Environment Waikato Technical Report 2006/23

Economic Instruments for the Environment

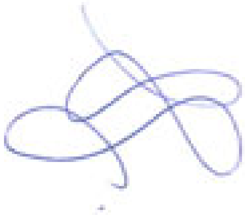
Prepared by:
Tim Denne (Covec Limited)

For:
Environment Waikato
PO Box 4010
HAMILTON EAST

ISSN: 1172-4005

August 2005

Doc # 1022616/v2

Peer reviewed by:
Annabelle Giorgetti Initials  Date May 2006

Approved for release by:
Reece Hill Initials  Date May 2006

Final Report

Economic Instruments for the Environment

Prepared for

Environment Waikato

August 2005

Covec is an applied economics practice that provides rigorous and independent analysis and advice. We have a reputation for producing high quality work that includes quantitative analysis and strategic insight. Our consultants solve problems arising from policy, legal, strategic, regulatory, market and environmental issues, and we provide advice to a broad range of companies and government agencies.

Covec develops strategies, designs policy, and produces forecasts, reports, expert testimony and training courses. Our commitment to high-quality, objective advice has provided confidence to some of the largest industrial and governmental organisations in Australasia.

Authorship

This document was written by Tim Denne. For further information email tim@covec.co.nz or phone (09) 916-1960

Disclaimer

Covec Limited Level 11 Gen-i tower 66 Wyndham Street
PO Box 3224 Shortland Street Auckland New Zealand
t: (09) 916-1970 f: (09) 916-1971 w: www.covec.co.nz

Contents

Executive Summary **iii**

1. Introduction **1**

1.1. Purpose of the Report 1
1.2. Objectives of Economic Instruments 1
1.3. Economic Instruments as Least Cost Policy Measures 5
1.4. Approach to Analysis 6

2. Mechanisms for Introducing Economic Instruments at the Regional Level **7**

2.1. Background 7
2.2. Resource Management Act 7
2.3. Local Government Act—General Competence 8
2.4. General and Targeted Rates 8
2.5. Financial Contributions 9
2.6. Transferable Permits 12
2.7. Subsidies 14
2.8. Conclusions 15

3. Case Studies **17**

3.1. Purpose of the Case Studies 17
3.2. Financial Contributions—Emissions Charge for Thermal Power Generation 17
3.3. Transferable Water Rights 21
3.4. Offsets for Air Pollution 24
3.5. Transferable Discharge Consents for Water Pollution 25
3.6. Subsidising Renewables 26
3.7. Efficient Contracting—Auctions of Land Management Contracts 29
3.8. Differential Rates for Non-Point Pollution 30

4. Conclusions **33**

4.1. Assessment of Individual Instruments 33
4.2. Most Promising Instruments 35

Annex A: Economic Instruments—What Are They and How Do They Work? 36

A1 Pricing under Competitive Markets 36

A2 Externalities 38

A3 Environmental Charges 39

A4 Transferable Permits 45

A5 Economic Effects of Charges and Tradable Permits 48

A6 Subsidies 49

Executive Summary

Background

This report explores the potential use of economic instruments for environmental purposes at the regional level. It describes the broad roles of economic instruments and the objectives that they can achieve, examines the practical means available to regional government to implement economic instruments and provides suggestions on the most promising areas for application.

Economic or market-based instruments are policy tools that affect the monetary costs or benefits of private actions, either through directly changing market prices (charges or subsidies) or introducing markets where previously there were none, eg through allocating rights to use resources and allowing owners to trade these rights.

They are being considered for possible application by Environment Waikato because they:

- have the potential to minimise the costs of achieving environmental outcomes;
- introduce ongoing and continual incentives for environmental improvement that can go beyond the incentives provided by traditional regulatory approaches; and
- are a potential alternative means for raising revenue.

Potential for Application at Regional Level

There is scope for regional councils to introduce economic instruments to achieve environmental purposes under existing legislation. Our assessment is that the instruments showing most promise for implementation at the regional level are:

- the use of financial contributions under the RMA;
- offsets;
- the use of differential rates under the Local Government (Rating) Act;
- transferable discharge permits; and
- subsidies.

The table below summarises the key attributes of these different instruments, implementation issues and the types of environmental issue that they might be used to tackle.

A series of case studies is used to better understand some of the practical implementation issues. Using the different examples, we examine:

- the potential of the mechanism to introduce a price effect at the margin;
- issues involved in implementation, including availability of data and the appropriateness of the legislative mechanisms; and
- the expected effectiveness of the instruments in achieving the desired objectives.

Economic Instrument Options Potentially Available for Regional Implementation

Instrument	Key Attributes	Implementation Issues	Suitable issues
Financial contributions	Consented activities that have residual damage (not avoided, remedied or mitigated) pay a charge related to level of damage. Level of charge can be based on estimate of damage cost Can provide an incentive for environmental improvement at the margin	Requires the basis for the charge and the way in which the revenues are to be used to be defined in a regional plan Damage costs need to be measured in monetary terms Specified use of the revenues must be defined. It must be related to the effect	Consented activities, eg industrial plants
Offsets	A form of financial contribution. Rather than contribution paid and then used for an activity, a project can be initiated elsewhere that offsets the damage of the consented activity	Requirements of the offset condition must be specified in a regional plan Means for measuring environmental improvement in offset project needs to be defined. May require definition of a baseline.	Consented activities, eg industrial plants
Differential rates plus remissions policy	A specific rate is set for a particular type of land/land use. Behaviours or outcomes on this land are rewarded by a remission (reduced rate) Can be used to provide incentive at the margin Level of remissions can be based on measure of environmental damage	Environmental issue needs to be isolated to a specific use of rateable land Remissions policy must be defined setting out basis for and level of remissions Monitoring system to be established	Land-based activity, eg farming Can be used for non-point sources
Transferable discharge permits	Discharges at a consented activity/site that are beyond consented levels can be offset through the transfer of 'parts of consents to discharge' at another site. Requirement for two or more consented activities/sites relating to the same issue. Trade must not result in a reduction in environmental quality.	Application to transfer must be lodged by both parties (buyer and seller). Application to transfer treated in the same way as a resource consent application	Consented activities, eg industrial plants
Subsidies	Payments can be made to reward desirable activities or outcomes Can be used to provide incentive at the margin	Basis for payment of subsidies set out in a plan	Wide range of activities and effects can be rewarded

The analysis suggests that there is considerable scope for regional councils to use economic instruments to achieve environmental outcomes under existing legislation. Conclusions relating to the different instruments analysed are set out below.

Financial Contributions under the Resource Management Act can be used as a means for introducing an environmental charge on consented activities. They require two elements: a level of charge based on an assessment of the damage costs of an activity, and a specified use to be made of the revenues—this can be as simple as addition to an environmental fund.

Environmental damage values typically have considerable uncertainty associated with them; this will complicate the development and use of this instrument. The expected effectiveness of the instrument was assessed using an example of a charge on SO_2 and NOx emission from thermal power plants; the analysis suggests that, if the charge was set at a level that was close to estimated damage levels, it may have no beneficial environmental effect, at least in the short run. Raising the level of the charge to have an effect is not justified in economic terms. It is equivalent to the project failing a cost benefit test. In addition, the financial contributions mechanism may not provide the statutory means, as there needs to be a clear link to environmental damage.

Transferable Water Permits are possible under the RMA and the Waikato Regional Plan. They allow holders of rights to take water to transfer this right, or parts of it, to other sites downstream in the same catchment.

Issues of concern relate to the potential for total use of water to go up as a result of trading because current permit holders, in many instances, will use less than their permitted amount. Selling the difference between actual use levels and permitted levels would enable additional use at another site while not reducing use at the existing site. Some means for reducing the total quantity of permitted water take needs to be introduced to the trading system. Dealing with low flows is an additional potential concern. The risk of low flows suggests that a trading system based on percentages of available flow, rather than physical volumes, may be a useful design element. In addition, the ability to trade rapidly during periods of low flow is important to ensure that limited resources are allocated, at all times, to those that value the resource most highly. An efficiently designed trading system can achieve this.

Offsets conditions require consent holders to offset their residual emissions or environmental damage via projects undertaken elsewhere. The most likely approach is one that starts with bilateral arrangements between the obligated party and another that could provide the offsetting project, but that tended over time towards greater competition for provision of the offsets, with different companies bidding to provide emission reductions at least cost. This is most simple to implement through providing the opportunity to yield an offset by reducing emissions below the level that is consented at another site. The more challenging design element is if the ability to produce offsets is extended to un-consented (permitted) activities, such as the transport sector. Measuring emission reductions requires establishing emission baselines.

Subsidies for renewables were examined. This is a relatively simple instrument to implement as there are no real legislative barriers. The important issues for the regional council relate to the nature of the electricity industry, the fact that it is national rather than regional in scope and that the responses to the instrument will be felt throughout New Zealand. For example, if the objective is to displace thermal power generation and thus emissions, in the Waikato, it is likely to be better to subsidise renewable generation in other areas of the country with better wind resources, as establishing wind farms there would yield greater reductions in thermal generation.

Subsidies which reward specific activities (renewable generation) are less efficient than other types of economic instrument, because they do not provide incentives for the full range of options for achieving the environmental goal. In contrast, a charge on emissions from thermal power stations in the Waikato would provide incentives for renewable generation, plus incentives for other actions such as introducing pollution control equipment or switching to lower sulphur coal.

Efficient contracting such as via auctions for land management contracts is not an economic instrument in the traditional sense. There is scope for minimising the costs of environmental outcomes using the auction approach through encouraging multiple bids, by establishing a system that enables different outcomes to be compared using the same metric, eg in monetary terms and by encouraging bids specified in outcome terms and that result in payments that change with levels of outcome.

Differential Rates plus Remissions Policies can be used to tackle non-point source pollution, such as nitrate output from dairy farms. It requires that a separate rate is set for dairy farms and that a remissions policy is defined in a regional plan that sets out the terms under which rates will be reduced (remitted). This might be for different management techniques that are expected to yield improvements in environmental outcome. Ideally, the remissions could be related to environmental outcomes, but in the nitrates example, it is difficult to isolate any changes in water quality in many catchments, to the actions of individual land owners. However, this will not always be the case, and this is the ideal way in which this tool might be used.

The design of the system could include marginal incentives, eg relating to length or quality of fences, to volumes of fertiliser applied and to stock numbers. Monitoring requirements for this instrument are likely to be significant. The instrument also is best implemented such that the level of rates remission reflects the value that the community gains from the environmental improvement. This is likely to require new research, albeit that this research should be undertaken anyway for policy purposes.

Most Promising Instruments

There is scope for implementing a number of these instruments. The most promising would appear to be:

- **Offsets**—they are an alternative mechanism to financial contributions for tackling point-source discharges and provide greater certainty of environmental outcome. The mechanism's effect may be limited because of the potential for a gap between actual and consented emissions, but they are relatively simple to implement. In contrast to financial contributions they do not require estimates to be made of the value of environmental damage.

- **Transferable water permits** are already allowed in the regional plan. It is likely that attention to some additional design elements would improve the existing mechanisms and reduce the chance of a reduction in environmental quality.

Differential rates plus remissions policies, and financial contributions, are both likely to require additional research before they can be implemented, particularly associated with the measurement of environmental damage. This research is relevant to any policy measures tackling these same issues, ie it is the input data for cost benefit analysis. However, it would delay any attempts to implement the policies.

Differential rates are the best way to introduce an economic instrument applying to non-point discharges. The costs of monitoring may be high.

Apart from the need for research on environmental damage, financial contributions used as an environmental charge on emissions from industrial sites, appears to be a relatively straightforward and useful mechanism to implement.

1 Introduction

1.1 Purpose of the Report

This report explores the potential use of economic instruments for environmental purposes at the regional level. It describes the broad roles of economic instruments and the objectives that they can achieve, examines the practical means available to regional government to implement economic instruments and provides suggestions on the most promising areas for application.

Economic or market-based instruments are policy tools that affect the monetary costs or benefits of private actions, either through directly changing market prices (charges or subsidies) or introducing markets where previously there were none, eg through allocating rights to use resources and allowing owners to trade these rights.

They are being considered for possible application by Environment Waikato because they:

- have the potential to minimise the costs of achieving environmental outcomes;
- introduce ongoing and continual incentives for environmental improvement that can go beyond the incentives provided by traditional regulatory approaches; and
- are a potential alternative means for raising revenue.

We explore these attributes below.

1.2 Objectives of Economic Instruments

As a background to the discussion in this report, Annex A provides an overview of the theory and use of economic or market-based instruments. They are of interest to policy makers for a number of reasons, particularly those noted above.

From an economics perspective, market-based instruments are of additional interest because of their ability to identify and achieve an efficient outcome. As with other uses of the word efficiency, in this context it means “no waste”; the objective is that resources are used by the community in the way that will provide greatest wellbeing. There is wastefulness if resources are employed for one purpose, when they would have been better to have been employed for another. For example, we may use streams as a sink for dispersing pollutant run-off whereas they are more highly valued by the community for their naturalness and support of particular habitats and species, eg fish. Economic instruments can assist both in discovering and achieving the best use of resources.

Economic theory suggests that economic efficiency can be achieved through the individual decisions of firms in a competitive market, but it relies on market prices being correct. And by correct we mean that the prices that individuals face are equal to the costs that the community as a whole faces in providing them. So, for example, when dairy farmers add additional cattle to their stock, it can result in additional nitrate loading of surrounding waterways, reducing water quality. Farmers are unlikely to take account of these full costs when purchasing additional stock.

Alongside appropriate means for valuing environmental damage, economic instruments in the form of environmental charges can ensure that these costs are taken into account.

There are thus three potential objectives for the use of economic instruments.

- Correcting externalities—ensuring that private decision makers face the full costs of their actions, that otherwise are borne by the wider community;

- Providing incentives for targeted outcomes—where desirable environmental outcomes are clearly defined, economic instruments, as market mechanisms, can provide incentives that ensure that environmental solutions are found at least cost;

- Raising revenues for specific purposes.

1.2.1 Correcting Externalities

From a theoretical perspective, economic instruments are seen firstly as means to correct market failures; firms and individuals make decisions that cause damage to the environment, partly because they do not bear the full costs of these actions—these costs are shared with the rest of the community. Economic instruments can ensure that these societal costs are taken into account.

In this context, the theoretically ideal instrument is a charge equal to marginal damage costs,[1] ie the measured damage associated with one more unit of consumption or activity. For example, where there is pollution associated with production (say electricity generation), and the damage costs of one unit (eg 1kg) of pollution can be assessed, then the producer should be charged the costs of that damage for each additional unit of output (or input) that produces one more unit of pollution. This provides an incentive to reduce pollution where this can be achieved for less than the costs of damage.

Using environmental charges in this way results in the environmental outcome being “discovered” by the market. To the extent that environmental damage can be valued in monetary terms, using the value as the basis for the charge is a way to ensure that the level of pollution is optimal.

This approach to the use of economic instruments, while having a strong theoretical background, is little used in practice. Two examples are the Landfill Tax and Aggregates Tax in the UK.

When the landfill tax was introduced the rates were based on estimates of the environmental externalities associated with disposing of waste at landfill. There are two tax rates: a standard rate, originally set at £7 per tonne, for “active” wastes; and a lower rate of £2/t for “inactive” wastes. Subsequently these rates have been revised upwards, largely because the inactive rate was not having any noticeable impact on levels of waste diversion, eg to recycling. The tax has thus changed from the theoretical ideal “internalisation of externalities” tax to one that is seeking to incentivise desirable outcomes. A UK tax on aggregates was also developed using an analysis of environmental damage costs, and similar approaches were used in analysing a possible water pollution tax[2], although this has not been adopted.

Correcting externalities, while at the heart of the theory of economic instruments, has played little part in their application. More important has been the objective of achieving environmental objectives at least cost.

1.2.2 Incentives

Charge mechanisms equal to marginal damage costs provide incentives to achieve an optimal level of pollution. However, often, governments (central or local) will want to achieve specific environmental outcomes.

---

[1] Baumol WJ and Oates WE (1988) The theory of environmental policy. 2nd Ed. Cambridge.

[2] Environmental Resources Management (1999) *Economic Instruments for Water Pollution Discharges*. Department for Environment, Food & Rural Affairs. www.defra.gov.uk/environment/water/quality/econinst2/contents.htm

Least Cost Achievement of Objectives

Economic instruments can provide incentives for the achievement of desired outcomes at least cost. A useful example is the cap and trade scheme introduced to limit SO_2 emissions in the US. It sets a cap on total aggregate emissions of SO_2 from power and major industrial plants. Individual plants are given allowances to emit a limited number of tonnes and the total number of allowances sums to the size of the aggregate cap. The ability to trade allowances ensures that those that can reduce emissions at least cost do so, freeing up allowances for them to sell, and those for whom it is expensive to reduce emissions can purchase allowances.

