# 1. Introduction: ecological tax reform[1]

Environmental issues are often characterised as trade-offs between environmental preservation and economic growth. On the other hand, the high and continuing levels of environmental degradation in Australia indicate that markets are not providing the right signals, so that environmental costs are being imposed on existing and future generations. While 'getting the prices right' through market instruments by no means provides the whole answer to attaining ecologically sustainable development, prices and financial incentives can have a powerful effect on decisions over use of resources and disposal of wastes.

In economics, the effects of economic activities that fall outside of the influence of markets are referred to as 'externalities' or 'external effects'. An externality exists when a factor affecting the welfare of a consumer or the profits of a producer is controlled by someone else. Here and elsewhere, the word 'welfare' is used in the economic sense to mean the well-being that consumers gain through consumption of goods and services.

The tax system can be a potent device for influencing behaviour. In addition to its revenue raising and redistributive functions, the tax system may be used to encourage activities that are socially and environmentally useful and to discourage activities that are not. Many aspects of the existing tax system *discourage* activities that have positive externalities – employment and investment – and *encourage* activities that have negative externalities – pollution and excessive resource use. There is scope to restructure the tax system in ways that promote greater employment and inhibit environmental damage. Changes in taxes and charges can do this through changing price signals so that employment of labour and investment are more attractive and polluting activities are penalised.[2] This basic idea is being extensively discussed and analysed in Europe and will be an important part of the environment debate in the future.[3]

The objective of ecological tax reform (ETR) has been defined as follows.

> Ecological tax reform involves shifting a large proportion of taxation off the value-adding activities of people (employment, enterprise and investment) and

[1] This research has benefited greatly from advice provided by several people with expertise in the areas covered in the paper. We would like to express our gratitude to: Terry A'Hearn (Victorian EPA), Chris Baker (Australian Centre for Cleaner Production), Cheryl Battergol (Cleanaway), Steve Dodds (Commonwealth Treasury), Mark Ellis (consultant), David Gargett (BTCE), Gerard Gillespie (ACT Waste), Terry Hillman (Murray-Darling Research Centre), Bill Leane (ACTEW), Scott Keyworth (Murray-Darling Basin Commission), Max Neutze (ANU), John Nevile (UNSW), Brett Odgers (Commonwealth Environment Protection Agency), Paul Pollard (Environment Australia), Hugh Saddler (Energy Strategies), Frank Stilwell (University of Sydney) and Philip Sutton (Green Innovations). However, the authors take full responsibility for all views expressed. The research project has been partly funded by the Search Foundation, to whom we are very grateful.

[2] The question of the extent to which economic growth and consumption actually improve well-being is not raised in this paper. We do, however, make the assumption that unemployment reduces well-being.

[3] A European Union White Paper on *Competitiveness, Growth and Employment* concluded that 'if the double challenge of unemployment/environmental pollution is to be addressed, a swap can be envisaged between reducing labour costs through increased pollution charges.' See also DRI (1994).

onto the value-subtracting use of energy and resources and associated creation of wastes and pollution (Gee 1996).

Changing price signals is a critical aspect of ecological tax reform, but the way in which the revenue raised from environmental taxes and charges is spent is also an essential part of ETR.[4] ETR is not a precise set of proposals but a suite of potential revenue and spending reforms aimed at improving environmental performance without generating economic costs. An appropriately designed tax reform package may actually increase economic growth and employment by overcoming some distortions in the economy. This phenomenon is known as the 'double dividend' and is discussed in the next section.

Changes in tax and expenditure patterns have implications for social equity. Environmental taxes and charges are widely believed to be regressive; that is, low-income households are forced to pay a higher proportion of their income than high-income households. The question of the extent of negative equity effects and measures designed to offset them are important policy issues that are considered in this paper. However, the equity question is more complex and involves issues that are usually overlooked in policy debates. In particular, the poor tend to suffer more from environmental degradation than the rich; and polluting activities by one section of the community may impose costs on others. These are inequitable, and failure to correct them may be more inequitable than the environmental tax or charge proposed. There may be a strong equity argument in favour of the polluter-pays principle. As *The Economist* magazine put it: 'it is clear that since polluters pay so little of the costs of pollution now, the tax burden should move in their direction' (November 16th, 1996). In addition, the descendants of today's poor will bear the brunt of environmental degradation that is not prevented now, so the intergenerational equity effects of environmental taxes and charges should be considered too.[5]

## 2. Economic benefits of ecological tax reform

Before commenting on the economic benefits of ecological tax reform it is worth noting that imposing taxes and charges for the first time can yield very large environmental improvements. In many cases, ETR will involve imposing charges for the use of the natural environment which have previously been regarded as freely available. In such cases, it is often possible to obtain substantial reductions in environmentally damaging activity even when charges are quite small and the cost burden on firms and households is correspondingly small.

When an activity has no obvious cost it is rarely subjected to close economic scrutiny. For example, if waste disposal is free there is no financial incentive to examine the waste stream to determine whether reductions in waste could be made cheaply. In fact, economic analysis of this situation yields the prediction, confirmed by experience, that in many cases some of the wastes could be recycled or reused in ways

[4] In some countries the spending as well as the taxing measures are emphasised by using the term 'ecological fiscal reform' (EFR).

[5] The equity issues of environmental measures are discussed in more detail in Hamilton (1996b).

that increase profitability. The initial impacts of the imposition of an environmental charge or tax may be sufficient to induce a leap to much more sustainable processes. The 50 per cent cut in wastes to landfill projected under current policies (discussed below) arises primarily from the first round effect rather than from the incentive effects of charges. In contrast, an 80 per cent cut in wastes to landfill may require firms and households to incur significant costs through taxes and charges set high enough to have the desired incentive effects.

*The double dividend*

There is growing evidence that an appropriately designed environmental tax package can both reduce environmental damage and increase economic welfare from the consumption of goods and services. If this is so then it is said to yield a 'double dividend'. In the absence of the double dividend, the economic costs of, say, a carbon tax must be weighed against the environmental benefits of reducing greenhouse gas emissions. In addition to the uncertainty associated with the extent of benefits from emissions reductions, the issue is complicated by the fact that the economic costs of a unilateral carbon tax are borne domestically while the environmental benefits are global. (Although of course the economic costs of failing to reduce climate change are borne domestically as well as globally.)

On the other hand, if a tax package has a double dividend then it is worth doing even in the absence of precisely known environmental benefits and may therefore be thought of as an economy-wide 'no-regrets' measure. The existence or otherwise of a net economic benefit from a policy designed to protect the environment therefore has considerable policy significance.

The economic framework for the double dividend derives from the economic theory of taxation. The key issue is the extent to which the existing structure of taxes causes the allocation of resources among economic activities to deviate from the allocation that would prevail in the absence of taxes in an economy characterised by competitive markets, and whether the new tax structure would be more or less distortionary.[6] In assessing the validity of the double dividend argument below, it should be made clear that the environmental benefits of the tax change are not included. Thus the absence of a double dividend does not invalidate the case for environmental taxes, it only means that the costs of the taxes must then be weighed against the environmental benefits.

The arguments for and against the existence of the double dividend have been systematised by Goulder (1995). Simplifying, the 'best' tax system is the one with least 'distortions', i.e. the one that leads to the least change in the patterns of production and consumption that would prevail in the absence of a tax (assuming markets are competitive). Under the best tax system, losses in producer and consumer surplus are minimised.

[6] This explanation of the double dividend should not be taken to imply that we accept the idea that there is an 'optimal resource allocation' that would prevail under competitive conditions. Consequently, we use the term 'distortionary' advisedly.

Simplifying again, taxes are less distorting the more broadly based and uniform they are.[7] Thus in the case of a carbon tax, a key issue is whether a carbon tax would be more or less broadly based, and more or less uniform, than the taxes it displaces.

Goulder describes what he refers to as the weak, strong and intermediate forms of the double dividend argument. These forms vary according to the uses to which the revenue from a carbon tax are put. The **weak** form says that recycling carbon tax revenue by reducing existing distortionary taxes (such as a payroll tax) involves a smaller efficiency loss than returning the revenue to households as a lump-sum cash payment. The existence of this form of double dividend is uncontroversial. However, the case for ETR still depends on the ability to demonstrate the extent of environmental benefits.

The **strong** form of the argument says that a tax shift from taxes in general, that is, the prevailing mix of taxes, to carbon taxes will reduce what Goulder refers to as 'the gross cost of taxation' (the impact of taxes on economic welfare from consumption of market goods and services, excluding environmental impacts). The strong form probably does not apply as carbon taxes, which apply to a single input, are likely to be more 'distortionary' than a general tax on output. If the strong form prevails then the environmental tax is worthwhile even without the environmental benefits.

The **intermediate** form of the double dividend argument says that imposing a carbon tax and using the revenue to reduce the *most distorting* taxes will reduce the gross cost of taxation. This is where the precise design of the tax package becomes important, as the net benefits of the package depend on the level of distortion in the taxes that are reduced or replaced.

The modelling evidence reviewed by Goulder (1995)[8] indicates that recycling revenue by cutting personal taxes *does not* improve economic welfare, but that cutting labour and capital taxes *does* improve welfare. In Australia, one serious proposal is to use carbon tax revenue to reduce payroll taxes. The claim that this tax change would produce both net economic benefits and environment improvements is a particular case of the intermediate form of the double dividend argument. We now examine this.

In principle, a payroll tax is a broadly based tax on the use of labour inputs. In practice, the Australian payroll tax system is characterised by so many exemptions, thresholds and rate variations that it is highly distorting. Since a carbon tax would be levied at a smaller number of points it would be easy to make it uniform in its application, although some exemptions may be granted. Although the base of the carbon tax is relatively narrow, fossil fuels are a major input to many industries, especially when indirect inputs are taken into account. The absence of rate variations may offset the relative narrowness of the carbon tax base.

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[7] Taxes on goods and services that have low price elasticities will better maintain the revenue base. Some theories of optimal taxation propose so-called Ramsay taxes which depend on the elasticity of demand for the commodities concerned, but these have not found much support in practice.

[8] A more general review of modelling studies of carbon taxes can be found in Grubb (1993).

A critical issue is the extent to which the cut in payroll tax would lead to an increase in employment. The employment impact depends on whether the tax cut allows employers to enjoy lower unit labour costs, including payroll taxes (for a discussion see OECD 1996). Cuts in taxes on labour are unlikely to increase employment if wages are flexible and increase immediately to offset the fall in labour costs. The actual outcome depends on institutional factors in the labour market.

The evidence reviewed by the OECD (1996) suggests that the impact of labour taxes on employment decisions varies across countries. In Germany and Canada, tax cuts tend to be offset by wage rises, while in the US and UK tax cuts result in lower labour costs and higher employment. Australia, Japan and France lie in between these cases. In Australia, wages are unlikely to increase to offset tax cuts so employment would probably increase.[9]

If the benefits of cutting labour taxes are small (because wages are flexible) then employment gains may be greater from reductions in capital taxes. This depends on the marginal excess burden (MEB) of various taxes, that is, the reduction in welfare (due to distortions) from a marginal tax increase. The OECD (1996) reports studies for the US economy estimating the marginal excess burdens of capital taxes to be 46%, of income taxes 31% and of payroll taxes 23%. This suggests that in the USA there would be greater gains from cutting capital taxes rather than labour taxes, even though lower labour taxes stimulate employment growth in the USA. Such estimates of relative excess burden are, however, highly sensitive to assumptions about the international mobility of capital. In models with highly mobile capital, the burden of taxation of capital income falling on domestic residents is much smaller.

*Empirical studies*

A number of studies have demonstrated employment and output gains from tax switching. In Australia, one study using the ORANI model simulated the short-run impact of imposing a carbon tax on domestic sales of fossil fuels (Common and Hamilton 1996).[10] The results show that different uses of the tax revenue have markedly different impacts on the economy. In contrast to the situation in which the revenue is used to retire public debt (i.e. without recycling), when the revenue is recycled to cut payroll tax, GDP and employment growth are stimulated.

