

# **Encouraging uptake of transport biofuels**

## **Assessment of policy alternatives**

### **Report to the Energy Efficiency and Conservation Authority**

**May 2005**



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## **Comment**

In 2004, the Minister of Energy requested that the Ministry of Economic Development (MED) prepare a report analysing the feasibility and appropriateness of instituting a mandatory biofuels blending requirement.

To assist officials' consideration, the Ministry commissioned the New Zealand Institute of Economic Research (NZIER) to prepare a report assessing the cost effectiveness of mandatory biofuels blending targets and mandatory biofuels sales targets.

The MED report is available on their website:

[http://www.med.govt.nz/ers/oil\\_pet/biofuels/index.html](http://www.med.govt.nz/ers/oil_pet/biofuels/index.html)

To compliment this report the Energy Efficiency and Conservation Authority commissioned NZIER to prepare a report on potential incentives other than a mandatory biofuels blending or sales target.

This report is provided as background information and is not intended to be indicative of the Government's official policy.

It should be noted that since this report was finished in July 2005, there have been several Government policy changes which will have impacts on the analysis. Current information on the state of the mandatory biofuels sales obligation is available on the Ministry of Transport website:

<http://www.transport.govt.nz/business/multimodal/environment/biofuels/>

## **Preface**

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

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NZIER was established in 1958.

## **Authorship**

This report has been prepared at NZIER by John Stephenson and Preston Davies, and reviewed by Peter Clough.

## Executive Summary

The Energy and Efficiency Conservation Authority (EECA), as part of the Biofuel Officials Group has requested a report providing “...*an analysis of the costs, benefits and practical implementation viability of policies which could be applied to complement or act as standalone alternatives to a mandatory transport biofuels target to incentivise the uptake of biofuels.*”

We consider first, what the in-principal motivations might be for introducing subsidies. We provide a brief discussion of economic externalities and market failure. We find potential justification for subsidies on the basis that benefits to society of biofuel use may not be adequately reflected in biofuel prices, which in turn is impeding the production and uptake of biofuels in the New Zealand context.

While externalities may exist, subsidies can have unintended and potentially perverse consequences which need to be managed carefully. Subsidies often do not attain a socially efficient resource allocation. Furthermore, we suggest that, irrespective of externalities, some subsidies are ‘good’ while others are ‘bad’. Any incentives introduced should be:

- Well targeted so that only a fairly narrow group of consumers or producers are recipients;
- Soundly based, so that incentives to provide the service efficiently are not undermined;
- Practical, so that the financial resources are adequate and the management of the program is feasible and affordable;
- Transparent, so that financial costs and the provisions of the program are clear;
- In effect only for a limited lifetime, (i.e. have a sunset provision) and be predictable so recipients can plan for future phase-down and phase-out;
- Close-to-market (technologies that are "deserving" of subsidies should not be over-subsidized lest the subsidy stifle commercial discipline and competition; the subsidy provided should be only equal to the magnitude of the externality); and
- Competitive, so that subsidies are provided through competitive mechanisms so as to ensure that excess "rents" do not persist.

We find that no particular form of subsidy fits perfectly within this framework. For example, a subsidy to producers which is not linked to output (such as capital cost subsidies) carries the risk that the subsidy will not lead to greater production and uptake of biofuels. On the other hand a producer subsidy linked to output may lead to over-production and so the cost of the subsidy may be larger than the benefits to society of pollution abatement from biofuel use. A subsidy to final consumption would not have

these problems but would instead not be very tightly targeted and is likely to be more costly than producer subsidies. However, some subsidies are better than others according to these guidelines.

With this in mind we have examined the impacts of subsidies using a cost effectiveness analysis. We estimate the costs of a variety of subsidies for incentivising the production and uptake of biodiesel and ethanol/petrol blended fuels. We have compared the effectiveness of subsidies to blending and distribution, production of fuel feedstocks, and subsidies to sales at the pump. We considered direct payments as well as tax exemptions as a basis for subsidies.

We find that subsidies to blending and distribution would not induce biofuel uptake. Similarly tax exemptions are unlikely to be sufficient to induce uptake. Thus, we focus on subsidies to producers and subsidies at the pump and consider their relative costs in achieving a notional target of 2 petajoules of biofuel use by 2012.

We find that subsidies to biodiesel use provide the least cost means of achieving the notional 2 petajoule target. The cost effectiveness of biodiesel is primarily due to emission reduction properties of biodiesel use being in excess of that for ethanol.

Biodiesel incentives have the particular benefit of leading to a far greater reduction in particulate matter emissions than ethanol blends. These emissions have the greatest impact on human health of all vehicle emissions. Currently diesel combustion is a significant contributor to the presence of these emissions in our environment. Biodiesel significantly reduces these emissions and biodiesel subsidies represent the lowest cost option of reducing the stock of particulate matter emissions. Hence, a biodiesel incentive, or subsidy, represents the most cost effective biofuel option for reducing ill-health effects related to vehicle emissions.

The finding that biodiesel is a more cost effective biofuel option than ethanol comes with the caveat that there is no readily obtainable supply of biodiesel available to meet a notional 2 petajoule target. Production is limited and international markets are thin. Any decision to incentivise biofuel production or consumption will need to be taken alongside extensive consultation with possible producers and retailers.

Producer subsidies prove to be a far more cost effective means of inducing biofuel uptake than subsidies at point of final sale. However, it is not clear that producer subsidies are necessarily a better option because of problems around incentives to ensure uptake as discussed above. Production incentives would, however, reduce New Zealand's dependence on external sources of transport fuels (i.e. oil), which would be advantageous in terms of planning for and responding to major oil supply disruptions.

In our view there is a useful complementarity between mandatory biofuel use and subsidies. A subsidy which is sufficient to ensure market prices do not rise in the event of a mandatory biofuel target ensures there is no consumer welfare loss associated with a mandatory blend target and higher fuel prices.

The summary table below outlines our estimates of the relative costs and benefits of biodiesel and ethanol blend subsidies to final consumption (subsidy at point of sale) and subsidies to producers. We provide estimates based on 50% and 100% market penetration to show the sensitivity of our estimates to assumptions about uptake. The table should be read from left to right. The first two columns are self explanatory. The third column shows the direct cost to government of subsidies per litre of biofuel blend. The fourth column is the total gross cost of the subsidy (i.e. subsidy per litre multiplied by number of litres used).

The fifth column shows the number of petajoules of unblended biofuel used in 2012, given our assumptions about market penetration. The next column shows the value of reduced CO<sub>2</sub> emissions based on a carbon tax or market value of carbon credit assumed to be \$15 per tonne. This value is removed from the gross cost of the subsidy in the fifth column, yielding the value of the subsidy in market terms. The negative values indicate that this is a net cost, before non-CO<sub>2</sub> emission reductions are taken into account. The next three columns show the amount of non-CO<sub>2</sub> emissions reduced. The last three columns show the implied value, or price, per tonne of emission reduced needed to ensure that the cost of the subsidy is equal to the benefits of the reduced emissions. This in effect assumes social cost is equal to social benefit under all scenarios. Hence we can compare the cost effectiveness of each scenario.

The summary table supports the view that a biodiesel subsidy to producers is the most cost effective option.

### **Summary of costs and benefits of a biofuel incentives**

Present (2004) value, cost and CO<sub>2</sub> benefit in \$ millions, renewable fuel use is 2012 consumption (PJ), emission reductions in tonnes, emission implied prices in \$ per tonne

Blend	Market penetration	Average	Total gross cost of subsidy	Renewable fuel use in 2012	Total CO <sub>2</sub> reduction benefit	Net market	Reduction in PM emissions	Reduction in CO emissions	Reduction in NMVOC emissions	Implied	Implied price of CO	Implied price of NMVOC
		subsidy per litre (cents)				value of subsidy (\$millions)				price of PM (\$millions)		
<b>Subsidy to producers</b>												
E3	50%	0.88	55.7	1.03	3.03	-54.5	0.77	132,430	13,067	68.164	0.003	10.075
E3	100%	0.88	111.4	2.05	6.1	-110.3	1.55	265,403	26,191	67.767	0.003	10.510
B2.75	50%	1.06	44.8	1.05	4.4	-40.4	42.2	5,782	1,042	0.954	0.06	97.0
B2.75	100%	1.06	89.5	2.10	8.8	-80.7	84.36	11,565	2,084	0.954	0.06	97.0
<b>Subsidy to final consumption</b>												
E3	50%	1.58	100.3	1.03	3.03	-97.2	0.77	132,430	13,067	125.8	0.006	18.6
E3	100%	1.58	200.5	2.05	6.1	-194.4	1.55	265,403	26,191	125.1	0.006	18.6
B2.75	50%	2.02	85.6	1.05	4.4	-81.2	42.2	5,782	1,042	1.92	0.112	195.0
B2.75	100%	2.02	171.2	2.10	8.8	-162.4	84.36	11,565	2,084	1.92	0.112	195.0

Notes: (1) Numbers may not add accurately due to rounding

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# 1. Introduction

The Energy and Efficiency Conservation Authority (EECA), as part of the Biofuel Officials Group has requested a report providing “...*an analysis of the costs, benefits and practical implementation viability of policies which could be applied to complement or act as standalone alternatives to a mandatory transport biofuels target to incentivise the uptake of biofuels.*”

1. EECA has asked that the following policy alternatives be considered:
2. provision of subsidies or other financial payments to producers
3. provision of subsidies or other financial payments to blenders/distributors of biofuels or blends
4. provision of incentives on a national or regional basis (eg Auckland where biodiesel benefits in reducing particulate matter emissions have potentially greater value than in other parts of the country)
5. any other possibilities for providing a favourable taxation regime (given that the only tax on diesel vehicles is road user charges which cannot distinguish fuel types)

For each of the policy alternatives identified, EECA are seeking a report that will:

- examine how it will contribute to government renewable energy policy objectives;
- assess the direct and indirect impacts that it will have on the economy, including the impact on fuel prices;
- assess the impact that it will have on the competitive environment in the fuels industry;
- assess the impact it will have on the environment and society (e.g. health impacts);
- outline the costs and benefits relative to the status quo and assess its complementarity or ability to substitute for other options - including possible mandatory transport biofuels requirements;
- outline how it might be implemented and enforced with reference to existing or new policy, legislative settings and financial/staff resource requirements; and
- explore its consistency with international obligations.

This report focuses on the use of ethanol and biodiesel blended with petrol and diesel respectively. While these fuels can, under some circumstances, be

used on their own and there are other bio-fuels which may be investigated, we have chosen to look entirely at these two fuel blends because on the face of it they represent the most feasible bio-fuel options to meet a renewable fuels target for transport biofuels in New Zealand. In addition, we have tried to be as consistent as possible with previous work recently completed for the Ministry of Economic Development (MED).<sup>1</sup>

Our report does not consider the full quantum of costs and benefits to society of biofuel use. This is partly because considering all costs and benefits of biofuel use would require a more substantial research process than has been possible within the scope of this research. As such, this report should not be taken as the final word on biofuel use but rather as a contribution to a larger set of policy research programmes and initiatives of which the cost effectiveness of biofuel targets is a small part.

## **1.1 Policy context**

The policy context surrounding bio-fuels for transport is articulated in a range of policy initiatives including:

- the Sustainable Development Programme of Action which identifies principles for sustainable development policy and decision-making. Sustainable energy is one of the key action areas with desired outcomes including energy use in New Zealand becoming progressively more efficient and less wasteful, and renewable sources of energy are developed and maximised;
- the New Zealand Transport Strategy which sets out the government's overall vision for the transport sector. One of the objectives of this strategy is ensuring environmental sustainability through reducing local and global environmental effects and shifting from non-renewable to renewable resources;
- climate change, air quality and waste policies which support greater supply of renewable transport energy;
- the National Energy Efficiency and Conservation Strategy which promotes energy efficiency, energy conservation and renewable energy with the objective of moving New Zealand towards a sustainable energy future. It contains an overall target of an additional 30 petajoules (PJ) of consumer energy from renewable sources by 2012 and includes an indicative target of at least 2 PJ per year for transport.

These policy initiatives provide the framework within which biofuel use is being considered by the government.

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<sup>1</sup> See NZIER (2004).

## 1.2 Approach

Our approach to assessing the relative costs and benefits of transport bio-fuel support options is a cost effectiveness framework. Again, this is in keeping with the MED work just completed, allowing for ease of comparison. Assessing the costs and benefits of renewable energy sources can be confounded by the fact that the full benefits of renewable energies are not likely to be accrued until some time in the future and that the precise nature of these benefits is difficult to forecast. This means that the costs of renewable fuel use in today's terms is often perceived or assessed to be in excess of the benefits. This is where policy intervention is necessary to make a judgement on the desirability of renewable fuel use. As a consequence the report is explicitly more concerned with identifying and measuring the effects of the policy alternatives, rather than assigning judgement on their suitability.

Within our cost-effectiveness framework, our analytical approach is both quantitative and qualitative. In the case of quantitative analysis we assess the relative costs and benefits of various subsidy alternatives. We assess the costs to the government (by proxy the cost to New Zealand), in dollar terms, of the respective subsidy alternatives. We then compare these costs against the quantifiable benefits of reductions in greenhouse gas emissions and derive a net present value of the benefits (positive or negative) for the various alternatives. We also provide a breakdown of the implied price of various vehicle emissions based on reductions in emissions from biofuel use compared to the costs of subsidies for biofuels use.

However, not all elements in the Terms of Reference are amenable to quantification. Where this is the case, more qualitative discussion is included. In the case of potential health benefits as a result of emissions reductions, we have not placed a monetary value on these benefits, due to there being less certainty around monetary estimates and some compositional issues (though we have estimated the cost of reducing emissions which cause ill health effects). Therefore, while the benefits of particular alternatives are consistent across this exercise (and the previous work) relying solely on the ratio of costs to benefits may understate the merits of any policy.

Time constraints on the production of this report mean that we have not been able to fully explore all of the economic issues around biofuel use, and subsidisation thereof. In particular, we have not been able to fully assess the impact on industry of implementing biofuel blend requirements.

In addition, we have not sought to derive what might be considered an "optimal" subsidy level, but rather have used a common consumption objective to enable comparison across options. The overriding objective is to structure assistance in such a way as to retain consumption for a

hypothetical bundle of a transport good at the same level as would have occurred in the absence of price increases resulting from uptake of biofuels. Further discussion of this approach is contained below. We also discuss issues around the supply of each biofuel.

In our analysis we have relied heavily on existing literature regarding the unit costs and technical feasibility of bio-fuels. We are especially indebted to the work of Duncan and Copeland (2004) and have drawn on their estimates of the non feed stock costs of ethanol and biodiesel use and their estimates of reductions in vehicle emissions from biofuel use.

The report is structured as follows. Section 2 covers some of the properties and characteristics of biofuels. Section 3 of the report provides a discussion of the economics of subsidies and introduces the analytical apparatus to be used in the report. The discussion also covers some of the implementation issues and choices associated with alternative options.

Section 4 discusses the framework and quantitative elements of our analysis. It begins by describing the determinants of subsidies required to achieve a target of 2PJ of renewable fuel use in the transport sector by 2012 and then presents the results of analysis of the costs and benefits of subsidies for biofuel use and production.

Sections 6 and 7 provide a summary assessment of the efficacy of regional incentive schemes and other possible alternatives, while section 8 is concerned with the complementarity of options with a mandatory requirement. Section 9 considers potential competition issues arising in the transport fuels industry.

## **2. Biofuels**

The use of petroleum based fuels as a transport energy source are increasingly coming under scrutiny. Petroleum based fuels are non-renewable and as such are unsustainable long run sources of energy. In addition to this, consumption of petroleum based fuels is a major source of air pollution and significant contributor to green house gas emissions. These apparent costs have caused many to look towards biofuels as an alternative source of transport fuel energy.

In this study we consider biodiesel and ethanol as biofuels which may be used in New Zealand as blending components in conventional fuels to reduce vehicle emissions.

### **2.1 Effects of biodiesel on vehicle emissions**

Biodiesel blends can have significant positive effects on vehicle emissions. The precise nature of the effects depend on the level of the blend, fuel

quality, and the type of vehicle using the blend. Typically, biodiesel use results in reductions of tailpipe emissions of unburned hydrocarbons, carbon monoxide, particulate matter, and CO<sub>2</sub>. Relative to low sulphur diesel, emission reductions from a 10% biodiesel/diesel blend are expected to be:<sup>2</sup>

- 2.4% reduction in carbon monoxide
- 2.0% reduction in non-methane volatile organic compounds (NMVOC)
- 2.3% reduction in particulate matter.
- 0.05% reduction in CO<sub>2</sub> emissions.

The principle emissions of interest in this study are those of CO<sub>2</sub> and of particulate matter. The former is the most prolific greenhouse gas and the gas on which carbon taxes will be charged post 2007. Particulate matter is of interest because it is these emissions which are most closely related to ill health effects from vehicle emissions. Preliminary New Zealand research conducted by NIWA for the Ministry of Transport has estimated that 399 people above the age of 30 die prematurely every year due to particulate matter emissions from vehicles (NIWA, 2002).