It is estimated that the cost saving attributable to formal trading under the US SO_2 system versus a uniform emissions rate standard was approximately $250m annually from 1995–2000, and approximately $784m annually from 2000 onwards, when the cap is tighter.[3] The cost savings result from providing flexibility to where and when emission reductions occur.

- *Where*, because plants that are given allowances to emit, can sell them if they reduce their emissions; plants with the lowest cost emission reduction options will make those reductions.

- *When,* because the trading system allows banking—if total emissions in one year are lower than the total cap, allowances can be retained for use in a later year.

Charges can also be used for their incentive effects. In this case the level of charge is set in order to have an effect rather than equal to some measure of damage. This does not attempt to achieve any optimal level of environmental outcome but to achieve a desired outcome at least cost. As for the trading example, the charge is a least cost instrument because it provides flexibility as to how emissions are reduced and allows companies not to reduce emissions if their costs of doing so are greater than the level of the charge. In Sweden the level of a tax on nitrous oxide (NOx) emissions was set at a level expected to result in plants fitting low-NOx burners (LNBs) [4]— control devices that result in lower emission rates at combustion plants. The decision to install an LNB is based on the comparison of total costs of control, discounted over the expected lifetime of the equipment, with the costs of paying the charge over the same period.

Subsidies have also been used to provide incentives. Rather than penalising environmental damage, subsidies are used to reward activities that have positive environmental outcomes. Generally, because they tend to be focussed on activities rather than outcomes, they are less economically efficient than other economic instruments because they do not provide incentives for the full range of activities that can limit environmental impacts. For example, subsidising renewable electricity as a means to limit pollution, provides no incentives for other measures that might be a lower cost means of limiting pollution, such as energy efficiency measures or switching from coal to gas.

A more economically efficient approach would be to use subsidies to reward environmental outcomes. The incentive effect on firms should be the same—being reward $250 for reducing a tonne of SO_2 should have the same effect as being penalised $250 for emitting a tonne. The reason for using a subsidy rather than a charge might be based on some assessment of the existing nature of rights. If it is perceived that firms have a right to pollute, then paying them to reduce their emissions would be appropriate. However, if firms do not have such a right—rather the community has a right to clean air—then using a charge is more appropriate. Alternatively subsidies might be used for more practical reasons if the legal mechanisms do not exist for implementing the charge.

[3] Carlson C., Burtraw, D., Cropper, M. and Palmer, K.L. (2000), 'Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?', *Journal of Political Economy*, **108**:6, 1292–326.

[4] Anderson RC and Lohof AQ (1997) The United States Experience with Economic Incentives in Environmental Pollution Control Policy. US Environmental Protection Agency

Where a subsidy approach is used as a way to achieve an environmental outcome at least cost, the other element that is required to ensure that the instrument is least cost, is that the revenue is raised in a non-distortionary way. This requires that revenues are raised in a manner that has minimal distortion on the decisions of individuals and firms and is achieved through raising revenue via mechanisms that:

- spread the financial burden “thin and wide” so that nobody or no firm faces a significant financial impact;
- target inelastic demand, ie revenues are raised via a charge on activities or goods for which levels of consumption will not change significantly in response to a change in price;
- are used to correct market failures, eg money raised using an economic instrument that has been used to internalise an existing environmental externality, as discussed in Section 1.2.1 above.

Where specific targeted outcomes are identified, subsidies can provide effective means to achieve desired results.

The way in which economic instruments work to limit costs is explored in more detail in Section 1.3.

Dynamic and Ongoing Incentives
In addition to providing firms with flexibility, another positive attribute of economic instruments is the dynamic and ongoing incentive for environmental improvement. This applies to charge mechanisms, but not to tradable permits. Specifically, unlike a regulatory instrument that requires a company to meet a specific emissions standard, economic instruments can introduce an increased cost for every tonne of pollutant emitted. This provides companies with an incentive to look for ways to limit their environmental impact down to the last tonne emitted. This provides incentives in the short run, for finding ways to limit effects, and in the longer run, through incentivising investments in low environmental impact plants.

1.2.3 Revenue Raising

Economic instruments, while primarily aimed at achieving environmental outcomes—either an optimal or targeted level of environmental quality—often have a secondary effect of raising revenues. This is of interest to local government because of community concern over the level of rates.

There has been considerable interest internationally in approaches that shift the burden of revenue raising (tax) instruments away from labour, goods and services, towards use of natural resources and the environment. From a theoretical perspective, this is a good idea when it reduces the distortionary effects of the revenue raising mechanisms.

Revenue raising instruments are distortionary when they are levied on goods or services, or on income, in a way that changes behaviour from what it would have been in the absence of the instrument. For example, taxes on labour mean that, to attract workers, wage rates need to be higher than they would be otherwise, and firms employ less labour and use more other resources. Using revenue from environmental taxes to reduce such taxes results in the so-called double-dividend of corrective taxes or charges. There is one social dividend (benefit) from correcting the externality; there is a second social dividend from reducing other taxes (or from correcting another market failure).

In a local government context, this shift is useful to the extent that existing tools are distortionary. However, rates are relatively non-distortionary in effect; they are lump sum payments with little affect on marginal decisions. Economic instruments for environmental purposes are clearly less distortionary (in terms of distorting behaviour away from how it would be under a competitive market operating with true social costs and values) when being used to correct externalities as discussed in Section 1.2.1.

The issue of hypothecated funds is important to raise in this context. This is where, as part of the design of the economic instrument designed primarily for other purposes, eg to correct externalities or to have an incentive effect, the revenues are assigned to be used for specific, often related, environmental purpose. Whereas there may be arguments for doing so in terms of public acceptability, there are economic efficiency arguments against such an approach. Using an instrument to correct an externality or reach a goal at least cost can be economically efficient; limiting the use of the revenue to a particular purpose can reduce the overall efficiency of the instrument if it is not the best use of the revenue, ie the use that has the greatest net benefit for society. Decisions about the instrument that should be used to achieve a specific purpose should be separated from decisions about the best use of the revenues.

1.3 Economic Instruments as Least Cost Policy Measures

It was noted above that economic instruments can provide incentives for least cost achievement of outcomes. In this section we outline briefly two aspects of this:

- the mechanism involved and specifically the importance of introducing a marginal effect; and

- the nature of costs, and specifically the difference between private and social costs of these instruments.

1.3.1 Marginal Effects

Marginal costs are an important concept in economics. They are the costs associated with one more unit of output. Marginal costs determine the level of output of a plant and are the basis on which firms compete. Firms are willing to run a plant or a business, provided that the price received for their output covers the marginal costs of production; and they will continue to produce up to the point where marginal costs exceed market price (or plant capacity or other constraints are reached).[5]

The ability of economic instruments to achieve environmental outcomes at least cost is because they affect marginal costs.

An environmental charge that applies to every unit of pollutant, eg per tonne of SO_2 has a marginal effect. For example, every unit of electricity generated by a coal-fired power plant will result in a fixed quantity of SO_2 being emitted and thus results in a charge liability that is fixed for every MWh of output. Similarly under a tradable permit scheme, every unit of output requires another allowance (permit) to be held. The charge or permit scheme thus affects the marginal costs of production and provides incentives for limiting output where the marginal cost (including the charge) is greater than product's value in the market. Economically, this is an important part of the economic efficiency of these instruments—because they can be used to make the marginal cost faced by a firm equal to the marginal cost faced by society, a firm will not produce beyond the point where the full societal costs of production are equal to the market price of the product, which we assume is also equal to the value that society places on that product.

[5] There are short run and long run expressions of marginal costs. An existing industrial plant or farm will be willing to produce in the short run so long as it covers its variable costs of production; these are often simply the energy and raw material costs. In the medium term, eg annually, it will need to cover its fixed costs (eg labour, maintenance, interest payments) and if these are not covered, the plant or business will close. However, these costs are unavoidable over the short run and do not determine decisions to produce for a company that faces price volatility in end use markets. In the long run, marginal costs are equal to the costs of production of the next plant or firm to establish. They will only enter the market if the potential revenue (price times output) is greater than or equal to the full costs of production. In the long run, marginal costs are equal to average costs.

In contrast, regulatory approaches introduce requirements on firms to undertake particular management practices or to install pollution abatement equipment, but generally do not provide a cost at the margin. Thus under a regulatory regime, a plant may adopt best practices to limit environmental effects but will continue production, under an economic instrument the incentives are in place not only to find means to limit effects that the regulator had not imagined, but also to limit output when costs are above community benefits.

Introducing a marginal effect is an important defining feature of an efficient economic instrument.

1.3.2 Private versus Social Costs

Economic instruments minimise social costs but do not necessarily minimise private costs.

By social costs we mean the total costs falling on society, including the costs of environmental damage. Economic instruments, such as environmental charges, provide incentives to firms to reduce their environmental impacts but if a firm has done all it can to limit effects, it will continue to pay a charge on the residual environmental effects. This is an important dynamic element of the instrument but it can raise private costs above that faced under a regulatory approach.

As an example, imagine an industrial plant that can limit emissions only by installing abatement equipment that reduces its emissions by 75%. Under a regulatory regime that forces it to do so, it faces the costs of that equipment only. Under an environmental charge system that provides incentives for it to introduce that same equipment, it will still pay the charge on the 25% of emissions that are unavoidable.

At the regional level we are unconcerned about that charge payment. It is regarded as a transfer payment from the company to the council and the money does not leave the regional economy. Ideally the revenue that is transferred to the council is subsequently used by the council for projects for which the net social benefit exceeds the costs. However, firms will sometimes face lower costs under traditional regulatory approaches.

It is important not to assume, on this basis, that the instruments are equivalent. Facing the charge on every tonne of pollutant with a consequent higher total private cost than under traditional regulation, provides a different long run signal. It signals to firms the benefits of alternative technologies or fuels, or that further investment in the sector is not justified.

1.4 Approach to Analysis

The review above outlines the objectives that might be adopted for economic instruments and some key attributes. For analysis here, we are assuming that the primary objective is to achieve environmental outcomes at least cost. This reflects the approach to policy adopted by regional councils, ie to set out desired outcomes, agreed with the community, rather than simply targeting an optimal environmental outcome that is discovered by the market.

In the next section we examine the different mechanisms that potentially are available to regional councils as means to introduce economic instruments. In analysing these options, we examine, in particular, whether they can introduce a price signal at the margin that provides incentives for environmental improvement at least cost.

We explore some options for using the instruments that show greatest promise through a series of case studies.

2 Mechanisms for Introducing Economic Instruments at the Regional Level

2.1 Background

Legal analyses of the potential use of economic instruments have gone back to the Constitution Act 1986. Under Section 22, any economic instrument that can be classified as a tax must be authorised by Parliament.[6] The definitions of a tax under New Zealand law are that it is:

- compulsory,
- for public purposes; and
- enforceable by law (you can be prosecuted if you do not pay).

Regardless of whether something might be defined as a fee or charge, if there is no relation between the amount paid and a service provided, and it meets these other criteria, it is defined as a tax.[7]

A recent Treasury working paper stated that there is no generic legislation in New Zealand (or even adequate provisions within the Resource Management Act) giving the support structure needed for many types of economic instrument, so measures such as fishing quota, aquaculture management areas and carbon credits have required specific legislation.[8] Introducing legislation is a lengthy process and is something that Environment Waikato could not undertake; it requires central government action.

Analysts have noted that the Resource Management Act (RMA) allows the use of some economic instruments, although it does not particularly encourage or facilitate these mechanisms. In addition to the RMA, the main statutory instrument that defines the ways in which regional councils can or cannot use economic instruments is the Local Government Act (LGA).

2.2 Resource Management Act

The RMA was drafted during a time in which there was considerable interest in the use of economic instrument for environmental purposes. The original Section 32 of the RMA stated that local government must consider alternatives, assess the benefits and costs of objectives, policies, rules and other methods. It should have regard to other means including "… the provision of information, services, or incentives, and the levying of charges (including rates)". Although this had required regional councils to consider economic instruments, it is not clear that it empowered them to use them;[9] there were no sections of the Act that provided any clear tools.

Similarly, under Section 24, one of the functions of the Minister for the Environment is to consider and investigate "… the use of economic instruments (including charges, levies, other fiscal measures, and incentives) to achieve the purposes of [the Resource Management] Act". This provides no specific powers to introduce economic instruments.

The amended version of Section 32 removes the explicit reference to charges and incentives, stating only that local government should consider "… the extent to which each objective is the most appropriate way to achieve the purpose of this Act; and

[6] Bullen S, Jacobsen V, Palmer G and Scrimgeour F (2000) The Use of Economic Instruments for the Control of Air Quality in Auckland: A Scoping Study. Prepared for the Auckland Regional Council. Arthur Andersen Chen & Palmer
[7] ibid
[8] Guerin K (2004) Theory vs Reality: Making Environmental Use Rights Work in New Zealand. New Zealand Treasury Working Paper 04/06.
[9] Bullen S et al (op cit)

whether, having regard to their efficiency and effectiveness, the policies, rules, or other methods are the most appropriate for achieving the objectives".

One specific channel for using economic instruments under the RMA is the provision for introducing financial contributions. This is explored in Section 2.5.

2.3 Local Government Act—General Competence

Legal analyses undertaken for Environment Waikato have examined potential options for the use of economic instruments under the Local Government Act using either the power of general competence or rates mechanisms (see below).

Section 12 of the LGA provides a local authority, with full capacity "to carry on or undertake any activity or business, do any act, or enter into any transaction" for the purposes of performing its role. Its role is defined with respect to the purpose of local government (Section 10) as *inter alia*, to promote the social, economic, environmental, and cultural well-being of communities in the present and for the future.

Simpson Grierson suggests that this cannot be used as the basis for setting a particular rate,[10] and by implication, any charge. This finding is consistent with the comments on the Constitution Act above and the restrictions on imposition of a new tax.

Similarly a Treasury Working paper notes that the power of general competence does not extend to regulatory powers or to taxing arrangements, which are limited to rates on land under the Local Government (Rating) Act 2002.[11]

We assume this is not an option that can be pursued.

2.4 General and Targeted Rates

The powers to set and assess rates are derived from the Local Government (Rating) Act 2002. There are two possible ways in which rates might be used.

2.4.1 Differential Rates plus Remissions Policy

A local authority can set a general rate for all land in its region. This can be set at a uniform rate in the dollar of rateable value or at different rates for different categories of land—a differential general rate.

The Regional Council can target certain properties or types of properties with a higher (loaded) rate, eg because of specific uses of the land. A remissions policy (which needs to be included in the Long Term Council Community Plan) could then be used to reduce all or part of the loaded part of the rate where the ratepayer has complied with criteria set by the council. [12] The council could use this approach to compile a generic list of targeted industries and the specific actions or behaviours that it wished to reward. Simpson Grierson suggest that particular land management practices could be rewarded using this approach. It is also possible that it could be used to reward particular outcomes, eg the level of remission would vary with the measured pollutant output from a land area. The key requirement is that the mechanism is established in a Remissions Policy.

In principle it seems that this approach could be used to introduce a marginal signal, that is, in which the extent of the remission would vary in response to small changes in behaviour or outcome, eg per kilometre of stream fenced (or part thereof) or per unit of pollution discharged.

[10] Simpson Grierson (2004) Rating and Environmental Incentives. Advice provided to Environment Waikato.
[11] Guerin K (op cit)
[12] Simpson Grierson (2004) Rating and Environmental Incentives. Advice provided to Environment Waikato.

It could provide a reasonably flexible means for introducing a charge mechanism for definable land uses.

Implementation Requirements
Introducing a differential rates plus remissions policy requires the following steps:

- The environmental issue that needs to be tackled needs to be isolated to a specific land use. Simpson Grierson use the example of dairy farming, but other identifiable land uses could presumably be used also, eg for specific industrial categories. It is likely to be most applicable to reasonably widespread land uses.A specific rate needs to be established for that land use.

- A remissions policy needs to be defined. This sets out how management of that land or the outputs/impacts of use will result in different levels of rates remission. Ideally the level of rates remission will vary with marginal changes in environmental impact. This requires:

  - The level of damage associated with marginal changes in activity/output to be defined;

  - Marginal changes in levels of environmental damage to be measured in monetary terms.

- A monitoring system needs to be established to measure the factors that determine the level of rates remission.

2.4.2 Targeted Rate plus Remissions Policy

A targeted rate plus remissions policy is also an option. Targeted rates must be set to raise revenue for activities, where an activity is a good or service provided by or on behalf of a local authority. Environment Waikato currently has a number of targeted rates, eg Biosecurity rates, Protecting Lake Taupo rates, Community Possum Control rates and Pest and Weed rate.