The study by Common and Hamilton (1996) is the basis for the carbon tax-payroll tax proposal developed below in Section 4. Similar results have been reported by Bertram *et al.* (1993) for New Zealand, by Barker (1993) for the UK and by Shackleton *et al.* (1992) for the USA. Perhaps the most salient and significant of these studies is a major study carried out for the European Commission which examined a full-blown ecological tax reform package involving a suite of revenue-raising and spending measures (DRI 1994). The integrated package of measures (including a range of sectoral taxes, charges and tradeable pollution permits) shows very substantial environmental gains. In addition, the recycling of revenue results in improvements in GDP growth and employment. Under the scenario involving cuts in

[9] The marginal tax rate on labour in Australia (including payroll, social security and income taxes) is low, around 39%, compared to over 50% in most European countries (OECD 1996, p. 69)

[10] Very similar ORANI simulations are reported by McDougall and Dixon (1996).

employer social security contributions, employment is projected to rise by over two million in the six major European Community countries by the year 2010 (see DRI 1994 and Hamilton 1996a for more detail).

*Politics of tax reform*

It might be argued that if removal of a distortionary tax (such as payroll tax) and its replacement by less distortionary taxes (such as a consumption tax) is beneficial (as Goulder's intermediate case suggests), then the tax change should be implemented anyway. Why introduce diversionary issues like ecological taxes? This argument is put by the OECD in its discussion of implementation of environmental taxes.

> [T]he introduction of the environmental tax is not a necessary case for achieving efficiency gains, and so the measurement of economic benefits in many modelling exercises conflates the improvement attributable to the environmental tax with benefits attainable in its absence (OECD 1996, p. 70).

Here we need to move from the economics of tax reform to the politics of policy formation. In general, major policy changes do not occur simply because they appear to be economically sensible. Linking ecological taxes to reductions in distortionary taxes helps build a coalition in favour of the proposed tax change package. Some groups are not opposed to carbon taxes *per se* but are concerned about the potential efficiency and equity implications. A well-designed package – including revenue recycling and offsetting welfare payments – can do a great deal to allay concerns and build support.

Thus to argue that if it were worthwhile to reduce distortionary taxes then it would or should be done anyway displays a lack of understanding of the political process. The refusal by John Hewson and the Liberal Party to build a package of measures that adequately dealt with equity effects (at least until the eleventh hour) resulted in the political death of the GST in Australia in 1993.

## 3. Approach to the analysis

This paper advocates the introduction of a range of environmental taxes and charges, coupled with spending programs, designed to bring about a dramatic improvement in Australia's environmental performance.

The analytical approach of this study is to compare the environmental and economic impacts of a 'business-as-usual' scenario with the proposed ecological tax reform package. The business-as-usual (BAU) scenario incorporates expected policy changes that have been implemented or appear likely to be implemented over the next several years. The ETR scenario incorporates a range of new policy measures and extensions of existing measures to achieve levels of environmental improvement that are feasible and achievable using existing technologies or technologies that are close to commercial viability.

The time frame for the projections is the period 1997-2020. This is long enough to permit some far-reaching changes in the ways resources are used and wastes are disposed of. While some of the projected environmental improvements flowing from the ETR package would occur within a few years of implementation, others, which may involve long-term investments in power stations and water recycling systems for example, will take the full period.

As for the analytical method, it has not been possible in this study to carry out a formal simulation of the effects of the ETR package using a detailed model of the Australian economy, with the important exception of the use of modelling results to estimate the impacts of a carbon tax and vehicle fuel efficiency measures. The projected environmental and economic impacts of the non-greenhouse policies are estimated using non-formal analytical methods, methods which nevertheless draw upon the best available sectoral information. The principal drawback of this approach is that it does not permit systematic analysis of intersectoral effects. For instance, we have not estimated the impact of investment in water recycling infrastructure on atmospheric emissions in the cement and steel industries. However, where we believe these second-round effects might cause a significant divergence between the BAU and ETR scenarios we have factored them in by making informal estimates.

It should be made clear that in advocating the tax changes contained in the ETR package we recognise that other major changes in Australia's tax system are needed for reasons of equity, efficiency, simplicity and the adequacy of the tax base. In particular, there are strong arguments in favour of a broadening of the indirect tax base and, *at the same time*, a broadening of the income tax base, including closing loopholes that permit tax avoidance and the introduction of wealth and inheritance taxes. These tax reforms should be pursued independently of, and in addition to, the reforms advocated in this study.

# 4. Atmospheric emissions

## *4.1 The current situation*

*Climate change*

The Commonwealth's State of the Environment report observed that potential changes in regional climates in Australia due to the enhanced greenhouse effect 'pose a major threat to sustainability' (DEST 1996b, p. ES-16). As global climate modelling becomes more precise, scientists are making more reliable estimates of the likely economic, health and ecosystem impacts of climate change as a result of the enhanced greenhouse effect. Some of the anticipated effects under scenarios involving the doubling or trebling of CO2 concentrations are very serious. For example, a recent path-breaking report by the World Health Organisation draws the following conclusions: the increased incidence of heat waves, storms and floods will result in thousands of deaths in many major cities around the world; the global incidence of malaria is expected to increase by 50-80 million cases each year; other diseases will spread; sea-level rise will affect agricultural production and displace populations; there will be food and water shortages; and many of the anticipated

consequences will be most serious for the poor and disadvantaged of the world (McMichael *et al.* 1996). These impacts will be felt with more or less force in Australia (Bouma *et al.* 1996).

While a great deal of analysis has been carried out on the economic costs of measures to reduce emissions, very little information is available on the likely costs of climate change. Studies starting to appear now suggest that the costs of climate change could be very large indeed, so that the benefits of a substantial slowing of climate change would be very large. For example, one study for the European Union estimates the cost of global warming at 1.6% of national income *for each degree of warming* (see the review of studies in Pearce *et al.* 1995).

One of the most comprehensive studies of the likely costs of climate change has been carried out by Sorensen (1997). Sorensen assumes a doubling of CO2 in the atmosphere over the next few decades, regarded as a conservative estimate by most climate scientists. The study estimates the economic costs due to deaths from heat waves, floods and disease as well as economic costs associated with loss of agricultural production and declining water quality. It concludes that the average annual value of the external costs due to the enhanced greenhouse effect, taken over the whole of the 21st century, is about US$10,000 billion each year. This represents about 40-50 per cent of global annual GDP. In other words, the external costs of expected climate change will be equal to roughly half of GDP each year over the 21st century.

Australia contributes around 2% of global emissions, so that a reduction in our emissions will have only a very small effect on future concentrations. However, Australia will benefit from measures to restrain the growth in emissions. In addition, Australia is a signatory to the Framework Convention on Climate Change which commits us to work with other nations towards 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. Australia has committed itself to take steps to limit its emissions with the aim of returning them to 1990 levels, although virtually no progress has actually been made.[11] International and domestic pressure to reduce sharply Australia's emissions will undoubtedly mount, especially in the lead up to and after the Kyoto meeting of the parties to the Convention in December 1997 at which mandatory targets appear likely to be agreed.

*Urban air pollution*

Urban air pollution is another potentially serious atmospheric environmental problem. Since transportation is one of the major sources of urban air pollution, measures to reduce greenhouse gas emissions from vehicles will also have a major bearing on urban air pollution. Urban air quality in most Australian cities has improved over the last decade. The State of the Environment Report concluded that:

> ... it is generally agreed that over the past 10 years some aspects of the air quality in major cities such as Melbourne and Sydney have improved following the introduction of stricter controls on motor vehicles, especially the

[11] For an assessment of the National Greenhouse Response Strategy see Wilkenfeld *et al.* (1995).

use of catalytic converters on all new cars since 1986 and the simultaneous introduction of unleaded petrol (DEST 1996b, p. 5-28).

However, the authors noted that in areas of rapid urban growth (such as south-east Queensland, Perth and western Sydney) vehicle emissions are likely to remain a major concern. CSIRO scientists have said that the improvement is likely to continue 'until a technological plateau is reached sometime in the next decade', after which 'total loads may then start to rise again as population levels and car usage continue to rise' (CSIRO 1996, p. 13).

Congestion is another environmental problem associated with transportation, although congestion may alternatively be thought of as a rather inefficient means of rationing scarce and expensive road space, with few effects on non-users. A study carried out by the National Institute of Economic and Industry Research (NIEIR) reports results that indicate that external costs associated with transportation in Australia – including noise, accidents, congestion and non-greenhouse gas emissions – amount to 2.0% of GDP, or around $9 billion per annum (DEST 1996a, p. 47). More than half of this (1.15%) is due to congestion.

### *4.2 Sources and levels of emissions*

There are several sources of atmospheric pollution from combustion of fossil fuels. The principal ones are electricity generation, transportation and industrial emissions.[12] In this analysis we concentrate on atmospheric environmental problems arising from the combustion of fossil fuels, in particular climate change due to greenhouse gas emissions and urban air pollution. As power stations are mostly located outside of cities, electricity generation does not contribute greatly to urban air pollution. Emissions reductions measures that reduce the number of vehicles on the road also reduce the problems associated with congestion.

Australia has perhaps the highest level of per capita greenhouse gas emissions in the world, totalling 33 tonnes of CO2 equivalent per person in 1990 compared to 23 tonnes in the USA and 15 tonnes in Germany (Hamilton 1994). While Australia's emissions per unit of economic output have been declining over the last two decades, they have been declining much more quickly in other OECD countries, so our relative position is worsening (DEST 1996b, p. 5-9). Between 1970 and 1992 Australia's energy-related CO2 emissions per unit of GDP fell by 13% while those of all OECD countries fell by 36% (Hamilton 1994, p. 14).

The national greenhouse gas inventories show that the three sources mentioned in Table 4.1 account for 59.9% of Australia's total emissions (measured in terms of global warming potential and excluding land use change and forestry, where the emissions are uncertain). Table 4.1 shows the major sources of emissions.

Australia's official attempts to cut emissions growth – principally, the National Greenhouse Response Strategy and the Greenhouse 21C program – have had minimal success (DEST 1996b, ES-15), primarily because of the lack of political will

[12] In Australia, land clearing and the livestock industry are also important sources of emissions.

(Wilkenfeld *et al.* 1995).

**Table 4.1 Sources of greenhouse gas emissions, Australia 1994 (percentage of total measured by global warming potential)**

| ***Sources*** | ***Percentage of total*** |
|---|---|
| Fuel combustion | |
| Electricity generation | 31.0 |
| Transportation | 15.1 |
| Industry | 13.8 |
| Other fuel combustion | 3.9 |
| Fugitive energy | 7.8 |
| Industrial processes | 1.8 |
| Agriculture | 22.4 |
| Waste | 4.3 |

*Source:* NGGIC 1996
Note: these estimates exclude emissions due to land use changes and forestry.
'Fugitive energy' includes releases of methane and CO2 associated with the production and distribution of coal and natural gas.

### *4.3 Revenue measures and their impacts*

An essential component of an effective greenhouse gas reduction strategy is a carbon tax, that is, a tax on the combustion of fossil fuels.[13] Taxation of consumption of fossil fuels means that the carbon tax would not influence the prices of Australian fossil fuel exports, although carbon taxes in other countries would. It is envisaged that the tax measures described below would provide temporary exemptions for export industries that are especially heavily dependent on energy inputs, mainly the aluminium industry. The exemption would be removed as other countries impose similar carbon taxes (or equivalent emissions reduction measures) thereby 'levelling the playing field'.

The carbon tax has most of the features of a good tax (see Common and Hamilton 1996). It tackles a major externality, it would be simple and cheap to administer and, as will be shown below, its effects on equity and growth are likely to be low. Given the extent to which all sectors are directly or indirectly dependent on fossil fuels, the carbon tax can be thought of as a more or less broadly based consumption tax. As a means of generating revenue to fund public spending it suffers from the drawback that the more effective it is at reducing consumption of fossil fuels the more the expenditure base of the tax is eroded.

[13] In practice the tax is levied on fossil fuels according to their carbon content.

The effectiveness of the carbon tax in reducing greenhouse gas emissions will depend on the price elasticity of demand for the various types of fossil fuels. In the short term demand for fossil-fuel based energy is not very responsive to price rises. In the longer term, as substitution possibilities in production and consumption increase, a price rise will have more impact on demand. In response to substantially higher prices, over a period of two or three years habits would change and substitutions would be made in production within the inherited technological structure. Over a decade or two, a large permanent change in relative prices would be expected to induce changes in the design of energy-generating and energy-using equipment and buildings, and substitution possibilities would be expanded.