From a survey of New Zealand and Australian research, Duncan and Copeland (2004) suggest that the potential benefits of reductions in emissions of particulate may be equivalent to 5.4 cents per litre of diesel displaced by biodiesel. These estimates are problematic because the extent of adverse health effects depends on the concentration of people as well as the stock of particulate matter in a given area. Indeed Duncan and Copeland point out that a significant proportion of biodiesel would need to be consumed in Auckland for there to be significant positive health impacts from particulate matter reductions.

Duncan and Copeland suggest that concentration of biodiesel use akin to a B20 blend in the Auckland market could deliver the most health benefits from reductions in emissions of particulate matter. In our view targeting subsidies at Auckland or any other region of New Zealand is not likely to be feasible for reasons discussed in section 6. In addition, B20 is not seriously considered as an option for general use, but rather is suited to fleet user users and other niche markets.

Problems around accurately estimating emission reductions and positive health impacts of emission reductions mean we have not independently estimated the precise monetary value of such reductions. However, in the analysis presented in section 5.2 we present discussion of existing studies on health benefits, and use the implied price to infer benefits. nor have we

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<sup>2</sup> The choice of a 10% blend is indicative only. Emission reductions from biodiesel relative to diesel combustion generally increase one for one with an increase in blend percentage. A 10% blend is considered the most useful benchmark in this context. However, a 10% blend is unlikely to be feasible for use in the New Zealand market given existing fuel standards and automotive technology.

included any estimates from the literature in our quantitative analysis later in the report. Nonetheless, biodiesel appears to offer benefits from reductions of emissions which impact on human health and these need to be considered in the overall context of policy options for encouraging the uptake of biofuels.

In our analysis tailpipe CO<sub>2</sub> emissions are assumed to reduce by 0.023% for every 1% of biodiesel in a diesel/biodiesel blend. In addition to this, for each 1% of biodiesel in a biodiesel blend, 0.924% of emissions are assumed to be due to biodiesel and therefore from a renewable source which does not increase the stock of CO<sub>2</sub> in the ecosystem. The net effect being that, based on CO<sub>2</sub> emissions alone, a 10% blend of biodiesel in diesel would result in an approximate 10% reduction in the amount of greenhouse gas emissions produced as a result of automotive diesel consumption.

The existence of carbon taxes and carbon credits for renewable fuels yields a useful reference point for our analysis of the benefits of bio-fuel blends. The government has capped carbon taxes at \$25 per tonne of CO<sub>2</sub>.<sup>3</sup> We assume that emissions are valued at \$15 per tonne in the market. Hence we value the reduction in CO<sub>2</sub> from biodiesel use at \$15 per tonne of CO<sub>2</sub> reduced compared to a baseline forecast.

## **2.2 Effects of ethanol on vehicle emissions**

Tailpipe emissions from ethanol powered vehicles differ from petrol powered vehicles. Reductions in air quality emissions from ethanol blended fuels depends on the vehicle technology, while the feed-stock used to create the ethanol influences net CO<sub>2</sub> emissions. However, ethanol does not confer the same benefits in terms of reduced emissions of particulate matter compared with that of biodiesel largely because emissions of particulate matter from petrol are significantly less than those from diesel fuel. Consequently, the estimated health benefits from ethanol use are insignificant.

Tailpipe CO<sub>2</sub> emissions are assumed to reduce by 1.0% for every 10% of ethanol in an ethanol/petrol blend. In addition to this, for each 1% of ethanol used in a ethanol/petrol blend, 0.667% of emissions are assumed to be due to ethanol and therefore from a renewable source which does not increase the stock of CO<sub>2</sub> in the ecosystem. The net effect being that, based on CO<sub>2</sub> emissions alone, a 10% blend of ethanol in petrol would result in an approximate 8% reduction in the amount of greenhouse gas emissions produced as a result of unleaded petrol consumption (disregarding for the moment any impact from increased volumetric fuel consumption as a result of ethanol/petrol blends).

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<sup>3</sup> In the months following our research for this paper, the New Zealand Government has announced a carbon tax of \$15.

The benefits of reductions in CO<sub>2</sub> emissions have been modelled using an assumed \$15 per tonne value of CO<sub>2</sub> as outlined above for biodiesel.

### 3. Subsidies

Few terms in public finance and economics are as familiar, or as evocative as “taxes” and “subsidies,” which are essentially opposing sides of the same coin (OECD, 1998). While economists may not agree among themselves on the precise definition of a subsidy, there is a reasonably well established framework in place to assess the first-order static effects of proposed subsidies.

Theory shows that the effects of subsidies depend on a number of factors, including:

- supply and demand elasticities
- the form of the subsidy
- the conditions attached to it (including tenure); and
- how it interacts with other policies

In general terms, elasticities of supply and demand determine to what extent the actual economic incidence diverges from the intended impact incidence of a subsidy: in a seller’s market, consumer subsidies will be shifted onward to producers, and vice-versa. Other policies can also influence outcomes, as when production quotas are imposed on the subsidised activities. Critics often point to the economic distortions created by subsidies, especially subsidies that are used to promote specific sectors or industries. Generally, such subsidies tend to divert resources from more productive to less productive uses, interfere with price signals, and in so doing reduce economic efficiency. Those who take a more benign view argue that subsidies can serve redistributive goals, or by dealing with externalities or public good aspects, can help to correct market failures.

Critics claim that the distributive consequences of subsidies are often precisely the opposite of what the framers of the policies intended. Most countries that subsidise farmers or fishers profess to be looking out for the small owner-operator. Yet, by design, subsidies that are tied to outputs or inputs tend to favour larger producing units. For example, the Environmental Working Group counted up all the direct payments made by the U.S. Government to farmers between 1985 and 1994 (i.e., before the Freedom to Farm Act was passed) and found that just 2% of recipients accounted for over 25% of the transfers (OECD, 1998).

Analyses of agricultural support programmes in other countries appear to lend credence to the 80:20 rule — the impression that 80% of support goes

to 20% of the beneficiaries.<sup>4</sup> Direct payments to individuals have the virtue of high transfer efficiency: most of what a government allocates to such programmes end up in the pockets of the intended recipients — initially. Subsidies to products or inputs, by contrast, may leak away to other activities, often in unexpected or unintended ways. Studies of policies used to support market prices for agricultural commodities, for example, have shown that typically 20% of the gross transfers created reach the target group. The remainder gets dispersed among the suppliers of inputs, programme administrators, and even fraudulent operators.<sup>5</sup>

In terms of their initial incidence, it is activities or things that tend to get subsidised rather than people. This contributes to a problem which Gordon Tullock labelled “the transitional gains trap”: the tendency over time for benefits, or more specifically economic rent, flowing from subsidy programmes to be dissipated by becoming capitalised into the least elastic factor of production.<sup>6</sup> Accordingly, the gains from subsidies tend to be transitional, accruing mainly to those who can immediately take advantage of a new scheme. Their successors often end up paying higher prices for land, fishing licences, mineral rights, etc. Removing the subsidy thus risks imposing a transitional loss on the subsequent owners of these assets.

While subsidies often have detrimental impacts, governments can have a clear and pressing policy goal for which subsidies are an appropriate instrument. There are a number of reasons generally given for adopting energy subsidies, including:

- Protecting domestic industry and promoting jobs at home;
- Reducing imports and improving national security;
- Managing risk;
- Making energy more affordable for specific social groups; and
- Protecting the environment.

It is widely believed that there are five properties of a “good” tax and it pays to keep these in mind when considering the obverse of a tax- a subsidy. The properties are summarised as<sup>7</sup>:

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<sup>4</sup> Ross (1996, cited in OECD, 1998) refers to the 80:20 rule as “the old truism”. Although origins of this rule are uncertain, it is supported by analyses of the distribution of output by class of production unit. Since most forms of support are tied to production or inputs, it logically follows that the distribution of support should approximate the distribution of production.

<sup>5</sup> See OECD (1995a) and Ross (1996).

<sup>6</sup> Tullock (1975)

<sup>7</sup> Stiglitz (1988)

- Efficiency: the tax should not interfere with the efficient allocation of resources. Things to consider here are the behavioural effects, the financial effects, the degree of distortion and/or corrective action and announcement effects of the tax/subsidy.
- Administrative simplicity: the system chosen should be easy and relatively inexpensive to administer. This may include compliance cost, transactions costs and implementation costs.
- Flexibility: the system should be able to respond easily (and in some cases automatically) to changed economic circumstances. This would include speed of adjustment considerations.
- Self-regulating and transparent: the system should be designed so that individuals or organisations can ascertain what it is they are paying (or being subsidised) for.
- Fairness: relative treatment of different individuals should be fair.

In discussing the merits of a programme of reform for energy subsidies, Pershing and Mackenzie (2004) describe “good” and “bad” subsidies. A “good” energy subsidy is one that is:

- Well targeted so that only a fairly narrow group of consumers or producers are recipients;
- Soundly based, so that incentives to provide the service efficiently are not undermined;
- Practical, so that the financial resources are adequate and the management of the program is feasible and affordable;
- Transparent, so that financial costs and the provisions of the program are clear;
- In effect only for a limited lifetime, (i.e. have a sunset provision) and be predictable so recipients can plan for future phase-down and phase-out;
- Close-to-market (technologies that are "deserving" of subsidies should not be over-subsidized lest the subsidy stifle commercial discipline and competition; the subsidy provided should be only equal to the magnitude of the externality); and
- Competitive, so that subsidies are provided through competitive mechanisms so as to ensure that excess "rents" do not persist.

It follows that a “bad” subsidy is one that is in conflict with the points above. Subsidies on renewable energy sources are often classified as “good,” though careful design is needed to avoid some of the negative aspects above.

### 3.1 Framework

We will consider the impacts of various policy alternatives using a framework based largely on “internalising externalities.” This framework is frequently used with reference to pollution, and it is on that general basis that we proceed. It deals with the situation when the full benefit to society of consumption (and/or production) of a commodity is not factored into productive or consumption decisions. As a result, the amount of consumption of the commodity is below the socially optimal amount. By subsidising the commodity, government can correct for this under-consumption.<sup>8</sup>

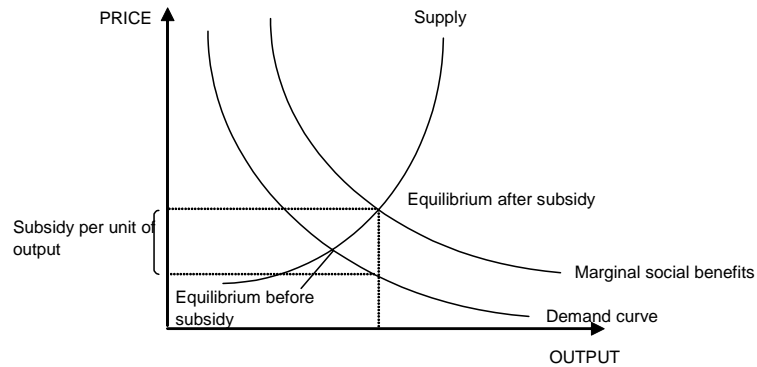
Consider Figure 1 below, which is a stylised representation of the market for biofuels. The price does not correctly reflect the true marginal social benefit of an extra unit of the commodity. The marginal social benefit exceeds the price, because, some individuals may reap some benefits from a given individual’s purchase (and use) of biofuels (i.e. there is a positive externality).

In the diagram we have assumed that there is no externality associated with the production of biofuels *per se* (i.e. the externalities arise due to consumption), so that the marginal private costs equal the marginal social costs. In the absence of a government subsidy, market equilibrium will entail price equalling marginal cost, and there will be too little consumption of biofuels. If there is a subsidy equal to the difference between the marginal social benefit and the marginal private benefit, then marginal private benefit (including the subsidy) will equal the marginal social benefit, and consumption of biofuels will be increased to the socially efficient level. As mentioned elsewhere, determination of the socially optimal amount of biofuels (and ergo the associated subsidy level) is beyond the scope of this paper. Rather, we determine the required subsidy rates to encourage consumption of biofuels to the same level as ordinary petrol or diesel. That serves as the start point for estimating the effects of the subsidy. Of course, government is free to choose whatever rate and form of subsidy it wants. The reason we have framed the analysis in this manner is to be as consistent as possible with the report dealing with a mandatory requirement.

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<sup>8</sup> This is a brief treatment of the economics of externalities. Any introductory or intermediate microeconomics text will provide a fuller treatment.

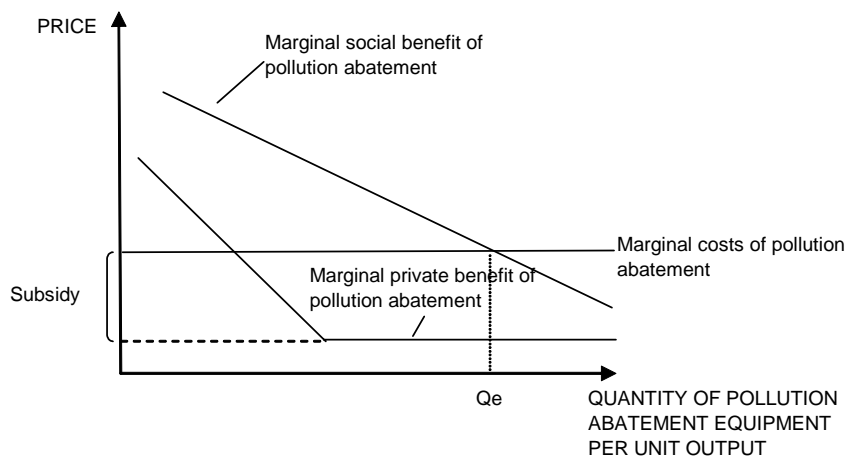
**Figure 1 Equilibrium with and without subsidies in the presence of positive externalities**



Source: Stiglitz (1988)

As discussed, a major reason behind the promotion of biofuels is their utility in terms of “pollution” abatement. In general, firms are likely to receive only a negligible direct benefit from pollution abatement (with most of the benefits accruing to the public more generally, and those in the vicinity of high “pollution” areas). Therefore, firms have little incentive to spend money on pollution abatement (investment in cleaner burning fuels). From a social point of view, there is too little expenditure on “pollution” abatement. By providing a subsidy equal to the marginal social benefit of “pollution” abatement and a firm’s marginal private benefit the efficient level of “pollution” abatement can be attained. This is depicted in Figure 2 below.

**Figure 2 Subsidy determination**



Source: Stiglitz (1988)

Stiglitz (1988) demonstrates that this remedy does not attain a socially efficient resource allocation. The reason is that the total marginal social costs of producing blended biofuels include the costs to the government of subsidies for “pollution” abatement. Firms fail to take this into account in

deciding on the level of production. The subsidy reduces the marginal social cost of output, but it also reduces the marginal private costs, resulting in an excessive level of production of fuels. The general point is that where choice exists over subsidies or taxes (on those who pollute) a Pareto-efficient resource allocation can be constructed from taxes, which is not possible under a system of subsidies (p.226).

This framework is conceptually very similar to the one used in the analysis of mandatory biofuels targets for MED. In both instances we are concerned with the behaviour and effects associated with prices. Whereas previously we assumed the introduction of a mandatory bio-fuels target behaved like a tax, in this case the use of subsidies to encourage biofuel use acts like a negative tax.

Another conceptual difference in the present situation is that there are foregone opportunities associated with using subsidies and/or financial payments sourced from taxation. That is, by directing revenues toward supply of biofuels, the government incurs an opportunity cost (as a result of the resources directed at biofuel supply that would otherwise have been directed elsewhere) that was not immediately present in the case of a mandatory target where a large proportion of the costs were 'resource costs' (which basically means it is more expensive to produce biofuels than fossil fuels). These opportunity costs are a crucial element in the assessment of the impacts of the incentive options.

A further element similar to the earlier analysis is that our reference good is consumption of transport fuels, petrol and diesel. Introduction of biofuels would, all other things held constant, result in an increase in consumption of transport fuels where the volumetric energy content of biofuels is less than the volumetric energy content of traditional transport fuels. In order to account for this effect we adopted an approach which views existing consumption of transport fuels not as consumption of petrol or diesel itself but of an input to transport as a good. As such, our base case of, for instance, 2,000,000 litres of petrol consumed, represents 2,000,000 of our transport good. When a blend is imposed we assume that all of the efficiency reduction is passed on as a price increase, which must therefore be offset by an equivalent increase in subsidy.

## **4. Cost benefit framework**

In order to analyse the costs and benefits of subsidies to encourage biofuel use we begin by analysing the relative prices of biofuel blends and conventional transport fuels to determine the current and future marginal private benefit of transport fuels – biofuels and conventional fuels – in terms of price.

Once the relative price differences have been determined we assess the likely cost of subsidies necessary to bring private benefit in line with social benefit – i.e. to induce suppliers to sell biofuels and consumers to purchase biofuels.