The targeted rate approach is thus firmly focussed on revenue raising and cannot be easily modified into a charge that targets specific outcomes or incentivises specific behaviours. The differential rate is the more flexible and suitable means for establishing an economic instrument and for introducing a price effect at the margin. We do not pursue the targeted rate option further.

2.5 Financial Contributions

Section 108 of the RMA states that a resource consent may require a financial contribution to be made. This might include payment of money or a land contribution (or some combination of the two). Financial contributions may be required for various purposes, including:

- offsets—providing funding for positive measures to improve the environment to offset adverse effects; and

- compensation—to mitigate adverse effects on the environment of use and development.

There are a number of requirements:

- a financial contribution condition cannot be imposed as a condition of a resource consent unless it is in accordance with purposes specified in a (regional) plan and at a level of contribution determined in the plan; and

- funds collected in the form of financial contributions are spent on the purposes for which they were collected. This expenditure must also be accounted for in accordance with the requirements of the Local Government Act.

For example, Environment Canterbury states that "where the adverse effect is on the habitats of plants or animals, contributions of money to Environment Canterbury shall be paid into the Environmental Enhancement Fund or other fund operated by Environment Canterbury and used for the general purpose for which such contributions are taken. Where the adverse effect is on the flood carrying capacity of a water body, contributions of money to Environment Canterbury shall be paid into the reserve funds of the relevant river rating district for expenditure on qualifying works in that district".[13]

The ARC states that financial contributions will only be taken where there are significant unavoidable adverse effects resulting from a proposal that have not or can not be avoided, remedied or mitigated by other conditions of consent or by positive effects of the proposal, and taking a financial contribution will better promote the purposes of the RMA than modifying or declining the application.[14]

In terms of the amount, the draft Auckland Regional Plan states that, if a financial contribution is taken, "it will be fixed at an appropriate amount that is in proportion to the significant unavoidable adverse effects of the activity that would remain once any mitigation works and services required by section 108(2)(c) conditions of consent had been implemented, but it will also be based on the actual and reasonable costs of achieving the stated purpose."[15] In other words the amount needs to be both in proportion to the level of damage and be based on the costs of the activity that will be funded by the contribution.

Financial contributions can be regarded as payments for residual damage when other actions have been included in the consent to avoid, remedy or mitigate the adverse effects. The main stipulation is that they need to be referred to in a Plan and the revenues need to be earmarked for expenditure on environmental improvement in a way that is related to the issue for which the contribution was levied.

The second requirement—that they are used for a related purpose—may reduce the economic efficiency of the instrument. As noted in Section 1.2.3, if a charge is levied to correct a market failure (ie equal to marginal damage), then the environmental issue has been dealt with efficiently. To use the revenue for a related environmental purpose may not be the best outcome for the community; it may be better served by spending it on a completely different outcome area.

2.5.1 Offsets

Offsets are mechanisms that allow environmental damage in one location to be compensated by environmental improvements in another location. They are a form of transferable or tradable permit (see Section 2.6). An offset requirement might measure the level of residual damage associated with a consented activity, or the level of emissions/discharge. A project would be required that reduced emissions/discharges or damage by the same amount, in some other location. Variants of this basic approach are:

- that the required offset elsewhere has a greater positive effect on the environment, eg if there is an emissions of one tonne of a pollutant at the consented site, then two tonnes would need to be reduced elsewhere. This has been an approach used in the US for new plants establishing in regions that are non-compliant with ambient air quality standards—new entrant firms are used to improve the ambient environment; and

---

13 Proposed Canterbury Natural Resources Regional Plan (www.ecan.govt.nz/Plans+and+Reports/NRRP/)
14 ARC (2005) Proposed Auckland Regional Plan: Air, Land and Water. Section 8 Financial Contributions
15 ibid

- that the offsets are tradable—see a more detailed discussion in Section 2.6.

The offset approach gets around the issue of setting a financial contribution that is both a measure of damage and is an appropriate level relative to the expenditure that it will be used for. The offset mechanism sets both. It uses the costs of environmental improvement as a proxy for damage (although it is not clear that they are the same) and defines the project that the expenditure will be spent on.

The Ministry for the Environment (MfE) has recently provided guidance on offsets where there are national standards. Here, a new plant or a re-consent that had emissions that, taken with those of other plants might breach ambient standards (eg for air quality), could be allowed if there was on offsetting reduction in emissions elsewhere. There are a number of requirements for such an offset mechanism to work:[16]

- the nature of the contaminants being "put-in" needs to be similar to those "taken-out";

- the "take-out" needs to occur at or before the "put-in"; and

- the spatial and temporal improvement from the "take-out" of emissions needs to give benefits in the area impacted by the “put-in” at the relevant time (ie location and duration of emissions must also be considered).

MfE points out that an emissions offset may be carried out by the proponent of the proposed activity or by the regional council. If the regional council were to undertake the project, presumably it could pay for some other party to undertake a project. In this sense it is very similar to a simple financial contribution in which the money is paid into an environment fund used to finance environmental improvement projects.

The offset mechanism can have an impact at the margin, because the level of requirement (how much of an offset/how many offsets) depends on the level of effect—offset requirements increase with increased adverse effect.

Implementation Requirements
Introducing an offsets mechanism requires the following steps.

- The requirements of the offset condition need to be specified in a regional plan. This includes the environmental effect that is targeted, eg discharges of a specified pollutant. It also needs to state what would constitute an acceptable offset, eg the nature of projects that might be acceptable (and this could be any project that reduced discharges to the same extent) and any geographical or other limitations.

- A means for measuring the level of environmental improvement in the offset project. This might include the definition of a baseline below which environmental improvements are measured.

- A translation factor, eg whether offset requirements are one-for-one or require a greater level of environmental improvement.

2.5.2 Compensation Mechanisms

The other approach to the use of financial contributions is as a simple compensation mechanism. This is equivalent to a charge set equal to the level of marginal damage of an activity.

[16] Ministry for the Environment (2004) The Users Guide to Resource Management Regulations (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) 2004 (draft)

Implementation Requirements
Introducing a financial contribution as a compensation mechanism requires the following steps.

- The level of environmental damage associated with a consented activity needs to be measured firstly in physical terms and then converted into a monetary equivalent. This requires that damage costs are measured using appropriate valuation techniques.

- A use of the revenues needs to be defined. This needs to be related to the issue for which the compensation requirement is established. However, it can be relatively ill-defined, eg the money can be contributed to an environmental fund.

- Both sides of the mechanism need to be defined in a regional plan—the amount that will be required as a financial contribution for residual effects of a consented activity and the use that will be made of the money collected.

2.6 Transferable Permits

Transferable or tradable permits[17] are mechanisms that allow transfers to another person, firm or site, of allowances or permits to undertake some activity, or to have some effect (eg emit a specified number of tonnes of a pollutant).

They are economically equivalent to charges and will have the same effect at a given price—for a given market price of tradable permits if the charge was set at that same rate, the response and environmental outcome would be the same. The difference is that, whereas for a charge, the price is set by the relevant authority, under a tradable permit scheme, the price is "discovered" by the market through the transactions of buyers and sellers. Thus environmental charges give some price certainty but often uncertainty of outcome, while transferable or tradable permits provide certainty of outcome but uncertainty of price. They come in two basic forms:

- Cap and trade, as used in the US acid rain programme;
- Credit-based systems, as used in the UK packaging and renewables systems.

The different approaches are described in more detail in Section A4 in the Annex.

Most notably, a cap and trade system has been introduced in the US for the control of SO_2 from electricity generation and large industry. It converted an aggregate cap of several millions of tons of SO_2 across the US into millions of individual allowances to emit a single ton. These were initially given to electricity generators who were subsequently allowed to trade these allowances. For compliance purposes, emission levels at individual plants were compared annually with allowance holdings. Trades occurred because some plants were able to reduce emissions at lower cost than others—emission reductions occurred through a mixture of installation of abatement equipment (flue gas desulphurisation or FGD) and use of low sulphur coal.

Initially, when the trading system established, trading occurred bilaterally between firms, but as the frequency of trades increased, brokers facilitated trades. As a result of many trades, market prices can be established. These were published by brokers, allowing companies to see the value of emission reductions and the costs of emitting. Frequent trading between numerous buyers and sellers (a liquid market) improves the economic efficiency of tradable permits. Whereas any trading is an efficiency improvement, the parties involved would not trade unless there was a cost saving involved, a liquid market with low transaction costs and published prices provides much greater market certainty, including certainty of price and that allowances can be bought and sold.

[17] We use the terms interchangeably here.

Credit-based systems are similar but the traded commodity is not an allowance to emit/cause damage but a certified reduction in emissions/damage or a certified positive contribution to the environment. Thus UK electricity suppliers must demonstrate that a percentage of their electricity is generated from renewables. Renewable generators can produce a certificate for each MWh of electricity generated from renewable sources; these can be sold to the electricity suppliers as holding these certificates is the means for suppliers to discharge their obligations.

There is limited current potential for the establishment of transferable or tradable permits under the RMA. In general, consents are transferable between owners, but not between types of activity or locations.[18] Currently there are three potential uses.

- Coastal permits, that allow holders to use coastal areas for specified purposes (section 12 RMA), may be transferred to another person, but not to another site, unless the consent or a regional coastal plan expressly provides otherwise (Section 135).

- Permits for damming or diverting water may be transferred only to owners or occupiers of the same site. Other permits, eg for taking water, may be transferred only if allowed in a regional plan and approved by the consent authority (Section 136).

- Discharge permits which may be transferred to other sites, if this is allowed in a regional plan, and provided the transfer will not reduce environmental quality (Section 137).[19]

Tradable permits are an effective means for ensuring that environmental goals are achieved at least cost. Provided that the penalties for non-compliance are stringent and predictable, it can be assumed that the overall environmental goal will be achieved. Least cost achievement of goals is possible because of the wide range of options available to meet goals, including a wide range of environmental improvements:

- on site;
- at another site that is included in the trading mechanism;
- in another time period, provided that the mechanism allows banking or borrowing of allowances.

2.6.1 Offsets as Tradable Permits

Offsets were described in Section 2.5.1 above. Typically they are viewed as mechanisms whereby an environmental impact at one site can be compensated through another project at another site.

Although there are clearly elements of tradability in an offset as described above, they begin to function more like a tradable permit system if the offset becomes a tradable commodity with many buyers and sellers, rather than as a simple bilateral arrangement. This requires a much wider scale application of the instrument so that there are a number of potential buyers and sellers, ie a proper market establishes. For example, new industrial boilers might be required to offset their NOx emissions. This could be achieved through holding NOx offset certificates. These certificates might be produced by companies in other sectors that undertook projects to reduce emissions. For example, companies investing a new fleet of hybrid rather than traditionally power vehicles.

[18] Guerin K (2004) Theory vs Reality: Making Environmental Use Rights Work in New Zealand. New Zealand Treasury Working Paper 04/06. (http://www.treasury.govt.nz/workingpapers/2004/twp04-06.pdf)
[19] This last opportunity has been introduced in the Resource Management Amendment Act (2005)

2.6.2 Transferable Discharge Permits

The ability to transfer discharge permits has been introduced under the Resource Management Amendment Act (2005) which came into force on the 10th August. This represents a significant new opportunity to use economic instruments at the regional level, albeit that there are a number of restrictive conditions. These include that:

- the transfer does not worsen the effects on the environment;
- if the discharge is to water, both sites are in the same catchment;
- if the discharge is to air, both sites are in the same region.[20]

This would allow transfers between consented sites, eg industrial plants discharging into rivers and into the air. The requirement for implementing this system, is that the application to transfer is lodged by both parties and is treated in the same way as a resource consent.

This type of approach is very different from that operating in the US SO_2 and NOx programmes where there is a liquid market allowing companies to buy and sell allowances and in which the EPA only requires that it is informed of the trade after it has occurred, ie there is a blanket approval for trades between allowance holders.

The system proposed under the RMA, while allowing bilateral trades, introduces considerable transaction costs to the process through the requirement to go through the consent process. This will limit trades to a few large transactions that offer significant cost savings rather than numerous individual trades with smaller cost saving potential. This still allows opportunities for cost saving—parties will only undertake the trade if there are cost savings to be obtained. But the potential for gaining cost improvements through numerous smaller trades in a liquid market is not available.

2.7 Subsidies

Grants or subsidies are used by local authorities in a reasonably routine way and the legislative ability would be covered by the powers of general competence in the Local Government Act. Examples include payments to community organisations such as environmental grants, tourism trust funding, iwi funding, youth councils, sports clubs, cultural groups, community events, safer communities grants and passenger transport subsidies.

Subsidies can provide marginal incentives. For example, payments might be made per unit improvement in environmental quality or unit reduction in impact. For example, an environmental fund could be used to reward environmental improvement at specified sites or for particular habitats.

As noted in Section 1.2.2 generally subsidies are less economically efficient than other economic instruments because they do not provide incentives for the full range of activities that can limit environmental impacts. This is because typically they are used to reward activities rather than outcomes. They might be used in a more efficient way through payments for marginal improvements in environmental outcomes.

This mechanism appears to be relatively simple to adopt and requires that the council publishes the basis on which the funding is available. Ideally this would be specified in a way that provided a marginal effect. It also requires an effective measurement and monitoring system to assess eligibility.

One risk with this approach is that the demand for subsidy payments was much greater than the revenue available. Where this is a risk, there are alternative ways to distribute

[20] Where a National Environmental Standard is in place, the transfer is restricted to the same airshed. In most instances this is the same as the region, but sub-regional airsheds may be defined under some circumstances.

funds, including the use of auctions that to distribute funds to those that bid, for example the greatest amount of environmental improvement per dollar allocated.

2.8 Conclusions

There appears to be scope for regional councils to introduce economic instruments to achieve environmental purposes under existing legislation. Our assessment is that the instruments showing most promise for implementation at the regional level are:

- the use of financial contributions under the RMA;
- offsets;
- the use of differential rates under the Local Government (Rating) Act;
- transferable discharge permits; and
- subsidies.

Table 1 summarises the key attributes of these different instruments, implementation issues and the types of environmental issue that they might be used to tackle.

There are a number of options that can be used to tackle point sources of emissions from consented activities. Non-point source effects, such as emissions from farms, are limited to the use of the differential rates plus remission policy.

In the next section we explore these options further using a set of case studies.

Table 1 Economic Instrument Options Potentially Available for Regional Implementation

Instrument	Key Attributes	Implementation Issues	Suitable issues
Financial contributions	Consented activities that have residual damage (not avoided, remedied or mitigated) pay a charge related to level of damage. Level of charge can be based on estimate of damage cost Can provide an incentive for environmental improvement at the margin	Requires the basis for the charge and the way in which the revenues are to be used to be defined in a regional plan Damage costs need to be measured in monetary terms Specified use of the revenues must be defined. It must be related to the effect	Consented activities, eg industrial plants
Offsets	A form of financial contribution. Rather than contribution paid and then used for an activity, a project can be initiated elsewhere that offsets the damage of the consented activity	Requirements of the offset condition must be specified in a regional plan Means for measuring environmental improvement in offset project needs to be defined. May require definition of a baseline.	Consented activities, eg industrial plants
Differential rates plus remissions policy	A specific rate is set for a particular type of land/land use. Behaviours or outcomes on this land are rewarded by a remission (reduced rate) Can be used to provide incentive at the margin Level of remissions can be based on measure of environmental damage	Environmental issue needs to be isolated to a specific use of rateable land Remissions policy must be defined setting out basis for and level of remissions Monitoring system to be established	Land-based activity, eg farming Can be used for non-point sources
Transferable discharge permits	Discharges at a consented activity/site that are beyond consented levels can be offset through the transfer of 'parts of consents to discharge' at another site. Requirement for two or more consented activities/sites relating to the same issue. Trade must not result in a reduction in environmental quality.	Application to transfer must be lodged by both parties (buyer and seller). Application to transfer treated in the same way as a resource consent application	Consented activities, eg industrial plants
Subsidies	Payments can be made to reward desirable activities or outcomes Can be used to provide incentive at the margin	Basis for payment of subsidies set out in a plan	Wide range of activities and effects can be rewarded

3 Case Studies

3.1 Purpose of the Case Studies

Section 1 above outlined some of the theory of the use of economic instruments and identified key defining characteristics. Efficient, least-cost instruments are those that introduced a price effect at the margin, ie for small changes in environmental effect, and that provided considerable flexibility in compliance. Some tradable permit schemes introduce flexibility over time as well as space.

Section 2 sets out a number of options available to regional government to introduce economic instruments at the regional level. A number of options are identified under the Resource Management and Local Government Acts.

