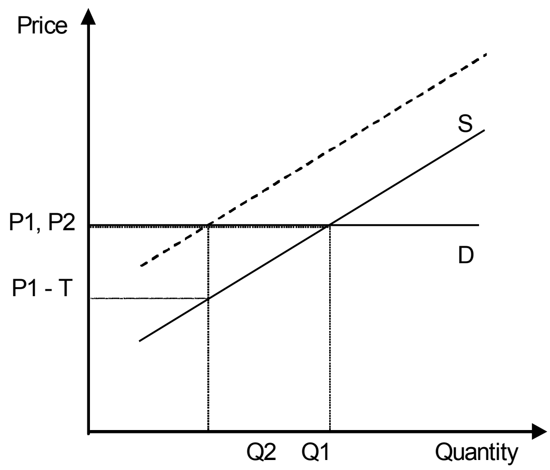



Figure 6
Case of highly elastic supply

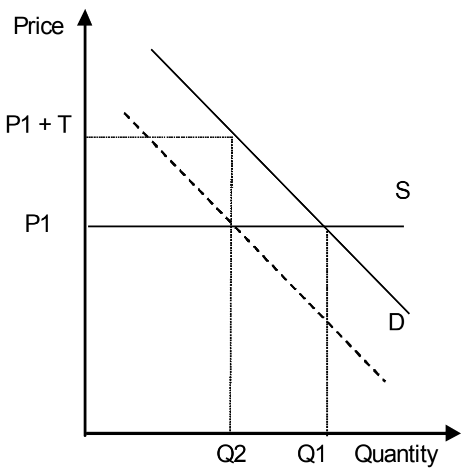
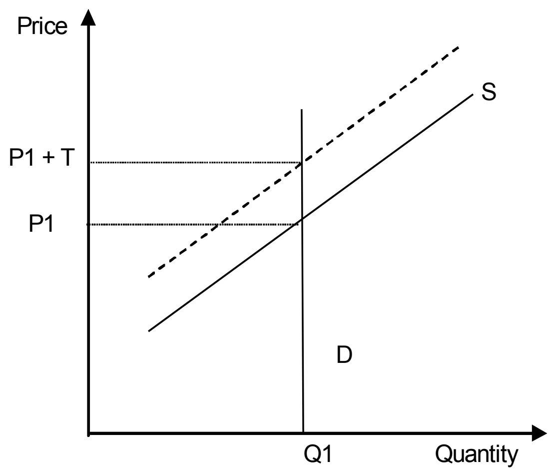



Figure 7
Case of fixed demand



on prices. Therefore, the net price to suppliers falls by the full amount of the carbon charge. Figure 4 shows the transaction price remaining at P1, or P2 = P1. The pass-through proportion is zero.

Figure 5 shows the case in which demand is extremely elastic, i.e. ed is infinite. As demand is highly responsive to price, all the burden falls on suppliers. As demand conditions determine the transaction price, the transaction price remains unchanged and the net price to suppliers falls by the full amount of the carbon charge. Figure 5 shows the transaction price remaining at P1, P2 = P1. The pass-through proportion is zero.

Figure 6 shows the case of extremely elastic supply, i.e. es is infinite. As supply is highly responsive to price, all the burden falls on purchasers. Supply conditions set the price after tax so this price remains unchanged and the transaction price, including tax, increases by the full amount of the carbon charge. Figure 6 shows that the new transaction price, P2, is P2 = P1 + T. The pass-through proportion is 100%.

Figure 7 shows the case in which demand is fixed, i.e. ed = 0. As the demand is fixed, all the burden falls on purchasers. As quantity is fixed, the only possible adjustment is on prices. Therefore, the transaction price increases by the full amount of the carbon charge. Figure 7 shows the price to purchasers increasing by the full amount of the charge, to P2 = P1 + T. The pass-through proportion is 100%.

### 2.13 The default situation

In the complete absence of information about demand and supply responsiveness, it would appear defensible to assume that the two elasticities are equal. In this case, the formula for the pass-through proportion gives:

$$PTP \quad = \quad 0.5$$

In the sense of having no empirical information, the default situation for the pass-through proportion is 50%. This is an important conclusion as it is at variance with the frequently found expectation that all tax is passed forward to purchasers, i.e. that the pass-through proportion is 100%. A 100% pass-through should not be taken as the default situation.

In fact, a 100% pass-through obtains only in two situations:

(1) if es is infinite, PTP = 1. This is the case in which the supply price is fixed and the effect of demand is simply to determine the quantity purchased and sold at this price. In graphical terms, this is the situation of a horizontal supply curve, such as set out in Figure 6, above.

(2) if ed = 0, PTP = 1. This is the case in which the quantity demanded is fixed and purchasers will pay whatever is necessary in order to acquire this quantity. In graphical terms, this is the situation of a vertical demand curve, such as set out in Figure 7, above.

If es is infinite or ed is zero, the pass-through proportion is 100%. In all other market situations, the pass-through proportion is less than 100%. Thus, it requires very particular market conditions for a 100% pass-through to occur. This reinforces the above point that the default situation is not one of 100% pass-through.

### 2.14 100% pass-through

The pass-through proportion is:

$$PTP = es / (ed + es)$$

As noted in the previous section, PTP = 1 in only two particular cases – if es is infinite or if ed is zero. The report now explores the first of these special cases, the case in which es is infinite, for it emerges that several fuel markets have exactly this property that es is infinite.

In particular, there are two market situations, which might be encountered for fuels used in New Zealand, in which es is infinite:

(1) purchase/sale contracts pass the tax entirely to the purchaser, or

(2) world prices dictate the fuel price within New Zealand.

If purchase/sale contracts state that purchasers pay a specified price for the fuel and that all excise and sales taxes, such as GST, are to be added to this specified price then we have a situation of infinite elasticity of supply. If the contract is silent as to who pays excise, sales and similar taxes then the carbon charge legislation will make it clear that the carbon charge is to be added onto the contract supply price; this also produces a situation of infinite elasticity of supply. In these cases, therefore, the supply price is fixed by contract and the entire tax is paid by purchasers.