We assess the costs of subsidies depending on where they are targeted in the chain between production and consumption. We then compare these costs against the benefits from reduced vehicle emissions and sustainability of renewable fuel use. Setting marginal social benefit equal to marginal social cost, such that the net benefit is zero, we can then infer prices for emission reductions and other benefits arising from subsidies where such prices are not already given by the market.

Our analysis is not intended to provide a framework for deciding whether a subsidy policy should proceed, but rather a means for comparing the relative benefits of subsidies.

## 4.1 Prices

The end cost of a subsidy incentivising consumption of biofuels will depend critically on the price of biofuels going forward. Here we present our forecasts of the price of biodiesel and ethanol blends.

The precise prices of these goods in the future cannot, of course be known. However, these forecasts are our best estimate of the likely price path of biofuel blends. We have chosen to base our analysis on forecast prices rather than a standard reference price through time because it means that our resulting cost benefit analysis will include some of the price induced variation in subsidy costs which we know will be the case in reality.

Our forecast prices used in this study are approximations of the retail price of the biofuels, petrol, and diesel. Our forecasts have been created by forecasting the unit cost of each fuel based on their various constituent costs.

### 4.1.1 Biodiesel blend prices

Drivers of the costs of biodiesel blends include:

- Feedstock costs.
  - The price of tallow.
  - The price of alternative feedstocks, eg vegetable oils.
  - The price of other inputs (methanol and potassium hydroxide).
- Non feedstock costs
  - Capital expenditure on plant

- Operating expenditure for plant
- Transportation, storage, and distribution costs
- Blending costs.

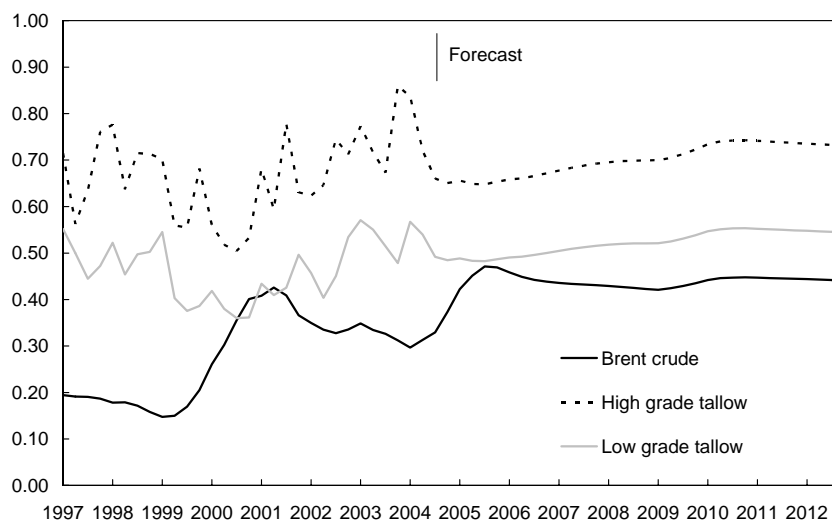
Domestic biodiesel production has the effect of raising the price of biodiesel from the raw input to including the capital costs associated with producing in the New Zealand market (though capital costs would on average over the long run also be reflected in biodiesel prices on the world market). Despite this, the primary driver of biodiesel costs is the feedstock input, which in this study is tallow (given that is the feedstock for which New Zealand has the largest available stock).

To conduct our analysis of biodiesel prices we have forecast the price of tallow out to 2012. For our forecasts we have used a reference price that is the mid range between high grade tallow and low grade tallow. This is not problematic in as much as the two prices move together, but it does effect the level of the cost of tallow inputted to our model. If biodiesel was to be manufactured in New Zealand from low grade tallow, we would expect a reduction in the difference between the diesel pump price and the B5 pump price – though B5 would not be cheaper than entirely petroleum based diesel.

Figure 3 shows the path of our forecasts for tallow prices compared with our forecasts for crude oil prices. The forecast for tallow is based on historical movements in the price of tallow on European commodity spot markets, and on an observed structural upward shift of meat and meat bi-product prices in the past four or five years. Our forecast for Brent crude prices are those produced in NZIER's *Quarterly Predictions*.

**Figure 3 Tallow and crude oil prices**

New Zealand dollars per litre



Source: NZIER

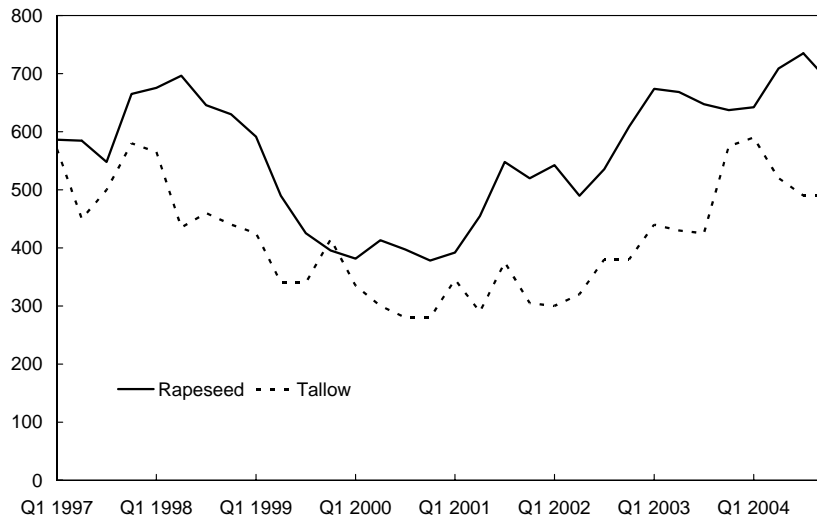
If the price of alternatives to tallow, such as rapeseed or canola oil, were to fall below that of tallow, we would expect a switch from tallow feedstocks to vegetable oil stocks. However, tallow prices have almost always tracked below vegetable oil prices in international markets (see Figure 4). As such we have not considered vegetable oil feedstocks and their effect on biodiesel prices.

The non-tallow costs used in our analysis are those reported in Duncan and Copeland (2004). We have divided the costs into those assumed to vary proportionally with the tallow feedstock price and those considered to be constant in cents per litre. The transport costs and costs of additional feedstock chemicals are assumed to be 22.32% of the price of the principal tallow feedstock. Those costs are deemed to remain constant are the non-tradeable blending costs, capital costs, and operating expenditure costs, assumed to be equal to 4.5, 4.9, and 0.003 cents per litre respectively.

Part of the additional non-tallow cost of biodiesel is offset by the production of saleable by-products such as glycerol. Duncan and Copeland (2004) estimate sales of by-products reduce the cost of biodiesel by 17 cents per litre. In our analysis we have assumed that the price of by-products moves in line with the price of tallow, and as such is a constant proportion of the cost of tallow equal to 26.4% of the price of tallow. Hence the proportion of non-tallow costs included in the biodiesel price is a net price reduction on the price of tallow of 4.08% - before the addition of the constant cent per litre costs outlined above.

**Figure 4 Tallow and rapeseed oil prices**

US\$ per metric tonne



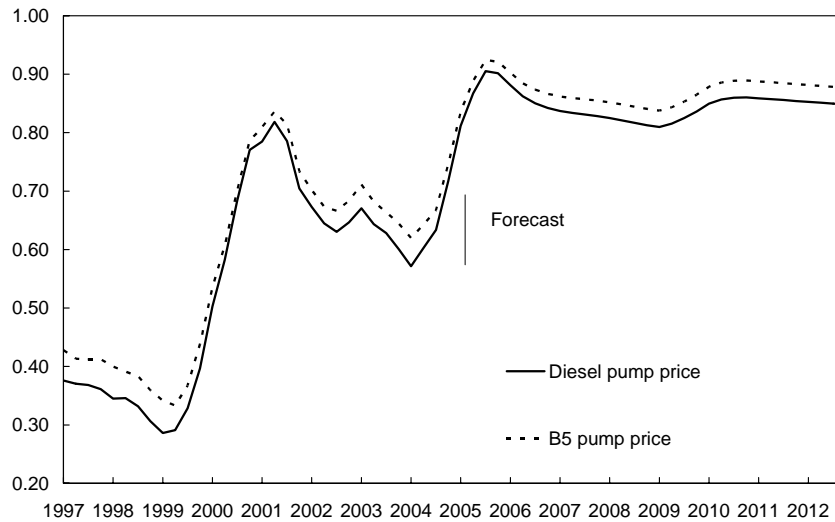
Source: Datastream

Figure 5 shows our forecasts for the pump price of biodiesel. The price of B5 is seen to track the price of diesel very closely. This is because 95% of the price is derived from diesel. But note that through 2004 and into 2005 the increase in oil prices makes the price of B5 nearly indistinguishable from the price of diesel.

Later we provide two series for pump prices in the case of ethanol blends, one series per litre of fuel and one series adjusted for fuel consumption efficiency of ethanol blends. This is not done for biodiesel because the fuel efficiency of biodiesel is around 99% that of regular diesel and consequently the impact on price from lost fuel efficiency is negligible in a B5 blend.

**Figure 5 Diesel and 5% biodiesel blend pump prices**

New Zealand dollars per litre



Source: NZIER

Table 1 provides the path of likely pump prices of various biodiesel blends relative to diesel pump prices. To make the price of diesel directly comparable to biodiesel blends, we have added an equivalent retail premium to each of the raw fuel input costs based on the average difference between the retail diesel and crude oil prices in the past four years. In reality this premium will vary through time and as a result the realised price of diesel may differ from the precise value at the pump currently. Furthermore, our reference prices for both diesel and biodiesel/diesel blends are the average annual price which dampens the effects of price shocks on the reference price in any given year. For the sake of comparison we have included the notional price of biodiesel blends were they to have been introduced from this year on.

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**Table 1 Diesel vs. biodiesel blend pump prices**

NZ cents per litre

Year	Diesel price	BD3 price and price difference		BD5 price and price difference		BD10 price and price difference	
2004	71.78	73.50	1.72	74.64	2.86	77.50	5.8
2005	90.15	91.34	1.19	92.13	1.98	94.10	3.95
2006	84.21	85.67	1.45	86.63	2.42	89.05	4.84
2007	82.81	84.41	1.59	85.47	2.66	88.13	5.31
2008	81.27	82.94	1.67	84.06	2.79	86.85	5.58
2009	83.62	85.34	1.71	86.48	2.86	89.34	5.72
2010	86.03	87.77	1.74	88.93	2.90	91.83	5.80
2011	85.42	87.15	1.73	88.30	2.88	91.18	5.76
2012	84.81	86.53	1.72	87.68	2.87	90.54	5.73

Source: NZIER

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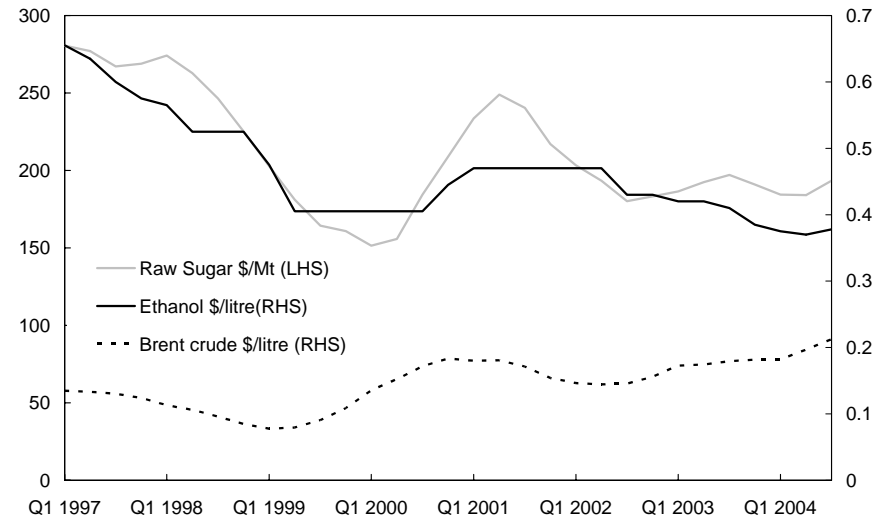
#### 4.1.2 Ethanol blend prices

The cost of ethanol blend fuels is primarily related to feedstock costs. However, instituting a mandatory bio-fuels target will impart additional costs, impacting on the price of transport fuels, associated with the cost of importing, transporting, storing, blending and distributing ethanol petrol blends.

The non-feed-stock costs associated with ethanol petrol blends have been estimated by Duncan and Copeland (2004) to be 1.1 New Zealand cents per litre of ethanol. In the following analysis we have assumed that this cost remains constant through time. The cost is added to the production of ethanol blended petrol before the imposition of an observed retail premium (the average difference between crude prices and pump prices). Ethanol is typically more costly per litre than petroleum based fuels. However, the price of ethanol has declined over time.

**Figure 6 Ethanol, sugar, and crude oil prices**

Rolling annual average US dollar spot market price



Source: Datastream

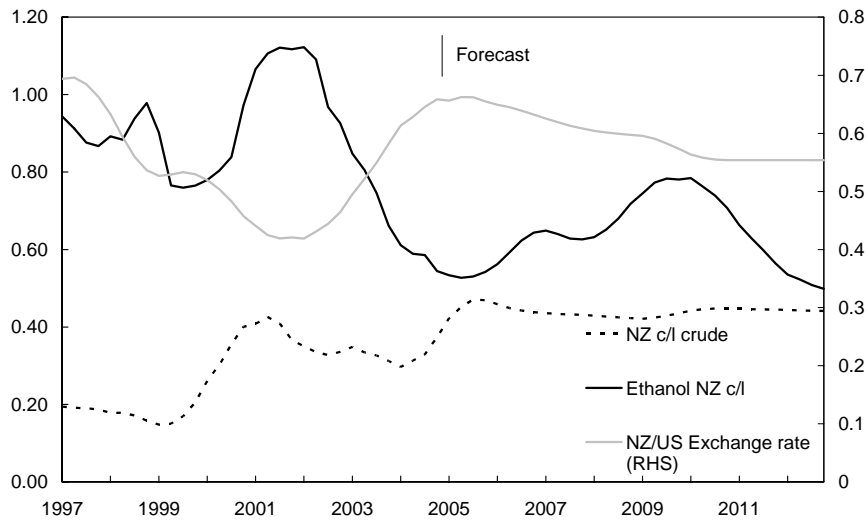
Our analysis of the price of ethanol suggests that in the past ten years the price of ethanol has been negatively correlated with the price of oil, suggesting that as oil gets more expensive ethanol is becoming a more economically viable substitute for oil.

Figure 6 shows that ethanol prices are in fact more closely correlated with the price of sugar than the price of crude oil. This relationship is not surprising in so far as the bulk of world ethanol supply is from sugar production.

The fact that ethanol prices do not track crude oil prices is important because it means that the relative cost of ethanol is likely to be inversely related to the price of oil and as the price of oil rises ethanol use becomes increasingly less costly. The downward track of ethanol prices over time suggests that the use of ethanol may be increasingly less costly in the future, particularly as crude oil prices are rising on the back of strong world demand growth and uncertainties surrounding world supply.

Figure 7 shows the path of our forecast for ethanol prices versus crude oil prices.

**Figure 7 Ethanol and crude price forecast**



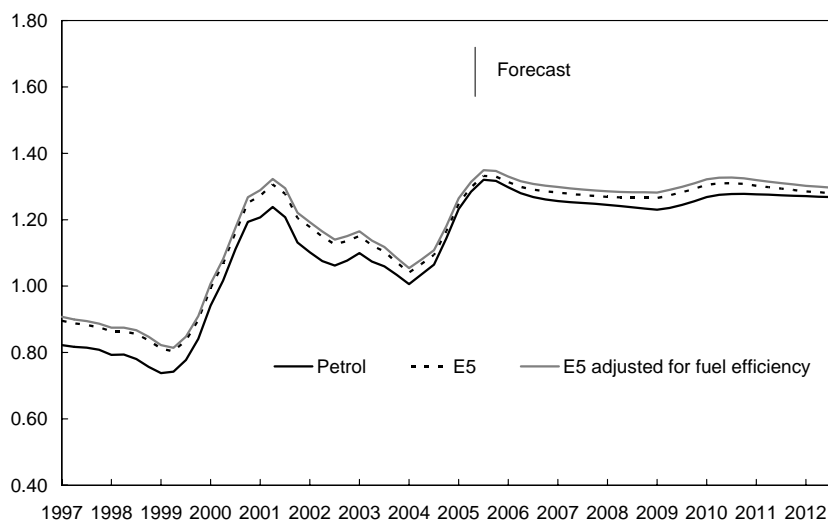
Source: Datastream, NZIER

In addition to the cost of ethanol per litre and costs of distribution, storage, and blending, ethanol is also more costly per litre than petrol as a transport fuel because it is less fuel efficient in volumetric terms. The precise loss in fuel efficiency from ethanol/petrol blends depends upon the type of vehicle, the feedstock used to produce the ethanol, and the age of the vehicle. In general, ethanol has a lower energy content than petrol and so more ethanol is required per kilometre of travel than petrol. The impact of fuel efficiency has been modelled as a price effect in our study, with ethanol raising the price of fuel by the percentage increase in fuel consumption estimated in Duncan and Copeland (2004) of 2.3% for every 10% of ethanol in an ethanol/petrol blend.