In this section we use a series of case studies as a means to better understand some of the practical implementation issues. Using the different examples, we examine:

- the potential of the mechanism to introduce a price effect at the margin;
- issues involved in implementation, including availability of data and the appropriateness of the legislative mechanisms; and
- the expected effectiveness of the instruments in achieving the desired objectives.

3.2 Financial Contributions—Emissions Charge for Thermal Power Generation

3.2.1 Analytical Issues

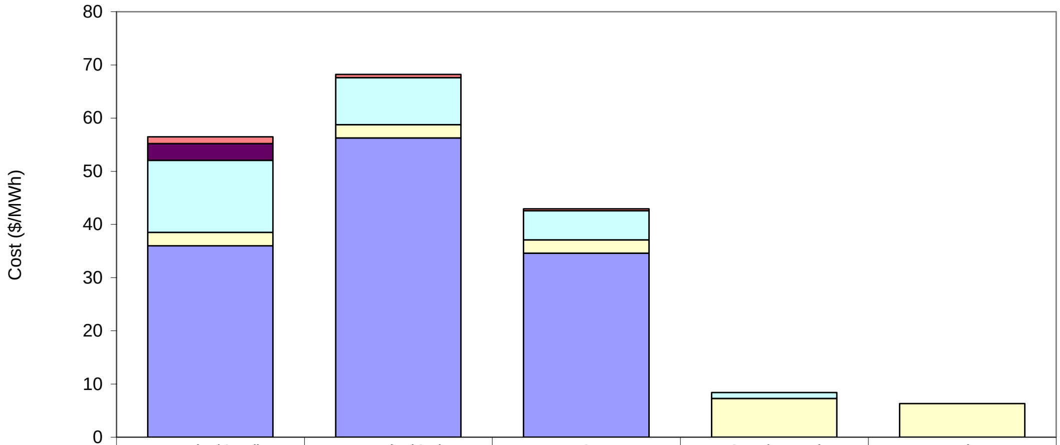
In section 2, financial contributions were identified as potential means for introducing an environmental charge. The way that this is defined in the RMA, makes it suitable for introducing as a means for internalising external environmental costs, ie ensuring that polluters face the full costs of their decisions. In this section we analyse, using emissions from thermal power plants as an example, whether a charge based on damage costs can be established, what is involved in doing so and whether it is likely to have an effect on environmental outcomes.

3.2.2 The Environmental Issue

An analysis of the full costs of electricity generation in the Waikato region[21] suggests that there are significant environmental costs associated with emissions of CO_2, SO_2 and NOx. Figure 1 shows the estimated marginal (variable) costs of generation from different plant types. For the plant owners, the variable costs are dominated by fuel costs. When taking a societal perspective, the emission costs are additional and vary by fuel type.

Figure 1 Full Variable Costs of Electricity Generation

[21] Covec (2005) Full Costs of Electricity Generation. Final Report prepared for Environment Waikato.



	Huntly (Coal)	Huntly (GT)	E3P	Geothermal	Hydro
NOx	1.23	0.64	0.39	0	0
SO2	3.16	0	0	0	0
Carbon	13.55	8.83	5.43	1.10	0
O&M	2.5	2.5	2.5	7.3	6.3
Fuel	36.00	56.25	34.62	0	0
Total	56.44	68.21	42.94	8.40	6.30

Source: Covec (2005) Full Costs of Electricity Generation. Final Report prepared for Environment Waikato

Sulphur dioxide (SO_2) and nitrogen oxides (NOx) are local and regional pollutants. Their main effects are associated with the formation of aerosols which are small particulates that have a range of health effects. In addition, NOx is a precursor of ozone, a local pollutant, and a short-lived greenhouse gas. NOx and SO_2 also have direct health effects. Both are managed by Environment Waikato.

The Resource Management Act restricts the extent to which local government can take CO_2 and other greenhouse gases into account in decision making. Section 70(A) states:

> … when making a rule to control the discharge into air of greenhouse gases … a regional council must not have regard to the effects of such a discharge on climate change, except to the extent that the use and development of renewable energy enables a reduction in the discharge into air of greenhouse gases …

From 2007 and the introduction of a carbon tax, the costs of CO_2 emissions will be internalised in the private costs of generation. There are and will be residual damage costs associated with SO_2 and NOx emissions.

The analysis suggested that the costs on a per tonne basis would be:[22]

- $794-5,113/tonne of SO_2; and
- $331-662/t of NOx.

These costs resulted from estimates of the marginal damage costs associated with the health impacts of the emissions. This included reductions in life years and respiratory illnesses. The values were estimated using published literature that estimated the costs of hospital visits and willingness to pay to extend lifetimes. There is considerable uncertainty in the values, reflecting uncertainty in the underlying science, particularly the way in which marginal changes in emissions and ambient concentrations of pollutants, result in changes to health effects. These kinds of uncertainty are typical of environmental damage costs evaluations.

These values could be used to set the level of charge that an emitter would face. In this section we also examine the expected effects of these instruments to provide additional information that might go into a decision on appropriate charge level.

[22] ibid

3.2.3 Effects

One of the most significant environmental impacts from introducing a charge on SO_2 and NOx emissions would be the impacts on fuel combustion at Huntly power station and specifically whether it would have an impact on fuel burn, ie switching from coal to natural gas. The assumptions used in analysis of this are shown in Table 2.

Huntly has been operating at relatively low load factors[23] (32% in the year to March 2004[24]) but is expected to increase production (generation of electricity) as total electricity demand increases and wholesale gas prices rise relative to coal. Load factors of 50-70% are likely in the future. Burning coal, Huntly is estimated to have CO_2 emissions of 4.5 million tonnes at a 50% load factor and 2.5 million tonnes burning gas. This compares with total New Zealand CO_2 emissions from energy use (including transport) of approximately 32 million tonnes in 2003[25].

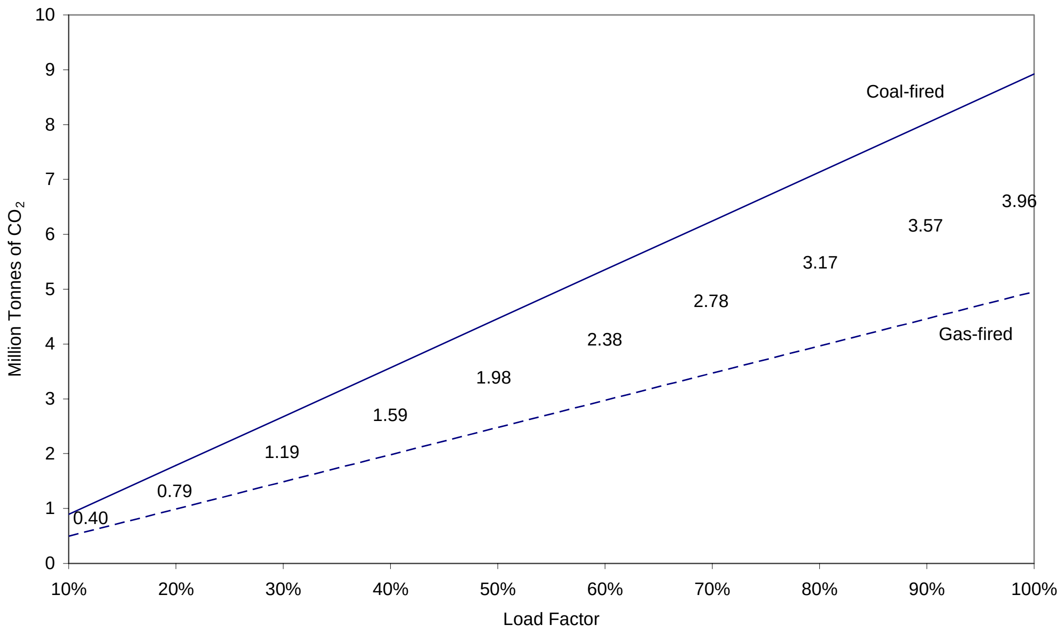
Table 2 Assumptions Used to Estimate Huntly CO_2 Emissions

Factor	Coal	Gas
Capacity (MW)[1]	1000	1000
Thermal efficiency[2] (%)	35%	35%
Thermal efficiency(GJ/MWh)	10.29	10.29
CO_2 (t/TJ)	99	55
SO_2 (t/PJ)	387.2	0
NOx (t/PJ)	361	171

[1] Plant capacity is the total potential instantaneous electrical output of the plant; thermal efficiency is a measure of the relationship between input of energy (as fossil fuel) to output of electrical energy

Figure 2 shows the potential CO_2 savings and estimated total CO_2 emissions from Huntly at different load factors.

Figure 2 CO_2 Emissions from Huntly Power Station burning Coal and Gas, and Savings from Burning Gas



Other emissions from Huntly are relatively low. Waikato coal has a very low Sulphur content (0.15% - 0.31%) and the existing consent restricts SO_2 emissions to $1200mg/m^3$ (1 hour average) and total sulphur emissions of no more than 90 tonnes per day[26].

[23] That is production as a percentage of total possible production
[24] MED (2004) Energy Data File July 2004
[25] MED (2004) Energy Data File July 2004
[26] $1200mg/m^3$ is equivalent to 88.9t/day at maximum output

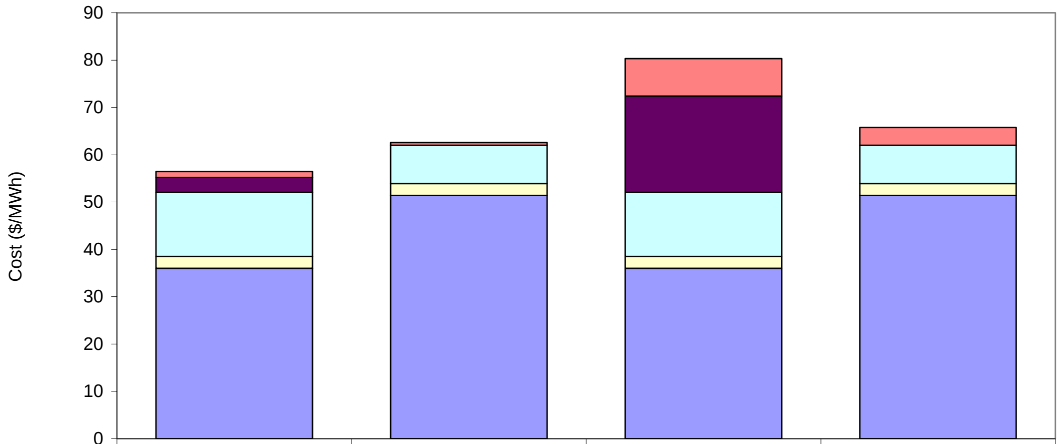
For comparison, the permitted SO_2 emissions in the US under Phase II of the acid rain trading program are based on an allocation equivalent to 1400mg/m^3. And in the EU, the revised Large Combustion Plant Directive sets emission limits for old plants that differ with plant size; for plants the size of Huntly, the requirement is 400mg/m^3.

The current Sulphur limit is achievable using coal with a Sulphur content of approximately 0.8%. Huntly is importing some coal currently from Indonesia; this also is estimated to have low sulphur content—approximately 0.3-0.4%.

With a 0.3% sulphur content, the sulphur emission rate is approximately 430mg/m^3, very close to the most recent EU requirements that will require retrofitting of FGD in most EU countries.

The current combustion of coal at Huntly reflects the relative price of gas and coal. The analysis shows the effects on fuel switching at Huntly of levying a charge equal to estimated damage costs on SO_2 at $794/t (low) or $5113/t (high) and NOx at $331/t (low) or $662/t (high), alongside carbon costs of $15/t (Figure 3).

Figure 3 Impacts of Pollution Charges on Generation (Variable) Costs



	Huntly (Coal) Low	Huntly (Gas) Low	Huntly (Coal) High	Huntly (Gas) High
NOx	1.23	0.58	7.91	3.75
SO2	3.16	0.00	20.36	0.00
Carbon	13.55	8.07	13.55	8.07
O&M	2.5	2.5	2.5	2.5
Fuel	36.00	51.43	36.00	51
Total	56.44	62.58	80.32	65.74

The analysis suggests that if a charge is based on the high cost assumptions (the two right hand columns in Figure 3), there is an incentive to switch from coal to gas because the variable cost of generation using gas is lower than for coal. However, our analysis suggests that actual damage costs are likely closer to the low estimate and that the charge, if it were to reflect environmental damage costs, would be better set using the low cost estimates.[27]

Also, the analysis is based on a gas price of $5/GJ, set against a coal price of $3.50/GJ. Gas prices are expected to rise steadily over the next few years as Maui gas runs out and is displaced by alternative sources including, eventually, LNG. The cut-off gas price, ie the price at which Huntly will be indifferent between coal and gas, at the high emissions charge rate is $6.42/GJ. Spot gas prices are already at $6/GJ[28] and prices for electricity generators would be expected to reach this level soon (currently generators have access to gas under prices determined in contracts of a few years' length).

If they were to have a positive environmental impact through encouraging fuel switching from coal to gas, charges introduced to address the damage costs of SO_2

[27] ibid

[28] Stone C (2004) Exploring Options for Gas Exploration Funding. Gas Industry Reform Conference, August 2004

and NOx would need to be set using rates based on the high end of the range of possible damage costs of these pollutants. If charge rates were set at the lower end of possible damage costs, which we believe represents a better reflection of true costs, it is unlikely that fuel switching would result.

3.2.4 Use of Revenues

A use of the revenues to improve air quality, or reduce the damage costs of poor air quality, would need to be defined. This could simply be a contribution to an environmental fund used to provide revenue to support environmental improvement programmes.

3.2.5 Implementing a Charge Mechanism

Implementing a charge as a financial contribution under the Resource Management Act would require:

- The approach to defining the charge rate to be included in the policy on financial contributions in a regional plan. The plan would need to state that emissions of SO_2 would be measured and that consent holders would be charged, say $1,000/tonne and emission of NOx at, say $500/tonne;

- The contribution to be included in new consents, ie a condition of the consent would need to include a statement on the level of contribution per measured unit of pollutant;

- A monitoring mechanism to be established. This could involve either stack monitors or be approximated on the basis of plant utilisation, fuel burn and fuel specifications;

- Variances to be applied to existing consents.

In addition, the use to be made of revenues collected would need to be specified in a way that related to the issue. As noted above, this could be a contribution to an environmental fund.

This case study has illustrated that this instrument has potential as way to set an environmental charge at regional level. It requires that the issue being tackled is amenable to analysis in monetary terms, ie that damage costs associated with marginal changes in environmental impact/discharge rates can be measured and monetarised.

3.3 Transferable Water Rights

3.3.1 Analytical Issues

In Section 2, tradable permits were identified as an instrument that can be used to achieve environmental improvement at least costs. Here we discuss the potential for using transferable systems for allocation of water to those that would value it most.

Water permits granted for damming or diverting water can only be transferred to another owner of the same site. Permits to take water can be transferred, provided that this is allowed in a regional plan. Environment Waikato has stated in its regional plan that:[29]

Environment Waikato allows the temporary or permanent transfer of the whole or part of a permit holder's interest in a water permit for the taking of surface water, provided that:

[29] www.ew.govt.nz/policyandplans/wrpintro/wrp/wrp3.4.4.htm

1. *the permit does not pertain to the taking of geothermal water from a Geothermal System, … and*
2. *the transfer is within the same catchment to any point downstream (excluding downstream tributaries) of the location to which the permit applies, and*
3. *the Water Management Class … is the same at the new site as that to which the water permit pertains, or the class at the new site specifies the same or less restrictive intake screening and intake velocity requirements than the site to which the permit applies, and*
4. *written notice signed by the transferor and transferee is given within 14 days to the Waikato Regional Council*

In Section 2 above, the assessment of tradable permits suggested that important elements of a transferable permit scheme are that a marginal effect can be introduced; it also noted the value of a market with numerous buyers and sellers.

3.3.2 The Resource Allocation Issue

Permits to take water are allocated to businesses and land users for a range of purposes, including as inputs to industrial processes. Water is scarce and administrators need to allocate it to those who would value it most, or those for whom the benefit to society is greatest. In practice, there are limitations to how efficiently allocation can be because potential users may come along one at a time. An administrator cannot perfectly predict future potential users.

Firms require certainty of access to resources for business and investment planning. Administrators cannot therefore remove water permits from a holder to give to another if a higher value user seeks to obtain water rights. Post-initial allocation trading is a useful way of ensuring that users that value the water most highly will gain access to it.

Environment Waikato enables post-allocation transfers to take place.

The important design elements include:

- Divisibility of permits and the introduction of a marginal effect;
- The environmental effect of the transfer; and
- Transaction costs and the number of potential trades.