If a fuel market in New Zealand is open to world trading and if such trading actually takes place, whether through imported products or through exported products, then the market price in New Zealand will be set by the world price (with allowance for transport and other costs that are part of bringing the product to retail in New Zealand). In other words, the fuel will be available to New Zealand customers at whatever quantity they want but at an exogenously determined price based on the world price of the product. This supply elasticity is infinite. As a result, the pass-through will be 100%, the entire tax will be passed forward to purchasers.

# 3 The carbon charge

## 3.1 Tax rate

The central rate of carbon charge investigated in this report is \$15/tonne $CO_2$ emissions-content (referred to as \$15/tonne). Later in the report, alternative rates of \$5/tonne and \$25/tonne are considered.

The carbon charge policy is that the tax will be introduced not before the start of 2007, will apply at a rate approximating the international trading price of carbon credits, and will not exceed \$25/tonne $CO_2$ emissions-content.

The base to which the tax is applied for each fuel is the $CO_2$ emissions-content of a standard physical unit of the fuel. These tax bases are shown in the next section.

To illustrate the approach, consider petrol. The standard physical unit is a litre. The $CO_2$ emissions-content of one litre is 0.0023 tonnes. If the tax rate is \$15/tonne then the carbon charge on petrol would be \$0.0023 x 15 or 3.5 cents per litre.

## 3.2 Tax bases

Indicative tax bases of each fuel, or the $CO_2$ content of a standard physical unit, are set out in Table 1, below. The sources of these bases are Negotiated Greenhouse Agreements Application Guidelines (2003), Energy Data File (2004) and Baines (1993).

Natural gas, pipeline refers to gas delivered through the pipeline system to users throughout the North Island; it excludes “petrochemical gas”. Petrochemical gas is natural gas delivered directly to producers of petrochemicals in Taranaki – in particular to Methanex (for methanol) and Ballance (ammonia/urea). The emissions factor for coal is for sub-bituminous coal (which is the median emissions factor between bituminous coal and lignite).

Table 1
Carbon charge bases of fuels

| Fuel | $CO_2$ content | Physical unit |
|---|---|---|
| Petrol | 0.0023 | Litre |
| Automotive diesel | 0.0026 | Litre |
| Marine diesel | 0.0027 | Litre |
| Fuel oil | 0.0029 | Litre |
| Aviation gasoline | 0.0022 | Litre |
| Jet fuel | 0.0026 | Litre |
| Natural gas, pipeline | 0.0521 | Gigajoule |
| Natural gas, petrochemical | 0.0521 | Gigajoule |
| LPG | 0.0016 | Litre |
| Coal | 2.053 | Tonne |

### 3.3 The charge on each fuel

The carbon charge amounts on each fuel, for a tax rate of $15/tonne, are given in Table 2.

Table 2
Carbon charge amounts on fuels

| Fuel | Tax, $ / unit | Physical unit |
| --- | --- | --- |
| Petrol | 0.035 | Litre |
| Automotive diesel | 0.039 | Litre |
| Marine diesel | 0.041 | Litre |
| Fuel oil | 0.044 | Litre |
| Aviation gasoline | 0.033 | Litre |
| Jet fuel | 0.039 | Litre |
| Natural gas | 0.78 | Gigajoule |
| Petrochemical gas | 0.78 | Gigajoule |
| LPG | 0.024 | Litre |
| Coal | 31 | Tonne |

# 4 Petroleum products

## 4.1 Products included

The following products are included under the heading petroleum products:

Petrol
Automotive diesel
Marine diesel
Fuel oil
Aviation gasoline
Jet fuel

## 4.2 The supply of petroleum products

Petroleum products are supplied into their New Zealand markets from two sources – the refinery at Marsden Point and from imports. Table 3 indicates the sources of supply of the principal categories of petroleum products in 2003. Units are thousands of tonnes. (Source: Energy Data File, 2004.)

Table 3
Sources of petroleum products

| Petroleum product | Production | Imports | Total supply |
|---|---|---|---|
| Petrol | 1,521 | 776 | 2,297 |
| Diesel | 1,852 | 332 | 2,191 |
| Fuel oil | 525 | 26 | 551 |
| Aviation fuels | 835 | 192 | 1,027 |

Notes to Table 3: diesel includes automotive diesel and marine diesel; fuel oil includes light fuel oil, heavy fuel oil, bunker oil, other fuel oils; aviation fuels includes jet fuels and aviation gasoline.

New Zealand production, from the Marsden Point refinery, involves purchasing feedstocks on the world markets, refining these into petroleum products then supplying these products to the New Zealand markets. As well as feedstock prices at world levels, refining, transport, distribution and retailing costs and taxes are included in the final prices. Imported products are purchased at world prices then distributed in New Zealand in a similar way to New Zealand-refined products. For some products, such as aviation gasoline, the entire supply is from imported product; for other products, imports make up the difference between demand and New Zealand-refined products.

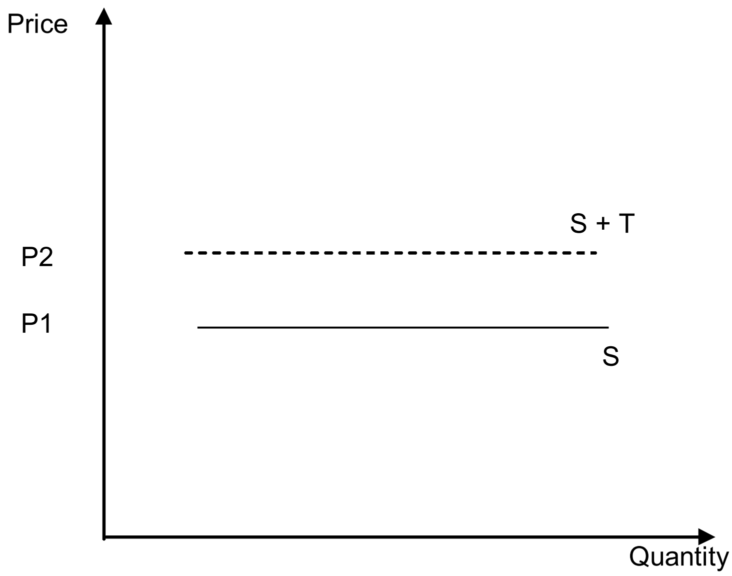
The situation in each of the markets is that all demand in New Zealand is met at prices reflecting world prices (plus transport and other costs plus taxes). In other words, whatever quantity is demanded is supplied at prices determined by world prices plus intra-New Zealand costs – any quantity is available at the prevailing price. If demand changes, and so the quantity supplied changes, the new quantity is available at the prevailing price level.