In Figure 8 two paths are provided for the price of an ethanol blend at the pump. One is the price of the ethanol blend assuming that the ethanol input provides for equivalent fuel efficiency of petrol. The second is adjusted for a 1.3% efficiency difference whereby the E5 blend leads to a 1.3% increase in fuel consumption which we have modelled as a price impact or additional tax.

**Figure 8 Petrol and 5% ethanol blend pump prices**

New Zealand dollars per litre



Source: NZIER

Table 2 provides the path of likely pump prices of various ethanol/petrol blends relative to petrol pump prices. The pump prices have been standardised using a retail premium as per the case for our biodiesel forecasts and our reference prices for both petrol and ethanol/petrol blends are the average annual price as was the case for biodiesel. For petrol prices, where the price varies depending on whether the fuel is premium or regular, we have used the premium fuel price as an upper bound for our forecasts. Thus the prices forecast for ethanol/petrol blends are those for ethanol blended with premium petrol.

Ethanol for blending with petrol has never been subject to excise tax in the way that petrol is. Cabinet confirmed in September 2003 that the zero excise would continue at least until September 2005. Thus the prices of ethanol blends in Table 2 exclude excise on the ethanol portion of the blend.<sup>9</sup>

In the table and hereafter ethanol petrol blends are referred to by the acronym E[percentage blend of ethanol].

<sup>9</sup> We have also assumed ACC fuel levies do not apply to ethanol. The enabling legislation and associated regulations for ACC fuel levies use the Customs and Excise Act 1996 (and schedules thereto), to determine where fuel levies apply. Given ethanol does not incur excise, we can only assume that it also does not incur ACC fuel levies.

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**Table 2 Petrol vs. ethanol blend pump prices**

NZ cents per litre, assuming fuel efficiency loss from using an ethanol/petrol blend

Year	Petrol price	E3 price and price difference		E5 price and price difference		E10 price and price difference	
2004	114.39	115.16	0.77	115.67	1.28	116.95	2.56
2005	131.69	132.06	0.37	132.30	0.61	132.88	1.19
2006	126.10	127.14	1.05	127.84	1.75	129.59	3.49
2007	124.78	125.76	0.98	126.42	1.64	128.06	3.28
2008	123.32	124.84	1.51	125.85	2.53	128.40	5.08
2009	125.54	127.34	1.81	128.56	3.02	131.61	6.07
2010	127.80	129.16	1.36	130.07	2.26	132.35	4.55
2011	127.23	127.82	0.59	128.21	0.98	129.17	1.94
2012	126.66	126.90	0.25	127.06	0.40	127.43	0.77

Source: NZIER

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## 4.2 Costs

In order to calculate the costs of a subsidy we need first to make some assumptions about the efficacy of a subsidy in inducing biofuel consumption. This includes making assumptions about demand for biofuels, and hence responsiveness to changes in the price of biofuels.

We assume first and foremost that the demand for low-level biofuel blends is the same as that for conventional transport fuels. In effect, we are assuming that other things being equal, consumers are indifferent between conventional fuels and biofuel blends. Thus, if a biofuel blend is slightly cheaper than its conventional fuel substitute, demand will be sufficient to consume all available supply of the biofuel blend. Our analysis is highly sensitive to this assumption and so we discuss the sensitivity of our results to this assumption in section 5.4.

Of course, biofuels are presently more expensive than conventional fuels. Thus for consumers to choose biofuels over conventional fuels the price of biofuels would need to be subsidised to the extent that the price of biofuels is equal to the price of conventional fuels. In addition to this, subsidies would need to push price below that of conventional fuels to provide an incentive for producers to incur transaction costs in shifting to biofuel blends. Therefore, in the following we have assumed that biofuel blend prices would need to cost half a cent per litre less than conventional fuels for consumers to be willing to choose them and suppliers willing to provide them. Hence we assume that:

*Price of biofuel blends less a subsidy is equal to the price of conventional fuels less half a cent*

The prices we use in our analysis are the average annual forecast prices of petrol, diesel and biofuels. This is an approximation to the price at which biofuels will need to be subsidised. In actuality a transport fuel supplier is likely to provide biofuel blends at prices equivalent to conventional fuels if the subsidised price of biofuel blends is marginally lower than conventional transport fuels on average over the long run. That is, firms will potentially incur losses in the short run, if they are making gains on average over the longer term – for our purposes we have assumed this is a calendar year – however, there is scope to consider a timeframe which is somewhat longer.

In considering where subsidies might best be targeted, we compare the costs of subsidies to producers, blenders and distributors, sales of biofuel blends to end consumers, and preferential tax arrangements.

We consider the end effect of output based subsidies targeted at each level of the production chain on the price of biofuels. While almost all of the subsidy types in Table 3 below usually work by lowering the cost of “production” they are not uniform in their effect or application. That is, while instruments such as accelerated depreciation, low-interest loans, or one-off capital grants will have impacts, our view is that these should be supported (or be substituted) by an output-based subsidy. This is especially so for the case of biodiesel, where capital costs constitute only a relatively modest cost (Duncan and Copeland, 2004).

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**Table 3 Types of energy subsidies**

Form of Government intervention	Example
Direct financial transfer	Grants to producers or consumers, low interest rates, per-unit output payments
Preferential tax treatment	Rebates, exemptions on royalties, tax credit, accelerated depreciation
Trade restrictions	Quotas, trade embargoes, technical restrictions
Energy related services provided by government at less than full cost	Direct investment in energy infrastructure, public R&D
Regulation of energy sector	Demand guarantees, price controls, market access restrictions

Source: UNEP/IEA (2002)

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As a starting point for our analysis we have determined the amount of biofuel use, as a percentage of total transport fuel use, required to achieve the government's target of 2PJ of renewable fuel use in the transport sector by 2012. The level required varies by biofuel. In the case of ethanol use, 2PJ equates to a 3% blend in all petrol sold or, approximately, 3.1 litres of ethanol sold as a transport fuel for every 100 litres of petrol sold in 2012. In the case of biodiesel a 2 PJ target implies a 2.75% blend of biodiesel in all diesel sold or an approximate 2.8 litres of biodiesel sold for every 100 litres of diesel sold. The reason a higher percentage of ethanol is required, despite the fact that petrol consumption is greater than diesel consumption, is the significant difference in calorific values of the two biofuels. Biodiesel comprises 35.93 MJ per litre, compared with 23.8 MJ per litre in the case of ethanol.

Subsidies required to achieve a 2PJ target of renewable fuel use by 2012 will have to be sufficient to make the price of an E3 blend slightly less than that of petrol and a B2.75 blend slightly less than diesel. This equates to 1.7 – 2.1 cent reduction in the price of B2.75 and a 0.75 – 2.3 cent reduction in the price of E3, between 2006 and 2012. The reason we cannot be precise about the amount that prices will need to change is that out to 2012 we expect the difference in prices of ethanol and biodiesel compared to crude oil to vary.

The total cost of a subsidy will vary depending on where the subsidy is targeted. The further a good is away from final consumption, the greater effect a one dollar subsidy can have on the final dollar price of the good. This is because the addition of value through the production process is, in part, proportional to the cost of value of the intermediate input. For example, a biodiesel supplier who purchases tallow for biodiesel production will want to achieve a rate of return on working capital which is proportional to the amount of working capital necessary to purchase the tallow. If a rate of return of 10% is desired and the cost of the tallow is \$100, then the biodiesel producer will seek to sell the value added product for \$110. However, if a \$10 subsidy is used to reduce the cost of tallow to \$90, then the price of biodiesel leaving the plant will reduce by \$11 (i.e. \$99), which is one dollar more than the cost of the subsidy<sup>10</sup>.

This dynamic is compounded in the presence of GST because GST is proportional tax. In the biodiesel producer example, if a \$10 subsidy is provided to blenders and distributors then the effective price of biodiesel from the producer is \$100. With the addition of GST, the final price of the biodiesel would be \$112.5. However, if the product was purchased at the lower subsidised price of \$99, then the end price with GST would be

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<sup>10</sup> This example assumes the only cost of biodiesel production is the opportunity cost of working capital tied up in tallow. This is obviously not the case, however the dynamic would still be the same in the presence of other costs.

\$111.375. This is \$1.125 less than the price of the biodiesel when the subsidy was levied later in the production chain.

We present these costs for a variety of subsidy types: Subsidies to final consumption; subsidies to feedstock producers; and subsidies to transport fuel merchants for the cost of purchasing unblended fuels and relating to blending and distribution costs. We have also provided an estimate of the fiscal costs of foregone excise tax revenue from substitution of petrol for ethanol which is not subject to excise taxes. The costs have been discounted back to their present value by an annually compounding 10% per annum discount rate. In all cases the costs of subsidies are far in excess of the benefits from the subsidies.

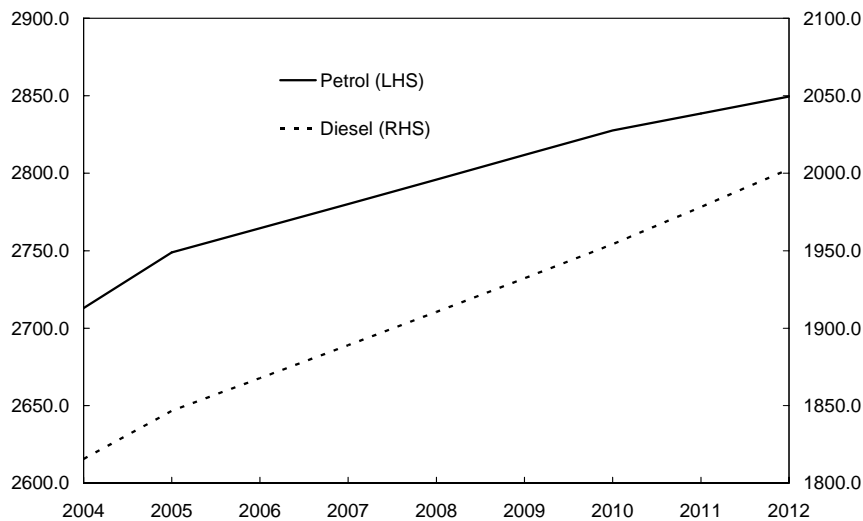
### 4.3 Benefits

Our analysis compares changes in fuel consumption, price, and CO2 emissions with those of our forecasts (“Business as usual” (BAU)) for consumption, prices, and emissions in each year out to 2012. We use price and consumption changes compared with BAU to assess the relative merits of the alternatives.

#### 4.3.1 Transport fuel consumption and emissions forecasts

**Figure 9 Transport fuel consumption forecasts**

Millions of litres of diesel (RHS) and petrol (LHS)



Source: NZIER

In order to assess consumptive and productive impacts of subsidies we have forecast consumption for each year out to 2012 and assessed impacts in terms of their deviation from baseline forecast in each year.

In producing our forecasts we have used MED's forecasts of transport fuel consumption, adjusting them as we deemed necessary given the time since the last *Energy Outlook* was published in October 2003.

Our forecasts have been split between diesel consumption and petrol consumption. Figure 9 shows our forecast for the path of petrol and diesel transport fuel consumption out to 2012 in millions of litres of fuel consumed.

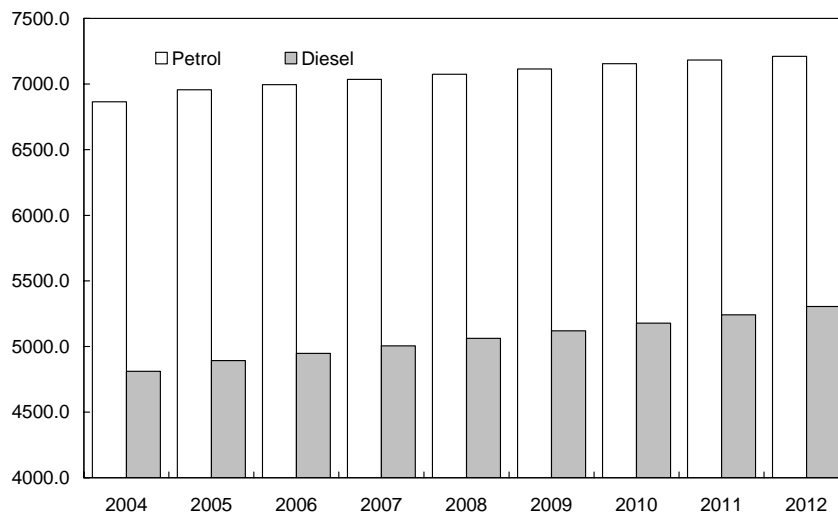
On top of these forecasts we have assumed a constant conversion of fuel to CO<sub>2</sub>, using conversion factors from MED (2004). Different factors apply for regular and premium petrol and diesel as follows:

- Regular petrol emits 66.2 kt of CO<sub>2</sub> per PJ of fuel consumed.
- Premium petrol emits 67.0 kt of CO<sub>2</sub> per PJ of fuel consumed.
- Diesel emits 69.5 kt of CO<sub>2</sub> per PJ of fuel consumed.

Because we have not differentiated between regular and premium petrol in our analysis we have taken an average of the conversion factors for regular and premium petrol weighted by the proportion of fuel used of each type in New Zealand in the year to June 2004. This yielded a conversion factor of 66.38 kt of CO<sub>2</sub> per PJ.

**Figure 10 BAU forecast of transport CO<sub>2</sub> emissions by source**

Kilotonnes of CO<sub>2</sub>



Source: NZIER

Our baseline forecast of CO<sub>2</sub> emissions is presented in Figure 10.

#### 4.3.2 Calculating benefits of reduced emissions

To calculate the benefits of reduced CO<sub>2</sub> emissions compared with business as usual we calculate the implied level of CO<sub>2</sub> at the new consumption level

(taking into account reduced emissions levels given the percentage of biofuels used) and deduct this from the BAU CO<sub>2</sub> emissions in each year. As per the deadweight loss to consumers, the benefit from reductions in CO<sub>2</sub> in each year is discounted through time and then summed to give the overall present value of the benefits of introducing mandatory biofuels. The costs of each scenario are then deducted from the benefits to yield the overall net present valued benefit (positive or negative) of each scenario.

In addition we attribute the remaining net cost (i.e. after subtracting CO<sub>2</sub> reduction from the overall cost of each subsidy alternative) to each emission reduction. This is intended to be illustrative only. It gives a sense of the value of each emission in terms of each emission – akin to the price of CO<sub>2</sub> in carbon credit trading. It is a useful way of comparing the relative benefits between each of the projects rather than simply looking at the overall net cost with no sense of what the costs might be representing. The total of all benefits in Table 9 add to the gross costs of each subsidy – by definition. Thus if the primary target of a subsidy was to reduce ill health effects from particulate emissions one could surmise that a subsidy to producers of biodiesel would be the lowest cost way of doing this.

In order to apportion costs according to the relative importance of each emission the net costs of the subsidy (after the benefit from CO<sub>2</sub> reductions has been removed) have been weighted according to cost estimates of their effects on ill health. This is intended to reflect a higher cost to society from particulate emissions in particular. This is discussed further in section 5.2.

## **5. Results of cost benefit analysis**

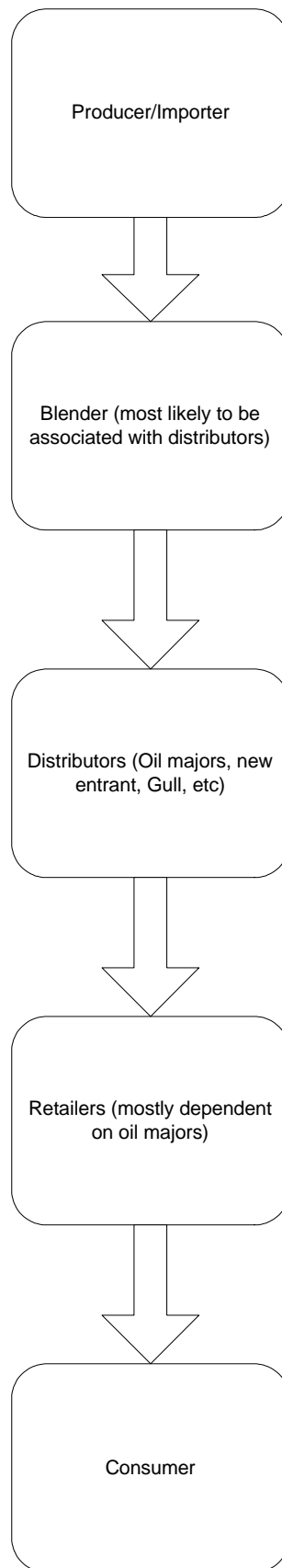
In this section we present our estimates of the costs and benefits of various subsidy options. Alongside these results we provide a discussion of implementation issues and potential risks associated with each option.