3.3.3 Permit Divisibility

An important design element is that permits are divisible. For example, if a permit holder had a right to extract 5,000m^3/day and a new entrant firm wished to purchase the right to extract 1,000m^3/day, could part of the existing permit be transferred.

Currently the rules in the regional plan allow this to happen, ie the permits are infinitely divisible. This is an important design element in ensuring existence of a marginal signal, ie that the existing consent holder sees a price signal for every unit of water demand reduced and that the new entrant can purchase individual units of rights so that efficient decisions can be made about the appropriate scale of plant or activity that is started.

The current plan is an effective means of ensuring this outcome.

3.3.4 Environmental Effect

There are a number of potential issues that can result in adverse impacts on the environment from trade. These include:

- the direction of trade;
- the potential for increases in total use as opposed to total use rights; and
- the treatment of low flows.

Trade Direction
Transfers of water permits can have adverse environmental effects, depending on where in a catchment the permit is transferred to. This is because catchments receive water inflows throughout the catchment, so that, in general water availability increases the further down the river you are.

The Waikato regional plan requires that transfers are to a site downstream of the original site. This is likely to deal with this issue adequately.

Total Use versus Total Use Rights
One issue that can lead to grater environmental effect as a result of transfers is that permits are set out in terms of maximum daily removals. In practice considerably less than the permitted amount may be extracted. This means that a permit holder could transfer part of its allowance to another firm without reducing its actual water take, while allowing another company to extract water. This can result in total water extraction increasing as a result of the transfer.

This is a difficulty of introducing a trading system, in which units components of water rights have value to a system in which they do not. It is a risk inherent in the current system. Ways to combat this might include:

- reassigning rights in a way that was more closely related to actual use levels;

- starting a trading system in a way that involved discounts associated with trades, eg to sell the right to extract $1m^3$/day would require the seller to also give up the right to $1m^3$/day. Such a system could be used until the aggregate quantity of water rights were reduced to a level that better reflected total desirable extraction.

Low Flows
During low flows, existing water rights may be too great. F all extracted to their allowable amount, in-stream values would be affected. Limits thus need to be set on how much can be extracted during low flows. Bringing this into a trading system might be achieved through trades being in percentages of water availability rather than in physical quantities of water.

Dealing with low flows efficiently requires that short term trading can be entered into. For example, there may be 10 companies within a catchment that can potentially trade with each other. Under normal flow conditions, the company that values the water most highly takes 20% of the flow. However, under low flow conditions this company's normal take is 50% of what is available. If this is the highest value user, the mechanism should ensure that the company can purchase the additional percentage of available flow for a limited period.

This is a challenging design element but one that is feasible.

3.3.5 Transaction Costs

Transaction costs are high when each transfer requires regulatory oversite. In the Waikato Regional Plant the requirement is for post-transfer notification of the council, albeit that the transfer does not come into effect in legal terms until the notice of transfer is received.

3.3.6 Implementation Issues

The regional plan allows trading of water permits. As currently set out it meets many of the requirements of an effective and efficient trading system. There are other elements that might usefully be added to deal with potential over-allocations and to address issues relating to lower availability under low flow conditions.

3.4 Offsets for Air Pollution

3.4.1 Analytical Issues

Offsets were described in Section 2 in two forms. One was a simple mechanism enabling companies that had residual effects of a consented activity, that was not avoided, remedied or mitigated, to undertake a project at another site that would yield an equivalent level of environmental improvement. The second involved a credit-based trading scheme, in which offsets were saleable commodities that were traded on the market.

The second type of instrument requires identification of an issue that involves multiple parties. It is more likely that a simple offset mechanism has greater potential in the short term.

However, we examine ways in which the offset mechanism can be developed as an efficient instrument. And specifically one that provided incentives for different bidders to provide projects, and that could provide incentives at the margin.

3.4.2 Design Issues

We use the electricity generation example given in Section 3.2 as the basis for discussion here, but the principles apply equally to all consented activities. A requirement might be established in a plan for all emissions to be offset through projects undertaken elsewhere. For SO_2 and NOx this could include projects that resulted in reductions in:

- Coal burn at industrial plants or by households;
- Oil burn in the form of transport fuels or fuel oil.

Environment Waikato would not have to specify the projects that could be undertaken, but might need to provide guidance on how emission reductions would be measured. This is a key element of the design—how to identify a baseline below which emission reductions are counted.

The obvious place to start is existing consents. A plant already located in the Waikato region could reduce discharges below that which it had to under its consent. These could be measured and verified and used to produce a discharge credit (offset). This raises the immediate issue that the consent is likely to set maximum emissions whereby there might be considerable “spare” consented emission, ie offsets could be sold without changing current activity. As an example of this potential, emissions of SO_2 from Huntly are below that consented because of the very low sulphur content of the fuel that is currently consumed at the site.

This might not be an important issue. The offset condition as proposed above is taking us beyond what is currently achieved via consent conditions. It cannot therefore lead to environmental deterioration, but will produce some environmental improvement, albeit of uncertain extent (and cost).

For un-consented activities, eg emissions in the transport sector, measuring emission reductions is less straightforward. Here clear guidelines will need to be developed by Environment Waikato for how emission reductions would be measured relative t business as usual baselines. For example, vehicle fleet purchasers that bought fuel efficient vehicles might be allowed to create an offset but this requires that a judgement is made on what they would have purchased otherwise. This issue is complex and beyond the scope of this report.

Offset conditions might be simpler to introduce for new market entrants, eg for the E3P plant; it will have significant NOx emissions. However, an offset condition has a marginal effect; it will increase the marginal cost of generation at E3P relative to other plants, including existing plants in the Waikato region and plants in other regions. This is an undesirable effect. If offset conditions are introduced they should be designed to apply to all plants—new and existing.

One potentially complicating factor is that a plant is likely to need offsets for the life of the plant and may need to enter into a transaction that guaranteed access to credits for several years into the future. This might be arranged bilaterally.

3.4.3 Implementation

Implementing an offset condition requires that it is set out in a regional plan. This will include the pollutants that will be subject to the condition and the types of activities that will be covered.

Guidance needs to be provided on how offsets will be measured, ie how to identify an emission reduction. This is relatively straightforward for consented activities as it can be defined simply as the difference between consented emissions and actual emissions. Extending the programme to un-consented (permitted) activities is more problematic. It requires the development of methodologies for establishing effective business as usual baseline emission rates against which actual emission can be compared to estimate reductions. These might be developed ad hoc or, if this is likely to be a widely used instrument, as sector- or source-specific guides.

3.5 Transferable Discharge Consents for Water Pollution

3.5.1 Analytical Issues

Transferable discharge consents are allowed under the Resource Management Amendment Act 2005. For water pollution, it requires that the trading parties are in the same catchment.

As for other tradable permit mechanisms, the key elements of analysis are whether the system can be used to set incentives for marginal improvements in environmental quality, and if the system can be established to minimise transaction costs, facilitating frequent trades.

3.5.2 Design Issues

Designing a tradable discharge consent system requires the following elements:

- **A cap**—total allowable discharges for a given catchment need to be estimated. Ideally this is estimated on the basis of estimates of the costs and benefits of reduction in discharges. In practice it might simply be established on te basis of existing allowable levels of discharge.

- **Traded commodity**—the traded commodity needs to be defined. This will be the right to discharge a specified quantity of a specified pollutant. Ideally traded quantities are infinitely divisible.

- **Compliance period**—the period within which comparison will be made between holding of a permit and actual discharges needs to be set, ie in terms of total load (ie tonnes or kilogrammes of pollutant) or rate of discharge (kg/day).

- **Distribution**—there are different ways in which permits are first allocated. For other tradable permit schemes, allowances may be given away to existing dischargers (ie grandfathered) or sold (auctioned) initially. For water pollution discharges, there will be existing consent holders. Most simply, introducing a trading element is undertaken by starting with existing use rights and allowing trading.

- **New entrants**—in some trading systems, allowances are retained for gift or sale to new entrants to ensure that discharge consent holding is not an entry barrier. Whether, a new entrant must purchase permits or is given them does not change the marginal costs of production, and will not change the competitiveness of the firm once it enters. But it does add to total costs and may affect the entry decision. Barriers to entry are limited if there is a liquid market in which permits are readily available. In the absence of a liquid market, it may be difficult to find sellers. This is no different from the existing system with no trading—enabling new entrants requires allowing additional total discharges or extinguishing the rights of current permit holders. Allowing trading considerably improves the outlook for new entrants over the existing approach; ability to trade is likely to be sufficient to ensure efficient entry.

- **Sales approval**—ideally a system could be established that pre-approved all sales so that transfers only needed to be registered. The legislation implies that each trade is treated as though it were a new consent application. This raises transaction costs considerably and is an unfortunate element f the legislation.

3.5.3 Implementation

Implementing a transferable discharge permit system for water pollution requires that transferability is set out in a regional plan. It would need to set out that parts of a discharge permit could be transferred and transfer eligibility, ie whether it was to anywhere in the catchment or, eg if it had to be downstream of the existing permit holder.

Decisions relating to the design issues noted above would need to be made and included in the regional plan.

3.6 Subsidising Renewables

3.6.1 Analytical Issues

Economic instruments might be used to encourage greater use of renewables for electricity generation. One way would be through providing a grant or subsidy. This approach would seem to be fairly straightforward.

Key issues for assessment are whether the subsidy can be applied in an efficient way to provide incentives at the margin for additional generation.

3.6.2 Design Issues

Environment Waikato could raise revenue to pay for subsidies going to renewable generation through general rates and use this revenue to provide support to renewable generation. It is not clear that it could develop any demand side mechanism, eg requiring companies to purchase electricity certified as being generated by renewables, eg as seen in the UK Renewables Obligation (Box 1).

Box 1 UK Renewables Obligation

The UK Renewables Obligation requires electricity suppliers to supply 10% of demand from approved renewable sources in 2010, with lower annual targets in years prior to this date.[30] Proof of compliance is via holdings of Renewable Obligation Certificates (ROCs), which are allocated to renewable generators for every MWh generated from an approved source.

There are a number of elements of this trading programme that are different from most:

- it introduces a price cap on ROCs. Suppliers have the option of purchasing ROCs or paying a buy-out price of £30/MWh. This is introduced because the government is not willing to meet the renewables target at any cost;

[30] Department of Trade and Industry (2001), 'New and Renewable Energy: Prospects for the 21st Century. The Renewables Obligation Statutory Consultation.'

- the revenues from the buy-out mechanism are returned to suppliers in proportion to their holdings of ROCs. This means that, while there is an overall under-supply, purchases of ROCs are worth more than the £30/MWh avoided cost of the buy-out because the value includes, in addition, the returned revenue from the buy-out[31]. ROCs are currently trading at just under £50/MWh[32]

The use of a buy-out is equivalent to a hybrid tradable permit/emissions tax system. Normally, in contrast to taxes that provide price certainty, but emissions uncertainty, tradable permits provide emissions certainty but price uncertainty. Such a hybrid, in which firms have an option of purchasing allowances or paying a charge, provides certainty in achieving an emissions objective only if the cost is below a certain amount. Above this, emissions are allowed to increase.

However, other approaches have been used in a range of countries including:[33]

- Feed-in tariffs, eg a government-guaranteed price received per MWh of generation either in absolute terms or in relation to wholesale price;

- Investment subsidies, eg capital grants for new plant;

- Quota obligations/green certificates—obligations to purchase electricity from renewable sources, eg verified through certificates produced when a unit of electricity is produced from renewables; and

- Fiscal measures, eg tax credits, accelerated depreciation.

The most straightforward way for Environment Waikato to introduce a scheme to reward renewable generation would be to provide a payment in one of two ways:

- a production subsidy per unit of generation; or
- a capital grant.

The approach taken could be either to provide a fixed amount or to develop a market that set the amount to be paid, eg in the form of an auction. The auction approach has been used in other countries, eg in Ireland where companies bid for pre-specified feed-in tariffs and offered volumes of supply capacity. The alternative way to use the auction process is to invite bids for additional support on a per MWh basis, over and above the wholesale price received.

The relative efficiency of the two approaches depends on the environmental effect of marginal additions to output from renewables. Renewables have high capital costs and very low variable costs of generation. Production subsidies might reduce the marginal costs of production to below zero, ie the generator would receive a net payment, over and above any variable costs, per unit generated. This will make no difference to the amount generated if renewables are competing with thermal plants. However, if there is competition with other renewables then Waikato regional plant may displace plant in other regions, with no particular environmental benefit.

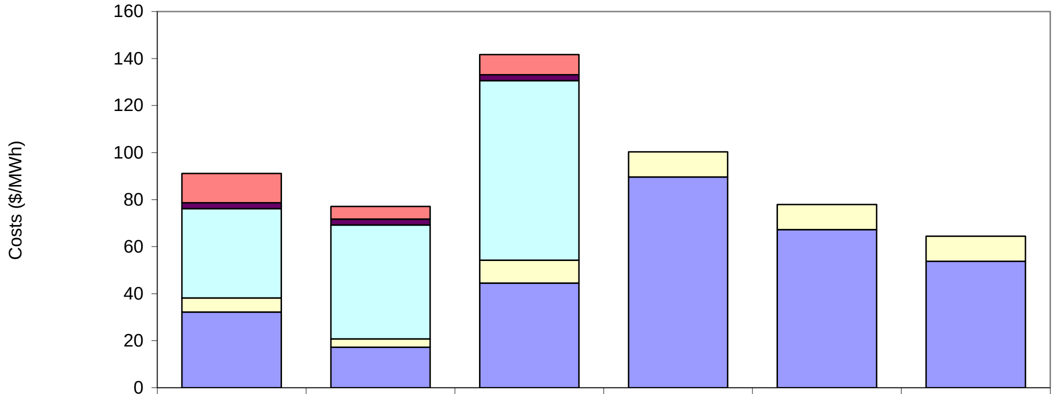
Under the assumption that there is competition from thermals, then subsidies as production subsidies will have the same effect as capital grants, at a given set of assumptions relating to costs of capital and load factors, ie a production subsidy can be converted into a capital grant equivalent through discounting future subsidies back to the present day and by making assumptions about load factor. The regional council's choice of instrument may come down to whether its cost of capital is greater or less than the electricity generator. If the council has a lower cost of capital, which is likely, it would favour providing a production subsidy.

[31] At the extreme, if there was only one ROC, the holder would receive all the buy-out revenue, equal to £30/MWh times 10% of total UK electricity supply (less one MWh).
[32] www.platts.com/Electric%20Power/Resources/News%20Features/roc/index.xml
[33] OXERA (2005) Renewables support policies in selected countries. Report prepared for National Audit Office.

3.6.3 Expected Costs and Benefits

A review of alternative generation costs for new electricity plant suggests that the relative position of wind against other technologies depends on the assumed load factor. Figure 4 shows the relative costs of new generation with 3 different load factors for wind plant: 30%, 40% and 50%.[34] Wind is the least cost generation option at a 50% load factor and is very close to Combined Cycle Gas Turbine (CCGT) plant at a 40% load factor. Its relative attractiveness will depend on local conditions. In addition, wind is able to meet small increments in demand and there is likely to be an ongoing need for larger thermal plant. New Zealand's largest wind farm (Te Apiti) has a capacity of 91MW, compared with a new thermal plant of 300MW or more.

Figure 4 Costs of New Generation



	Coal	CCGT	OCGT	Wind (30% LF)	Wind (40% LF)	Wind (50% LF)
Carbon	12.48	5.43	8.56	0	0	0
O&M	2.5	2.5	2.5	0	0	0
Fuel	37.89	48.46	76.36	0	0	0
Annual fixed	6.04	3.55	9.70	10.65	10.65	10.65
Capital	32.20	17.23	44.53	89.66	67.25	53.80
Total	91.12	77.17	141.65	100.32	77.90	64.45

Subsidies might be used to encourage more wind generation in the Waikato region. However, the benefits (less generation at thermal plants) will increase as a result of regional location only if there are transmission constraints. It is more likely that greater benefits will be achieved through location of wind farms in windier areas, eg Wellington and Manawatu regions as wind farms there will achieve greater load factors.

In addition, the benefits of new wind generation for the Waikato region depend on Waikato thermal plants being marginal generation, ie the plants that are the highest cost electricity generators in the New Zealand electricity system, and thus the first to be displaced by additional low cost generation. Huntly currently spends relatively little time on the margin, but is likely to increasingly following the introduction of the carbon tax which will increase its costs relative to gas plant. Projecting Huntly's future time on the margin is complicated by the dynamics of gas prices in New Zealand. In the absence of major new gas discoveries, gas prices will rise to a level that is expected to be set by imports of liquefied natural gas (LNG). At an LNG price for gas, coal plant will be more competitive in the wholesale market and Huntly would be expected to spend less time on the margin and be less likely to be displaced by new wind generation.