Cost conditions determine the supply price and cost conditions, including the crude oil price, are not affected by small changes in New Zealand demand. Nor does New Zealand refining capacity determine prices as (1) prices of petroleum products are already at world levels, allowing for internal costs and taxes, as a result of there already being significant importation of products, and (2) if the New Zealand refinery cannot meet all New Zealand demand, the balance is made up from imports.

### 4.3 Pass-through proportion

Petroleum products in New Zealand are characterised by a particular supply condition. This supply situation is represented graphically in Figure 8.

Figure 8
Supply of petroleum products in New Zealand




Any quantity is available at the prevailing price, P1. The supply curve is horizontal. Introducing a carbon charge will increase the price to P2 = P1 + T. Customers will be able to purchase whatever amount they wish at the new price, P2. The nature of demand makes no difference to the price, only to the quantity purchased and sold.

In terms of the incidence model, the elasticity of supply of petroleum products is infinite. The pass-through proportion is given by the incidence model as:

$$PTP = es / (ed + es)$$

When es is infinite, this formula reduces to:

$$PTP = 1$$

This conclusion is independent of demand conditions and the elasticity of demand (as long as ed is finite, which it is). The general conclusion is that the pass-through proportion for petroleum products is 100%.

# 5 Natural gas

## 5.1 Products included

This report considers two types of natural gas – pipeline gas and petrochemical gas. In addition, the gas industry produces LPG; this is considered as a separate fuel.

Petrochemical gas is natural gas supplied to major petrochemical facilities in Taranaki, in particular to Methanex, for the manufacture of methanol, and Ballance Agri-Nutrients, for the manufacture of ammonia and urea. Petrochemical gas represented around 26% of New Zealand's natural gas consumption of 164 PJ in the year to March 2004.

The remaining gas is denoted as pipeline gas and is transmitted through the pipeline systems in the North island and used for industrial, commercial, residential and electricity generation purposes. These uses accounted for 74% of consumption in the March 2004 year with electricity generation and cogeneration representing 49% of the total and the remaining 25% of the total being reticulated to end users.

## 5.2 Supply in the short run

In the short run, gas is supplied under existing contracts. These contracts are commercially confidential but, to the best of our knowledge, these contracts specify the price or price schedule to the purchaser. In this case, the carbon charge will be imposed on top of the prices in the existing price schedule. If the contract is silent concerning excise and sales taxes, any ambiguity will be removed by the carbon charge legislation as it is probable that the legislation will specify that the charge may be imposed on top of the prices specified in supply contracts. This is analogous to the case of GST where the tax is added to contractually-specified supply prices.

The incidence model can be applied to these markets, making use of this information about supply conditions. The elasticity of supply is infinite. Accordingly, the pass-through proportion can readily be calculated to be 1. In graphical terms, the supply curve is horizontal, exactly as in the case of petroleum products in Figure 8. Customers will continue to purchase their gas but they will be faced with a new price P2, where P2 = P1 + T. Demand conditions will not affect the new purchase price – contractus and legislation will determine the price level. Customers are able to purchase whatever amount they wish at the new price, P2. The nature of demand makes no difference to the price, only to the quantity (unless the contracts also specify purchase quantities).

The role of contracts in natural gas supply means that, in the short run at least, all of the carbon charge will be paid by purchasers, the pass-through proportion will be 100%.

### 5.3 Use of gas in petrochemicals in the long run

The analysis from the previous section applies for as long as the present contracts remain in effect and govern the supply and purchase of gas to the petrochemical companies. We do not know the details of these contracts so do not know their duration. While prices are determined in this way, the price at which purchases take place is exogenously determined and purchasers will pay all the carbon charge.

If new contracts, or more specifically new price schedules, come into force, the situation might change. If the price received by suppliers, net of the carbon charge, is lower than it would have been in the absence of the carbon charge, some of the charge will be passed back to suppliers, i.e. the pass-through proportion will be less than 100%. We now examine whether this is a likely situation.

The demand for gas feedstock by Methanex and by Ballance is likely to be highly inelastic, i.e. the demand for gas is unlikely to be significantly reduced in response to modest increases in the price of this gas. The likely range of the gas price increase caused by the carbon charge is 15 – 20%. Such a price increase is unlikely to lead to a significant change in the quantity demanded. This is for two reasons.

(1) The plant and equipment of the petrochemical companies is in place, it is a sunk cost. Continuing to purchase gas and produce methanol etc will generate a positive financial contribution (contribution is revenue from

the sale of methanol etc less the cost of purchasing the gas and other variable operating costs). The logical business strategy in this situation is to continue to purchase gas in order to maximise the financial contribution. The likely effect will be that the petrochemical companies continue to purchase the same quantities of gas as otherwise, even at the higher price.

(2) There is no economically viable substitute for gas as a feedstock into methanol etc. The choice is to continue to purchase gas, even at a higher price, or close down. It is highly likely that the commercially sensible decision will be to continue producing petrochemicals; doing this will require continuing purchases of natural gas.

In terms of the incidence model, these demand features correspond to an extremely low elasticity of demand for gas by the petrochemical purchasers, i.e. the quantity demanded will respond little or not at all to a small increase in price.