### **5.1 Costs and implementation issues**

In discussing different points at which support/subsidies might be implemented, we have in mind stylised industry structure (see Figure 11).

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**Figure 11 Stylised Industry Structure**



Source: NZIER

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### 5.1.1 Subsidy to final consumption

When we refer to subsidies to final consumption we are referring to subsidies to transport fuel suppliers for on-selling biofuel blends to consumers. Subsidies to final consumption are arguably the least risk and most simple subsidies to administer but are also the most costly in terms of dollars of subsidy per PJ of biofuel.

Subsidies to final consumption are low risk because for every litre of biofuel being subsidised government can be certain in the knowledge that a litre of biofuel is being consumed. Thus there is no risk that a litre of biofuel will be subsidised that will not be contributing to the governments' 2PJ target.

In Table 4 we provide the present value of the cost of subsidies to final consumption. We have presented the results of our analysis in terms of blend levels – E3 and B2.75.

We find that the cost differs between ethanol and biodiesel blends. In the case of ethanol a subsidy sufficient for consumption to meet the government's renewable fuel objective costs between \$22 million and \$40 million dollars per annum in present value terms. This compares to subsidies between \$19 million and \$28 million per annum in the case of biodiesel blends.

**Table 4 Present value costs of subsidising end use**

Cents per litre, millions of dollars, PJ of renewable consumed

	E 3			B 2.75		
	Subsidy per litre	Cost (\$m)	Renewable used	Subsidy per litre	Cost (\$m)	Renewable used
2006	1.55	34	1.99	1.83	28	1.96
2007	1.48	22	2.00	1.96	28	1.98
2008	2.01	35	2.01	2.04	27	2.00
2009	2.31	31	2.02	2.07	25	2.03
2010	1.86	38	2.03	2.09	23	2.05
2011	1.09	40	2.04	2.09	21	2.08
2012	0.75	30	2.05	2.08	19	2.10
Total	-	201	14.15	-	171	14.19

Source: NZIER

### 5.1.2 Producer subsidies

For the purposes of this study we have assumed that “producers” are defined as the manufacturers of biofuels, as opposed to producers of feedstock for

biofuels manufacture. Duncan and Copeland (2004) indicate that assistance to feedstock producers would be impractical due to the many alternative uses for feedstocks, in particular tallow. We concur, and thus focus on manufacturers of biofuels.

The various forms of assistance available are:

- Research and development grants
- Capital expenditure grants
- Accelerated depreciation allowances
- Direct output subsidies

In Table 5 we provide our estimates of the costs of direct output subsidies aimed at inducing consumption of 2PJ of renewables by 2012. The costs are significantly smaller than equivalent end consumption subsidies.

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**Table 5 Present value costs of producer subsidies**  
Cents per litre, millions of dollars, PJ of renewable consumed

	E 3			B 2.75		
	Subsidy per litre	Cost (\$m)	Renewable used	Subsidy per litre	Cost (\$m)	Renewable used
2006	0.86	20	1.99	0.98	15	1.96
2007	0.82	17	2.00	1.03	15	1.98
2008	1.12	21	2.01	1.06	14	2.00
2009	1.28	22	2.02	1.08	13	2.03
2010	1.03	16	2.03	1.10	12	2.05
2011	0.61	9	2.04	1.09	11	2.08
2012	0.41	6	2.05	1.09	10	2.10
Total	-	111	14.15	-	89	14.19

Source: NZIER

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### **a) Implementation issues**

#### **Biodiesel**

Though biodiesel production is ramping up in the EU, the US and Australia, there is still somewhat limited worldwide supply and thus biodiesel production to meet transport fuel blend targets will need to be met almost exclusively from domestic production. Currently New Zealand has only one domestic biodiesel producer, but production is in small quantities. Thus, the barriers to entry that government might seek to mitigate could be the initial costs (and concomitant risks) of set-up. Looking forward, lowering the unit

costs of emerging technologies requires experience, which generally comes from building and operating plants. The time needed to gain this experience may be too long for the market to bear without a degree of government support. In saying this however, the costs and risks associated with set-up in New Zealand are reduced somewhat by the progress in biofuel production overseas. New Zealand might be able to make use of “off the shelf” plant, given overseas experience. Pershing and Mackenzie (2004) claim that “few energy technologies have reached maturity without substantial public sector investment.” (p. 14). It may be that, in the longer term Government is more interested in subsidising ongoing operation costs rather than focussing on set-up.

One international biodiesel producer, Argent, have said that they could enter the New Zealand market and be at full production of 55 million litres within four years of the decision to invest. Thus, in terms of the contribution to the government’s goal of increasing the supply of renewable energy in the transport sector of at least 2 PJ a year, this could be achievable by 2012 using biodiesel alone, if the decision to invest was made by 2008.<sup>11</sup> Argent are by no means the only party interested in producing biodiesel in New Zealand, but are noteworthy from the perspective of igniting somewhat the Minister of Transport’s interest in biofuels.

Decisions would need to be taken in respect of the degree of capital-related costs versus more operational costs that would be supported.<sup>12</sup> In the case of nascent industries like biodiesel, research and development grants also feature more prominently than would be the case of developed production (i.e. ethanol). An element of competition might be desirable in the implementation and allocation of the assistance. For instance, firms might be required to ‘bid’ for available assistance, based on projected cost efficiencies, production volumes, reputation, tenure and/or commitment to New Zealand. Assistance could be forthcoming to say, the top two firms. This would allow the government some discretion in choosing who receives assistance, as well as potentially lessening the fiscal uncertainty and efficiency loss associated with spreading available assistance across a number of entrants.

Such discretion might be particularly valuable in ensuring that New Zealand was able to benefit from any economies of scale and scope that may accrue in the future. Given the dearth of biodiesel manufacturers world-wide there is a risk that world prices may be higher than domestic ones, and the manufacturer seeks to supply off-shore markets, to the detriment of local consumers. It may be possible to contract for such security of supply conditions as part of the assistance process. In addition, subsidising biofuel

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<sup>11</sup> Based on there being 165,000 barrels of oil in a PJ, resulting in around 26m litres in a PJ and a relative energy content of biodiesel of around 0.98.

<sup>12</sup> Note however, that we expect capital costs to be included in the price of biodiesel in the longer run.

for export may run foul of world trade rules, which would provide some support for the subsidised party having to refund the equivalent proportion of the subsidy associated with exports.

Nevertheless, to the extent that a subsidy is tied to production, and there are economies of scale, it is conceivable that production over and above the 2 PJ requirement is encouraged (and subsidised) whereby overseas parties accrue some of the benefits of lower production costs in New Zealand.

We understand that a number of Australian companies have looked into biodiesel production and some plants are already producing. We would suggest discussion with Australian firms with interests in biodiesel production to assess the future feasibility of importing biodiesel from Australia, if necessary. Bilateral supply may even be possible given the level of excise rebates available to biofuel production there, though there may be some questions around requirements in Australia to maintain the subsidy.

The introduction of a biodiesel/diesel blend would also require the creation of a New Zealand biodiesel standard. We understand that this is underway and will be completed in the near future.

### ***Ethanol***

The most obvious difference between biodiesel and ethanol is that a world market exists for ethanol, and therefore, there is less need to encourage producers to New Zealand. While there is some domestic capacity to produce ethanol through New Zealand's dairy industry<sup>13</sup> it is perhaps valid to ask if we would even want to subsidise production at all in New Zealand, especially in the absence of information indicating that we enjoyed a comparative advantage in the area. We do not see any major problems in accessing sufficient supply of ethanol through importing. While only about 10% of world production of ethanol goes onto the world market, this proportion is expected to increase in the future, with the IEA expecting that worldwide fuel grade ethanol should reach about 80 billion litres by 2012 from around 22 billion in 2002 (IEA, 2004). Moreover, production is becoming increasingly efficient with the introduction of new fuel production technologies and as a result the cost of ethanol is likely to fall in the future increasing its viability as a mineral fuel alternative.

That said, if the amount of ethanol traded on world markets continues to be only around 10% of world production, this would result in only 8 billion litres being available for purchase on the world market. As such, net

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<sup>13</sup> Around 11 million litres of ethanol (0.3 PJ) per annum may be available for blending with petrol (Duncan, 2003).

importing countries of ethanol could well face higher prices, particularly if the trend towards ethanol/petrol blends continues the world over. This would have the effect of raising world prices for ethanol above our forecasts.

An additional element that needs also to be considered is that ethanol production continues to be subsidised in Europe and the United States. If these subsidies are removed in the future then the price of ethanol will rise. In addition to this, export quotas and subsidies exist for sugar producers which lowers the cost of sugar on world markets. International trade liberalisation through the WTO could well lead to increases in sugar prices and subsequent increases in the price of ethanol. Thus there are non-trivial risks to our forecasts of ethanol prices.

#### ***b) Risks/downsides***

As indicated above the main risk associated with subsidising biodiesel production is that it may be destined for foreign shores. Another potential downside is similarly related to the act of subsidising producers. This is the degree of distance from the actual decisions of consumers. The idea behind providing support to incentivise the uptake of biofuels is to influence consumption, rather than production. In the extreme, it is possible that the required level of biofuel production is achieved to meet the 2 PJ target, but it effectively remains unconsumed.

This could occur if distributors sought to profit from the introduction of biofuels on to the market by charging a premium for distribution and/or access to retailers whom they have agreements with. It is possible to construct a subsidy that minimised this type of “hold-up” but it would be significantly more expensive than seeking to subsidise blenders/distributors directly.

A further complicating factor for the Government is how to effectively limit over-production of biofuels (as mentioned in the discussion above). The most obvious way would be to structure the subsidy to shut off once the 2 PJ level had been reached. However, once consumption had reached such a level it would be difficult to then limit financial support and risk differential pump prices, or shortages at the pump. Difficulty in reducing or reforming subsidies once in place is a general feature of subsidies, rather than for producer subsidies in this instance, but may be more acutely felt in the producer subsidy case.

One possible advantage of supporting production is that cost structures may be more transparent. As mentioned previously in relation to a regional petrol tax, the cost structures of the oil companies remain something of a mystery, and it may potentially be very difficult to discern genuine price increases as a result of cost increases from rent-seeking behaviour. By subsidising a

producer who is established, or has prepared a business plan for entry, it would assist in transparency.

### **5.1.3 Blenders and distributors**

Subsidies targeted at reducing blending and distribution costs would be insufficient to induce biofuel use in the case of either ethanol or biodiesel blends. This is because the blending and distribution costs are such a small portion of the overall costs of the biofuel blends that introducing a fraction of a percentage of biofuels to a conventional fuel would raise the cost over and above that which could be retrieved from a subsidy to blending and distribution. Hence we have not provided a breakdown of the costs of blending and distribution subsidies as we have with the other options above.

Nonetheless a blending and distribution subsidy could be used in addition to other measures. In this case the costs would range from 8.0 to 9.0 million dollars per year in the case of an E3 blend and 3.0 to 4.0 million dollars per year in the case of a B2.75 blend. These figures are not present value but real expenditure estimates and they are based on 0.33 cent per litre subsidies in the case of E3 and 0.165 cent subsidies in the case of a B2.75 blend.

If a blending and distribution subsidy was instituted in the presence of a subsidy on end consumption it would reduce the required subsidy to end consumers by 0.37 cents in the case of an E3 blend and 0.19 cents in the case of a B2.75 blend. In addition to a producer subsidy a subsidy to blending and distribution would lower the required subsidy per litre by 0.19 cents per litre in the case of an E3 blend and by 0.10 cents per litre in the case of a B2.75 blend.

The range of support instruments available is very similar to that for producers. In fact, Duncan and Copeland (2004, p.45) claim that “*..[T]here appears to be little advantage one way or the other in terms of providing the output subsidy (or other forms of assistance) to biofuel manufacturers or fuel blenders and distributors.*” While there is a great deal of similarity, we suggest below some possible differences between subsidising suppliers and distributors.

In the case of blenders/distributors the capital costs are much less than for producers, and therefore a policy of subsidising capital expenditures, or an accelerated depreciation option is unlikely to be sufficient to make biofuels competitive with fossil fuels (Duncan and Copeland, 2004). Thus, while lower initial capital costs are a positive in terms of fiscal cost, they also mean that support in terms of capital costs will have less incentive effect. Despite the current exemption from excise taxes for ethanol there does not appear to be a rush to blend/supply biofuels, which indicates that tax relief would need to be augmented by other measures as well.

The oil companies have well established brands and high levels of consumer awareness and trust. That is not to say that consumers' trust extends completely to discount collusive behaviour among firms, but as an industry the major players are well known. This could have the effect of minimising consumer uncertainty that may accompany a 'new' product, especially given the well established distribution networks of the majors. In the absence of the involvement of the majors, there may be some reluctance in terms of uptake.

In providing support to blenders/distributors, the "hold up" problem is less likely to emerge. Blenders/distributors would be left to source adequate supply with which to blend. While this minimises the prospect of "hold up" it increases the risk associated with security of supply. Setting the assistance level to account for such search behaviour is possible, though is non-trivial.

Duncan and Copeland (2004) indicate that there could be administrative advantages to assisting the distributor only as it involves one payment only and the oil companies already collect fuel taxes. In addition, there would likely be less concern with separating the transport related production (and applying the assistance only to that portion) under this option.

#### **a) Risks/downsides**

There are some risks common to both blenders/distributors and producers. The possibility of sending subsidised biofuels offshore exists in the case of blenders/distributors as well, although possibly to a lesser extent. Over production is also less of a possibility. Depending on the nature of assistance a further downside common to both blender/distributor and producer assistance, is that direct financial support will be from general tax revenue, meaning it will be borne by the general taxpayer, as opposed to transport fuel consumers. To the extent that there are public good elements to clean air, this may not be such an issue.

#### **5.1.4 Preferential tax treatment**

Under the assumption that demand for biofuels is the same as demand for conventional fuels, exemption from taxation or other preferential tax treatment is not different to a subsidy, in financial terms. For example, if ethanol remains exempt from excise then it is in effect receiving favourable treatment, relative to petrol, from which producers can potentially gain financially.

Of course, in terms of the objectives of tax policy, it may well be that it is inappropriate to levy a charge on biofuels which may not have the same properties which gave rise to the taxation of fossil fuels in the first instance. That is, to the extent that fossil fuels are taxed because of their pollutant qualities, it may be appropriate to exempt (or, in the case of ethanol, continue to exempt) biofuels from the tax. However, it would be

inappropriate to view a reduction in tax which is levied for other reasons to be viewed as anything other than a subsidy.

We have assessed the costs to government of not introducing taxes on biofuels at the same rate as taxes levied on their respective substitutes – 0.355 cents per litre in the case of diesel and 41.965 cents per litre in the case of petrol.<sup>14</sup> Not taxing either ethanol or biodiesel at the same rates as tax levied on their conventional counterparts is in neither case sufficient to induce consumption of either biofuel in blends. However, like subsidies to blending and distribution, no equivalent tax could serve as a conduit to other subsidies. Table 5 provides present value estimates of the costs of not taxing biofuels.

**Table 6 Present value costs of not taxing biofuels**  
Cents per litre, millions of dollars, PJ of renewable consumed

	E 3			B 2.75		
	Subsidy per litre	Cost (\$)	Renewable used	Subsidy per litre	Cost	Renewable used
2006	1.43	32.6	0	0.0110	0.169	0
2007	1.43	29.8	0	0.0110	0.155	0
2008	1.43	27.3	0	0.0110	0.143	0
2009	1.43	24.9	0	0.0110	0.131	0
2010	1.43	22.8	0	0.0110	0.121	0
2011	1.43	20.8	0	0.0110	0.111	0
2012	1.43	19.0	0	0.0110	0.102	0
Total		177.2	0		0.935	0

Source: NZIER

In the case of biodiesel blends the exemption from tax amounts to a very small subsidy with overall fiscal cost consequently very small. In the case of ethanol, the fiscal cost from reduced petrol tax revenue is non-trivial, though it amounts to a small reduction relative to overall government revenue from petrol taxes and levies.<sup>15</sup>

<sup>14</sup> In our subsidy cost estimates we have not included excise taxes and ACC levies on the ethanol components of ethanol/petrol blends.

<sup>15</sup> Our estimates presented here for reduced petrol tax revenue do not take account of policy changes which have raised petrol taxes by five cents per litre and allow for an annual adjustment of the National Road Transport fund portion of the tax by inflation each year. Given these policy changes, our estimates are on the low side.

## 5.2 Benefits and prices of emission reductions

Benefits of biofuel subsidies remain the same irrespective of where a subsidy is targeted, although they do vary over time as consumption changes. Table 7 shows that biodiesel blends offer the largest benefit in terms of volumes of emissions reduced.