Of note, the Resource Management Act restrictions on local government's consideration of the climate change benefits of reductions in CO_2 and other greenhouse gases (under Section 70(A)), do not extend to the development of renewable energy.

3.6.4 Implementation

The most suitable options for establishing a support mechanism for renewables at the regional level would include establishment of:

[34] Load factors for other plant are assumed to be 85% (coal), 90% (CCGT) and 20% (OCGT)

- a grant scheme that paid a fixed amount either on a capacity (per MW) or an output (per MWh) basis; and
- an auction for capacity (per MW) or generation (per MWh) payments.

The fixed amount provides considerable volume and thus financial uncertainty. It requires that Environment Waikato estimates its willingness to pay for renewable generation. This would require modelling of the electricity system to estimate how an additional MW of wind (or other renewable) capacity would affect generation by other plants, the impacts on generation at thermal plant in the Waikato region and the implications for emissions of SO_2 and NOx; the council would need to decide whether to take account of the greenhouse gas benefits also. It would also need to decide whether to pay out for generation in other regions.

The impacts on emissions in the Waikato has large uncertainties, especially as it depends critically on decisions made in the future about additional plant, including decisions to install new renewable technologies at other locations in New Zealand.

If willingness to pay is estimated, and used as the basis for a guaranteed subsidy amount, it exposes Environment Waikato to considerable volume and financial uncertainty, because the volume of grant applications is uncertain. If large numbers of applicants were received it exposes EW to a potential requirement to pay out large sums. This does not matter if it is certain that the estimation of benefits truly reflects the level of benefits received by the Waikato region, but if there is uncertainty over this—and there always will be given the uncertainty in projecting future electricity markets, this may not be an optimal solution.[35]

The alternative approach is to invite bids for renewable supply. EW would still need to understand its willingness to pay for renewable generation in order to evaluate bids. However, it provides the council with a basis for limiting its financial commitment. For example, it could pay out only if the required subsidy was less than a specified amount (its willingness to pay per MWh) and only up to a specified total amount of available funds.

3.7 Efficient Contracting—Auctions of Land Management Contracts

3.7.1 Analytical Issues

Auctions of land management contracts are a form of subsidy payment in which the amount of subsidy is set in the market. It is an approach that has been adopted in Australia[36] and is a form of efficient contracting, rather than an economic instrument in the traditional sense. However, it is an instrument of interest to Environment Waikato.

Issues for analysis include the extent to which this approach can be used to provide incentives for marginal improvement in environmental quality.

3.7.2 Design Issues

Environment Waikato undertakes projects that result in improvements in environmental quality. These are projects are implemented under contract to third parties. An auction system is a way to ensure that these contracts are let to those that will provide the most environmental outcome per unit of subsidy. This is much the same approach as used in other areas of contracting by regional councils, eg for waste or public transport services.

[35] This assumes that Environment Waikato does not attempt to use the consent process to limit the quantity of renewables to below what it would be otherwise.

[36] www.nrm.gov.au/publications/nrm-mbi/price.html#auctions

Design of an efficient contracting system includes ensuring that there are sufficient bidders and that alternative bids can easily be compared when they offer different types of management and different potential outcomes. This may require evaluation of environmental outcomes in monetary terms so that bids can be compared.

The key element in ensuring that there is an incentive for efficient provision of outcomes is for the contract to include variable payments relating to different levels of environmental outcome.

3.7.3 Implementation Issues

Implementation of an efficient contracting system requires the following elements:

- That the management contract I specified in outcome terms rather than, or in addition to, input terms, so that the council has a specification of what environmental outcomes will be achieved;

- That different environmental outcomes can be compared, eg through valuation of outcome sin monetary terms;

- That the contract terms include payment per unit of environmental outcome so that there is reward for marginal improvements.

3.8 Differential Rates for Non-Point Pollution

3.8.1 Analytical Issues

Differential rates are a means for introducing economic instruments to tackle non-point source pollution. Point source discharges are more difficult to measure and to assign liability to. Thus it is often simpler to define desirable (and undesirable) management practices than it is to set charges relating to specific outcomes.

In this section we assess the issue of nitrate pollution from dairy farms. Pollution of waterways adjacent to a farm may be attributable to that farm, but may be attributable partly to nearby farms. Providing incentives to an individual farmer for improvement in environmental quality may be problematic as the farmer may have limited control over the outcome. However, farmers do have control over their inputs, including land management practices, fertiliser inputs and stock numbers.

In this section we assess the extent to which an efficient charge system can be designed using differential rates, and the extent to which it can provide incentives for marginal improvements in management practices.

3.8.2 Nitrates—the Environmental Issue

Dairy farming requires intensive use of nitrate fertilisers. This, in addition to inputs of urine, raises the level of nitrates in streams and ground water. Measures that can be used to reduce the impacts include:

- reduced stock access to waterways via fencing and buffer strips;
- reduced or more efficient use of nitrate fertilisers;
- reduced stock numbers.

These practices are encouraged voluntarily through good practice guides and extension activities with farmers and the Clean Streams project which covers up to 35 percent of farmers' costs for fencing and planting waterway margins.[37] In addition,

[37] www.ew.govt.nz/enviroinfo/land/management/runoff/waterwaymargins.htm#Heading2

there is already a specific mechanism in place to address problems arising at Lake Taupo, including the following measures:[38]

- purchase private land and convert it to low-nitrogen land uses or retirement to reduce nitrogen emissions from rural land;

- purchase nitrogen reduction directly where land cannot be purchased;

- fund research and development of profitable low nitrogen pastoral systems and alternative land uses;

- establish a system to benchmark to the total amount of nitrogen entering the lake and monitor future reductions of nitrogen;
- establish a land management trust to buy and sell land and manage the nitrogen reduction.

3.8.3 Design Issues

Differential rates, as discussed in Section 2.4, can be used as a mechanism to apply to non-consented activities. They might be used to provide more direct incentives for adopting improved management strategies on dairy farms.

Good practice guidance could be used to develop a set of criteria used as a basis for defining eligibility for remissions. They might, for example, include rates remissions for streams that are fenced or for some defined rate of application of nitrate fertiliser.

However, there are clear practical implementation issues associated with this approach. More specifically, to be effective, requires considerable monitoring of individual properties. To explore these issues, we first define a possible mechanism and then explain the difficulties in implementation.

The mechanism might apply a defined rate per hectare of dairy farm. This would be greater on a per hectare basis than for other types of farm. The rate would be reduced by two factors:

- if streams were fenced there would be a reduction from the loaded rate, ideally at a rate that would vary with the length of fence and its quality; and

- if the rate of nitrogen fertiliser rate was below some threshold it would be reduced further or might reduce in proportion to some rate of fertiliser application.

These approaches show some potential for introducing marginal incentives by varying the rate of remission with respect to marginal changes in activity on the farm.

Stream fencing would require inspection of the property and raises the following pertinent issues:

- what if the fence is inadequate in part; or
- if the property has no streams; or
- if damage is occurring to groundwater?

Some of these questions are resolvable, eg a defined adequate standard for fencing can be applied and remissions might be available for properties with no streams. But the approach is likely to entail high costs in monitoring.

For the application of nitrogen fertiliser, the obvious question is how is this monitored at all? The regional council would have no powers or means to check the volumes of fertiliser purchased or applied.

[38] Environment Waikato (2004) Delivery a Sustainable Future. Long Term Council Community Plan 2004-2014.

In addition to practical monitoring issues, there are issues of valuation. As for the financial contribution instrument, this measure requires that the remissions policy is set on the basis of some understanding of environmental value. Ideally the level of rates remission should be equal to the measured change in environmental damage. This requires analysis of the benefits of on-farm management activities and conversion into monetary equivalents that are reasonably applicable across a range of properties. This is likely to require new research. However, it is research that is relevant to any policy measure that tackles on farm measures to reduce nitrates.

A more arbitrary approach might be used to set the levels of remission but this risks over or under-paying for environmental outcomes.

3.8.4 Implementation Issues

Using a differentiated rate with a remissions policy, as a way to introduce economic instruments, has considerable potential, especially given the apparent flexibility of remissions policies. It is likely that this approach can be used to effectively provide incentives at the margin. The complications are practical and relate to the high monitoring costs that are likely, at least for the specific example given.

4 Conclusions

Economic instruments are policy tools that affect the monetary costs or benefits of private actions, either through directly changing market prices (via charges or subsidies) or introducing markets where previously there were none, eg through defining tradable allocations of use rights.

They are most efficient and effective when they provide incentives for marginal changes in behaviour.

There is considerable scope for regional councils to introduce economic instruments to achieve environmental purposes under existing legislation. Conclusions relating to the different instruments analysed in Section 3 are set out below.

4.1 Assessment of Individual Instruments

Financial Contributions under the Resource Management Act can be used as a means for introducing an environmental charge on consented activities. They require two elements: a level of charge based on an assessment of the damage costs of an activity, and a specified use to be made of the revenues—this can be as simple as addition to an environmental fund.

The example explored in Section 3 used environmental damage values based on published work. These had considerable uncertainty associated with them, something that is likely to be typical of other environmental damage valuations. The expected effectiveness of the instrument was assessed; the analysis suggests that if the charge was set at a level that was close to estimated damage levels, it may have no beneficial environmental effect, at least in the short run. This raises the issue of whether such an instrument should be used simply to internalise damage costs or to have an effect, eg by raising the level of charge such that a change in behaviour would result. In economic terms this is not justified. It is equivalent to the project failing a cost benefit test. In addition, the financial contributions mechanism may not provide the statutory means, as there needs to be a clear link to environmental damage.

Valuation of environmental damage is likely to be a critical element in the design of an environmental charge using this mechanism.

Transferable Water Permits are possible under the RMA and the Waikato Regional Plan. They allow holders of rights to take water to transfer this right, or parts of it, to other sites downstream in the same catchment. A number of important design issues were identified, including the divisibility of the permits (which is possible), possible adverse environmental effects, and the system of pre-approval of trades that limits transaction costs.

Issues of concern relate to the potential for total use of water to go up as a result of trading because current permit holders, in many instances, will use less than their permitted amount. Selling the difference between actual use levels and permitted levels would enable additional use at another site while not reducing use at the existing site. Some means for reducing the total quantity of permitted water take needs to be introduced to the trading system. Dealing with low flows is an additional potential concern. The risk of low flows suggests that a trading system based on percentages of available flow, rather than physical volumes, may be a useful design element. In addition, the ability to trade rapidly during periods of low flow is important to ensure that limited resources are allocated, at all times, to those that value the resource most highly. However, an efficiently designed trading system can achieve this.

Offsets for air pollution were assessed using the same example as for financial contributions. Offset conditions apply to consented activities and require consent holders to offset their residual emissions or environmental damage via projects undertaken elsewhere. The most likely approach is one that starts with bilateral arrangements between the obligated party and another that could provide the offsetting project, but that tended over time towards greater competition for provision of the offsets, ie different companies bidding to provide emission reductions at least cost.

This is most simple to implement through providing the opportunity to yield an offset through reducing emissions below the level that is consented. This provides opportunities for sales of “hot air” ie emission reduction credits that exist anyway—under business as usual actual emissions would be below consented emission levels. However, this may not mater. Introducing trading can still provide incentives for real reductions in emissions, and it provides greater reductions than a system that does not require offsets.

The more challenging element of this system is if the ability to produce offsets is extended to un-consented (permitted) activities, such as the transport sector. Measuring emission reductions requires establishing emission baselines. This is a complex activity and may be better left to a later stage of implementation of this instrument, or it may be left for the companies involved to fund.

Subsidies for renewables were examined. This is a relatively simple instrument to implement, ie there are no real legislative barriers. The important issues for the regional council relate to the nature of the electricity industry, the fact that it is national rather than regional in scope and that the responses to the instrument will be felt throughout New Zealand. For example, if the objective is to displace thermal power generation and thus emissions, in the Waikato, it is likely to be better to subsidise renewable generation in other areas of the country with better wind resources, as establishing wind farms there would yield greater reductions in thermal generation.

Subsidies which reward specific activities (renewable generation) in this way are less efficient than other types of economic instrument, because they do not provide incentives for the full range of options for achieving the environmental goal. In contrast, a charge on emissions from thermal power stations in the Waikato would provide incentives for renewable generation, plus incentives for other actions such as introducing pollution control equipment or switching to lower sulphur coal.

Efficient contracting such as via auctions for land management contracts is not an economic instrument in the traditional sense. There is scope for minimising the costs of environmental outcomes using the auction approach through encouraging multiple bids, by establishing a system that enables different outcomes to be compared using the same metric, eg in monetary terms and by encouraging bids specified in outcome terms and that result in payments that change with levels of outcome.

Differential Rates plus Remissions Policies can be used to tackle non-point source pollution, such as nitrate output from dairy farms. It requires that a separate rate is set for dairy farms and that a remissions policy is defined in a regional plan that sets out the terms under which rates will be reduced (remitted). This might be for different management techniques that are expected to yield improvements in environmental outcome. Ideally, the remissions could be related to environmental outcomes, but in the nitrates example, it is difficult to isolate any changes in water quality in many catchment, to the actions of individual land owners. However, this will not always be the case, and this is the ideal way in which this tool might be used.

The design of the system could include marginal incentives, eg relating to length or quality of fences, to volumes of fertiliser applied and to stock numbers. Monitoring requirements for this instrument are likely to be significant. The instrument also is best implemented such that the level of rates remission reflects the value that the community gains from the environmental improvement. This is likely to require new research, albeit that this research should be undertaken anyway for policy purposes.

4.2 Most Promising Instruments

There is scope for implementing a number of these instruments. The most promising would appear to be:

- **Offsets**—they are an alternative mechanism to financial contributions for tackling point-source discharges and provide greater certainty of environmental outcome. The mechanism's effect may be limited because of the potential for a gap between actual and consented emissions, but they are relatively simple to implement. In contrast to financial contributions they do not require estimates to be made of the value of environmental damage.

- **Transferable water permits** are already allowed in the regional plan. It is likely that attention to some additional design elements would improve the existing mechanisms and reduce the chance of a reduction in environmental quality.

Differential rates plus remissions policies and financial contributions are both likely to require additional research before they can be implemented, particularly associated with the measurement of environmental damage. This research is relevant to any policy measures tackling these same issues, ie it is the input data for cost benefit analysis. However, it would delay any attempts to implement the policies.

Differential rates are the best way to introduce an economic instrument applying to non-point discharges. The costs of monitoring may be high.

Apart from the need for research on environmental damage, financial contributions used as an environmental charge on emissions from industrial sites, appears to be a relatively straightforward and useful mechanism to implement.

Annex A: Economic Instruments—What Are They and How Do They Work?

This Annex provides a theoretical background discussion of the use of economic instruments.

Economic or market-based instruments are policy tools that use market incentives to achieve objectives. Examples include taxes and charges, tradable permits and subsidies.

Below we describe the different types of economic instrument in generic terms. Some introductory economics concepts are included because of their importance to discussing the effects of the instruments on prices, costs and quantities of production and use, and decisions to enter a market.

A1 Pricing under Competitive Markets

Economic instruments function by changing costs and thus prices; understanding price-setting and consumption is important to understanding their effects. We discuss pricing issues initially under ideal market conditions, followed by discussion of the impacts of relaxing these assumptions, and how market structure may alter the functioning of the economic instruments.

The first concept that is useful to understand is marginal cost pricing. Under competitive markets, prices of goods and services are expected to be defined in the market through the interaction of costs of production (supply) and consumers' willingness to pay for products (demand), and to equal the marginal costs of supply—defined as the cost of supplying one more unit of product[39]. When prices equal marginal costs, goods are allocated in an economically efficient way, because successive units are consumed only if the value to the consumer is greater than or equal to the cost of supply, and producers will continue to produce so long as consumers' willingness to pay is at least equal to the costs of production.

Ideally charges and transferable permits are specified in a way that changes marginal costs. They can ensure that market prices equal the true marginal cost of supply, taking account of wider costs to society, or they can ensure that some desired quantity of consumption is achieved at least cost.

Figure A1a represents pricing under a competitive market. The supply curve (S) is upward sloping and it represents the price at which firms are willing to supply another (marginal) unit of a specific product—this can be interpreted in the short and long run.

[39] However, where there are economies of scale, short run marginal cost pricing will not be sufficient to cover a firm's fixed costs.