It should be pointed out that among the three major energy-related emission sources – electricity generation, industrial processes and transportation – fuel price rises will have the least impact on emissions from the transport sector. While there remains substantial scope for the substitution of natural gas for coal in electricity generation and industrial processes, reducing emissions growth in transport is a more difficult task and will require additional measures.[14] A set of such measures is described in the next section.

The carbon tax proposed here is levied at the low rate of $23 per tonne of CO2 (in 1992/93 prices), a rate sufficient to raise $6.3 billion in revenue annually.[15] This sum would be enough to eliminate payroll taxes.[16] However, it is proposed to earmark $500 million of the revenue to fund programs promoting fuel efficiency in the transport sector. A tax rate of $25 per tonne of CO2 would raise around $6.8 billion, enough both to eliminate payroll taxes and to set aside $500 million for promotion of fuel efficiency. The tax would be phased in over three years and would raise *average* fuel prices by around 43%. However, the average conceals large differences between coal, gas and petroleum. Moreover, while petroleum and gas are consumed more or less directly coal makes up only a small portion of the costs of electricity production. Thus in terms of impacts on final consumers, the carbon tax would result in price rises of around 7% for petrol, 17% for gas and 21% for electricity.[17] Simulation of the *short-run* effects of this tax using the ORANI-E model are shown in Table 4.2.[18] The rate of carbon tax set here should be regarded as a minimum and there is a strong case for raising it substantially in subsequent years.

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[14] BTCE (1996b, p. 148) estimates a short-run elasticity for petrol demand of –0.1 and a long-run elasticity of –0.2.

[15] The carbon tax of $23 per tonne of CO2 is equivalent to a tax of $84 per tonne of carbon. In its analysis of a carbon tax the BTCE considers five levels, the *lowest* of which is $100 per tonne of carbon (BTCE 1996b)

[16] The proposal here is Scenario 4 in the ORANI-E simulations reported by Common and Hamilton (1996).

[17] These are based on residential prices. Some big industrial uses pay much lower prices for electricity and gas so that the proportionate increase in price would be higher. For example, a very big user of electricity may pay only 5 c/kWh instead of 11 c/kWh. The carbon tax would over time induce a shift from coal to gas for electricity production which would result in a fall in prices. Note that the BTCE results show a carbon tax of $27.30/t CO2 ($100/t carbon) results in petrol price rises of 8.3% (BTCE 1996b, Table 9.1, p. 147).

[18] The model results are based on the assumption that all of the carbon tax revenue is used to eliminate payroll taxes.

The revenue from the carbon tax is 'recycled' through the abolition of payroll taxes and as a result output and employment in the economy are stimulated. While these results are indicative only, the carbon tax-payroll tax swap induces a short-run increase in GDP of 0.2% and of employment of 0.69% or around 53,000 jobs. Inflation falls slightly and the budget balance worsens marginally. Note that the model has been 'closed' by assuming that money wage rates are fixed, which in the face of a fall in the CPI implies a small increase in real wages. If real wages are held fixed then the fall in prices must be matched by a fall in money wages and this leads to a further expansion of output and employment.[19]

**Table 4.2 Short-term effects of a carbon tax of $23 per tonne of CO2 using ORANI-E with revenue recycling (percentage changes)**

| *Variable* | *Percentage change* |
|---|---|
| GDP | 0.20 |
| CPI | -0.57 |
| Budget balance (as percentage of GDP) | -0.14 |
| Employment | 0.69 |
| CO2 emissions | -11.7 |

*Source*: Common and Hamilton 1996

The tax mix change induces a fall in CO2 emissions across the various fuels of 11.7% in the short run. This is an aggregate over various fuels and fuel uses. The carbon tax would have a large impact on the prices of coal and gas, but only a small impact on the price of petrol. Much larger falls in emissions would be expected over the longer term. The long-run elasticities for electricity and industrial fuel consumption are likely to be higher than those for petroleum. There is very substantial scope for substitution of natural gas and renewables for coal in electricity generation and for energy-efficiency measures in industrial production and household energy use. The total fall in CO2 emissions from coal and gas is likely to be closer to 40% over the period to 2010 and perhaps over 50% by the year 2020. In the absence of these measures, under the BAU scenario total emissions from electricity and industrial fuel use are likely to rise by around 10% to the year 2020.

The long-term employment implications are perhaps more difficult to judge. By 2020 renewable energy would be the dominant form of energy under the ETR scheme. Generation of renewable energy appears to be more labour-intensive than conventional sources of electricity generation. Although it appears that no

[19] Very similar results, also using ORANI-E, have been reported by McDougall and Dixon (1996).

comprehensive studies have been carried out, a British study indicates that use of wind energy technology generates more employment than the equivalent coal-fired power station and substantially more than combined cycle gas turbines (British Wind Energy Association 1997). A study in Wisconsin in the US suggests that use of renewables generates about three times more employment than the same level of imported fossil fuel use and the required investment in power stations (US Department of Energy 1996).

If these results applied broadly in Australia (and there is no reason to expect that they would not), we would anticipate much larger employment gains than indicated by the short-run ORANI results. Employment gains would arise both from the reduction in labour costs due to the abolition of payroll taxes and from the shift, over the longer term, to more labour-intensive renewable energy technologies.

### *4.4 Additional measures in the transport sector*

In addition to the introduction of the carbon tax discussed above, the transport sector needs to be targeted by special measures to reduce vehicle emissions. The measures described below focus on increasing the fuel efficiency of the vehicle fleet rather than measures to cut travel or to bring about a large-scale shift from private to public transport. However, the measures described here do not preclude additional policies aimed at the latter objectives.

Unlike reductions in non-CO2 pollutants, any measures to reduce carbon dioxide emissions from the land transport sector in Australia need to be aimed at reducing the total amount of petroleum burned. Two facts are especially important in this regard:[20]

1. Australian passenger vehicles have a life-span of around 20 years before being scrapped, and the average age of the car fleet is about 10 years; and

2. new vehicles are on average more fuel efficient than old vehicles. In 1995 the average fuel intensity of new vehicles was 10.38 litres/100 km compared to 11.36 in 1985 and 12.28 in 1975 (BTCE 1996a, Table II.2).

Although new vehicles are significantly more efficient, the fuel intensity of the passenger fleet is falling only very slowly due to the slow turnover of the fleet. It seems likely that advances in vehicle design by major manufacturers will reduce fuel intensity much more rapidly over the next 10-20 years, quite conceivably to as low as 2-3 litres/100km (BTCE 1996a, p. 35). With the rapid reduction in fuel intensity of new vehicles over the next decade or two, measures to encourage the more rapid turnover of the fleet have the potential to make a very substantial contribution to reducing fuel consumption and emissions.

The Bureau of Transport and Communication Economics has evaluated the costs of reducing greenhouse gas emissions from Australian cars (BTCE 1996a and 1996b). Although the results are tentative, the Bureau concluded that accelerating the introduction of fuel saving technology through mandatory fuel efficiency standards for new cars is the most promising approach (compared to improved emission control

[20] Most of the information and analysis in this section is drawn from BTCE 1996a and 1996b.

technology, compulsory tuning of engines and accelerated scrappage of older cars). We adopt this scheme below but with some important additional measures, namely the use of some of the revenue from the carbon tax to offset the increased prices of new cars due to mandatory fuel efficiency improvements. Combined with the price effect of the carbon tax on petrol, these measures would reduce fuel consumption and emissions markedly.

The BTCE's maximum technology scenario (MTS) anticipates the fuel intensity of large vehicles falling from 12 litres/100 km in 1995 to 6 litres/100 km in 2005, and the fuel intensity of small vehicles falling below 3 litres/100 km, with other classes of vehicles experiencing reductions in between these. These are achieved through mandatory fuel efficiency standards, with the technological choices needed to achieve the standards left to vehicle manufacturers. The BTCE estimates that vehicle prices are likely to rise by no more than 10% to achieve a 50% fall in fuel intensity (BTCE 1996a, p. 37).[21] Dramatic reductions in fuel intensities appear increasingly feasible with recent breakthroughs in technology. It is expected that European manufacturers will be offering vehicles with fuel intensities of 3 litres/100 kilometres for general sale by the year 2000.

In the absence of changes in fuel prices and with a 10% increase in new car prices, the BTCE analysis predicts that some of the emissions reduction due to improved fuel efficiency will be offset by increased kilometres travelled as fuel bills fall. The impacts of these changes are forecast using the Bureau's CARMOD and ITS/BTCE models. The results of the analysis show that total fuel consumption falls to 69% of the base case level by the year 2015, despite a 7% increase in total vehicle kilometres. This will result in annual greenhouse gas emissions from vehicles falling from 45.2 million tonnes in 1995 to 33.9 million tonnes in 2015 (a 25% fall), instead of rising to 49.4 million tonnes under the base case (a rise of 9%) (BTCE 1996a, Table IV.7).

However, the two additional measures proposed in this study would result in larger reductions in greenhouse gas emissions from vehicles. Firstly, after phasing in over three years, the carbon tax will increase petrol prices by around 7%. The approximate 50% fall in the fuel intensity of new vehicles by the year 2005 means that the fuel bill for the same distance travelled would fall by around 45%. The BTCE (1996a, p. 39) suggests that declining fuel bills of 50% per kilometre travelled would see vehicle kilometres rise by around 7% over the base case to the year 2015,[22] so we might expect vehicle kilometres to rise by around 5%.

In addition, in order to hasten further the turnover of the fleet, it is proposed to use $500 million per annum of carbon tax revenue to reduce the price to consumers of the most fuel efficient vehicles.[23] The most effective means may be to reduce or abolish

[21] Compared to the 6% increase suggested by other authors, the 10% estimate is described as 'conservative' in BTCE 1996a. Nevertheless, in BTCE 1996b the estimate is raised to 15%. This increase raises the estimated social costs of introducing fuel efficiency standards.

[22] The base case anticipates a 28% increase in kilometres travelled (from 133 to 170.5 billion km) between 1995 and 2015 (BTCE 1996a, Table II.1). See note 14 above on price elasticities.

[23] The BTCE anticipates that under its scheme the cost to consumers of vehicle price rises of 10% over the 1995-2015 period would be $6.09 billion, or an average of $300 million per year (BTCE 1996a, Table IV.16).

sales tax on the most fuel efficient vehicles and this is the measure advocated here.[24] (This is similar to the 'feebate' system in operation in Ontario, Canada where purchasers of small, fuel-efficient vehicles receive a rebate funded by fees charged on sales of inefficient vehicles. Conceptually, it is similar to the price differential for low-alcohol beers.)

In addition, further greenhouse gas savings could be secured by increasing sales tax on the most inefficient vehicles with the revenue used to further reduce sales tax reductions on efficient vehicles. To the extent that these changes in relative vehicle prices hastened the turnover of the fleet and the shift to greater fuel efficiency, greenhouse gas emissions would fall more quickly than projected by the BTCE.

Taking these two measures into account (mandatory fuel efficiency standards and sales tax reductions for fuel efficient vehicles), annual greenhouse gas emissions from vehicles are likely to be in the order of 30-35% below 1996 levels by the year 2015. In the absence of any measures, emissions from vehicles are likely to rise by around 10% by the year 2015 (BTCE 1996b, Figure 2.8). Extrapolation to the year 2020, the end year of this study, would see a further increase in the proportion of new vehicles in the fleet so that the decline of annual emissions is likely to be in the order of 35-40%, instead of an increase of around 10% under business as usual.

In addition to the reductions in greenhouse gas emissions, the decline in fuel consumption will result in reduced health costs and improved amenity from falling non-CO2 emissions. However, in the absence of tighter regulations aimed specifically at them, the non-CO2 emissions will fall by less than CO2 emissions under the present set of proposals. In assessing the net effect on urban air pollution we need to add to the 'side effects' of the greenhouse measures the effects of the measures to reduce industrial emissions described in Section 6 under the headings cleaner production and load-based licensing. As an approximation, the combined effects of these measures are expected to reduce urban air pollution in the year 2020 by around 30% below current levels. In the absence of them, urban air pollution is expected to increase by around 10% under business as usual.