**Table 7 Emission reductions from subsidies**

Reduction in volume of emissions (negative indicates increase)

	E 3				B 2.75			
	CO <sub>2</sub> (kt)	PM (t)	CO (kt)	NVMOC (kt)	CO <sub>2</sub> (kt)	PM (t)	CO (kt)	NVMOC (kt)
2006	-6.21	0.217849	37.3	3.7	13.61	11.64	1.60	0.29
2007	-6.25	0.219082	37.5	3.7	13.76	11.77	1.61	0.29
2008	-6.28	0.220323	37.7	3.7	13.92	11.91	1.63	0.29
2009	-6.32	0.22157	37.9	3.7	14.08	12.04	1.65	0.30
2010	-6.36	0.222824	38.2	3.8	14.24	12.18	1.67	0.30
2011	-6.38	0.223685	38.3	3.8	14.41	12.33	1.69	0.30
2012	-6.40	0.22455	38.5	3.8	14.59	12.48	1.71	0.31
Total	-44.21	1.549883	265.4	26.2	98.61	84.36	11.57	2.10

Notes: (1) Assuming a target of 2 PJ of renewable fuel use by 2012.  
 (2) Values in italics indicate a subsidy in excess of the value of the costs the subsidy is aimed at reducing  
 (3) Subsidies to blending and distribution costs would have to be in excess of the contribution of blending and distribution costs to the price of the biofuels for the subsidy to reduce the price of the respective biofuel blends to a level below that of their conventional fuel counterparts.

Source: NZIER

In order to evaluate various emission reductions we have worked backwards from the net cost of the subsidies to calculate an implied price or marginal social benefit of each tonne of non-CO<sub>2</sub> emissions reduced. We begin by calculating the net benefit/costs of subsidies using those elements of the subsidy cost and benefits for which we have market prices. These elements are the cost of the subsidy (calculated using estimated future market prices of biofuels and petroleum based fuels) and the benefits of CO<sub>2</sub> reductions using a market price for CO<sub>2</sub> of \$15 per tonne. In all cases the net of these figures (costs of subsidy less benefits of CO<sub>2</sub>) turns out to be negative. We then assume that the residual cost is offset by the price or marginal social benefit of reductions in the other, non CO<sub>2</sub>, emissions. By dividing the net subsidy cost through by tonnes of emissions reduced we arrive at an implied price for each tonne of non-CO<sub>2</sub> emissions reduced.

In our analysis we have considered emissions of carbon monoxide (CO), non-methane volatile organic compounds (NMVOC), and particulate matter (PM). These emissions have varying effects on health and the environment and so we have chosen to weight each emission by their relative impact on human health<sup>16</sup>. The weights we have used are informed by two Australian studies cited in Duncan and Copeland (2004). These studies provide estimates of health costs per tonne of vehicle emissions. We use these estimates to weight each tonne of reduced emissions by the relative size of health costs per tonne of emission for each type of pollutant. The weights and costs from the Australian studies are shown in Table 8.<sup>17</sup> This approach gives the most weight to particulate emissions. As such, tonnes of PM reduced are priced against a greater share of subsidy costs than CO and NMVOC. This is intended to reflect the fact that if PM emissions are more costly than CO or NMVOC emissions, then the marginal benefit (or implied price) per tonne of PM reduced should reflect this.<sup>18</sup>

**Table 8 Health costs from atmospheric pollution and weights applied to emission reductions**

Pollutant	Estimated health cost per tonne (1)	Weight
CO	\$3.3	0.000008
NMVOC	\$944	0.0025
PM	\$379,611	0.9975

Notes: (1) NZ\$, converted from AUS\$ at 0.9:1 (AUS\$:NZ\$)

Source: Duncan and Copeland (2004)

In calculating the above implied price we are in effect assuming that the marginal social cost of each subsidy will be equal to the marginal social benefit. By definition, if we sum the value of the benefits of all emissions reduced, using implied prices and the estimated market price for CO<sub>2</sub> emissions, and subtract the cost of the subsidy we will invariably arrive at the result that the net cost/benefit of each subsidy is zero. Thus we cannot look to the net benefit of the subsidy to determine which policy alternative is the most desirable. However, we can look at the implied prices to

<sup>16</sup> Unfortunately we do not have data with which to weight the emissions by environmental impact. However, the benefit from reductions in CO<sub>2</sub> emissions provides an adequate proxy of overall environmental benefits.

<sup>17</sup> Health costs from vehicle emissions vary by concentration of population. The Australian studies cited in Duncan and Copeland (2004) refer to four bands of population concentration when providing estimates of vehicle emission costs. In calculating our weights we have used only band 1 or large city estimates.

<sup>18</sup> The costs used to inform our weights are for atmospheric pollution in general and not emissions exclusively from automotive engines.

determine which is the more cost effective means of achieving equivalent reductions in emissions holding the level of renewable fuel use constant.

Table 9 provides an example of implied emission prices. The “Producer total” and “End use total” rows provide the portion of the net present cost of the subsidy which is being apportioned to each emission type as an assumed benefit. CO<sub>2</sub> is included in the table for illustrative purposes – though the implied price of CO<sub>2</sub> remains \$15 by assumption and the net present value of reduced CO<sub>2</sub> is calculated using both total emission reductions and the proportion of CO<sub>2</sub> emissions attributable to the renewable biofuel used (see 0)

Table 9 shows that for ethanol blends the implied price of particulate matter emissions is in billions of dollars per tonne. This is because the volume of reductions in particulate matter reduced by ethanol blends is very small relative to biodiesel where the implied price is between \$800,000 and \$1,000,000 depending on where a subsidy is targeted. Because the costs of biodiesel subsidies are smaller than for ethanol blends, the implied prices of emission reductions from ethanol subsidies are far in excess of the implied prices for biodiesel. This is true, except in the case of CO where the implied price under a subsidy to ethanol is smaller than for biodiesel. This figure needs to be treated with particular caution. The figure used in this analysis for reduction of CO emissions from ethanol blends (2.69% per 1% of ethanol) is arguably only appropriate for older engines and some small vehicles where carburetors regulate air-fuel mix. The reduction in CO emissions in newer (late 80’s on) vehicles with fuel injection systems is likely to be less than this.

The smallest price of particulate emissions in Table 9, \$800,000 per tonne reduced, may seem excessive on the face of it. However, it is in not entirely dissimilar from the orders of magnitude of health costs that are estimated in an Australian study on the effects of emissions on health (cited in Duncan and Copeland, 2004). In this study, costs of PM emissions in a large urban city (comparable only with Auckland) is in the vicinity of AUS\$341,650 (\$NZ379,611 at the average 2004 exchange rate). That said, the price placed on particulate emissions in this study (to equate marginal social cost with marginal social benefit) is outside the bounds of these estimated health costs.

**Table 9 Present value of emission reductions 2006 - 2012**

Present value millions of dollars, implied price in dollars per tonne

Subsidy	E 3				B 2.75			
	CO2	PM	CO	NMVOG	CO2	PM	CO	NMVOG
Producer total	6.1	105.031	0.001	0.263	8.8	49.2	24.6	24.6
<i>Implied price</i>	<i>15</i>	<i>68 million</i>	<i>0.003</i>	<i>10.051</i>	<i>15</i>	<i>0.8 million</i>	<i>2,125</i>	<i>3,890</i>
End use total	6.1	193.921	0.002	0.486	8.8	90.0	44.9	44.9
<i>Implied price</i>	<i>15</i>	<i>125 million</i>	<i>0.006</i>	<i>18.557</i>	<i>15</i>	<i>1 million</i>	<i>11,792</i>	<i>21,588</i>

Source: NZIER

Results of our analysis, in terms of emissions prices (i.e. marginal social benefit) and subsidy costs is provided in the tables in section 5.4.

### 5.3 Sensitivity to assumptions

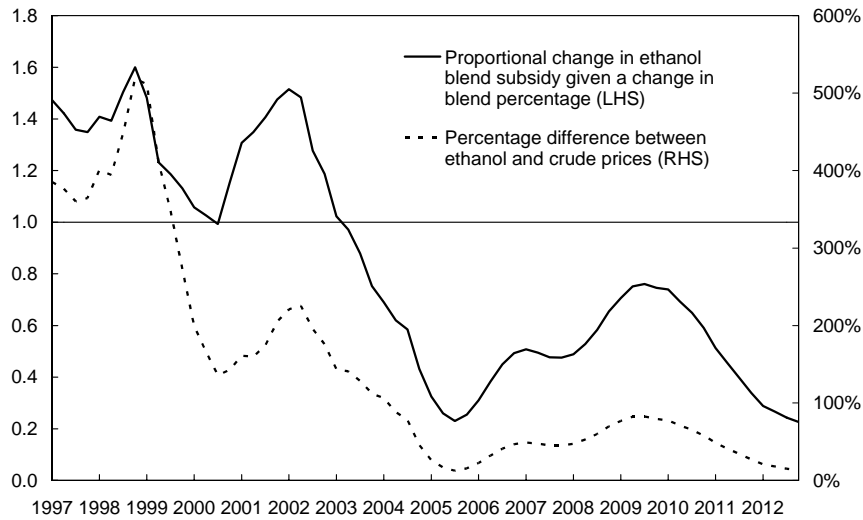
In the above we assumed that with the price of biofuels at half a cent cheaper than the price of conventional fuels consumers would be indifferent between conventional fuels and biofuel blends. However, this assumption may prove too strong in reality. Consumers may in fact be cautious about purchasing biofuels because of evidence that biofuels can have unwanted effects on engine condition. To overcome this additional costs would be borne to achieve a 2PJ renewable fuel target.

Firstly, an information campaign would need to be conducted to allay consumer concerns and convince them that biofuels do not have adverse impacts on engine condition at low blend levels. For an information campaign to be effective it would entail a widespread and relatively intensive information campaign that might cost between \$1 million and \$3 million dollars.

Secondly, even in the absence of an information campaign it may well be the case that consumers are unwilling to take up an across the board 3% blend of ethanol in petrol or a 2.75% blend of biodiesel in diesel. If this were the case a 2PJ target might be achieved through a less than full penetration of the market of biofuel blends, but at a higher blend. For example, if 50% of consumers were comfortable with ethanol/petrol blends (and were indifferent to the blend percentage) then if 50% of all petrol purchased including 6% ethanol, then the 2PJ target would be achieved with approximately the same reductions in volumes of emissions as 100% of all petrol sold consisting of an E3 blend. However, the costs would not be the same and consequently neither would the implied prices on non-CO2 emission reductions.

**Figure 12 Ethanol blend change effect on subsidy**

Percent change LHS, percent difference in feedstock prices RHS

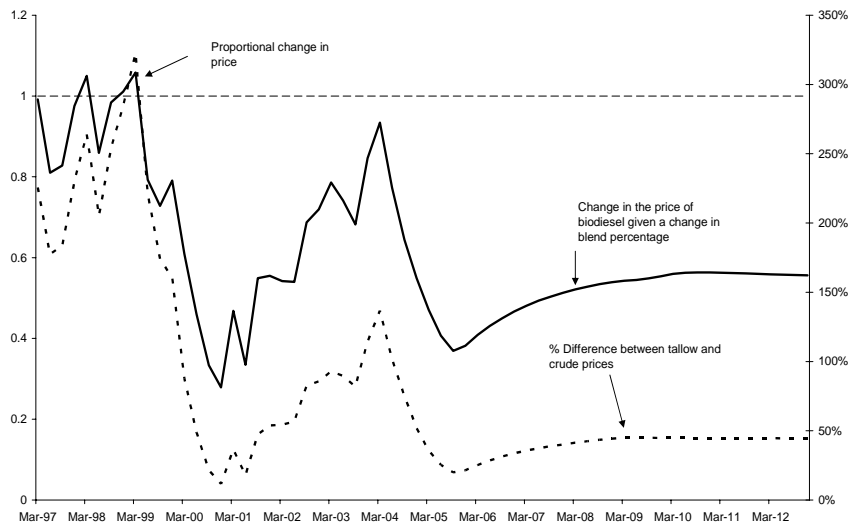


Source: NZIER

In the case of both biodiesel and ethanol the price of biofuel blends is an increasing function of the blend percentage – holding all other things, including transport fuel consumption, constant. Thus, the size of a subsidy will also need to increase with an increase in blend. The implications of this vary as between biodiesel and ethanol.

**Figure 13 Biodiesel blend change effect on subsidy**

Percent change LHS, percent difference in feedstock prices RHS



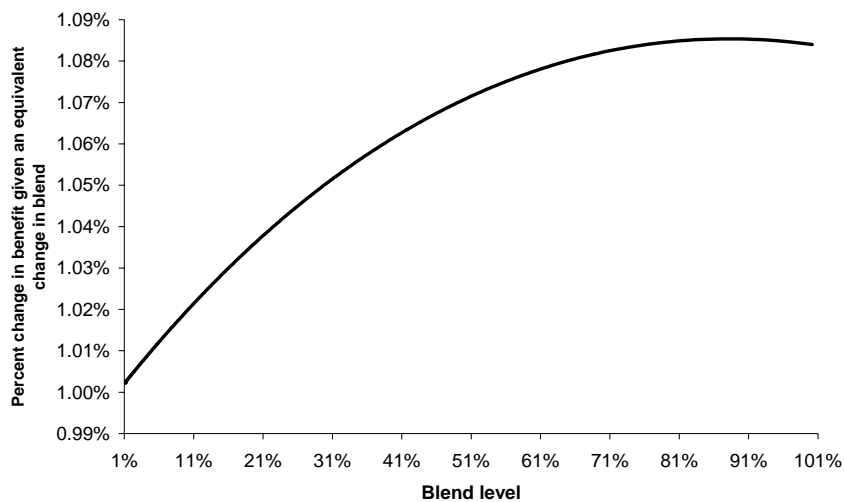
Source: NZIER

Figure 12 and Figure 13 show the effects on subsidy costs given an increase in blend percentage for ethanol and biodiesel respectively. For both ethanol and biodiesel blend the costs of the subsidy are a function of the percentage difference between biodiesel and ethanol and the price of crude. Through

our forecast horizon, both biodiesel and ethanol subsidy costs increase by less than 1% for a 1% increase in the blend percentage used. Whether this in turn means increasing returns (or lower losses) at higher percentage blends depends on the rate at which the benefits from each biofuel subsidy increase.

Figure 14 shows that a 1% increase in blend percentage will increase the benefits associated with ethanol use by greater than 1%. Given that the cost of ethanol blend subsidies increases by less than 1%, an increase in blend percentage will yield a proportional reduction in the overall net cost of the subsidy. This means that if a subsidy targeted at making E6 economic (because 50% of petrol consumers were unwilling to use ethanol blends at a 3% level) then the increased costs of the E6 subsidy would be offset by greater emission reductions and lower implied prices for those emission reductions (i.e. higher costs offset by relatively cheaper benefits).

**Figure 14 Marginal benefit of ethanol blends**



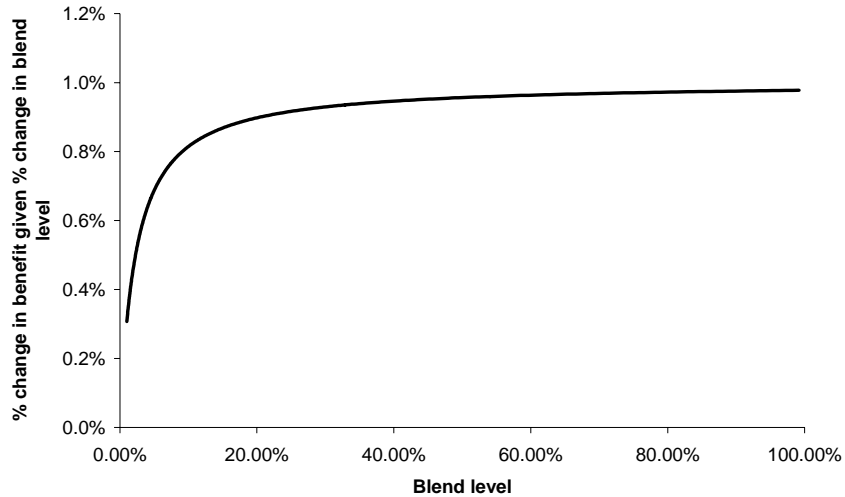
Source: NZIER

Thus, an E6 blend consumed by half of the petrol consuming population would result in the same level of ethanol being consumed as was the case with the E3 blend (approximately 2.03 PJ in 2012), but the net cost of the initiative (cost of a direct subsidy to end consumption less the benefits from CO<sub>2</sub> emissions priced at \$15) would decline from \$371 million (net present value) to \$332 million.

Conversely, Figure 15 shows that the picture is less clear in the case of biodiesel. Whether a percentage increase in blend reduces net costs will depend on the initial blend level and will depend year by year on the relative prices of biodiesel and crude oil. However, we do find that over our forecast horizon a doubling of the blend at which the subsidy is targeted, assuming that half the consumers of diesel choose a B5.5 blend over diesel, would yield a net reduction in the cost of a biodiesel subsidy. That is, the net cost

(cost of a direct subsidy to end consumption less the benefits from CO<sub>2</sub> emissions priced at \$15) would decline from \$162 million to \$132 million while the amount of renewable fuels consumed in 2012 would remain at around 2.10 PJ as in the case of a B2.75 blend.