### 5.4 Pass-through proportion for petrochemical gas in the long run

The likely features of the market for petrochemical gas in the long run is that either the price will be exogenously set by contracts/legislation (so the elasticity, es, is approximately zero) or that demand will be insensitive to modest increases in the price of gas (so that the demand elasticity, ed, will be equal to or close to zero). The formal analysis of the pass-through proportion in these conditions is as follows.

If the elasticity of supply is extremely high:

$$\begin{aligned} PTP &= es \;/\; (ed + es) \\ &= 1 \;/\; (ed/es + 1) \\ &= 1 \end{aligned}$$

If the elasticity of demand is zero:

PTP = es / (ed + es)
= es / es
= 1

Either way, the pass-through proportion is 100% (or very close to 100%).

## 5.5 Supply of pipeline gas in the long run

Prices in the long run will probably change from present prices as new contracts are entered into and new pricing schedules introduced. If prices are set by market forces, rather than being locked in by present contracts, then gas supply behaviour needs to be examined and taken into account.

Supply of natural gas from existing producing fields is a relatively straightforward matter of managing the volumes extracted and injected to the pipeline system. In the long run, though, an increasing share of production will come from new fields. Accordingly, the new production process needs to be taken into account.

New supply of natural gas involves a sequence of activities:

- seismic investigation
- exploratory drilling
- discovery
- proving
- development
- production

All these activities respond, to a greater or lesser extent, to the price of natural gas.

Gas supply in New Zealand has been dominated for years by the Maui field. The Maui field is so large that its pricing has dominated gas prices and it has minimised the incentive for developing new fields. However, the end of Maui production (at least under the present contracts) is now in sight. In the expectation of higher gas prices in the future, exploration and development activity has recently begun to increase. New discoveries are being made and a sizeable new field, Pohokura, is about to enter production. The discovery and development of the Pohokura field is an example of the long run gas supply mechanism. The prices received for gas from new fields such as Pohokura significantly exceed the prices received for Maui gas.

This long run gas supply process has not been modelled for New Zealand but has been modelled in detail for the United States and for Europe. There may well be differences in some of the details between United States, European and New Zealand geology but the overall process is the same, regardless of location. The business and decision aspects of the process are the same and even the major players are the same. Therefore, it appears reasonable to draw on the broad results from the United States and Europe.

The key long run price elasticities are:

Table 4

Long run price elasticities of supply of natural gas

| Activity | Location | Author | Elasticity |
|---|---|---|---|
| Discoveries | US | Fisher (in Dismukes) | 0.9 |
| Discoveries | US | Erickson Spann | 0.69 |
| Production | US | Huntington | 0.4 |
| Production | US | MacAvoy Pindyck | 0.24 |
| Production | Europe | SNF | 0.75 |
| Production | Europe | Golombek Braten | 1.0 |
| Production | Europe | Asche et al | 0.71 |

Elasticities for discoveries can be expected to exceed elasticities for production or supply as new discoveries constitute only a part of supply in any year. Consistent with this, discovery elasticities are at least double the supply elasticities for the United States studies.

Supply elasticities for the United States are in 0.4 or less and are noticeably less than the elasticities for Europe, which are 0.7 or more. In all cases, though, there is a significant response of natural gas supply to the price of gas.

The only question is what numerical value best summarises this response. We use the value of 0.4. There are two reasons for this. (1) this is in the more conservative part of the range and, in the face of uncertainty, we prefer to be conservative, and (2) the Huntington value of 0.4 is itself the result of a survey of estimates rather than a single estimate by a single modeller.

### 5.6 Demand for pipeline gas in the long run

The principal use of pipeline gas is for electricity generation or cogeneration. Therefore, we must start by obtaining a reasonable estimate of the elasticity of demand for gas into electricity. We construct this estimate by means of the following analysis.

Additional electricity generation is sustained half by additional gas-fired generation and half by additional coal generation. (This is implied by the electricity emissions factor adopted by NZCCO, see Concept Consulting, 2003.) Gas accounted for 23.4% of generation in 2003. We assume that electricity prices are equal to the short run marginal cost of generation. In these conditions, a 1% increase in the price of gas leads to a 0.5% increase in electricity prices. If the price elasticity of demand for electricity is 0.75 (a reasonable estimate) there follows a 0.375% reduction in electricity use and in energy input to electricity. Gas input will decline by 0.188 out of 23.4 or by 0.8%. Therefore, the price elasticity of demand for gas into electricity is 0.8.

Demand elasticities for other uses are summarised in Table 5.

Table 5
Long run price elasticities of demand for natural gas

| Activity | Location | Author | Elasticity |
|---|---|---|---|
| Industrial | G7 | Martin | 0.86 |
| Industrial | US | Joskow Baughman | 0.81 |
| Industrial | US | Beierlein et al | 0.61 - 0.63 |
| | US | Balestra Nerlove | 0.58 – 0.69 |
| Commercial | US | Kaboudan Liu | 0.57 |
| Residential | US | Mackinac | 0.5 |
| Residential | Australia | Akmal Stern | 0.22 |
| Residential | US | Dumagan | 0.23 |
| Residential | Canada | Ryan Wang | 0.25 |
| Residential | US | Beierlein et al | 0.23 – 0.35 |
| Residential | Germany | Asche et al | 0.35 |
| Residential | UK | Asche et al | 0.32 |
| Residential | Spain | Asche et al | 0.22 |

On the basis of the above information, we calculate the overall price elasticity of demand for pipeline gas as shown in Table 6. The shares are the shares of the demand element in total gas use in New Zealand in 2003 (see Energy Data File, 2004). The separate elasticities are weighted by these shares to calculate the overall elasticity of demand.