In addition, the present set of proposals will not bring about a fall in vehicle kilometres travelled below projected levels, and may in fact increase them because fuel bills will fall substantially as vehicles become more efficient. As a result, the proposed measures will not tackle the problem of congestion so that further measures will need to be considered.

In sum, the package of measures – a carbon tax with revenue recycling, vehicle fuel efficiency standards and reductions in sales tax on fuel-efficient vehicles – are likely to reduce greenhouse gas emissions from the combustion of coal, gas and petroleum in Australia by around 40% over 1996 levels by the year 2020, instead of a 10-20% increase under business as usual. In addition, there is likely to be a significant gain in employment in the longer term from the reduction or abolition of payroll taxes and the adoption of renewable energy technologies. There will also be a sharp improvement in non-greenhouse gas emissions.

[24] Sales tax revenue on vehicles in 1993-94 was $2.2 billion (*).

### *4.5 Equity impacts*

We now ask whether the tax and expenditure changes described above would have a disproportionate effect on low-income households. The equity implications are more complex than implied by the usual focus on changes in real incomes due to price changes. Firstly, the employment impacts of policy measures must also be considered because unemployment is one of the principal causes of poverty. The double dividend argument and modelling evidence suggest that the taxing and spending measures may have a significant stimulatory effect on employment. The new jobs would be weighted towards blue-collar workers (McDougall and Dixon 1996, Table 5).

Secondly, there are likely to be serious equity effects arising from the business-as-usual scenario because the distribution of the impacts of climate change – health effects, food price rises, property damage, discomfort from warming – will fall more heavily on the poor. In general, poorer households suffer more severely from the effects of pollution. Poorer households would thus benefit disproportionately from the environmental improvements that would flow from greenhouse gas abatement measures.[25]

Returning to the foremost issue, that of the income effects of the carbon tax and associated measures, it is generally the case that indirect taxes are regressive. However, in the case of the carbon tax the regressivity is not as large as is commonly believed. Common and Salma (1992) assessed for Australia the distributional implications by income decile of price rises due to a carbon tax of $20 per tonne of CO2. They concluded that while prices paid by the most-affected decile (which is the second lowest) would rise by 3.00%, prices paid by the least-affected decile (the highest decile) rise by 2.62%. Thus price increases weighted by spending for the most-affected households are only 14% higher than those for the least-affected households. More precise modelling by Cornwell and Creedy (1995a, 1995b) for Australia concluded that a carbon tax large enough to achieve the Toronto target would have little redistributive effect and that transfer payments could easily be adjusted to eliminate regressive effects.

The equity impacts of the measures aimed at transportation require additional attention. The main effects on consumers are:

- an increase in petrol prices of around 7%, introduced over three years;
- a sharp increase in fuel efficiency in new vehicles within a few years and a large increase in the efficiency of the entire fleet by the end of the study period. These changes will mean that although petrol bills will rise for a few years, in the longer term fuel bills will fall markedly; and
- the prices of new smaller, more fuel-efficient vehicles will decline due to the fall in sales taxes (and scale economies as volumes increase) making them more affordable for low-income families.

[25] For a more detailed discussion of these issues see Hamilton (1996b).

As we have seen, the carbon tax taken alone has a small regressive effect. One of the reasons it is commonly believed that petrol price rises are regressive is the assumption that poorer households drive older and less fuel-efficient vehicles. The assumption turns out to be untrue. According to a recent analysis: 'if households with annual incomes greater than $80,000 (about 7 per cent of Australian households in 1993) are excluded, then the spread of vehicle ages is roughly similar for all income groups' (BTCE 1996a, Figure 6.5).

The small redistributive effect on low income households will be more than offset after some years as opportunities become available to reduce fuel bills very substantially by purchasing more fuel efficient vehicles.

Other equity impacts include reduced urban air pollution as a result of a more fuel efficient fleet, increased employment especially in blue-collar jobs due to the reduction in payroll taxes and shift to renewables, and the longer-term mitigation of climate change. Each of these would benefit poorer households proportionately more than richer households. In sum, in the absence of compensatory measures (such as changes in income tax rates or thresholds, or increases in social security benefits), the impact of the measures proposed here is likely to be slightly regressive over the first few years but to benefit poorer households disproportionately after that time.

### *4.6 Summary of measures*

The measures proposed to reduce atmospheric emissions are:

- a carbon tax on fossil fuels levied at a rate of $23 per tonne of CO2, which raises $6.3 billion per annum;
- the abolition of payroll taxes;[26]
- the introduction of mandatory fuel efficiency standards inducing a shift to a maximum technology scenario;
- the reduction of sales taxes on fuel efficient vehicles by $500 million annually.

It is anticipated that these measures will reduce annual greenhouse gas emissions from electricity generation and industrial fuel consumption to 40-50% below 1996 levels by the year 2020. In the absence of these measures, annual emissions would be around 10% higher than 1996 levels. In the case of transportation, the measures proposed here would reduce vehicle emissions by about 40% below 1996 levels instead of 10-20% higher under BAU. The average fall in greenhouse gas emissions will thus be around 40-50% instead of a 10-20% rise. In addition, non-CO2 emissions and urban air pollution will be reduced significantly. Employment will be increased, perhaps substantially in the longer term, due to both the cut in payroll taxes and the shift to renewable sources of energy.

[26] A carbon tax of $25 per tonne of CO2 would be required to both abolish payroll tax and reduce sales tax on fuel efficient vehicles by $500 million.

**Table 4.3 Summary table: Atmospheric emissions**

| | |
|---|---|
| Estimated revenue p. a. | $6.3 billion from carbon tax |
| Expenditure p. a. | $6.3 billion on pay-roll tax cuts and reduced sales tax on fuel-efficient vehicles |
| Environmental impacts<br>- greenhouse gases<br>- urban air pollution | BAU ETR<br>+10% –40%<br>+10% –30% |
| Equity impacts | Slightly regressive for first few years then progressive (especially due to avoided impacts of climate change if international measures are adopted) |
| Economic impacts | Significant gain in growth and employment (around 50,000 new jobs in short term and an additional 100-150,000 in the longer term) |

# 5. Water use and water quality

## *5.1 The current situation*

This section considers the environmental problems associated with Australia's water supply and water quality. While issues of supply and quality appear to be separate, in fact the recycling and conservation technologies now emerging tend to tackle both water shortages and declining quality together. The more natural division is between urban water issues and the problems arising from irrigation and this is the division adopted below.

Outside of urban areas, water quality in Australia is declining due to salinisation, algal blooms, turbidity, loss of biodiversity and an 80% loss of riparian vegetation (CSIRO 1995, p. 10). In the longer term, scientists fear increasing problems of acidification and toxic sedimentation. The situation in agricultural areas is especially dire; agricultural water use and run-off are the major processes affecting water quality in Australia.

In urban areas, sewage systems are being improved, although large investments remain to be made in many locations (CSIRO 1995). On the coastal zone, eutrophication of estuaries and acidity in coastal rivers are of increasing concern as are the implications of these for the marine environment. Projections indicate that Australia's coastal waters may suffer a 50% increase in town wastewater discharge by the year 2020 (CSIRO 1996).

DEST (1996a) estimates that the financial subsidy to the water supply industry is around $3.0 billion per annum most of which is attributed to the fact that water supply authorities have not made commercial rates of return on their assets.[27] In the early 1990s, real rates of return for metropolitan water utilities ranged from 4.4% in Victoria to -0.5% in the ACT. Returns were lower in non-metropolitan areas and especially low for irrigation water (DEST 1996a, Table 9, p. 65).

However, while a public utility should cover costs, there is no reason why it should earn a commercial rate of return. The appropriate rate of return for public utilities is the cost of capital to government, about 5%. To achieve this rate of return water prices need to rise somewhat. However, in addition to a reasonable rate of return on existing investments, water corporations need to meet rising standards of environmental protection requiring, in some cases, large new investments.

## *5.2 Urban water use*

In addition to new investments, reductions in water consumption and improvements in water quality require an appropriate set of incentives for water users. When price rises are required it is important that they are introduced in a form that is both equitable and provides the right signals to users. Fixed charges based, for example, on property values do not allow users to save money by reducing consumption through more efficient use or through measures such as converting lawns to native gardens. There is

[27] However, since it is not clear where the subsidy is coming from it is not clear that there is a subsidy.

consistent evidence that demand for water is sensitive to price increases. Thus price rises needed to fund investment will also reduce demand for water.

A shift to user charges for water is essential to a long-term conservation strategy. COAG advocates a two-part tariff comprising an access fee and a volumetric consumption charge. Currently a variety of water pricing methods prevail, including charges based on property values, fixed charges based on the nature of a property, fixed allocation of water units with uniform or rising block tariffs on excess consumption and one-part tariffs with no access charge. A Queensland survey of local governments found that 89 of 125 local governments currently meter their consumers. By 1998 it is expected that 93% of the State's population will be metered and 53% will be paying a two-part tariff (DLGP 1997, pp. 18-19).

When the Hunter Water Corporation introduced user charges, water consumption per household fell by around 30% (IC 1992, p. 158; DEST 1996a, p. 67).[28] Water authorities are thus moving towards replacement of fixed charges with user charges (DEST 1996a, p. 67). This is appropriate and desirable, although there are some equity issues to be considered. The licensing conditions of Sydney Water require it to reduce water consumption per capita by at least 25% on 1990 levels by the year 2000 and by at least 35% by the year 2010 (DLGP 1997, p. 15).

The system under which water services are funded by rates involves, in effect, a property tax whose proceeds are used to pay for water consumption. The shift proposed here to user charges of water means that this subsidy is removed. However, this does not necessarily imply that the previous property tax should be entirely removed. The revenue generated from user charges for water should be allocated to the uses which will generate the greatest benefit. It may not be desirable to devote the entire proceeds of user charges to reductions in water rates.[29] It may be preferable to maintain some portion of the rates and use the revenue for other purposes such as rebates to low-income households to offset any inequitable impacts of the shift to user charges and higher water prices. In other words, although property-based rates are replaced by user charges for water, some part of the rates should still be levied for other purposes.

An appropriate benchmark for urban water quality is provided by the Clean Water Program (CWP) of the Sydney region. The CWP was established in 1989 and involves spending of $7 billion over 20 years. It includes a series of major capital investments aimed at improving inland and marine water quality, restoring bush and wetlands and reducing odours. There has been marked success in some areas already (DEST 1996a, p. 81-82). The CWP has been financed in part by an environmental levy on water and sewerage accounts.

It is estimated that achievement of the targets of Sydney's Clean Water Program across Australia would cost around $3.5 billion per annum over 10 years (DEST 1996a, p. 81). The Industry Commission reported in 1992 that $2.5 billion of new

[28] Neither source reports how much water prices in the Hunter rose.

[29] In 1995-96, rates collected amounted to $5.1 billion (and land taxes an additional $1.5 billion) (ABS 1996c). Note that many councils had by this time shifted to user charges which do not appear as municipal rates.

investment in urban sewage treatment assets is needed to provide limited improvements in nutrient removal (IC 1992, p. 153).

Current thinking among Australian water experts suggests that whilst there is considerable scope over the next few years for savings in urban water use from existing water conservation measures involving changes in behaviour, the big savings in the future will also come from new recycling technologies (see Leane, 1995).

Anderson (1995) considers a number of urban water scenarios for the next century. They are set out in Table 5.1. The scenarios have markedly different impacts on patterns of water consumption and water quality due to population growth and urban expansion. The first scenario, the traditional approach, reflects projections of current usage patterns. The second scenario is based on current best-practice 'water conservation' measures while the third involves the recycling of wastewater and stormwater for non-potable uses. The fourth involves a shift to recycling for all uses including potable uses. Very large potential reductions in urban water use are projected, with the savings depending on the rate of adoption of conservation and recycling technologies. The last column of Table 5.1 shows the estimated net present value (NPV) of the investment streams required by the four scenarios.