**Figure 15 Marginal benefits from biodiesel blends**



Source: NZIER

This all suggests that our initial estimates based on the minimum blend percentage to deliver 2PJ of renewable fuel use, assuming complete consumer uptake of the blend, are upper bounds on the likely costs and benefits of subsidy initiatives.

## 5.4 Summary of cost benefit analysis

Table 10 and Table 11 provide a summary of the relative costs and benefits of producer and end use subsidies including what the relative costs, benefits and implied prices of emission reductions would be in the case of limited and full market penetration of biofuel blends. The costs presented exclude fiscal costs from reduced transport fuel tax revenue.

**Table 10 Summary of costs and benefits of a producer subsidy**

Present (2004) value, cost and CO<sub>2</sub> benefit in \$ millions, renewable fuel use is 2012 consumption (PJ), emission reductions in tonnes, emission implied prices in \$ per tonne

Blend	Market penetration	Average subsidy per litre (cents)	Total cost	Renewable fuel use in 2012	Total CO <sub>2</sub> reduction benefit	Net market value of subsidy (\$millions)	Reduction in PM emissions	Reduction in CO emissions	Reduction in NMVOC emissions	Implied price of PM (\$millions)	Implied price of CO	Implied price of NMVOC
E3	25%	0.88	27.9	0.51	1.5	-26.7	0.38	66,147	6,526	68.365	0.003	10.088
E3	50%	0.88	55.7	1.03	3.03	-54.5	0.77	132,430	13,067	68.164	0.003	10.075
E3	100%	0.88	111.4	2.05	6.1	-110.3	1.55	265,403	26,191	67.767	0.003	10.510
B2.75	25%	1.06	22.4	0.525	2.2	-20.2	21.1	2,891	521	0.954	0.06	97.0
B2.75	50%	1.06	44.8	1.05	4.4	-40.4	42.2	5,782	1,042	0.954	0.06	97.0
B2.75	100%	1.06	89.5	2.10	8.8	-80.7	84.36	11,565	2,084	0.954	0.06	97.0
E6	25%	1.48	47.1	1.03	3.0	-45.97	0.77	132,430	13,067	57.054	0.003	8.433
E6	50%	1.48	94.2	2.07	6.1	-93.1	1.55	265,403	26,190	56.718	0.003	8.412
E6	100%	1.48	188.0	4.13	12.3	-187.3	3.13	532,972	52,605	56.056	0.003	8.370
B5.5	25%	1.85	39.2	1.05	4.4	-34.8	42.2	5,782	1,042	0.822	0.048	83.0
B5.5	50%	1.85	78	2.1	8.8	-69.2	84.4	11,565	2,084	0.822	0.048	83.0
B5.5	100%	1.85	157	4.2	17.6	-139.4	169	23,130	4,168	0.822	0.048	83.0

Notes: (1) Numbers may not add accurately due to rounding

**Table 11 Summary of costs and benefits of a subsidy to final consumption**Present (2004) value, cost and CO<sub>2</sub> benefit in \$ millions, renewable fuel use is 2012 consumption (PJ), emission reductions in tonnes, emission implied prices in \$ per tonne

Blend	Market penetration	Average subsidy per litre (cents)	Total cost	Renewable fuel use in 2012	Total CO <sub>2</sub> reduction benefit	Net market value of subsidy (\$millions)	Reduction in PM emissions	Reduction in CO emissions	Reduction in NMVOC emissions	Implied price of PM (\$millions)	Implied price of CO	Implied price of NMVOC
E3	25%	1.58	50.1	0.51	1.5	-48.6	0.38	66,147	6,526	126.2	0.006	18.6
E3	50%	1.58	100.3	1.03	3.03	-97.2	0.77	132,430	13,067	125.8	0.006	18.6
E3	100%	1.58	200.5	2.05	6.1	-194.4	1.55	265,403	26,191	125.1	0.006	18.6
B2.75	25%	2.02	42.7	0.525	2.2	-40.5	21.1	2,891	521	1.92	0.112	195.0
B2.75	50%	2.02	85.6	1.05	4.4	-81.2	42.2	5,782	1,042	1.92	0.112	195.0
B2.75	100%	2.02	171.2	2.10	8.8	-162.4	84.36	11,565	2,084	1.92	0.112	195.0
E6	25%	5.53	84.80	1.03	3.0	-81.8	0.77	132,430	13,067	105.8	0.005	15.6
E6	50%	5.53	169.61	2.07	6.1	-163.5	1.55	265,403	26,190	105.2	0.005	15.6
E6	100%	5.53	339.0	4.13	12.3	-326.9	3.13	532,972	52,605	104.0	0.005	15.5
B5.5	25%	3.5	74.9	1.05	4.4	-70.5	42.2	5,782	1,042	1.67	0.098	169.0
B5.5	50%	3.5	150.0	2.1	8.8	-141.2	84.4	11,565	2,084	1.67	0.098	169.0
B5.5	100%	3.5	300.0	4.2	17.6	-282.4	169	23,130	4,168	1.67	0.098	169.0

Notes: (1) Numbers may not add accurately due to rounding

## 6. Geographical considerations

EECA have requested consideration of incentives based on a national or regional basis. In particular, the possibility of a special incentive structure for Auckland, where biodiesel benefits in reducing particulate emissions have potentially greater value than in other parts of the country. There is little doubt that impacts in terms of transport-related emissions reductions in Auckland would be greater than other parts of the country, but the implementation logistics of such a targeted move would seem to rule such an option out.

The case of regionally-based petrol taxes illustrates the inherent difficulties associated with such approaches.<sup>1</sup> The major difficulty relates to the ability to “ring fence” the tax. In essence, there is no cost effective way to restrict the tax to a particular region. Recent experience shows that oil companies did not directly pass on the cost of the tax in the regions that were granted the right to levy a regional petrol tax. They effectively spread the collection of the tax nationwide, arguing that they were collecting the tax in the selected regions but simply operating different pricing policies for their own product across the country.

It is this pricing structure that creates the difficulty. The ability of oil companies to successfully argue differential pricing structures raises the possibility that prices in Auckland may not alter to the degree that might otherwise be required to affect consumption changes. In the presence of pricing structures that do not allow true regionally-based costs to be identified, it would be extremely difficult to structure a subsidy regime that didn’t “over-subsidise” and end up covering more parts of the business than intended. This has both cost and efficiency implications.

There is also the issue of equity, which bears considering around the efficacy of subsidising consumers in Auckland. Some may view preferential treatment of a particular region as perverse, given the emissions levels prevalent in the region. There may be some justification in “punishing” those who do harm, rather than “rewarding” them with incentives. If it is the case that the polluting behaviour of the inhabitants of the favoured region is no different from those in other regions (i.e. it is just a case of larger numbers producing higher volumes of emissions), then horizontal equity may be compromised by such a policy.

On top of this, there are additional questions around how regional incentives would work in practice. Any incentive on the production/distribution side in the Auckland area could induce entry in Auckland, where the current storage capacity is limited, necessitating new investment which would add

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<sup>1</sup> See LECG (2003) and NZIER (2003) for further detail.

to the incentive required. In terms of the possibility of “leakage” to other regions, subsidising Auckland in particular may not present a particular problem. The reductions in CO<sub>2</sub> are irrespective of location while the PM<sub>10</sub> effects are localised but volumetrically small. The degree of border effects/physical “leakage” in terms of biofuels purchased in Auckland but consumed outside the region is not likely to be large. However, to the extent that there is regional variation in the subsidy, the likelihood is that the support becomes capitalised into the value of assets in certain regions. This may impeded the adjustment of industry structure over time.

Looking more widely to consistency with international obligations, there does not appear to be any particular inconsistency issue. Many countries have already implemented subsidies for the production and/or consumption of renewable energy, such as biofuels. Environmental protection is one of the reasons why uptake is encouraged. While Australia is looking at phasing out its per unit support, and a number of other countries are looking to scale back subsidies, in our view this is a reflection of the length of time that existing support has been in place, rather than a change in mood around the merits of biofuels.

## 7. Other possibilities

EECA has asked us to consider the costs and benefits of any other possibilities for providing a favourable tax regime to incentivise the uptake of biofuels. While we considered exemption from excise taxes earlier, we also briefly considered the following (though did not conduct any modelling):

- Relief from GST to encourage consumption at the pump.
- Exemptions from license fees, registration fees

Relief from GST on the biofuels element would have the effect of encouraging biofuels consumption, which might have the flow-on effect of encouraging suppliers to establish capacity in New Zealand. However, for policy and practical reasons it is unlikely to be feasible. The first problem is that one of the desirable properties of a GST is that it is broadly based. Providing exemptions for certain goods or services (regardless of possible beneficial consequences) would effectively “open the flood gates” for other goods and services. In terms of implementation issues, it is not clear how such an exemption would work. Like tax credits, the administrative costs could be prohibitive if some kind of voucher scheme was posited.

Furthermore, a cursory comparison of the subsidy levels required for consumers versus producers to reach the same hypothetical quantity bundle of biofuel good indicates that the subsidy level to consumers (based on GST exemption) would be much higher than subsidising producers through some

other mechanism. That is, it appears more costly to use GST exemption as the mechanism to provide support. At times it is twice as costly.

Exemptions from license and/or registration fees was ruled out because of the indeterminate effect on biofuels uptake.

## **8. Complementarity with mandatory blend target**

In broad terms, instituting a mandatory blend alongside other subsidies would have interesting effects on efficacy. The risk of hold-up by blenders/distributors would largely be removed by having a mandatory requirement, making the option of subsidising producers more attractive. However, there are deadweight costs to this option, in terms of subsidising activity that may have occurred anyway.

In particular, Argent By-Products Group Ltd have indicated interest in establishing a biodiesel production facility in New Zealand on the condition that a 5% mandatory requirement was implemented. Thus, a policy that included a 5% requirement and sought to substitute producers would risk diverting resources toward funding production that would have taken place without the subsidy. Therefore, at least in terms of biodiesel and a mandatory requirement in the order of 5%, a mandatory requirement would be a substitute for producer subsidies.

The combination of a mandatory requirement and blender/distributor subsidies would lessen any deadweight costs of this nature. There is no evidence at hand to indicate that oil companies would make the move to cost effective biofuel production in the absence of subsidies, and therefore the subsidy regime would be to ensure that the costs faced by producers under a mandatory requirement would not alter the consumption price.

In terms of implementation costs and complexity, there is a degree of complementarity between all options and a mandatory requirement. That is, we believe that implementation costs and potential problems associated with retailer capture and/or hold up from distributors would be alleviated through introducing both a mandatory requirement and a subsidy regime. This could potentially lower the costs of transition also, by eliminating the option of blenders/distributors to participate or not. The installation of separate pumps at retail outlets (some catering to biofuels with others remaining as previously) would also be avoided. In addition, a mandatory requirement would alleviate any concerns about take-up (consumption) of biofuels, and ergo concerns around meeting transport-related renewable fuels targets.

However, under a mandatory regime, the subsidy ceases to be an “incentive” and becomes a compensatory device, which has the effect of

holding the price down. If this is the case, then it may be necessary to consider the efficacy of other compensatory measures, such as direct income supports, consumer tax rebates, and the like. While no modelling of this type was able to be completed within the constraints of the project, this aspect may warrant further attention in the future.

## **9. Competitive effects on the transport fuels industry**

This section discusses the likely impact of the four policy alternatives on the competitive environment in the fuels industry. In the previous analysis for MED, we used the structure-conduct-performance paradigm to assess the impact of a mandatory blending requirement. This assessment is not repeated here, but the broad elements are contained in what follows.

There are no immediately obvious differences in competitive effects among the four proposals outlined above. Some subtle differences are postulated below, however.

Providing assistance to producers is likely to have two somewhat countervailing effects. Financial assistance is likely to mean there is effectively a new player in the market for transport fuels, who was able to avoid/reduce potential (direct and indirect) barriers to entry. This could exert competitive pressures on the incumbents, despite the level of integration that would be required. This would be particularly so if cost efficiencies, brought about by innovation were apparent in the production of biofuels, although as mentioned previously this often takes time.

Conversely, it raises the prospect of an effective monopoly in production, particularly in the case of biodiesel, where potential entrants might be few. As mentioned above, subsidies tied to units of output tend to favour bigger producing players. Providing support (even for a limited time) would effectively cement the role of the single provider to the point that even if the subsidies/assistance were removed some time in the future, there would be effective barriers to other entrants. While it is possible to continue to alter the subsidy/rate of support until a further player emerged, there would be considerable uncertainty and costs (both direct costs and deadweight/crowding out costs associated with subsidising activity levels that would have occurred without the support).

The option with the least effect on the competitive environment is likely to be an exemption from GST for consumers of biodiesel.

To the extent that all oil companies decide to participate in any assistance programme that offers financial incentives to blenders/distributors, the effects on competition are likely to be muted. However, if some companies

participate and others do not, or some companies are unsuccessful in their bids for assistance, then the likelihood of a dominant firm acquiring market power would increase, such that the Commerce Commission becomes interested. There do not appear to be any particular cause for concern around collusive behaviour associated with subsidising blenders/distributors over and above those that already exist.

## 10. References

- ACIL Economics and Policy (1997) “Barriers to Entry in the New Zealand Downstream Oil Market.” Report for the Ministry of Commerce.
- Creedy, J. (2003) “The Excess Burden of taxation and Why it (Approximately) Quadruples When the Tax Rate Doubles. Treasury Working Paper 03/29. New Zealand Treasury, December, 2003.
- Creedy, J. (2004). “The Effects on New Zealand Households of an Increase in the Petrol Excise Tax”. Treasury Working Paper 04/01. New Zealand Treasury, March, 2004.
- Duncan (2003). “Ethanol for Blending with Petrol: Availability and Costs”. Report to the Energy Efficiency and Conservation Authority and the Ministry of Transport. East Harbour Management Services Ltd. February, 2003.
- Duncan, J and Michael C Copeland (2004) “ Economically Efficient Support for Transport Biofuels.” Report prepared for EECA.
- IEA (2004). Biofuels for Transport: An international perspective. International Energy Agency, OECD, Paris.
- IEA, UNEP (2002) “Reforming Energy Subsidie, OECD/IEA, Paris.
- Judd, B (2002). “Biodiesel from tallow”. Report to the Energy Efficiency and Conservation Authority, November, 2002.
- LECG (2003) “Implementing a Regional Petrol Tax” (Confidential) Report prepared for Auckland City Council.
- MED (2003). *New Zealand Energy Outlook to 2025*. Ministry of Economic Development. Wellington. October, 2003.
- MED (2004). *New Zealand Energy Greenhouse Gas Emissions, 1990-2003*. Ministry of Economic Development, Wellington, June 2004.
- Miller, R (1989) “Price Setting and Deregulation: The Flour Milling and Petrol Wholesaling Industries.” NZIER.
- NIWA (2002). “Health effects due to motor vehicle air pollution in New Zealand”. Report to the Ministry of Transport, January, 2002.
- NZIER (2003) “Implementation of a Regional Petrol Tax in the Auckland Region.” Report to Auckland City Council.

NZIER (2004) “ Mandatory Transport Biofuels- Costs and benefits of mandatory Biofuel Blends in Transport Fuels.” Report to the Ministry of Economic Development.

OECD (1998) “Previous Multilateral Efforts to Discipline Subsidies to Natural Resource Based Industries.”

<http://www.oecd.org/dataoecd/2/62/1918086.pdf>

Pershing, J and Jim Mackenzie (2004) “Removing Subsidies: Leveling the Playing Field for Renewable Energy Technologies” Paper prepared for International Conference for Renewable Energies.

Pickford and Wheeler (2001) “The Petrol Industry: Deregulation, Entry and Competition.” NZ Trade Consortium Working Paper No. 12. Available at: [http://www.nzier.org.nz/SITE\\_Default/SITE\\_Publications/x-files/371.pdf](http://www.nzier.org.nz/SITE_Default/SITE_Publications/x-files/371.pdf)

Prakesh, C (1998). “A critical review of biodiesel as a transportation fuel in Canada”. Report prepared for the Transportation Systems Branch of the Air Pollution Prevention Directorate of Environment Canada. March 25, 1998.

Scott, G (1997) “Conditions of Entry into Petrol Importing, Wholesaling and Retailing in New Zealand”. LECG, Wellington.

Smith, Z (2000). “The Petrol Tax Debate”. Briefing note 8, Institute of Fiscal Studies. Available at <http://www.ifs.org.uk>.

Stiglitz, J E (1998) *Economics of the Public Sector*. Second Edition, WW Norton and Company.

# Appendix A Biodiesel and Ethanol background

## A.1 Background

The word biodiesel is a generic term which refers to diesel fuel substitutes derived primarily from non-fossil fuel feedstocks. Biodiesel is typically formed through two distinct production processes. One is the transesterification of feedstock oils or fats through reaction with methanol and a potassium hydroxide catalyst. The other is production of synthetic diesel fuel made from biomass through gasification. In the following we discuss biodiesel produced by transesterification of oils or fats.