Table 6
Calculation of the overall price elasticity of demand for natural gas

| Demand for | Elasticity | Share |
|---|---|---|
| Electricity | 0.8 | 0.66 |
| Industrial | 0.8 | 0.17 |
| Commercial | 0.5 | 0.11 |
| Residential | 0.25 | 0.06 |
| Total | 0.7 | 1.00 |

The overall elasticity of demand for pipeline gas is estimated to be 0.7. Note that this is the same elasticity as that adopted by the Commerce Commission in its gas control inquiry in 2004 (Commerce Commission, 2004). This provides support that an elasticity of 0.7 is reasonable for use in the New Zealand market.

### 5.7 Pass-through proportion for pipeline gas in the long run

The pass-through proportion is given by the incidence model as:

$$PTP = es / (ed + es)$$

The long run elasticities for pipeline gas are estimated to be:

$$ed = 0.7$$
$$es = 0.4$$

so the pass-through proportion in the long run is calculated to be 0.36. Thus, it is estimated that 36% of the carbon charge will be, in the long run, passed-through to gas purchasers.

# 6 LPG

## 6.1 Products included

LPG comprises liquefied petroleum gas and natural gas liquids. LPG typically is made up of around 60% propane and 40% butane. The principal sources of LPG are from natural gas extraction, from the refinery at Marsden Point and from imports.

## 6.2 The supply situation

The supply situation in New Zealand in 2003 is summarised in Table 7 (source: Energy Data File, 2004).

Table 7
Supply of LPG in New Zealand

| Source | Quantity, PJ |
|---|---|
| LPG extracted from natural gas | 8.7 |
| LPG from the New Zealand refinery | 0.9 |
| Imports | 0.5 |
| Exports | 1.2 |
| Losses, processing, inventory etc | 2.1 |
| Use by New Zealand customers | 6.8 |

The presence of imports and exports in significant quantities means that the marginal supply is from imports and the marginal demand is for exports. If demand in New Zealand exceeds local production, the deficit is imported. If the supply within New Zealand exceeds demand, the surplus is exported. With the market so open to world trade, the world price can be expected to drive the New Zealand price.

(This is the world price in a c.i.f. sense, i.e. allowing for the product price, insurance and freight.)

This market structure means that LPG is available at the prevailing price and that the prevailing price can be expected to be driven by the world price. New Zealand purchasers of LPG therefore are price takers – whatever quantity is demanded is supplied at the prevailing price. Price does not affect quantity supplied although it does affect quantity demanded.

This supply situation, which applies in the short run as well as the long run, is characterised by an extremely high elasticity, i.e. es can be taken to be infinite. Its graphical representation is the same as for petroleum products, this was shown in Figure 8.

## 6.3 Pass-through proportion

The pass-through proportion is given by the incidence model as:

$$PTP = es / (ed + es)$$

$$= 1 / (ed/es + 1)$$

In the LPG market, where es is infinite, this formula reduces to:

$$PTP = 1$$

This conclusion is independent of demand conditions and the elasticity of demand (as long as ed is finite, which it is). The general conclusion, is that the pass-through proportion for LPG is 100%. This applies in the short run and the long run.

# 7 Coal

## 7.1 Supply in the short run

It appears that coal supply, in the short run at least, takes place under existing contracts that specify the price or price schedule to purchasers. Carbon charges will be imposed on top of these prices. Any ambiguity will be removed by the carbon charge legislation which will specify that the charge will be imposed on top of the prices specified in supply contracts. The most likely effect will be that the carbon charge will be paid entirely by the purchaser.

In terms of the incidence model, these contractual and legislative features imply that coal is available at exogenously determined prices, i.e. the elasticity of supply is infinite. This is similar to the short run supply situation for natural gas.

The graphical analysis is similar to that for petroleum, see Figure 8, above. The supply curve is horizontal. Customers will purchase their desired quantities of coal but at the prevailing, contractual price. With the carbon charge, they will be faced with a new price corresponding to P2 = P1 + T. Customers are able to purchase whatever amount they wish at the new price, P2. The nature of demand makes no difference to the price, only to the quantity purchased and sold.

## 7.2 Supply of coal in the long run

The supply situation in New Zealand in 2003 is summarised in Table 8 (source: Table B.21, Energy Data File, July 2004). Units are petajoules (PJ).

Table 8
Supply of coal in New Zealand

| | Bituminous Coking | Bituminous Other | Sub-bituminous | Lignite |
|---|---|---|---|---|
| NZ Production | 71 | 3 | 58 | 4 |
| + Imports | | 3 | | |
| - Exports | 70 | | | |
| = NZ consumption | 1 | 6 | 58 | 4 |

There are large exports of coking coal and there is active international demand for coking coal. As a consequence, it is likely that intra-New Zealand prices for coking coal are set to world levels, with allowance for transport and related costs. The supply curve in this situation will be horizontal, i.e. the elasticity of supply will be extremely large.

Bituminous coal, other than coking coal, is produced in New Zealand and imported in equal measure. As the marginal source of supply is imports, market forces will drive the price to world levels. Supply will be available at world prices (these will be c.i.f. prices). Changes in demand will give rise to a quantity response, not to a price response. The supply curve in this market structure is horizontal, i.e. the elasticity of supply is extremely large. This situation is the same as that for petroleum products.

Table 8 indicates that all sub-bituminous and lignite coal comes from New Zealand production. It appears that world trade does not enter into this market. (This was the situation in 2003.) Therefore, the price will be at or below the world c.i.f. price and will reflect New Zealand market conditions.

This coal is produced from mines in the Waikato, West Coast, Otago and Southland areas and comes from a number of producers. There is also a large resource base that will allow supply to be increased. Resource Management Act considerations appear to be such that supply of coal can be increased. These observations suggest that the supply side of the market in New Zealand is relatively competitive. Supply in these conditions is typically characterised by a rising supply curve where supply is sequenced in ascending cost order.

This analysis of market structure suggests that the long run elasticity of supply of sub-bituminous and lignite coal is positive and probably finite. The remaining question is to determine a reasonable numerical value for this elasticity.

Estimates of the price elasticity of supply of coal in various countries are shown in Table 9.