Figure A1a: Competitive Pricing

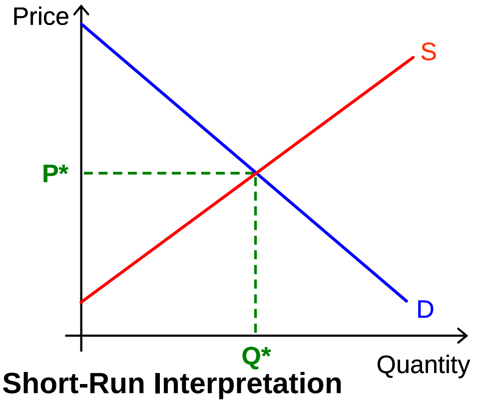
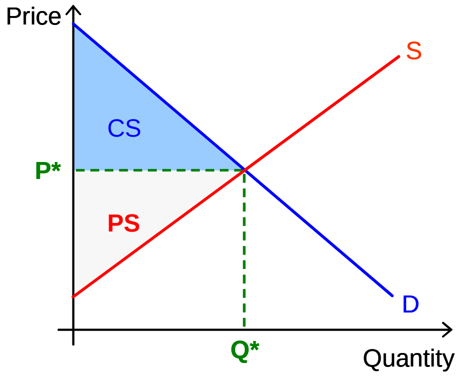


Figure A1b: Surpluses



Short-Run Interpretation

Short run marginal costs (SRMC) just include the variable costs of production. For example, the marginal costs of producing electricity are very largely the costs of fuel.

Within individual firms or plants, marginal costs of supply may be constant over large volumes of output. Costs will often increase as output approaches capacity but, more importantly, marginal costs increase as output shifts to the next (less efficient) producer[40]. Under competition, firms are willing to increase output, provided that the sales price covers their marginal costs of production. In making this decision, fixed costs, including costs of capital, are ignored in the short run, because they are unavoidable. Thus:

- short run marginal costs determine the level of output or production of a product from an existing plant or process; and
- firms compete on the basis of their marginal production costs.

The demand curve (D) represents the quantity consumers are willing to purchase at various prices. Some consumers will be willing to pay higher prices than others; the demand curve represents the marginal willingness to pay as we move from consumers willing to pay the most to those willing to pay the least for a product.

Under competitive markets, an equilibrium is reached—a price (P^*) and a quantity (Q^*) of output at which demand is exactly equal to supply. At this point, no firm is willing to supply any more units unless the price increases, and no consumer is willing to purchase any more unless the price falls.

From this we can estimate the total national benefits of this market (Figure A1b). It is made up of two elements:

- consumer surplus (CS) equal to the difference between the price that consumers would be willing to pay for a product (D) and what they actually had to pay (P^*); and
- producer surplus (PS) equal to the difference between the costs to producers of producing a unit of product (S) and what they received (P^*).

The sum of consumer and producer surpluses represents the total national value of that quantity of production and consumption, over and above the costs of production. Competitive markets can ensure that the combined size of these two surpluses is maximised.

Long-Run Interpretation

These concepts can also be used to explain longer term effects. The long run marginal costs (LRMC) of supply can be thought of as the costs of supply from the next plant or product to come on line to meet demand; long run marginal costs include short run

[40] The supply curve assumes that, if demand for a product was much less, it would be supplied by the lowest cost plant. As demand increases, the next cheapest plant provides supply, and so on.

marginal costs plus an amount to cover annual fixed and capital costs over the lifetime of the plant; it is equivalent to an average incremental cost of supply. Firms are willing to enter a market, or to introduce a new product, provided that the expected sales price, times expected output, covers the costs of entry and production; this would include the costs of meeting the regulatory requirements.

Thus market entry is determined by the average costs of production. And competitive market prices will generally trend to long run marginal costs, at least on average[41].

A2 Externalities

Competitive markets produce economically efficient outcomes. But they fail when some costs (or benefits) borne by society are not taken into account.

An externality is a cost or a benefit affecting someone other than the buyer or seller in a market, such as the environmental or health impacts of pollutants from electricity generation.

Where externalities are negative, we can think of the effect as an additional external or social cost of supply[42]. For every unit of product, the external cost would equal the costs of damage associated with production of each unit, such as the pollution (CO_2, SO_2, NOx) impacts of electricity generation.

Figure A2a shows the effects of internalising external costs as a higher supply curve—the marginal social cost of supply. Whereas the private market price was P^* resulting in consumption of Q^*, the socially optimal price is $P^{s.}$ This is the equilibrium market price that results if the marginal costs of supply include the damage costs associated with the production of an additional unit; it results in a socially optimal level of consumption of Q^s.

Figure A2a: Social Cost of Supply

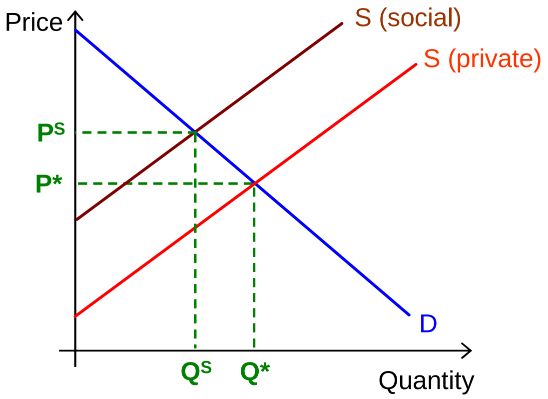


Figure A2b: Effects on total surplus

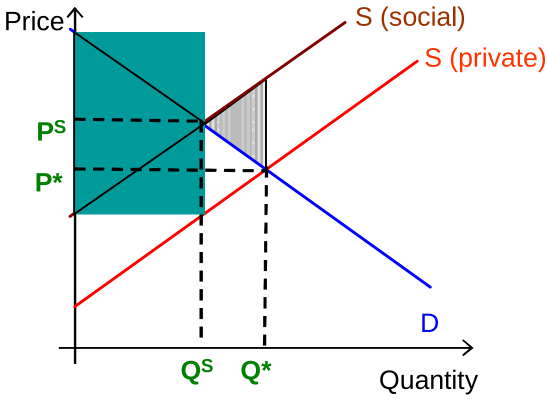


Figure A2b illustrates the true social value of production—the shaded triangle to the left of Q^s, rather than the larger triangle pictured in Figure A1b. And consuming Q^* (which is what results when prices do not reflect social costs) rather than Q^s, has a cost for society equal to the small shaded triangle to the right of Q^s; this is the difference between the (higher) social costs of producing Q^* and the value to consumers, represented by D.

[41] Where there is excess current production capacity there is competition at the margin and prices may fall to SRMC, but as demand approaches potential production, there is less competition and firms can raise prices; they are limited by the costs of new entry, as raising and sustaining prices above that point will result in new firms entering the market. If demand exceeds supply (or is close to doing so), firms enter and can price to recover their costs, again limited by the potential for additional firms to enter. If new entrants have lower (average) costs than the SRMC of existing suppliers, these firms will enter the market, even when there is excess current capacity.

[42] We use the term “social” to represent the effects on society as a whole

A3 Environmental Charges

We first discuss the functioning of environmental charges in theory, followed by some examples of their use.

A3.1 Internalising Externalities

Environmental charges operate by increasing the cost of a unit of production. Theory would suggest that the optimal environmental policy instrument is a charge on each unit of production (or consumption) equal in size to the marginal damage cost[43]. For a charge on a production externality, this would result in the effect illustrated in Figure 2a above. Costs of supply would increase to equal the social cost of supply, prices would rise and the higher equilibrium price would result in reduced levels of consumption. In theory, if the damage costs can be measured accurately, this is the best outcome for society and results in an optimal level of environmental damage (see Box A1).

At Q^s, the value to the marginal consumer of the product is exactly equal to the marginal cost of supply, including the damage costs.

[43] Baumol WJ and Oates WE (1988) The theory of environmental policy. 2nd Ed. Cambridge.

Box A1: Policy Objectives—Economic Efficiency

Economics treats the optimal point that society can achieve as an economically efficient outcome. This is based on the original definition posed by Italian economist Vilfredo Pareto as a point at which no other distribution of goods could be achieved that would make someone in society better off without making someone else worse off. But this pareto optimality criterion is difficult to achieve—changes usually make some people better off while making others worse off, eg pollution associated with production or consumption of a commodity. The criterion is modified by an additional test—can the winners compensate the losers? From the perspective of society as a whole, it does not matter if there are losers, so long as the winners would be able to compensate them. This can happen if the benefits to the winners are, in aggregate, greater than the costs faced by the losers. And this is the result if we can measure the damage costs of a pollutant, charge this cost to users of a product, and consumers are willing to pay this additional cost. The value of the product to consumers must be at least as high as the costs of production, plus the environmental damage.

Note, under this definition (know as Kaldor-Hicks efficiency), it does not matter if compensation is not actually paid to the losers. What is important is that it could have been paid. This then makes society as a whole better off and better able to tackle any distributional issues, such as occur when certain communities bear greater proportions of environmental damage.

In contexts where these redistributions are never actually made, policy makers have sometimes concerned themselves with the distributional impacts of environmental policy. Hence environmental justice (EJ) is an increasing concern particularly in the US, where market approaches to environmental policy have resulted in some concentration of environmental effects in identifiable communities.

The UK landfill tax was originally set this way[44]. A study of the environmental damage associated with landfilling different types of waste[45] was used to develop a charge with two levels—one for standard waste (originally set at £7 per tonne) and a lower rate for inert waste (originally set at £2 per tonne).

A UK tax on aggregates was also developed using an analysis of environmental damage costs, and similar approaches were used in analysing a possible water pollution tax[46], although this has not been adopted.

If markets are competitive, and the level of the charge truly reflects the environmental damage cost, policy makers might be indifferent to the outcome. In other words, if the imposition of the charge leads to very little change in behaviour and little change in environmental effect, it suggests that the commodity is highly valued; its value to society is sufficiently high that the community is willing to accept some level of environmental damage in order to continue consumption of the product. In making this statement, we are using a specific approach to measuring what is optimal for society (see Box 1).

However, the examples of efficient taxes (equal to damage cost) given above are atypical. Very often, marginal environmental damage costs are difficult to estimate and more arbitrary methods are used to select the size of a charge, or they are set with reference to analysis of levels required to have a desired effect.

A3.2 Incentive Effects

Environmental charges are often used to achieve pre-specified outcomes rather than to achieve some notional optimal level of environmental improvement. Environmental charges can have a number of outcomes that include:

- reduced consumption, because of the increased market prices that result from increased marginal costs of supply—the effect depends on the price elasticity of demand (see below);

[44] Prime Minister's Strategy Unit (2002) Waste Not Want Not. A strategy for tackling the waste problem in England. www.number-10.gov.uk/su/waste/report/ downloads/wastenot.pdf

[45] CSERGE, EFTEC and Warren Spring Laboratories, (1993). *Externalities from Landfill and Incineration*, HMSO, London.

[46] Environmental Resources Management (1999) *Economic Instruments for Water Pollution Discharges*. Department for Environment, Food & Rural Affairs. www.defra.gov.uk/environment/water/quality/econinst2/contents.htm

- investments or management changes that result in reduced charge liability and thus reduced environmental damage, eg using cleaner production methods or changing substance ingredients;
- reduced market entry because of increased average costs; and
- market exit—firms ceasing production because they can no longer cover costs while selling at a competitive price.

In Sweden the level of a tax on nitrous oxide (NOx) emissions was set at a level expected to result in plants fitting low-NOx burners (LNBs) [47]— control devices that result in lower emission rates at combustion plants. The decision to install an LNB is based on the comparison of total costs of control, discounted over the expected lifetime of the equipment, with the costs of paying the charge over the same period.

To ensure targeted outcomes, charges have also been set in tandem with other instruments. For example, the UK Landfill Tax was set on the basis of estimates of damage cost, which in theory, should result in the optimal rate of final disposal, of recycling and of product redesign. However, the government has taken additional steps to achieve recycling targets, particularly through a set of regulations covering the packaging industry.

Elasticities

The environmental effects of a charge depend on the price elasticity of demand for the goods and the competitiveness of the market. The price elasticity of demand is a measure of the change in consumption that results from a change in price.

Figures A3a and A3b show the market outcome of an environmental charge on two goods with different demand elasticities. In Figure A3a, demand is relatively elastic—a change in price results in a significant shift in demand. Because of the demand elasticity, not all of the charge is passed on to consumers—the difference between P^0 (equilibrium price without the charge) and P^1 (equilibrium price with the charge) is less than the size of the charge. The price increase that is passed on leads to a reduction in the quantity consumed (from Q_0 to Q_1), and thus reduced environmental damage.

Figure A3a: Elastic demand

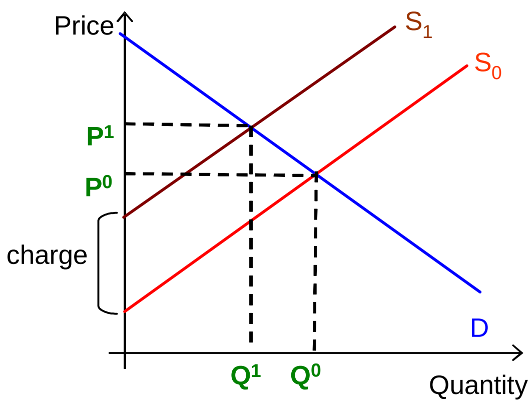
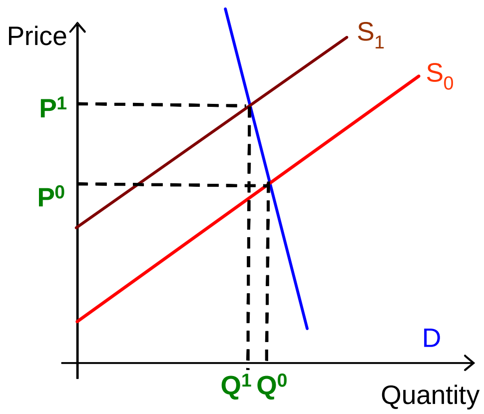


Figure A3b: Inelastic demand



In contrast, Figure A3b illustrates the case with inelastic demand. Here more of the charge is passed on to consumers but the resulting reduction in quantity consumed, and thus in environmental damage, is small.

[47] Anderson RC and Lohof AQ (1997) The United States Experience with Economic Incentives in Environmental Pollution Control Policy. US Environmental Protection Agency

Long run elasticities can be different from short run elasticities[48]. In the short run, price increases can only alter the way in which existing assets are used; in the long run, price increases change the types of assets that are invested in.

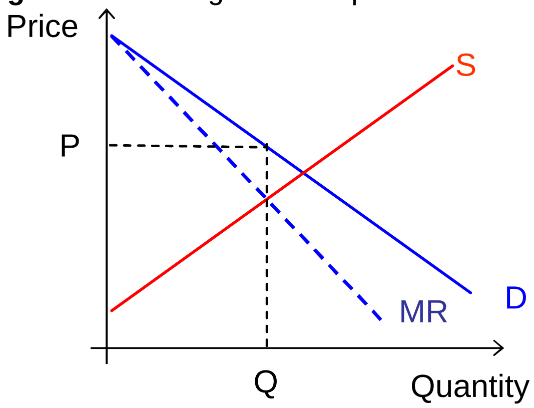
Uncompetitive Markets

The other factor that will result in differences in the effects of an environmental charge is the competitiveness of the market. To this point we have discussed the way prices are set and the relationship to consumption in competitive markets, ie those with numerous buyers and sellers, and no barriers to trade. Many markets for many hazardous substances do not meet this description.

Price setting under monopoly or near monopoly markets differs from competitive markets. Quantities of production will be determined by the interaction of the marginal revenue curve and the marginal cost of supply. Marginal revenue is the change in revenue with a change in sales. It falls with quantity produced because of the lower willingness to pay for the product by the marginal consumer, and because the lower price is spread across all sales. Thus the marginal revenue curve is increasingly lower than the demand curve as output increases (Figure A4). Price is set at a level that limits consumption to a quantity at which marginal revenue = marginal costs of supply (S).

[48] In the MED's energy model, the long run elasticity of demand for petrol is approximately three times as high as the short run elasticity. Ref: Fuels & Energy Management Group Ltd (2000) Road transport sector energy demand & CO_2 output. Projections & Analysis of Reduction Strategies. Appendix C: Energy Demand Projection Modelling Procedures.

Figure A4: Pricing in uncompetitive markets



Under such markets, if supply costs are increased via an environmental charge, this will result in a smaller change in price than under a competitive market (Figures A5a and A5b). However, it may mean that prices are already above the socially optimal and the policy problem is not an environmental one; too little of the commodity is being consumed, not too much. But the change in environmental quality attributable to the instrument can be considerably reduced[49].