**Table 5.1 Projected urban water use in Australia (million ML)**

| Scenario / Year | 1991 | 2016 | 2041 | 2091 | NPV $b |
|---|---|---|---|---|---|
| 1. Traditional approach | 3.12 | 4.19 | 5.25 | 7.37 | 25.5 |
| 2. Water conservation | 3.12 | 3.24 | 3.41 | 4.42 | 22.8 |
| 3. Non-potable recycling | 3.12 | 3.05 | 3.22 | 3.62 | 26.9 |
| 4. Potable recycling | 3.12 | 2.92 | 2.73 | 3.09 | 26.0 |

*Source*: Anderson (1995), Table 2
Note: NPVs are arrived at using a 7% discount rate.

These projections suggest that by the year 2041 (by which stage Australia's population is assumed by Anderson to have grown to 31 million), urban water use could be almost 50% lower than it would be under the business-as-usual approach. This saving increases to almost 60% by the year 2091. The increase between 2041 and 2091 reflects an increase in the assumed rate of adoption of the new technologies from 40% to 60% in the intervening years.

Anderson assumes a very high rate of population growth. The population of Australia is projected by the ABS to be between 24.4 and 27.1 million in 2041 (ABS 1996b), rather than Anderson's 31 million. The effect of a downward revision of population growth will be to scale down both the projected growth in water use under each scenario and the investment required.

Each of these scenarios requires a large investment program over the next decades. However, according to Anderson the recycling technologies require only slightly higher investment outlays than the traditional approach while the water conservation approach is the cheapest option. As it is better understood and less expensive than recycling, we give emphasis to the conservation approach. Prices charged to urban water users will need to rise over time to provide the funds to finance this investment in both conservation and recycling. It has been suggested that price increases in the order of 30-40% would be a reasonable approximation (Bill Leane, *pers. comm.*). Part of these may take the form of special environmental levies.

These price rises will both induce a faster shift to water conservation and provide the funds for the required investment if the decisions are made to shift to potable recycling. The spread of recycling technologies in urban areas would not only sharply reduce water consumption but would bring about a major improvement in water quality in streams and rivers as the need for discharge of treated sewage will fall very markedly.

Drawing on Anderson's projections, as a rough estimate we might expect urban water consumption to rise by up to 40% by the year 2020 under business as usual (the traditional approach) but to rise by less than 5% under a scenario of increased water conservation and recycling.

### *5.3 Irrigation*

Irrigation accounts for around 70% of water use in Australia and rural use overall accounts for around 79% of total water use (ABS 1996a, Table 6.5.3)[30]. As it accounts for 75% of irrigation water in Australia, we concentrate on the Murray-Darling Basin in this study.[31] The principal irrigated crops are fodder, rice, oilseeds, cotton, sugar and horticultural crops. In the Murray-Darling Basin irrigated agriculture yields an output valued at $3 billion per annum (MDBC 1995, p. 2).

The average natural flow in the Murray-Darling Basin is 13,750 GL/year, of which 10,684 (78%) was diverted in 1994, up by 8% since 1988 (MDBC 1995, Table 2).[32] Of this amount, 95% was used for irrigation. It is now recognised that these diversions are having a severe impact on the riverine environments of the Basin and need to be reduced and rescheduled (i.e. released at different times of the year). The impacts include:[33]

- drought-like flows that would naturally occur in one of every 20 years now occur in 12 of every 20 years;

[30] See also Industry Commission (1992) p. 23. The ABS figures are from a 1987 source.
[31] The North-East Coast and South-East Coast divisions account for most of the remaining irrigation in Australia, with around 10% each (ABS 1996a, Table 6.5.3).
[32] Note that currently allocated entitlements permit 16,902 GL to be diverted each year, 23% more than the average annual flow in the Basin (Keyworth 1996). Thus actual diversions in 1994 were only 63% of total permitted diversions.
[33] The impacts of irrigation in the Macquarie and Gwydir Valleys is reviewed by Morrison and Bennett (1997).

- more frequent and serious algal blooms due to shallower streams, greater nutrient concentrations, reduced oxygen levels and increased stagnation;

- declining domestic water quality due to rising salinity and increased costs for industries dependent on water with low mineral content;

- a dramatic decline in the condition of floodplain wetlands which 'are vital for the protection of healthy, sustainable rivers'; and

- as a result of the decline of wetlands, 'a dramatic impact on the biodiversity of the Murray-Darling Basin. There has been a serious reduction in numbers of many species of birds, fish, amphibians, insects and plants. Many of these species have become locally extinct in areas where they were once common' (MDBC 1995, pp. 26-27).

The critical reform required to prevent the further decline of the environments of the Murray-Darling Basin is the allocation of adequate water to environmental flows. This will require a cut in current diversions of 20-30% (Keyworth 1996), from 10,684 to approximately 8,000 GL/year, and changes in the seasonal flows of water in ways more in harmony with natural cycles.[34] The flood plains of the Basin require longer floods (4-6 months instead of the current 2-3 months) and floods that occur in spring and early summer. The process of increasing the volume and variability of environmental flows has begun; the Murray-Darling Ministerial Council in 1995 imposed an interim cap on diversions at their current actual levels, with a final cap to be agreed by June 1997.

Key indicators are required to assess the likely environmental impact of provision of adequate environmental flows. One such indicator would be an index of native fish survival. According to Dr Terry Hillman of the Murray-Darling Freshwater Research Centre (*pers. comm.*), it would be reasonable to conclude that if such an index stood at 100 in 1996 then in the absence of the necessary action (i.e. business as usual) the index will plummet to around 20 in the next few years. With adequate environmental flows it should rise to around 200, reflecting a return to the conditions prevailing in the Murray-Darling riverine ecosystems of 20 years ago (prior to the construction of the Dartmouth Dam.

In order to allocate the maximum off-take efficiently (after determination of adequate environmental flows) a comprehensive system of tradeable water entitlements needs to be developed and implemented. Some trade in water entitlements already occurs in the Basin – between 1988 and 1993 temporary and permanent transfers of entitlements accounted for between 1% and 4% of total water allocation (MDBC 1995, pp. 37-38). Some of the existing entitlements will need to be recovered by governments in order to permit environmental flows. Keyworth (1996) suggests three possible mechanisms:

- purchase of existing licences;

[34] This is an initial estimate only. Under the Sustainable Rivers Project, scientific committees in each of the affected states are now carrying out research to determine the appropriate environmental flow regime (Keyworth 1996, p. 6).

- non-renewal or modification of existing licences; and
- provision of new supply infrastructure (such as lining of channel systems) or new technology to improve efficiency of water use.

The second would be the cheapest option for governments. In the case of the third option, it is hard to see why the tax-payer should subsidise investments in water efficiency that will solely benefit private producers. Efficiency gains will be sought by producers as the volumes to which they are entitled are reduced.

Keyworth (1996) argues that there are unlikely to be significant costs to irrigation industries from reduced entitlements because the effect of capping water off-takes will be to constrain future expansion of the industry (which may benefit existing producers) and because major savings in water use can be had cheaply through a range of physical, technological and managerial measures. The Industry Commission argued that higher charges for irrigation water are likely to induce farmers to invest in water-saving technology and to induce other farmers to switch to dry-land farming (IC 1992, pp. 158-59).

### *5.4 Equity impacts*

For urban water consumers the policy changes advocated here have two aspects that may affect equity – the shift from property-based charges to user charges and the 30% increase in average water prices.

Neutze (1995) argues that, while a shift from taxes to user pricing may well be regressive for services funded from general tax revenue (such as education, health and public transport), a shift from specific taxes or access charges to user pricing may not be regressive at all. Property-based water rates for urban households may be more regressive than volumetric water pricing so the transition to the latter may benefit low-income households disproportionately.[35]

On the other hand, the 30% increase in the price of water per litre will lead to higher water bills in the absence of reductions in consumption. However, the introduction of user charges provides all households with the opportunity to reduce their water bills by using less water, something denied to them under a system of property-based access charges. Even large reductions in water consumption can be had without any increased risks to health and safety, although there may be some loss of amenity (such as reduced enjoyment from gardens). Overall, the proposed changes in urban water pricing are unlikely to have a regressive impact. However, if more detailed analysis

[35] The issue is complex. Property-based charges may well be progressive with respect to gross wealth, but regressive with respect to income since there are large numbers of low-income households that own valuable family homes. According to Neutze (1995), in 1988/89 when rates were the main source of revenue for water, sewerage and drainage services, those rates as a proportion of total expenditure for the lowest income quintile were 2.4 times higher than for the top income quintile. A study by the Tasman Institute examined the change in expenditure by customers of Sydney Water over the seven-year period 1987-88 to 1994-95, a time in which, among a number of reforms, there was a substantial shift from property-based to user charges. Spending on water by the five lowest income groups fell by 0.062% of their incomes while that of the five highest income groups fell by 0.065% (Neutze 1995). While property-based charges may be progressive with respect to gross wealth, they may be less so with respect to net wealth.

reveals that some poorer households would be disadvantaged then some part of the previously levied water rates should be retained in order to fund rebates to those households.

### *5.5 Summary of measures*

The measures proposed to reduce water consumption and improve water quality are:

- a 30% increase in urban water prices along with a nation-wide shift to user charges in place of property-based charges;
- a $25 billion long-term investment program in water conservation and recycling projects funded by price increases;
- rebates on rates for low-income households adversely affected by price rises;
- capping of irrigation off-takes in the Murray-Darling Basin at 25% below current levels; and
- introduction of a full-scale system of tradeable water permits for the Murray-Darling Basin.

**Table 5.2 Summary table: Water use**

| | | |
|---|---|---|
| Estimated revenue (p. a.) | Urban water charges up 30%<br>Investment program of $25 billion over 20 years in conservation and recycling | |
| Environmental impacts<br>- urban water consumption<br>- irrigation water use<br>- Murray-Darling ecosystem health | BAU<br>+40%<br>–10%<br>–80% | ETR<br>+5%<br>–30%<br>+100% |
| Equity impacts (urban) | Probably neutral | |
| Economic impacts | Reduction in water costs for industry | |

# 6. Solid and industrial wastes

### *6.1 The current situation*

The problem of solid waste disposal is attracting a great deal of attention and legislative action overseas. The European Union has targeted certain waste streams for priority legislative action, including used tyres, end-of-life vehicles, construction and demolition waste, clinical waste and electronic and electrical waste (DRI 1994, p. 82).

According to the Commonwealth EPA, in 1991 Australians disposed of more than 14 million tonnes of solid domestic, commercial and industrial waste (CEPA 1992; HORSCERA 1994, p. 59). This is one of the highest levels of waste per capita in the world. Of the total, household waste accounts for about 50%, commercial wastes for 35-40% and building and demolition wastes 15%.

In Australia in 1989, volumes of household waste per person collected by councils stood at 354 kg in Sydney and 338 kg in Melbourne. They were lower in other cities with the exception of Hobart (ABS 1996a, Table 9.2.1). In Sydney, putrescibles made up 48% of the total weight, paper 21%, glass 9%, metals 6%, plastics 8% and other 8% (ABS 1996a, Table 9.2.4). The figures for Melbourne are very similar.

In recent years, kerbside recycling schemes have been adopted by many local councils. In 1993, 49% of the population lived in local government areas with kerbside collection schemes (ABS 1996a, Table 12.1.3.8). Many households participate in other recycling schemes in addition to or instead of kerbside collections. As a result, growth in the annual volume of solid wastes going to landfills has slowed to the point where, in many areas, the volume has been falling (ABS 1996a, p. 324 & Table 12.1.3.6).

In metropolitan regions landfill areas are becoming more scarce and expensive. The Industry Commission estimated that in 1993 the total cost of solid waste collection and disposal in Australia was $675 million (of which two thirds were the costs of collection and one third the cost of disposal) (Industry Commission 1993, p. 51). However, outside of metropolitan areas some private companies own large landfill areas, a fact that is expected to keep landfill prices low for the foreseeable future (Cheryl Battergol, *pers. comm.*).

The environmental problems associated with solid waste disposal include: pollution of ground water and surface water through leaching; impacts on habitat from dust; health impacts from leaching and dust, and from the release of toxic substances through incineration; the contribution of landfill to greenhouse gases; and, loss of amenity due to odour, litter and visual pollution. In addition, availability of relatively cheap landfill encourages excessive use of ‘disposable’ resources.