The bulk of world supply of biodiesel is produced using vegetable oils, primarily in Europe where rapeseed oil is the principal input. However, biodiesel can also be produced from waste fats and tallow. Tallow as a feedstock has not been very widely used, but it has been singled out as the most likely feedstock for biodiesel production in Australasia due to the large quantities of tallow available from meat processing. A recent study on the feasibility of biodiesel production in New Zealand suggested that sufficient tallow production existed to support biodiesel production in New Zealand for a 6% biodiesel/diesel blend (hereafter biodiesel/diesel blends are referred to as B[blend%]) (Judd, 2002). In this report our discussion of the costs and benefits of biodiesel/diesel blends focuses on biodiesel produced from tallow in New Zealand.

Biodiesel is used in Europe and the United States at levels of B5, B20, and in some cases neat or 100% biodiesel as a transport fuel. For the most part, biodiesel is best used in low level blends. The higher the level of biodiesel used in a blend, the greater the likelihood of problems occurring in unmodified vehicles. This is particularly the case for biodiesel produced from tallow, which on its own begins to crystallise at under 20°C (Judd 2002). Problems around cloud point can be mitigated through additives however, though this is an issue that would need to be dealt with by fuel quality authorities rather than in the present context.

At lower blends, biodiesel has useful properties, including increasing the lubricity of the fuel. Fuel lubricity is important because in many diesel engines some moving parts are lubricated by the diesel itself. Thus the introduction of biodiesel can lead to reduced engine wear and some studies even suggest increased fuel efficiency compared with low-sulphur content diesel.

The most commonly cited negative effect of biodiesel on vehicle performance is reduced power (Prakesh, 1998). This is due to the fact that biodiesel contains slightly less energy than regular diesel on a volumetric

basis. Many of the studies which cite loss of power as an adverse effect of biodiesel use also note that the problems can be attributed partly to fuel quality issues.

We have chosen ethanol/petrol blends as the only alternative biofuel that could be used in mandatory transport fuel blends. Ethanol has a substantial pedigree as a biofuel, having been used in the United States, Europe, and Brazil for many years. Moreover, the global supply is growing rapidly.

That said, vehicle manufacturers in New Zealand and the Motor vehicle association have indicated an unwillingness to support ethanol blends over 3% (Duncan and Copeland, 2004). However, internationally, car manufacturers have expressed a willingness to accept blends up to 10%. This is the case in the United States and in Australia.<sup>2</sup> In general, vehicle manufacturers accept that “nearly all recent model conventional gasoline vehicles are fully compatible with 10% ethanol blends” (IEA 2004). This suggests that while there appears to be a reluctance to accept E5 or E10 in New Zealand, acceptance is far from out of the question.

Ethanol can also be blended with diesel to produce a fuel known as diesohol. We have not directly considered diesohol because of the inordinate cost difference between ethanol based biofuels and tallow based biodiesel. It is unlikely that ethanol prices will ever be small enough, relative to tallow/biodiesel prices for diesohol to be economically viable over biodiesel.

Ethanol in petrol blends is known to have a number of both positive and negative effects on vehicle performance. Though the precise effects vary by make of vehicle and through the life of the vehicle.

Ethanol can also damage engine components, particularly seals and rubber fuel lines. Also, ethanol is more corrosive than fossil fuels and as the ethanol level in fuel increases engine wear can increase as a result.

However, ethanol has a high oxygen content relative to petrol and as a result burns more cleanly than petrol, potentially leading to a reduction in engine deposits. The higher oxygen content also leads to more efficient energy use, with more kilometres able to be travelled per petajoule of ethanol than per petajoule of petrol. This is not the only way to view energy efficiency however, and discussion of volume of fuel per kilometre is more appropriate for our purposes.

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<sup>2</sup> See <http://www.deh.gov.au/atmosphere/ethanol/petrol/issues.html#vehicleop>

## Appendix B Petrol industry structure

### B.1 Industry structure

Figure 16 below is a stylised depiction of the vertical structure of the oil industry used by Pickford and Wheeler (2001) to assess the effects of deregulation of the petrol industry in 1988.<sup>3</sup> There is a relatively high level of vertical integration in the industry. The four major oil companies are significant shareholders and customers in the refinery company. Finished product is distributed in roughly equal proportions either through the Wiri pipeline or coastal tankers and road. Despite the involvement of BP, Caltex, Mobil and Shell, the product only becomes differentiated by company at the point where the retail delivery trucks are loaded and company-specific additives are added.

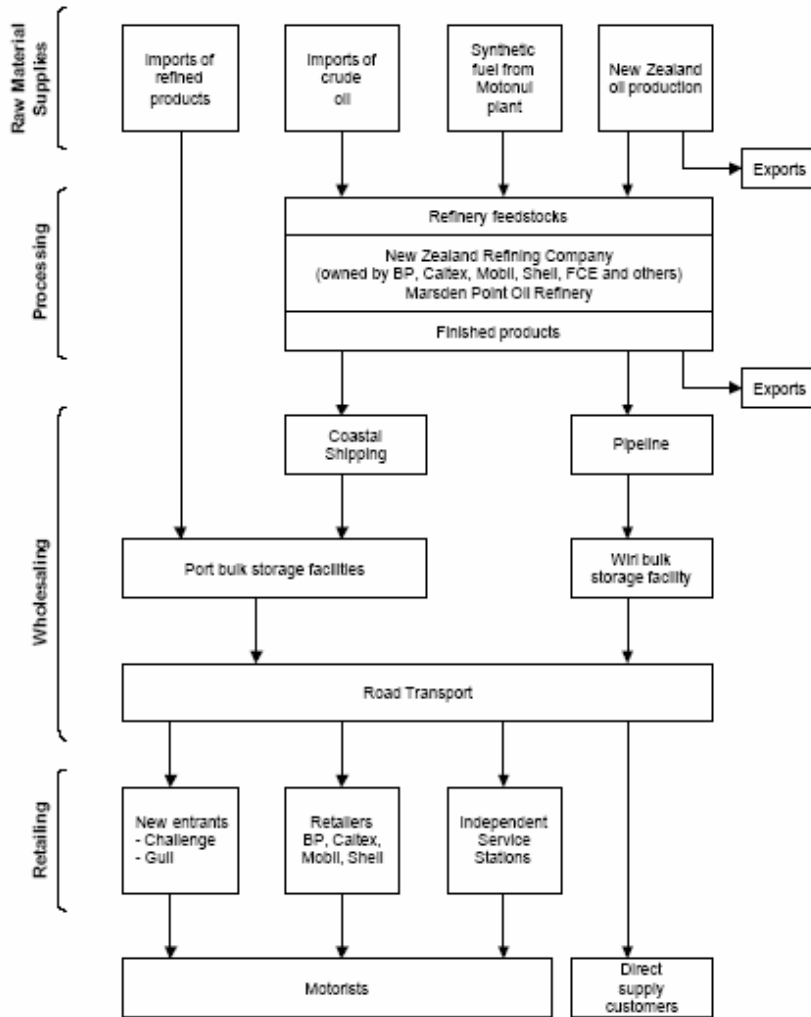
The four major companies, while being the major wholesalers and retailers of refined products, also own most of the bulk storage facilities, as well as owning or contracting with most of the retail outlets. Pickford and Wheeler (2001) note that not all four majors are represented at all of the ports, and “hosting” arrangements involving leasing capacity from the others are used when one of the wholesalers exceeds its own capacity or has no capacity. There are obvious efficiencies here, given the scale economies inherent in storage, however, such mutual co-operation benefits each of the incumbents, but might hinder an entrant if it were to be denied access on similar terms. Duncan and Copeland (2004) claim that: “ *[the] most likely location for ethanol to be blended into petrol will be at the principal storage depots of the oil companies*” and

*“ [the] New Zealand oil products storage and distribution network has little or no surplus storage capacity and locations where blending occurs will require additional storage facilities and equipment for blending ethanol into the petrol basestock” (p.14).*

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<sup>3</sup> The actual diagram is produced by the Ministry of Economic Development, and has subsequently, though not majorly, been updated.

**Figure 16 Structure of the New Zealand Oil Industry (excluding exploration)**



Source: Pickford and Wheeler, 2001

## B.2 Market structure

Miller (1989) identified inherent conditions that were thought likely to cause oligopolistic interdependence between the wholesalers: the few sellers; a consumer view of a homogeneous and non-complex product; transactions between sellers and buyers being frequent, stable, and numerous (aiding price monitoring by rivals); an inelastic demand (making collusion potentially more profitable); and a history of cooperation between the companies (because of regulation and joint activities).

A key characteristic of petrol is its technical homogeneity, in that stripped of its brand, buyers would not be able to distinguish the offering of one supplier from that of another. Better informed buyers are also aware that all domestically produced petrol comes from the one refinery, albeit that it is

mixed to varying degrees with imported petrol. Hence, not surprisingly, buyers seem to treat each brand as being a very close substitute with all other brands, and hence typically will buy from the lowest-priced option. This suggests that the cross-price elasticities of demand between brands will be very high, meaning that a small rise in one company's price will result in a large fall in sales as consumers switch to other brands, and vice versa. All this is consistent with the observation that prices of brands are very uniform, if not identical—down to one-tenth of a cent per litre—across a particular locality. This is often seen as evidence of collusive behaviour.

There are some particular features of the oil industry which further raise suspicions about possible collusion. These are the horizontal arrangements between the companies themselves, and the vertical arrangements between the companies and many of their dealers. As discussed above, the former include the Marsden Point refinery, the Wiri pipeline, the Wiri terminal, and the coastal tankers, all of which are directly owned or controlled by the four majors, together with the “hosting” and “borrow and loan” arrangements between them. ACIL (1997, pp. 29-31) argued that such arrangements are efficiency enhancing, partly because they yield economies of scale, particularly with respect to the refinery, and partly because they allow all four companies to compete over nationwide networks. They are also a feature of the oil industry overseas. On the other hand, it could also be that such joint activities provide opportunities for company representatives to meet and to develop understandings which could soften the competition between their companies.

Vertical arrangements, in terms of the supply arrangements between the oil companies as wholesalers and their retail dealers, may be more difficult to justify on efficiency grounds. According to ACIL, these typically include such restrictive provisions as the following:

- lengthy terms and termination clauses (five years and 6-12 months respectively);
- the supplier having first right of refusal to purchase the site on termination;
- exclusive dealing (solus) arrangements; and
- equipment to be owned and installed by the supplier. However, this length of lease may, for the supplier, both facilitate planning (through establishing a stable demand base) and allow sufficient time to amortise the costs incurred in installing tanks, pumps and signage, while giving the retailer security of supply over its principal product (Scott, 1997, pp. 20-21).

The Commerce Commission has successfully prosecuted one or more of the oil companies under the Commerce Act in two separate collusion cases, though both were what might be termed non-standard pricing issues. It is difficult to prove overt collusion, unless one of the parties involved spills

the beans. The “leader-follower” pattern of parallel price changes could be seen as a form of tacit collusion, but it is difficult to see how else price changes needed to reflect changes in raw material costs could be introduced, in a market characterized by a homogeneous product and oligopolistic interdependence between firms.

However, it is possible that this practice could give rise to an upward bias to prices if one company were to become the recognized price leader, and were able to gain the compliance of the others through signaling intended price changes in advance of their implementation (Pickford and Wheeler, 2001). The increase in pump prices as a result of biofuel blending requirements would be scrutinized by the Commerce Commission, motoring organizations, the press and the public at large, and this scrutiny would tend to limit the opportunities for (overt) collusion by the oil companies.

### **B.3 Entry**

The petrol market in New Zealand has been characterised as one in which there has been relatively little entry following deregulation. Depending on which side is expressing their views it may be because the profits are too low as a result of existing competition and “high” margins might indicate “high” distribution and servicing costs rather than “high” profits, or it could be due to entry barriers.

Considering ease of entry is of interest for two reasons. First, it allows an assessment of the “pressure” on incumbents to act competitively, and second, it provides context for considering whether a single, dominant player is likely to enter the market for production and supply of biofuels. It is important to keep in mind that it is not actual entry that is a major constraining force on anti-competitive behaviour (though the entry of Gull and Challenge in 1998/99 coincided with a period of price-cutting). What matters is the threat of , or the potential for, other parties to enter.

Pickford and Wheeler (200, p.33) suggest entry barriers may arise in a number of ways:

- entry may require a substantial investment in sunk costs (including initial business planning and organisation, promotion, and specialised equipment and facilities) which can not be recouped upon exit, together with direct exit costs
- because of environmental clean-up costs. By adding to the “down-side” risk, these may deter entry in the first place;
- an entrant may face a higher cost of capital because it lacks the track record of the incumbent, and hence entails a higher risk;

- the incumbent may enjoy a “first mover” advantage of lower costs from being first on the “learning curve”, or of superior product differentiation from being able to establish its brand before others appeared;
- size may allow economies of scale in brand promotion and maintenance;
- the incumbent may credibly be able to threaten potential entrants with strategic forms of behaviour, which would make entry less profitable (especially where sunk costs are a significant component of entry); and
- entry may involve a scale of operations which would be hard to sustain by the share of the market likely to be gained (there are substantial scale economies in bulk shipping and, to a lesser extent, with terminal storage and retail outlet operation).

The critical considerations for an entrant are the post-entry price, and its unit cost given its likely market share, both of which have to be assessed in the context of the changed structure of the market. A study by ACIL (1997) looking into entry barriers in the downstream oil industry, found as follows: “No permanent or long run cost advantages to incumbents were identified and therefore the conclusion can be drawn that there are no barriers to entry.” (ACIL, p.108)

However, it conceded that a new entrant could “initially experience a small cost disadvantage” because of the “time to achieve the intended scale of operations.” Scott (1997, cited in Pickford and Wheeler (2001)) reached a similar conclusion: “At most, the ‘problem’ seems to be that, in order for a potential entrant to avoid significant cost penalties and risks, new entry must occur at a scale which is large relative to the overall size of the market.” However, he recognised the potential pitfalls associated with entry:

*“A rational new entrant would have to make complex commercial calculations in order to choose the scale of entry, the distribution of wholesale and retail outlets, internal transport and take measures to offset a range of risks. At the wholesale end there exist potential disruptions to supply and strong economies of scale and therefore ‘lumpiness’ in the physical size of various facilities. At the retail end there are the possibilities of disrupted internal transport and variations in demand which might overwhelm normal storage facilities. The relationship between the optimal economic scale of transport and storage facilities and the price elasticities of demand for the product need careful balancing also. This industry has strong economies of scale in several places in the chain and a new entrant would have to set up their system in such a way as to take advantage of them in order to be competitive.” (p. 27)*

These arguments apply to entry into the downstream oil industry. This is due to an acknowledgement that it would be impractical for a new entrant to build its own refinery, given that the market is too small to allow the

Marsden Point refinery to exploit all of the economies inherent in refining technology. It is suggested that the minimum efficient scale for a new refinery is about twice the current size of the Marsden Point refinery (ACIL, 1997, p.103). The principles of the arguments apply to the situation of a potential new entrant considering blending opportunities in terms of ethanol, or biodiesel. While it appears that there are no barriers to entry, the sunk costs (which have largely already been experienced by the incumbents) , degree of vertical integration and shared facilities arrangements enjoyed by the incumbents may act as significant disincentives to invest.

While a new entrant could be encouraged to incur capacity costs to enter in order to export the bulk of its biofuel output, there is considerable doubt as to whether New Zealand enjoys a comparative advantage in biofuel blending.

#### **B.4 Oil company views on competition**

As part of an assessment of the efficacy of implementing a regional petrol tax, the Auckland City Council commissioned a study by the Law and Economics Consulting Group (LECG). As part of that work, the views of oil companies on the competitive environment were sought. They indicate that the competitive environment has changed significantly since the mid 90's:

- Competition between oil companies is now far stronger than ever before, with huge pressure on profit margins. This is partly due to the entry of new, independent, low-cost operators into the market in recent years. Prices are more volatile as a result, with one oil company estimating that petrol prices may now be changing as often as 50-60 times per quarter, whereas around 1996, petrol prices often remained stable for two or more quarters at a time.
- Oil companies are very aware of each other's price movements in all regions and are also very aware of external price signals. It is estimated that they can react to price signals from other companies within 45 minutes. This makes it almost impossible for any company to follow a particular policy without the others noticing it and acting accordingly.
- There is now significant competition between fuel retailers in one region with those in other regions, and consumers are generally more aware and better informed of fuel prices and the differential between regions.
- Oil companies are extremely sensitive about perceptions of price collusion and at least one company indicated that their awareness of this issue has resulted in them accepting prohibitive corporate guidelines about consultation or even attending industry forums where competitors may be present.
- The presence of low cost, independent operators in urban areas, specifically in Auckland, provides a point of reference for fuel prices that did not exist in the past.

These comments provide a backdrop against which we can place the observations around pricing and the presence of collusion. The addition of Gull and Challenge no doubt intensified the competitive nature of the market, and saw increases in non-price competition as well.