Table 9
Price elasticities of supply of coal

| | Location | Author | Elasticity |
|---|---|---|---|
| Long run | OECD | IFE-Iddri | 2.0 |
| Long run | Australia | Beck et al | 1.9 |
| Long run | Australian mines | Beck et al | 2.7 – 3.5 |
| Long run | Europe | SNF | 2.0 |
| Long run | Europe | Golombek Braten | 4.0 |
| Long run | US | Mellish | 7.3 |
| Short run | World | Light et al | 0.3 |
| Short run | Australia | Beck et al | 0.4 |

There is a clear consistency in the supply elasticities modelled for other countries. The short run elasticity is less than the long run elasticity which is exactly what is to be expected. The short run elasticity is at or below 0.4, the long run elasticity is at or above 1.9. We use the estimate of 2.0 for long run elasticity as this is clearly the modal estimate in Table 9.

### 7.3 Demand for coal in the long run

Coal in New Zealand is used predominantly in industry and for electricity generation and cogeneration. There is a small residential and commercial demand. It is necessary to estimate the long run elasticity of demand for coal in each of these using sectors.

Additional electricity generation is sustained half by additional gas-fired generation and half by additional coal generation. Coal accounted for 7.3% of generation in 2003. We assume that electricity prices are equal to short run marginal cost. A 1% increase in the price of coal leads to a 0.5% increase in electricity prices. If the price elasticity of demand for electricity is 0.75 there follows a 0.375% reduction in electricity use and in energy input to electricity. As coal input will decline by 0.188 out of 7.3, or by 2.6%, the price elasticity of demand for gas into electricity is 2.6.

A summary of elasticities of demand in the other using sectors is given in Table 10.

Table 10
Price elasticities of demand for coal

| Activity | Location | Author | Elasticity |
|---|---|---|---|
| Industrial | US | Joskow Baughman | 1.14 |
| Industries | Australia | DoE, NSW | 0.36 – 1.93 |
| Industrial | G7 | Martin | 1.55 |
| Residential | New Zealand | Morris | 0.27 |

On the basis of the above information, we calculate the overall price elasticity of demand for coal as shown in Table 11. The shares are the shares of the demand element in total coal use in New Zealand in 2003 (source: Energy Data File, 2004). The separate elasticities are weighted by these shares to calculate the overall elasticity of demand. We use the elasticity of 1.55 for industrial demand for coal as (1) it is in effect the median estimate in the above range, and (2) it is calculated for the G7 industrialised countries so, being so widely based, may be more relevant to New Zealand conditions than the estimate for any one country.

Table 11
Calculation of the long run price elasticity of demand for coal

| Demand for coal from | Elasticity | Share |
|---|---|---|
| Electricity | 2.6 | 0.43 |
| Industrial | 1.55 | 0.50 |
| Residential, Commercial | 0.27 | 0.06 |
| Total | 1.9 | 1.00 |

### 7.4 Pass-through proportion for coal

The pass-through proportion is given by the incidence model as:

PTP = es / (ed + es)

In the short run, the elasticity of supply is most likely infinite. Accordingly, the pass-through proportion in the short run is 100%.

The long run situation involves different elasticities. Entering into the incidence formula the estimated long run elasticities gives:

PTP = 2.0 / (1.9 + 2.0)

= 0.51

Thus, it is estimated that just over 50% of the carbon charge will be, in the long run, passed-through to coal purchasers.

# 8 Outputs

## 8.1 Required outputs

NZCCO requires the following outputs from this study – to determine:

(1) The extent of cost pass-through to NGA firms that is likely to occur as a result of the payment of the emissions charge earlier in the supply chain, in the firm's purchase of the specified fuels.

(2) The feasibility of calculating and verifying such cost increases for the purpose of providing relief from the emissions charge.

(3) What are the implications on the extent of the pass-through if the market has knowledge of the firm's relief from the emissions charge and the Crown's assessment of the extent of the pass-through. Will the pass-through default to the Crown's assessment?

(4) For each specified fuel, would the extent of the cost pass-through and the feasibility of calculating and verifying such cost increases alter for NGA firms that are large energy consumers or that have special contracting arrangements with fuel suppliers?

(5) How would the extent of the cost pass-through change if an emissions charge of $5 or $25 per tonne of $CO_2$ was assumed for each specified fuel (instead of the principal assumption of $15 per tonne of $CO_2$).

(6) During the first commitment period (2008 – 2012), is it likely that the extent of the cost pass-through will significantly change and require a recalculation. If so, what are the likely factors or circumstances that will drive this change?

These outputs are presented in the following sections.

## 8.2 NGA cost pass-throughs

The question to be addressed is: what is the extent of cost pass-through to NGA firms that is likely to occur as a result of the payment of a carbon charge of $15/tonne on fuels purchased by the firm.

This report has focussed on the pass-through proportion, PTP. The pass-through amount can be found from the pass-through proportion simply by multiplying PTP by the tax amount, $15/tonne of $CO_2$ emissions content of the fuel. PTPs for each fuel have been calculated in previous chapters. There is one set of PTPs applying in the short run, another applying in the long run. These PTPs are set out in Table 12.

Table 12
Carbon charge pass-through proportions

| Fuel | PTP, short run | PTP, long run |
|---|---|---|
| Petroleum products | 1 | 1 |
| Natural gas | 1 | 0.36 |
| Gas to petrochemicals | 1 | 1 |
| LPG | 1 | 1 |
| Coal, bituminous | 1 | 1 |
| Coal, sub-bituminous and lignite | 1 | 0.51 |

In the short run, all pass-through proportions are 100% so the pass-through is the full amount of the carbon charge.

In the long run, all pass-throughs are 100% except for pipeline gas and for sub-bituminous and lignite coal. The long run pass-through proportions are forecast to be 36% for pipeline gas and 51% for sub-bituminous and lignite coal.

The forecast pass-through proportion for a particular year is a separate question as time will have to be introduced into the incidence model and its application. (This is also discussed in a later section of this report.)