NIEIR argues that leaching is causing substantial costs. It estimates that the environmental subsidies to solid waste disposal amounted to roughly $140 million in 1994, assessed mainly as the expenditures that would be necessary to meet tighter environmental regulations to reduce leaching to an acceptable standard (DEST 1996a,

pp. 90-92). The latter would require pits to be lined with impermeable materials such as clays or high density polyethylene.

In 1991, the Commonwealth developed with the States the National Waste Minimisation and Recycling Strategy (NWMRS) aimed at reducing waste generation, increasing recycling, treating harmful wastes and improving safe disposal. It set targets for a range of waste categories with the overall aim of reducing solid waste disposal in landfills by 50% on a per capita basis by the year 2000.[36] According to estimates by the Commonwealth EPA in 1996, the targets are unlikely to be achieved for some plastic containers, liquid paperboard and oil, but are likely to be met or exceeded in the cases of PET bottles, glass and aluminium containers, newsprint and paper packaging. Overall, progress on achieving the national target of a 50% reduction has been 'insufficient' (ABS 1996a, Table 12.1.3.5). The HORSCERA report indicated that progress is being constrained primarily by lack of commercial viability of recycled inputs (HORSCERA 1994, p. 60).

The 50% per capita cut in wastes to landfill is probably the maximum that can be expected under current methods of production and recycling, and using the methods envisaged by the NWMRS. However, under policies being developed by the Victorian Environment Protection Authority (EPA), solid wastes going to landfills could be cut to 20% of current levels over the next 20 years. The Victorian EPA has developed a waste minimisation hierarchy that emphasises 'reduce' as the preferred option, moving to reuse and recycle, with disposal the least-preferred option.

While in practice to date much of the waste minimisation focus has been on recycling and composting, in some cases there have been significant gains in the more preferred approaches of reduction and reuse. In the case of industrial waste, radical reductions in resource use, waste generation and emissions are feasible with a wholesale shift to cleaner production, along with a range of measures to increase the rate of recycling.

### *6.2 Cleaner production*

To date, the emphasis of policy has been on waste minimisation through recycling and composting. Emphasis is set to shift to 'the other end of the pipe', that is, to reducing the volumes of materials used in production. This is known as cleaner production and refers to industrial processes that emphasise the 'reduce' component of the slogan 'reduce, re-use, recycle'. Adopting the UNEP definition, HORSCERA defined cleaner production as 'conserving raw materials and energy, eliminating toxic materials, and reducing the quantity and toxicity of all emissions and wastes before they leave a process. It is achieved by applying know-how, by improving technology and by changing attitudes' (HORSCERA 1994, p. 40). Cleaner production has particular relevance to commercial and industrial waste generators, rather than to households.

[36] However, the Victorian Recycling and Resource Recovery Council has indicated that up to two thirds of waste can be diverted to re-use or recycling (quoted in NIEIR 1996, pp 86-87). It is reported that around 48% of paper, 62% of aluminium cans and 42-44% of glass are collected for recycling in Australia. The percentage for plastics is much lower (HORSCERA 1994, p. 62).

Australian manufacturing industry in the early 1990s is estimated to have spent $278 million on 'end-of-line' environmental measures and only $77 million on 'change-in-production' measures. The principal industries in the former category are (in descending order of expenditure) non-ferrous metals, chemicals, iron and steel and petroleum refining, and in the latter category petroleum refining, iron and steel and non-ferrous metals (ABS 1996a, Table 13.2.7).

The evidence indicates that a large proportion of firms that introduce cleaner production technologies and processes enjoy significant cost savings (HORSCERA 1994, pp. 40-41).[37] Some successful Australian examples are reported in Box 6.1. Given that cleaner production increases profits, we must ask why it has not been more widely adopted. A major reason is that businesses lack the information on new technologies and methods. Another reason is that some firms want unrealistically short payback periods on their investments.

Widespread adoption of cleaner production will depend on persuading firms that it is in their commercial interests to do so. Thus the Victorian EPA has developed a program of advice, demonstration and support for targeted firms. In Queensland, a similar approach is being taken by the Cleaner Production Taskforce, a tri-partite initiative of government, business and universities. Firms that successfully adopt cleaner production are encouraged to promote its application elsewhere in their industries. In addition, industry organisations are urged to promote cleaner production as a service to their members.

Currently the Victorian EPA both runs specific cleaner production programs and promotes the cleaner production philosophy through the full range of its programs. It spends approximately $12 million annually on its approval and licensing system. Only $600,000 is spent annually on direct promotion of cleaner production but an additional $500,000 to $1 million in staff time is devoted to implementing or enshrining cleaner production practices. There is scope to expand this type of program and extend it to other states. The annual cost would be around $6 million. Such a program could have a major impact on materials use and emissions at both ends of the pipe. The effect of the program would be reinforced by a subsequent move to require mandatory corporate reporting on measures taken to reduce discharges to the environment.

Taken alone, such a program would be expected to reduce wastes and emissions per unit of output by the year 2020 by 25-30% while resource use per unit of manufacturing output could be reduced by 15-20% (Chris Baker, *pers. comm.*) Under current policies the figures are likely to be in the order of 10-15% for emissions and 5-10% for resource use. However, the impact of cleaner production will be redoubled if load-based licensing is also adopted.

[37] HORSCERA (1994, pp. 42-43) also points out that in some industries the introduction of cleaner production may result in some job losses.

**Box 6.1 Examples of cost savings from adoption of cleaner production**

**BASF**, manufacturers of latex products, lost valuable products and used large volumes of water in lines used to pump acrylic latex products. By changing production schedules and using reversible pumps, BASF made savings in productivity, water costs, waste disposal fees and down-time. The volume of latex flushed away was reduced by 85%. The payback period for the investment was 4 months.

**Ford Australia** used caustic cleaning of paint in its car assembly plant creating dangerous working conditions and environmental discharges. Ford switched to using high-pressure water jets. Chemicals, and thus disposal costs, have been eliminated from this process and heating costs have been cut. The pay-back period on the investment was 5 months.

**Con Agra's** wool scouring process generated sludge and solid waste that was costly to dispose of. It was also a heavy water user. The introduction of hydrocyclones and other changes to processing waste are expected to reduce sharply BOD and solids discharged into sewers and save 60% on liquid waste disposal costs. The payback period on the investments is 1.3 years.

*Source:* Victorian EPA

### *6.3 Load-based licensing*

Victoria introduced a system of load-based licensing for industrial and commercial polluters in 1991 and NSW has followed suit more recently. Licence fees are tied to the volume and nature of pollutants emitted thus providing a financial incentive to reduce emissions. According to the NSW EPA: 'By encouraging licence holders to adopt technical and managerial innovations over time, the scheme has the potential to reduce the economic impact' of achieving the Government's pollution and waste minimisation objectives (EPA NSW 1996, p. 6). Load-based licensing represents a shift away from regulations that limit concentrations of certain pollutants to imposing fees according to actual load or mass discharges of pollutants, backed by absolute maximum load limits. Reflecting a polluter-pays philosophy, licence fees are linked directly to pollutant loads.

Load-based licensing schemes include industry-specific and pollutant-specific emission targets. NSW has specified both short-term and long-term targets for a range of pollutants.[38]

[38] For example, in the case of sewage treatment plants the short-term target for suspended solids is 0.7 kg/person while the long-term target is 0.088. The targets for all metals discharged from sewage plants are 0.036 kg/person in the short-term and 0.004 kg/person in the long-term. In the case of

Currently, Victoria collects approximately $12 million in load-based licence fees. The impact of existing systems of load-based licensing is difficult to assess at this stage, but they appear to be significant motivating factors in reducing pollution. In addition to the penalties for pollution, the Victorian EPA has developed the Accredited License Scheme which provides for a 25% reduction in license fees for the best performers in an industry. To gain accreditation firms must adopt an approved environmental management system, subject themselves to an external audit and develop an environmental improvement plan in consultation with the local community. Experience suggests that while a 25% cut in license fees may be trivial financially, especially for large companies, the benefits of being an accredited firm can be very substantial. The reported benefits include improved public relations, easier access to finance for investment and exemption from most works approval requirements.

It is proposed to extend load-based licensing to all States and territories and increase licence fees over the next 5 years. This is expected to raise around $50-60 million in revenue, enough to finance the extensive cleaner production programs described above.

The combination of load-based licensing and promotion of cleaner production proposed here is expected to reduce emissions per unit of industrial output by 45-55% over current levels and resource use by 25-30%. Under present policies the figures are likely to be a reduction of around 20% for emissions and 10% for resource use. Since industrial production is likely to approximately double between now and the year 2020, these figures imply that under current policies total wastes and emissions will increase by around 60% and materials use will increase by 80%. With extensive adoption of cleaner production and load-based licensing total emissions will not change while materials use will increase by around 40%.

HORSCERA reports figures that indicate that a reduction of waste disposed of by 50% and concomitant expansion of recycling would create several thousand new jobs (1994, p. 60). The economic and employment effects of a large-scale shift in water conservation/recycling and solid waste changes could be substantial if account is taken of the technological advantage that is likely to evolve. It is worth quoting from the 1994 House of Representative inquiry into green jobs:

> Worldwide, the market for environmental goods and services is already larger than the aerospace market. While the world market for the pollution control and waste management sectors of the industry are expected to grow by at least five per cent per year, a much higher growth rate is forecast for South-east Asia which will provide substantial opportunities for Australian industry (HORSCERA 1994, p. xv).

Based on OECD estimates, the inquiry found that employment in the Australian pollution control industry could grow by at least 20,000 by the year 2000. If Australia could capture just 2 per cent of the world market by the year 2000, 'some $8 billion of business could generate 150,000 jobs'. Two per cent is quite achievable. The

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petrochemical works, the short-term target for fine particulates is 0.02 kg/tonne manufactured while the long-term target is 0.003 kg/tonne (EPA NSW 1996, Appendix 5).

Industry Commission noted that the Asia-Pacific region provides the greatest potential source of export sales for the Australian waste management sector.

> Moreover, many of the environmental priorities in Asian countries are linked closely to areas of Australian EWMESS [Environmental Waste Management Equipment, Systems and Services] firms' strengths. The most immediate environmental problems for developing countries include unsafe drinking water and inadequate sewage treatment (Industry Commission 1993, p. 55).

### *6.4 Domestic and commercial wastes*

Turning to the problems of domestic and (non-industrial) commercial waste generation and disposal, at present most waste collection is funded by property-based charges. However, property-based charges for household and commercial waste disposal are ineffective in persuading households and firms to reduce wastes generated. A number of studies have shown that user pays charges set according to volume are effective at reducing wastes and encouraging recycling.

A US study found that replacing a property tax financing system for collection of household waste with a fee of US$1.50 per bag (a fee that covers the marginal cost of collection and disposal) would reduce household waste by 18%. When combined with a free kerb-side recycling program the waste volume is reduced by over 30% (Repetto et al., 1992, p. 18). A large proportion of households, up to half in some areas, find that they pay less for garbage services under a pay-by-the-bag system than under a flat-fee system.

In Australia, according to the recent NIEIR study: 'Many councils still do not have specific garbage rates and even fewer adopt charging systems for garbage that are based on pay-by-volume or pay-by-weight basis. There is, therefore, little incentive for residents to minimise their waste' (DEST 1996a, p. 88).[39] However, voluntary recycling stimulated by effective collection systems (including big bins) have proven to be very effective at increasing the volume of waste recycled.

In addition, there may be difficulties with applying pay-by-volume schemes to households, including the problem of illegal dumping and use of neighbours' bins. There are also equity concerns as poorer households may be required to pay a larger proportion of their income than under property based systems.[40]

The main obstacle to the continued growth of household and commercial recycling is the instability of markets for recycled materials. Prices paid for recycled glass and paper can fluctuate sharply and this instability may discourage investment in recycling plant and equipment. However, markets for virgin materials, including some that compete directly with recycled materials, also fluctuate and producers adapt to this. There may be some scope for policies to stabilise the markets for recycled materials, but a better policy response would be to implement measures to give recycled

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[39] Plastic shopping bags account for 11% of plastic waste collected on Clean Up Day Australia 1995 (ABS 1996a, Table 9.2.8). It is claimed that a charge of 10 cents per bag would reduce consumption substantially (*Canberra Times* 21 August 1996).