Figure A5a: Competitive market

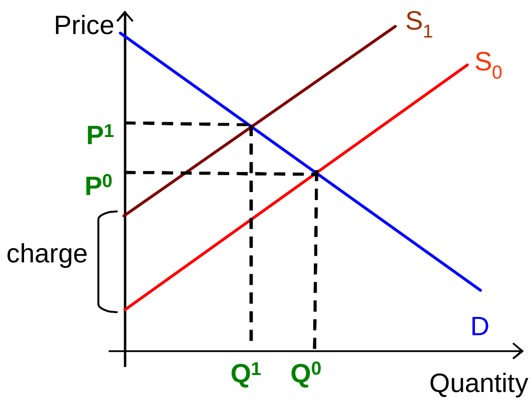
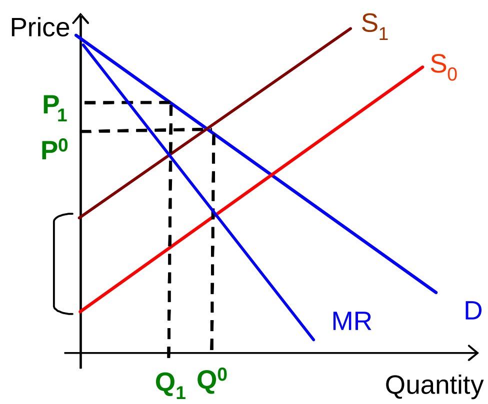


Figure A5b: Monopoly Market



A3.3 Revenues

Environmental charges produce revenues. The use that is made of the revenues involves a separate decision from the decision to introduce the charge. In practice, often some, at least, of the revenues are retained to achieve environmental objectives related to the objectives of the charge, eg some portion of the UK's landfill and aggregates tax revenues are allocated to related projects.

- Landfill site operators who contribute to organisations "with objects concerned with the environment, enrolled under the Landfill Tax Credit Scheme", may claim a credit of up to 6.8% against their annual landfill tax liability[50].
- Some of the revenue from the Aggregates Levy is contributed to a Sustainability Fund used to finance programmes to minimise demand for primary aggregates, promote environmentally friendly extraction and transport, and reduce the local effects of aggregate extraction[51].

---

[49] Note this is not the same as a reduced environmental outcome, because the counter-factual is different.
[50] HM Customs & Excise. www.hmce.gov.uk/news/bb-0904.htm
[51] Environment Protection Economics Division (2003) Mid Term Evaluation of the Aggregates Levy Sustainability Fund. Department for Environment, Food and Rural Affairs. www.defra.gov.uk/environment/waste/aggregates/pdf/mte.pdf

Such targeted use of funds, referred to as hypothecation, can remove some of the economic efficiency gains from using the instrument.

As noted above, if a charge is imposed at a level equal to the marginal damage cost, the resulting market behaviour—supply and consumption of the good on which the charge is levied—is optimised. The theoretical best use of the revenue collected is to correct some other market distortion, either in the form of a subsidy, where this is the best market correcting approach[52], or more likely, to replace income raised through a distortionary tax, eg a tax that has been levied to raise revenues rather than to correct a market failure/externality. Taxes are distortionary when they are levied on goods or services, or on income, in a way that changes behaviour from what it would have been in the absence of the tax. For example, taxes on labour mean that, to attract workers, wage rates need to be higher than they would be otherwise, and firms employ less labour and use more other resources. Using revenue from environmental taxes to reduce such taxes results in the so-called double-dividend of corrective taxes or charges. There is one social dividend (benefit) from correcting the externality; there is a second social dividend from reducing other taxes (or from correcting another market failure). This approach has been championed in a number of countries, most notably via the call in European Community President Jacques Delors' 1993 White Paper on growth, competitiveness, and employment, for a shift in the burden of taxation within the EU from "goods" to "bads"[53].

Consistent with this, when the landfill tax was introduced in the UK, it was accompanied by a 0.2% reduction in employer national insurance contributions (NICs); and the aggregates levy was accompanied by a further 0.1% cut[54].

In contrast, when, as a result of the additional revenue raised, the government spends more, the test, from an economics perspective, is—is this additional expenditure well-being enhancing? In other words, do the benefits to society outweigh the costs?[55] Even where additional spend is justified, there are arguments for separating the expenditure from the revenue raising tools. More specifically, revenue raising is uncertain, which means too much, or too little can be spent on the new activities. Similarly, reductions in distortionary taxes can be done to too great or too little an extent. The reduction in national insurance contributions associated with the UK's landfill tax, for example, has consistently been greater in value than the amount raised by the tax[56].

The unpredictability of revenues from environmental taxes is compounded by the incentive effects that they have. The principles of good taxation for revenue raising purposes, which relate to the low levels of distortion (eg by taxing goods with low price elasticity of demand) can be at odds with the objectives for environmental taxation, which can be to distort, ie to change patterns of consumption.

Hypothecation has been suggested as a means to limit the impacts of the economic instrument on specific sectors. For example, the tax reduces firm revenue and profitability and this can be partly compensated through lump-sum or some other compensation. The efficiency (and environmental) impact of the instrument remains, provided the compensation is not on the same (marginal) basis as the original instrument. For example, if there is a charge on each tonne of SO_2 from electricity

[52] For example, where there are positive externalities, or benefits for the wider community. Fireworks would be a trivial but illustrative example of a hazardous substance with positive externalities.

[53] White Paper on growth, competitiveness, and employment: The challenges and ways forward into the 21st century. COM(93) 700 final. Brussels, 5 December 1993

[54] Employees pay 11% of income between £4,615 and £30,940 per year, and 1% of income above this limit. Employers pay 12.8 % on all earnings above £4,615 a year. The link is somewhat confused over time as NICs have subsequently been raised to pay for additional government expenditure on the National Health Service. There is an efficiency gain if, because of the Landfill Tax and Aggregates Levy, other taxes are lower than otherwise they would be. This is almost impossible to test.

[55] This is a necessary but not sufficient reason for intervention which should also be justified on the basis of market failure.

[56] HM Treasury and Department for Environment, Food & Rural Affairs (2002) Possible changes to the Landfill Tax Credit Scheme: Consultation Paper.

generation, and pricing reflects marginal costs, lump sum compensation would not reduce the price impact, or the incentive effect of the instrument. It would simply enable levied firms to retain profits[57]. In Denmark, simultaneously with the introduction of the pesticides tax, property taxes were lowered for agriculture properties.

A3.4 Cost Recovery Charges

Cost recovery is a specific example of a tied charge, ie the charge is levied specifically to recover the costs of a regulation, or activity. Local government examples include targeted rates to recover costs of weed and pest control.

Here, we are assuming a prior choice is made to incur the costs. The important economic consideration here is whether the charge is an efficient way to raise revenue.

Tax theory suggests that the best way to raise revenue is to cause least distortion. In the absence of tax, people will be making choices about their expenditure in a way that maximises their well-being, taking account of market prices (that reflect costs of delivery) and the benefits that they obtain. Levying taxes changes effective prices, changes patterns of expenditure and reduces well-being. Changes to patterns of expenditure are minimised when tax levels are small and/or when the goods or services taxed have low price elasticity of demand; here changing the price via tax has minimal impacts on expenditure patterns and well-being.

In addition, taxes that correct externalities are efficient, because, although they may distort behaviour, they distort it towards a pattern of expenditure that is desirable—it is the pattern of expenditure that results from prices fully reflecting social costs so the new pattern is more optimal (using the definition outlined in Box A1 above).

A3.5 Transaction Costs

Environmental charges can have significant transaction costs, ie administrative and other costs involved in implementation, particularly because of greater monitoring requirements. Emission charges have required much more sophisticated systems for measuring emission rates, for example.

The level of transaction costs will often determine who a charge is levied on. For example, charging at a very disaggregated level, eg individual farms to monitor use of a product rather than the importer, will have much more significant transaction costs per unit of tax or damage. These additional costs reduce the available revenue from the instrument that might be used to reduce other market distortions.

A4 Transferable Permits

Whereas environmental charges give some price certainty but often uncertainty of outcome, transferable or tradable permits provide certainty of outcome but uncertainty of price. They come in two basic forms:

- Cap and trade, as used in the US acid rain programme;
- Credit-based systems, as used in the UK packaging and renewables systems.

A4.1 Cap and Trade

Where there is some overall limit on emissions, damage, industrial activity, production or use of a substance, tradable permits or allowances[58] can provide market incentives for discovery of the least cost means to meet this limit. A binding cap is converted into individual allowances to emit, damage, import, produce or use smaller units (eg one tonne) of the product.

[57] It does over-reward the industry and over-encourage investment, if continued over the long term.
[58] 'Allowances' is the term used in the US trading systems. It differentiates between a 'permit', which allows a plant to emit at a certain rate annually, and an 'allowance' to emit a single tonne.

Where there are fewer allowances available than aggregate emissions/imports would be under business as usual, allowances have a monetary value. For the US SO_2 emissions trading system, in comparison with their own costs of limiting emissions, plant owners are willing to buy allowances at a price equal to or below this cost, and are willing to sell allowances at a price equal to or above this cost. Plants that reduce their emissions can free up allowances that they can sell, and reduce their own and aggregate demand for allowances.

Prices of allowances are set in the market in the same way as for other commodities. They are expected to equal the marginal costs of supply. In the case of the US SO_2 allowance market, this is the marginal cost of emission controls. For an overall limit on nitrate fertiliser, for example, it would be expected to equal the additional costs of an alternative but inferior or more costly substance, or the costs of doing without the substance.

Firms within the same industry will value allowances differently, reflecting their specific costs of using substitutes, and they may require different quantities. This is the basis of trade. Allowances will be bought and/or held by those firms that value them the most.

The required elements of a cap and trade system are listed in Box A2.

Box A2: Elements of a Cap & Trade System

The Cap

A cap is essential to the cap and trade system. For emissions, a limit is set on total aggregate emissions.

Unit of Trade

The aggregate limit, eg an overall tonnage limit on imports, is converted into individual rights to emit a single tonne. These rights or allowances can then be owned, bought or sold. The allowances will generally be unique, numbered commodities and will be specific to a time period, eg a single year.

Allocation

Individual allowances can be given away initially or sold (eg by auction). This has distributional effects but is not expected to affect the final market price of allowances. The US SO_2 system included a mix of both approaches; auctions were useful initially in helping firms to identify the market price.

Non-compliance penalties

The market value of allowances is determined by the penalty for not holding sufficient allowances. Under the US SO_2 system penalties have been set at a level approximately ten times the market price of allowances.

Compliance period

The compliance period is the time period for which the holding (or surrendering) of allowances must at least equal the emissions or import levels. Typically this will be a single year, although inter-year trading may be possible also. For international greenhouse gas emissions trading, the compliance period is five years, as defined under the Kyoto Protocol.

Tracking System

To achieve compliance, and the integrity of the system, cap and trade schemes maintain records of the individual allowances and who owns them. Allowance registries are used to register trades and current holdings.

Other elements that can be introduced include the ability to trade over time as well as space. For example, an allowance initially allocated for this year might be unused and held over to use next year. This is termed banking. Banking can ensure a smoother price path over time—there is no end of year price spike or trough because of under or over-supply—and it improves compliance; holding too many allowances has a low cost as the allowances have a value past the compliance date. Borrowing involves using this year an allowance initially allocated for use in a future time period. Borrowing can similarly help to smooth the price path, but does not have the same compliance benefits—it can enable firms to avoid the actions that the policy measure is targeting; this is problematic especially where there is limited liability.

A4.2 Credit-based systems

A credit-based system works to encourage desired activities or outcomes rather than placing a limit on undesirable outcomes. Allowances are not distributed initially. Rather, they are created. The UK packaging recycling system is based around tradable recovery notes, generated when a volume of waste is recycled. These are used to demonstrate compliance with an obligation to achieve targeted rates of recycling. Similarly, the UK's Renewables Obligation enables companies that generate a MWh of electricity from renewable sources to produce a Renewable Obligation Certificate (ROC) that can be purchased and used to demonstrate compliance by local electricity suppliers with renewable supply targets.

Some greenhouse gas trading schemes, such as the means to comply with the provisions of the Kyoto Protocol, include a mixture of cap & trade (emissions trading) and credit-based systems (joint implementation and the clean development mechanism, both of which involve the calculation of emission reductions associated with specific projects).

Credit-based systems can be highly complicated because of the need to establish a counter-factual, ie a scenario of what would have happened otherwise. This has led to very significant transaction costs in defining levels of reduction from greenhouse gas projects. Here credit-based systems are used to reward emission reductions. But to define a reduction requires, for example, the definition of levels of expected energy efficiency improvement in an industry alongside the specific achievements of an individual firm.

In contrast, examples such as the recycling and renewables schemes noted above, are introduced far more readily, because the counter-factual is assumed to be no recycling and no renewables generation.

A5 Economic Effects of Charges and Tradable Permits

The economic effects of taxes/charges and tradable permits are broadly equivalent.

They both introduce a cost at the margin. This affects prices and levels of consumption of a product, or provides incentives for actions to limit the liability to the charge or the requirements for allowances.

A5.1 Efficiency Improvement

The theoretical basis for efficiency improvement is clear. For charges equal to damage costs, private decisions are expected to lead to efficient allocations of resources in the economy. For tradable permit systems, the flexibility provided to firms ensures that least cost means can be discovered for achieving a given government policy requirement. In practice, some of the theoretical advantages of economic instruments such as tradable permits can be lost through poor design, including following political interference to protect individual firms and industries[59]. However, ex-post analysis of the functioning of tradable permits has demonstrated that, when well designed and with low barriers to trade, a very high proportion of the predicted efficiency gains can be achieved[60]

Analyses of the costs of environmental policy have confirmed the cost reductions associated with the use of economic instruments[61]. It is estimated, for example, that the cost saving attributable to formal trading under the US SO_2 system versus a uniform emissions rate standard is approximately $250m annually in 1995–2000, and that it would be approximately $784m annually from 2000 onwards, when the cap is tighter.[62]

A5.2 Private Costs

While an incentive-based charge can be effective, it can result in higher costs for industry than traditional regulatory means. Taking the NOx charge example discussed above; under a regulatory requirement to meet environmental standards, plant owners face the costs of installation and running of low-NOx burners or other control devices. Under an environmental charge devised to provide this incentive, plant owners face these same costs—the Swedish charge is set at a level that ensures that firms install this equipment—but they also face a charge on the residual emissions.

This is still an efficient outcome where the charge is equal to damage cost. If the plant could not afford to pay the charge from its residual profit, it means that the value to society of this plant is less than the damage it causes.

---

[59] Stavins RN (1995) Transactions Costs and Tradeable Permits. Journal of Environmental Economics and Management 29:133-148.

[60] Kerr S and Maré D (1997) Transaction costs and tradable permit markets: the United States Lead Phasedown. College Park: University of Maryland. In: Newell and Rogers (op cit)

[61] See, for example, Winston Harrington, Richard D. Morgenstern, and Peter Nelson (1999) On the Accuracy of Regulatory Cost Estimates. Resources for the Future Discussion Paper 99-18.

[62] Carlson C., Burtraw, D., Cropper, M. and Palmer, K.L. (2000), 'Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?', *Journal of Political Economy*, **108**:6, 1292–326.

A5.3 Competitiveness

Impacts on competitiveness are frequently a concern of policy makers. This can be misplaced. The objective of economic instruments is to reduce the competitiveness of firms that cause more damage. Firms compete on the basis of their marginal costs of production; economic instruments increase marginal costs because there is damage associated with marginal production and/or consumption.

The legitimate concern of government is with fair competition, ie that competition among firms is based on the true economic costs of production[63]. The issue of fair competition arises in the case of industries for which regulation in one country is more stringent than in another, eg an environmental charge in new Zealand increases costs for agricultural production above those in other countries. Here not imposing an environmental charge results in over-production if comparing true social costs with the market price (value) of the product. But where that price is set in international markets in which there are no environmental charges, imposing one in New Zealand may result in unfair competition and under-production.

A6 Subsidies

Subsidies work by providing financial rewards for particular activities or outcomes.

Subsidies can be used to reward outcomes, eg pollution levels that are less than some specified amount or to reward specific actions, eg electricity generation from renewables.

There are a number of concerns with the use of subsidies over other instruments.

- When used to reward particular activities, they do not provide incentives for the least cost means for achieving a specific outcome. For example, subsidies for renewable generation do not provide incentives for other means to reduce emissions.
- When used to reward specific outcome, eg pollution levels less than some amount, there is a risk that this will reward business as usual levels of pollution, ie there is a need to define a counter-factual.

[63] Kerr S (2000) Fair Competition and Annex B Trading. In: Kerr S (Ed) Global Emissions Trading. Key Issues for Industrialized Countries. Edward Elgar. pp:157-184.