### 8.3 Verifying fuel price increases

The question here is to comment on the feasibility of calculating and verifying such cost increases (the pass-through of the carbon charge) for the purpose of providing relief from the emissions charge.

It is essential to be clear as to what can be observed and what can only be estimated. Observed indicators can be verified, estimated indicators cannot be verified. This matter has been reviewed in general terms in an earlier section of this report. The present section applies a similar analysis to address the question of verification.

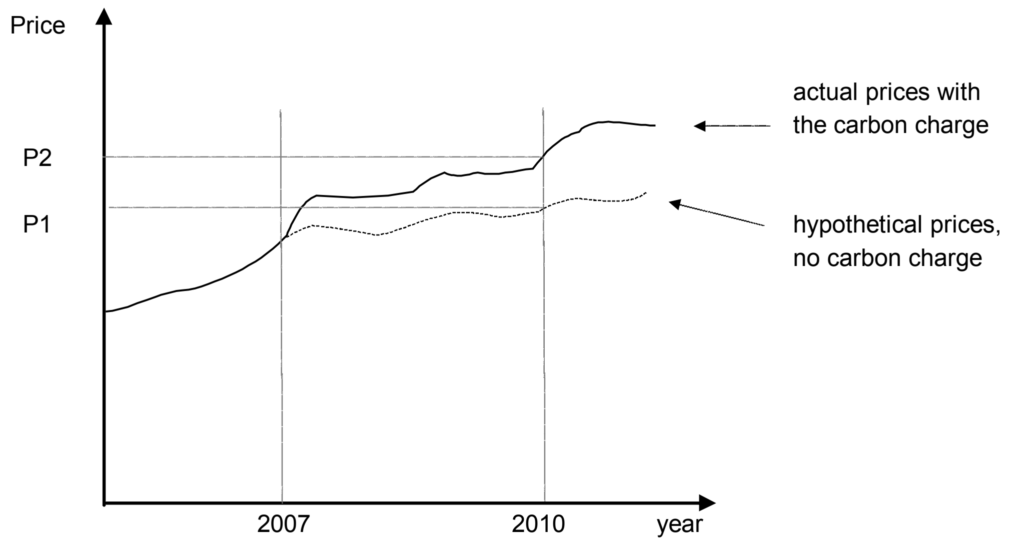
The future price of a fuel can be visualised as in Figure 9. This represents the price of fuel to the purchaser, including the effects of the carbon charge.

The sold line shows the actual price path, i.e. the movement over time of the prices actually paid by purchasers of the fuel being considered. In this example, the price jumps in 2007 because of the introduction of the carbon charge but the price was increasing in each year anyway. The dotted price line is the hypothetical price path – the future prices that would have occurred if there had not been a carbon charge.

The actual price to purchasers in 2010 is P2. This price can be verified from purchasers' records.

The pass-through in this example is P2 – P1. P1 is the price that would have applied in 2010 in the absence of a carbon charge. This price is hypothetical as in fact there is a carbon charge in 2010. P1 is not observable. It follows that neither the pass-through amount, corresponding to P2 – P1, or the pass-through proportion, (P2 – P1) / T, is observable.

Figure 9
Illustration of future fuel prices




Pass-through effects are inherently unobservable, they cannot be measured, they must be done calculated analytically. As a consequence, the pass-through amount or proportion cannot be verified in the sense of observation and measurement. All that can be done in estimating the pass-through is to use a theoretically robust approach and apply this reasonably to the market in question.

## 8.4 Implications of knowledge of relief

What are the implications on the extent of the pass-through if the market has knowledge of the firm's relief from the emissions charge and the Crown's assessment of the extent of the pass-through. Will the pass-through default to the Crown's assessment?

The pass-through proportion is driven by market forces, in particular by the average responsiveness of suppliers to price changes and the average responsiveness of purchasers to price changes – the elasticities of demand and supply. These elasticities reflect many factors such as costs of production, demand for the service produced using the fuel, possibility of substituting other inputs for the fuel, number of purchasers in the market, and strength of competition in the fuel market. These factors are independent of knowledge of the Crown's assessment of the pass-through.

There is no reason to think that the rise in the price in the price of a fuel, resulting from the carbon charge, will default to the Crown's assessment of the pass-through. There is every reason to think that the rise in the market price will be determined by normal market forces.

The NGA program might affect the net price of a fuel to a company and this, together with abatement activities carried out by the company because of the NGA program, may well affect a company's actual purchases of fuel. However, in a relatively competitive market with many purchasers – such as exist for the fuels under consideration – this will not affect market prices nor will it affect the pass-through.

### 8.5 Effect of special purchase arrangements

For each specified fuel, would the extent of the cost pass-through and the feasibility of calculating and verifying such cost increases alter for NGA firms that are large energy consumers or that have special contracting arrangements with fuel suppliers?

The quantity of energy or even the quantity of a fuel purchased by a single company is not relevant to the pass-through in markets that are reasonably competitive. What could be relevant is a single purchaser accounting for most of the demand. Such a purchaser might be able to dictate or at least influence the terms of purchase and sale, reducing the pass-through proportion. However, there are no markets in the fuels considered where a single buyer dominates the market in this way. And, even if a single purchaser did dominate the market, this would be taken into account in the elasticities that enter into the pass-through proportion model.

Accordingly, we conclude that the pass-through would not be different for a NGA firm that is a large energy consumer.

However, the situation might be different for some types of purchasing arrangements. The critical factor is whether or not existing contracts dictate the future purchase price of a fuel.

If existing contractual arrangements will continue into the distant future and if the price of fuel, or the formula for the price, is rigidly set in the contract then the pass-through proportion will be 100%. This situation is readily accommodated in the incidence model. And, this situation appears to apply in the short run for fuels such as natural gas and coal.