[40] But see footnote 35 for evidence on the regressivity or otherwise of a shift from water rates to user charges.

materials a price advantage that fully reflects the external environmental benefits associated with recycling. Abolition of sales taxes on all recycled materials and mandatory purchasing of recycled paper by government agencies would make a major contribution to promotion of recycling.

Charging full cost recovery for landfill services would raise the costs of goods that generate substantial wastes and should be encouraged. This would provide an advantage to goods that are recyclable and promote more efficient use of materials. In addition, the current best-practice kerb-side recycling schemes in Australia should be extended to all municipalities with priority given to major urban areas. Outside of urban areas the emphasis should be on hazardous wastes.

Introduction of kerb-side recycling and landfill charges can have a dramatic impact on the volumes of waste going to landfill. Some waste management authorities have developed a 'no waste to landfill' strategy, with the aim of reducing waste to zero. In the ACT considerable progress has been made along this path under its 'No Waste by 2010' strategy. Total wastes to landfill fell 39% between 1993/94 and 1995/96, from 416,000 tonnes to 252,000. This was due principally to the introduction of waste disposal charges. Over the same period, the introduction of kerb-side recycling saw the volume of recycled materials collected rise 125% from 118,000 tonnes to 265,000 tonnes. The household participation rate is 98% (ACT Government 1996). The ACT strategy and performance is far ahead of almost all other parts of Australia.

The extension of the best waste management schemes, including landfill charges and recycling, to all areas in Australia could see waste to landfill largely disappear over the next 20 years. Under current policies we are likely to see wastes to landfill stabilise or fall slightly.

### *6.5 Equity impacts*

There are no significant equity implications of the policies advocated here. However, to the extent that the sharp reductions in wastes and emissions improve the quality of the environment in residential areas, we would expect low-income households to benefit disproportionately.

### *6.6 Summary of measures*

The following measures are proposed in order to bring about a major reduction in materials used in production and an increase in recycling.

- implement an extensive demonstration program for cleaner production and subsequent move to mandatory corporate reporting on measures taken to reduce discharges to the environment at an expected cost of $6 million per annum;

- implement a comprehensive system of load-based licensing for industrial and commercial polluters through Australia, raising $50-60 million per annum;

- introduce full cost-recovery charges for landfill;

- invest $140 million (funded by landfill charges) over 5 years in renovating tips to sharply reduce environmental problems associated with leaching, odours and spread of materials;

- extend best-practice kerb-side recycling to all local government areas with priority given to major urban areas;

- abolish sales taxes on recycled materials and require all government agencies to use recycled paper.

**Table 6.1 Summary table: Solid and industrial wastes**

| | |
|---|---|
| Estimated revenue p. a. | Load-based licensing system: $50-60 m<br>Increased land fill charges |
| Expenditure measures p. a. | Demonstration of cleaner production: $6 m<br>Improvements to tips: $140 m over 5 years<br>Abolish sales tax on recycled materials |
| Regulatory and other measures | Government purchasing of recycled paper<br>Extension of kerb-side recycling |
| Environmental impacts<br>- industrial wastes<br>- industrial materials use<br>- household and commercial wastes | BAU ETR<br>+60% 0<br>+80% +40%<br>–10% –90% |
| Equity impacts | None |
| Economic impacts | Expansion of employment (100-150,000) due growth of pollution and waste management industries<br>Some short-term job losses with cleaner production<br>Increased profits due to cleaner production |

# 7. Natural amenities

## *7.1 The current situation*

The pressures on natural amenities in Australia vary from region to region. While there are several positive trends in natural amenity values, amenity values in coastal and urban areas and some agricultural regions are declining under pressure from 'overcrowding, pollution and overuse' (CSIRO 1995, p. 19). While the task of repairing seriously degraded rural landscapes is beginning to be addressed, the adverse impacts of population drift to the coasts and the explosive growth of inbound tourism are not being systematically tackled.

The growth of tourism is placing pressures on some local environments. Few studies to date have provided numerical estimates of the impacts of tourism, but some case studies and anecdotal evidence give cause for concern. The ABS provides some case study material (ABS 1996a, pp. 276-282). In Tasmania's Southwest National Park, growing tourist numbers are causing 'rapid deterioration in the condition of walking tracks' measured by trampled and removed vegetation, increased mud depth, erosion and introduction of weeds and soil pathogens. However, discussions with experts indicate that walking trails in Australia's tropical forests are not suffering any environmental damage.

Tourism is one of Australia's largest and fastest growing industries. In 1993-94 total expenditure by tourists amounted to $46.9 billion, approximately 6.6% of GDP. Inbound tourists (i.e. overseas tourists) contributed $10.6 billion to the economy in 1993-94. The Tourism Forecasting Council (1996) has estimated that inbound tourist numbers will more than double in the next decade, from 3.7 million in 1995 to 8.8 million in 2005, an average annual growth rate of 8.9%. Export earnings from international tourism to Australia are expected to grow from $13.1 billion in 1995 to $31 billion in 2005.

Access to Australia's natural attractions is a major determinant of the growth of inbound tourism. According to the Australian Tourism Commission, more than 70% of inbound tourists nominate Australia's unique flora and fauna and open landscape as the main reasons for their visit (ABS 1996a, p. 273). Data from the International Visitors Survey show that beautiful scenery, natural wonders, wildlife, attractive beaches and cleanliness have a major influence on the choice of Australia by overseas visitors. In 1994 around half of overseas tourists visited a national park or similar natural attraction, and over half visited a zoo or marine park (Bureau of Tourism Research 1994).

In 1991-92, government expenditure on Australia's national parks, reserves and wildlife protection amounted to at least $563 million (ABS 1996a, Table 13.2.3).[41] At present, most of the management costs for Australia's natural attractions are met by Australian tax-payers.[42] Significantly higher management costs are expected in the

[41] Using a different classification, NIEIR (DEST 1996a, pp. 114-115) estimates public agency expenditure on parks and flora and fauna conservation at $449.1 million in 1994-95.

[42] The Great Barrier Reef Marine Park charges a fee of $1 per head on tourists. The Federal Government raised the fee to $6 in the 1996-97 budget. Fees are also charged to enter Kosciusko and

future, particularly with the rapid increase in visitation that will place far greater pressure in the quality of environments.

### *7.2 Proposed measures*

To the extent that the management costs of parks and other attractions are met wholly by Australian tax-payers, the failure to charge overseas tourists for use of the parks represents a subsidy by the tax-payer to overseas tourists and the tourist industries. This is neither efficient nor equitable.

One solution is to charge all users, Australian and overseas, a fee to cover fully the costs of maintaining the parks. However, for the following reasons the imposition of full cost user charges for national parks and other reserves is not an appropriate response:

- there are equity and ethical objections to charging Australian citizens the full cost of park management on entry, not the least of which is the fact that non-users benefit from the existence of the parks. In addition, access to areas of natural value should not be limited by ability to pay. Thus high entry, camping or other fees would be at odds with the social objective of giving all Australians the opportunity to experience nature; and

- the administrative costs of imposing user charges may be large, especially for remote areas with low visitation rates.

For the Australian community, general taxation is the appropriate means of funding the management of national parks, with some role for user charges in suitable cases. The appropriate means of ensuring that overseas visitors make an adequate contribution to the cost of maintaining and, where necessary, repairing natural amenities in Australia is to apply an environmental management fee to overseas visitors. At present, passengers departing Australia (both foreigners and Australian citizens) pay a Passenger Movement Charge ('departure tax') of $27. This fee is collected by airlines or their agents when passengers purchase tickets, so the administration of the charge is easy and cheap. The Passenger Movement Charge (PMC) was designed to cover both the costs of customs, immigration and quarantine services and the cost of issuing visas to tourists. In 1995-96, revenue from the PMC was $147.8 million, which exceeded the costs of customs, immigration, quarantine and visas by $19.1 million (Auditor-General 1996). Almost $100 million was collected from overseas visitors and the remainder from departing Australians.

It is proposed to double the PMC to $54 for departing foreign passengers in order to cover some of the costs of maintaining Australia's natural attractions. However, the cost increase for most foreign visitors would be offset by the abolition of visa requirements, discussed below. The charge for Australian citizens should remain at $27. The additional charge on foreign tourists should be ear-marked and clearly identified as an 'environmental levy' devoted to maintaining and improving the quality of Australia's natural attractions. In 1993, the average expenditure in

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Uluru National Parks and, until recently, Kakadu National Park. For others, see NIEIR 1996 Table 18, p. 111.

Australia by all visitors to Australia was a little under $1800; for those engaged in a number of nature-based activities the average ranged from just over $2,000 to well over $3,000 (ABS 1996a, pp. 129-130). The environmental levy would have no appreciable impact on the demand for Australian tourism and, if marketed effectively as an environmental levy devoted to preserving and improving the natural amenities of Australia, could actually increase demand. The increased PMC would generate additional revenue of over $100 million in the short term, rising to around $240 million in 2005. These funds would make a significant contribution to the cost – currently totalling around $500 million – of managing Australia's national parks, reserves and wildlife.

It would be feasible to reduce the basic PMC on foreign visitors by abolishing the visa requirement for overseas tourists from low-risk countries. Representatives of the tourist industry have been arguing for some time that in an era of sophisticated information technology visas are unnecessary. Visas may impede inbound tourism as there are considerable compliance costs for tourists and their agents. The administrative cost of the visa system in Australia has been estimated by the tourism industry at $3 million per annum (Tourism Council of Australia, 1996). By abolishing the visa requirement for visitors from low-risk countries, the total charge on foreign visitors would be increased to approximately $42 instead of $54.

It is difficult to assess the impact of the proposed changes on the condition of Australia's natural amenities. In a climate of fiscal restraint, pressure on the budgets of park and wildlife management agencies is increasing and the services provided by those agencies are constrained. As a very rough approximation based on a number of professional opinions, the general condition of natural amenities under a properly funded program of repair and protection would improve somewhat, while in the absence of well-funded initiatives under business as usual the condition will decline somewhat over the years to 2020.

Given the potential for real damage to some of Australia's natural amenities, the provision of adequate funding for parks and other attractions through the imposition of the environmental levy on foreign tourists will work in the longer term interests of the tourism industry. In addition, the view of Australia from abroad is dominated by images of unspoiled natural features with an environment relatively free of industrial blight. This image is fragile and could be lost quickly if natural amenities were allowed to decline, if diseases broke out in domesticated and wild animals or if pollution were left uncontrolled. Maintaining the 'clean, green' image has major economic advantages not only for the tourism industry but also for Australia's $13 billion of annual food exports.

### *7.3 Equity impacts*

The proposals outlined here would have no significant negative effects on social equity. By protecting the key assets on which the inbound tourist industry depends, the measures may assist in sustaining employment growth in the tourism, hospitality and related industries as well as food export industries.

### *7.4 Summary of measures*

The following measures are proposed in order to protect and repair the natural amenities of Australia:

- increase the Passenger Movement Charge (PMC) on departing foreign tourists from $27 to $54. This measure will initially raise around $100 million per annum increasing to around $240 million in 2005;

- abolish visa requirements for overseas tourists from low-risk countries, permitting the PMC for tourists from those countries to be set at $42 (instead of $54); and

- use the revenue raised to fund the management of Australia's national parks, reserves and wildlife protection, including new and expanded programs of protection and repair.

**Table 7.1 Summary table: Natural amenities**

| | |
|---|---|
| Estimated revenue p. a. | $100 million in 1997 rising to $240 million in 2005 |
| Expenditure measures p. a. | $100 million rising to $240 million to be allocated to national parks and other natural amenities |
| Environmental impacts<br>- improvement in national parks and other reserves (figures rough indicators only) | BAU ETR<br>−10% +10% |
| Equity impacts | No negative, assist in maintaining employment growth in tourism, hospitality and related sectors |
| Economic impacts | Contribute to longer term viability of inbound tourist industry and food exports |

# 8. Native forests

## *8.1 The current situation*

The previous section dealt principally with effective management of the environmental values of protected ecosystems in national parks and reserves. This section deals with the loss of environmental values due to forest operations in native forests.