The are two fuels for which the long run pass-through proportions are estimated to be less than 100%, these are pipeline gas and coal. These pass-through conclusions could be affected by the nature of contracting arrangements. If fuel prices are pre-determined even into the long run, the pass-through proportions would be 100% instead of the present forecasts of 0.36 or 0.51. This would require all the following conditions were met. (1) existing contracts lock in fuel prices for many years into the future (until at least 2012), (2) all purchasers in the market are tied into such contracts, and (3) if new suppliers or new purchasers enter the market, they too will enter into such contracts. Although we consider it unlikely that these conditions will apply, it is nonetheless possible that they will apply.

Our conclusion on the effect of special purchasing arrangements is as follows. It is theoretically possible that the nature of contracting or purchasing arrangements might be such that the long run pass-through proportions for pipeline gas and coal would differ from the present estimates (of 36% and 51%, respectively).

### 8.6 Pass-throughs for different rates

How would the extent of the cost pass-through change if an emissions charge of $5 or $25 per tonne of $CO_2$ was assumed for each specified fuel (instead of the principal assumption of $15 per tonne of $CO_2$)?

The pass-through proportions have been calculated using the incidence model. These proportions apply to any carbon charge rate, whether $5/tonne or $15/tonne or

$25/tonne. The amount of the pass-through, in $/physical unit for a fuel, will vary directly with the charge rate, in $/tonne. Will, in addition, the pass-through proportion differ for different tax rates?

The incidence model is general, it does not depend on the tax rate. The application of the model involves numerical elasticities. Therefore, the question can be rephrased as: will these elasticities differ for different tax rates?

For small price changes, such as might result from a carbon charge rate of $5/tonne, it is conceivable that supply and demand responses might be less, proportionately, than for large price changes. This would occur, for example, if companies were to absorb price changes rather than changing their purchasing or selling behaviour. If this effect were present, both the elasticity of demand and the elasticity of supply would be closer to zero. The pass-through proportion depends on the ratio of the elasticities and it is possible that the ratio would not change even if each elasticity diminished in magnitude. Nonetheless, it must be recognised that the numerical values of the elasticities might be different for different tax rates. (Also, the elasticities might differ according to the prevailing level of oil and gas prices.)

Clearly, further work is needed to clarify the likely numerical values of elasticities for small rates of carbon charge compared to medium or large rates of carbon charge.

### 8.7 Will the pass-through change over CP1?

During the first commitment period (CP1, 2008 – 2012), is it likely that the extent of the cost pass-through will significantly change and require a recalculation? If so, what are the likely factors or circumstances that will drive this change?

The pass-through amount depends on:

> The carbon charge rate, $/tonne
> the carbon content of the fuel, tonnes/physical unit, e.g. tonnes/litre
> the pass-through proportion.

The pass-through amount, in $/physical unit such as $/litre, is the product of these three factors.

The pass-through proportion is a function of time – the time since the carbon charge was introduced. In CP1, the time since introduction of the carbon charge will increase from 1 year in 2008 to 5 years in 2012. The pass-through proportion will increase over CP1 as the pass-through proportion moves from its short run value, of 100%, closer to its long term value. For coal and gas, the long run pass-through proportion is less than 100% so the pass-throughs for these fuels will vary from year to year.

The pass-through amount will need to be recalculated in each year of CP1 or even beyond 2012, if the NGA mechanism extends beyond 2012. The pass-through proportion will be different for each year. The recalculation can be carried out now. It is a natural follow-on study to extend the incidence model developed in this report to allow for the transition from short run to long run, i.e. to make the pass-through proportion an explicit function of time

# 9 Conclusions

## 9.1 Model established

NZCCO is faced with the challenge of forecasting the pass-through of the carbon charge.

This report has established a model that provides a framework for the estimation of the pass-through. The model is robust. Numerical parameters are then entered into the model to apply it to particular markets. The forecasts of particular pass-throughs are provided through these applications.

## 9.2 Next steps

This report has analysed the structures of various markets and has been able, based on market structure, to infer parameter values for these markets. The pass-throughs for petroleum products, petrochemical gas, LPG and bituminous coal have been handled in this way. The market analysis for these products has been sufficiently clear and robust that NZCCO can have confidence in the pass-through estimates for these products.

These analyses have also shown that the model parameters for two fuels, pipeline gas and sub-bituminous and lignite coal, cannot be deduced from market analysis but rather have to be inferred from analysis of market behaviour. Initial estimates of parameter values in these two markets have been identified. However, these are just initial estimates. Further investigation into these areas is needed. International information has been used to provide initial estimates. Considerable additional work is needed to refine these estimates and to align these to New Zealand conditions.

Refinement of the parameter values within the model is needed also to allow for cross-elasticities of demand. The initial treatment, in this report, focussed on own elasticities of demand. This is appropriate as the first step. However, a robust empirical analysis also needs to allow for the interaction between fuel prices in terms of purchase decisions for any given fuel. Imposition of a carbon charge will lead to higher prices for all fuels, i.e. all fuel prices will goes up simultaneously (although by different amounts). The feedback of these multiple fuel price increases onto the demand for any one fuel needs to be taken into account. It is possible to extend the incidence model to allow for these so-called cross effects. It is essential that this extension of the model be carried out.

The initial investigation, in this report, dealt with time in only a first approximation way – it separated time into two blocks – the short run and the long run. However, a more detailed treatment of time is required in order to address the questions of interest to NZCCO. For example, NZCCO needs to forecast the pass-through for gas in 2010 and 2011 and 2012, not just in the long run. The parameters of the incidence model need to be extended to incorporate time explicitly.

This initial investigation has come a long way – a robust theoretical framework has been developed and a robust empirical application has been carried out for a number of fuels. A further benefit of this initial work is that areas of uncertainty, whether further investigation is needed, have been identified. The logical next step is for NZCCO to commission ***e-dec*** Ltd to perform this more detailed work in the following areas:

(1) investigation of the price elasticity of demand and the price elasticity of supply for natural gas and for coal, particularly allowing for New Zealand conditions and also allowing for the magnitude of the carbon charge;

(2) incorporation of price cross elasticities of demand in the gas market and in the coal market;

(3) incorporation of time into the parameters of the incidence or pass-through model for natural gas and for coal.

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