In this section we distinguish between high and low conservation value native forests. High conservation value native forests may be defined as those forests determined by scientific assessment to be likely to contribute significantly to long-term maintenance of the biota and the ecosystem processes on which they rely. This definition covers perhaps 60-80% of native forests currently available for logging, including privately owned land (Hamilton 1995).

In a recent statement the National Biodiversity Council, Australia's peak scientific body concerned with the conservation of biological diversity, wrote that it 'is extremely concerned at the continuing threats to biological diversity in Australia's native forests. It believes that current forest management (including the level and manner of logging) is having a severe effect on biological diversity causing local and regional extinctions' (National Biodiversity Council 1996, p. 2).

A recent study of financial subsidies compared timber revenues with forest management expenses of the forest management agency in Victoria, the Department of Conservation and Natural Resources (DCNR). Dragun (1995) concluded that the financial subsidy to the Victorian native forests logging industry is at least $50 million per annum.

A thorough study by Read Sturgess of the logging and water values of the Thomson Catchment, which provides part of Melbourne's water supply, showed that if account is taken of the impact of logging on water yields from the catchment then the existing forest management regime is the least efficient of the alternatives considered and that the net present value of the resource could be increased by $147 million if logging were prevented altogether (Read Sturgess 1992).

Apart from the direct financial subsidies to logging, if the prices of native forest logs included compensation for some of the external environmental costs of logging then they would be much higher than at present. This would undoubtedly give a substantial price advantage to the main competing product for native hardwoods, that is, plantation softwood for sawn timber and softwood and recycled paper for pulp and paper production. (Plantation hardwoods account for about 10% of existing plantations and will make an important contribution to hardwood woodchip supplies in the future.)

In view of the fact that the environmental damage from native forest logging is much greater than that of plantation forestry, it is anomalous, to say the least, that state forest management agencies charge higher royalties for softwood logs than for hardwood logs, around 30-40% higher according to 1991-92 ABS data (ABS 1995, Table 4.6). According to Victoria's Auditor-General the DCNR sets royalties for

hardwood sawlogs at an average of $21 per $m^3$ while the royalty for pine plantation sawlogs is $38 per $m^3$, 90% higher (see Hamilton 1995).

In the face of the apparently heavy subsidies to native logging it is remarkable that plantation softwoods have in fact been driving hardwoods from the market for some years. This trend will continue. In 1994, plantations supplied 9.6 million $m^3$ of logs while native forests supplied 10.3 million $m^3$. In 2005, while native forests are not expected to supply any more, the volume of logs from plantations is expected to grow to 18.5 million $m^3$ (Clark 1995). As demand for sawn timber is not expected to grow over the next decade, this suggests that native forest timber will be largely driven from the market for commodity-grade timbers. The faster this occurs the better the conservation outcomes will be.

### *8.2 Proposed measures*

It would be inappropriate to attempt to use economic instruments to protect the environmental values of high conservation value native forests. It is not a question of the 'optimal level' of logging but one of environmental standards based on scientific and ethical principles. The appropriate instrument is thus regulation, viz. a simple ban on all logging in these forests. Opinion polls and economic studies of willingness to pay have repeatedly shown that such a move would have the support of a large majority of Australians (on willingness to pay see Hamilton 1995). However, it would be inequitable if timber workers were required to shoulder, through job losses, the costs of a decision on behalf of the majority. A suitable compensation and retraining package is required.[43]

The appropriate policy response is to provide for the costs of phasing out logging in high conservation value forests over 2-3 years by increasing the royalties on remaining logging of native forests. This would not only provide some means of internalising the costs of environmental damage, but would hasten the transition to a plantation-based industry. It is proposed to increase the royalties charged on native forest logs to an average of $42 per $m^3$ for sawlogs and $15 $m^3$ for pulp logs. In the case of sawlogs this represents increases over 1991-92 levels of 30-40% for NSW and Victoria and 100% for Tasmania (ABS 1995, Table 4.6).

If the volume of timber from native forests is reduced over three years from 10.3 million $m^3$ to 4 million $m^3$, these royalty increases would generate additional funds of around $100 million in the first year declining to $40 million after three years. In response to these price changes, hardwoods would increasingly be replaced by softwoods in markets for commodity grade timber so that hardwoods would be confined largely to markets for high value-added appearance grade timber products. As a result the surplus royalties would decline further.

These funds would be dedicated to providing for compensation and retraining for displaced timber workers, some of whom would find employment (after additional training) in the plantation-based industry. The NSW Government has recently announced an effective halving of quotas for timber taken from native forests and is

[43] For a more detailed discussion of compensation and retraining packages see Streeting and Hamilton (1991).

funding the transition with a $120 million package (half provided by the Commonwealth). Thus the bulk of the new funds could be devoted to off-setting the structural adjustment costs of phasing out logging in the high conservation value forests of Victoria, Tasmania and Western Australia.

The phasing out of logging, rather than an immediate ban, will mean some decline in the environmental values of high conservation value native forests – notionally we might anticipate a decline of around 10% as around 10-20% of the remaining high conservation value forests will be logged before the ban is fully imposed. In the absence of this policy it is likely that all of the remaining unprotected high conservation value forests will be logged within the next decade or so. Notionally, if logging continues we might expect the environmental values of these forests to decline by perhaps 60%.

### *8.3 Equity impacts*

The equity effects of the proposed measures will be negative or positive depending on the changes in the timber industry under business as usual. If, as argued above, commercial pressures will see plantation softwoods largely drive native hardwoods from markets for most timber products, then workers dependent on logging of old-growth forests are destined to lose their jobs anyway (just as 20,000 jobs have been lost in the industry over the last 20 years due to structural change in the industry). In those circumstances a package of measures that brings forward their movement out of the industry and provides compensation and retraining will have a positive impact on equity. In our view, this scenario is the more likely one.

If, on the other hand, one believes that the native forest timber industry would continue to maintain its market share then the banning of logging in high conservation value native forests will mean the loss of jobs that would otherwise be preserved. The proposed compensation and retraining package would not offset all of the negative equity effects of the proposal to ban logging in high conservation native forests.

It is sometimes agued that protection of forests and other places of natural beauty is a middle-class preoccupation. However, survey evidence consistently shows that poorer households support protection of these areas as strongly as wealthier households (see Hamilton 1996b).

### *8.4 Summary of measures*

The following measures are proposed in order to protect the environmental values of high conservation value native forests and to assist the transition to a timber industry based predominantly on plantations:

- a ban on logging in high conservation value native forests phased in over 2-3 years;

- increase the royalties charged on native forest logs to an average of $42 per $m^3$ for sawlogs and $15 $m^3$ for pulp logs; and

- use the revenue generated by increased royalties (around $100 million in the first year declining to $40 million after three years) to fund a compensation and retraining package for displaced timber workers.

**Table 8.1 Summary table: Native forests**

| | |
|---|---|
| Estimated revenue p. a. | $100 million declining to $40 million |
| Expenditure measures p. a. | Compensation and retraining package – $100 million declining to $40 million p.a. |
| Environmental impacts<br>- environmental values of native forests (notional measure only) | BAU ETR<br>–60% –10% |
| Equity impacts | Probably positive |
| Economic impacts | Bringing forward probable job losses in native forest logging industry |

# 9. Overview of impacts of the ETR package

We now draw together the environmental, economic and equity impacts of the ecological tax reform policy package described in this paper. Implementation of the package would bring about a major transition in the economy that would place Australia on the path to a truly sustainable economic structure. The essence of the package is a set of economic instruments that induce a large-scale shift in technologies and behaviours across the economy, including the household sector.

*Environmental impacts*

The expected environmental impacts of the ETR package are summarised in Table 9.1. The table shows the likely change in a range of indicators between 1997 and 2020 under both the business as usual and ETR scenarios. A downward-pointing arrow indicates a deterioration in environmental quality by 10% (which may be an increase in resource use or emissions) while an upward-pointing arrow represents a 10% improvement in environmental quality (which may be a decline in emissions or resource use).

It is apparent that most aspects of Australia's natural environment will deteriorate if governments adopt the business-as-usual approach. Under the ecological tax reform package of measures, most indicators improve and some of them improve sharply.

*Economic impacts*

In developing each of the policy instruments put forward in the ecological tax reform package consideration has been given to the economic impacts on the sectors directly affected and the wider economy. The economic impacts have been assessed principally in relation to the likely impacts on economic growth and employment.

The carbon tax-payroll tax trade-off would have the most substantial impact on the economy overall, with perhaps 50,000 additional jobs over the first few years and more if the low initial rate of carbon tax were subsequently increased and the revenues used explicitly to stimulate labour-intensive investments. In addition, the shift to renewable energy technologies – which could be very substantial after the initial shift to natural gas in electricity generation – is also likely to result in net employment creation because of the greater employment intensity of renewable technologies compared to the prevailing technologies, especially coal-fired power stations.

In addition, beyond the first 5-10 years there could be very substantial benefits to growth and employment from the development and widespread adoption of a range of pollution control and waste management technologies, especially if Australia can gain some market leadership in the Asia-Pacific region. Numbers are difficult to forecast, but job growth in the order of 100,000-150,000 is probably quite achievable. This sort of job growth would more than offset the minor job losses that may result from the adoption of cleaner production.

**Table 9.1 Summary of environmental impacts (changes between 1997 and 2020 under BAU and ETR scenarios)**

| ***Environmental indicator*** | ***Business as usual*** | ***ETR*** |
|---|---|---|
| *Atmosphere* | | |
| Greenhouse gas emissions | ⇓ | ⇑⇑⇑⇑ |
| Urban air pollution | ⇓ | ⇑⇑⇑ |
| *Water* | | |
| Urban water use | ⇓⇓⇓⇓ | 0 |
| Irrigation water use | ⇑ | ⇑⇑⇑ |
| Riverine ecosystem health | ⇓⇓⇓⇓⇓⇓⇓⇓ | ⇑⇑⇑⇑⇑⇑⇑⇑⇑⇑ |
| *Waste* | | |
| Industrial wastes and emissions | ⇓⇓⇓⇓⇓⇓⇓ | 0 |
| Industrial resource use | ⇓⇓⇓⇓⇓⇓⇓⇓⇓ | ⇓⇓⇓⇓ |
| Volume of household and commercial wastes to landfill | ⇑ | ⇑⇑⇑⇑⇑⇑⇑⇑⇑ |
| *Amenity and forests* | | |
| State of national parks etc | ⇓ | ⇑ |
| Environmental values of native forests | ⇓⇓⇓⇓⇓⇓⇓ | ⇓ |

⇓ : *deterioration* of 10% between 1996 and 2020 (i.e. 10% increase in environmental pressure)

⇑ : *improvement* of 10% between 1996 and 2020 (i.e. 10% decrease in environmental pressure)

The other major employment impact of the ETR package arises not from the creation of new jobs but the prevention of job losses in sectors that depend on maintaining the quality of the natural environment. The tourism-related industries are the most important sectors in this regard. On the other hand, the rapid phasing out of logging in high conservation value native forests would bring forward some job losses that are very likely to occur over the next 10 years anyway as a result of the commercial dominance of plantation timbers.

In sum, over the longer term the tax reform package described in this report could result in a net increase in employment in the vicinity of 250,000 jobs as well as the protection of jobs in the tourism-related industries that are at risk from degradation of natural amenities.

*Equity impacts*

As a rule, poorer households suffer disproportionately from environmental degradation and benefit disproportionately from improvement in environmental quality. This is especially true with respect to the impacts of climate change, urban air pollution, industrial wastes and water quality.

As for the effects of the ETR package, the carbon tax and fuel efficiency standards will have a small regressive effect in the first few years but will then permit households to reduce their fuel bills substantially. The shift to user charges for urban water consumers is unlikely to have a regressive impact but the increase in water prices may need to be offset by rebates to poorer households for some years. After that time households will be able to reduce their water bills substantially through water conservation and recycling.

In the forestry sector, the compensation and retraining package will have a positive effect on equity if the workers in question are likely to lose their jobs anyway as a result of commercial pressure from the plantation sector.

Finally, it should be noted that the job growth due to the carbon tax-payroll tax trade-off will benefit blue-collar workers disproportionately. Overall, the long term effect of the ETR package will be to improve social equity as a result of both the ETR measures themselves and the environmental improvements they bring about.

## References

ABS 1995, *National Balance Sheets for Australia: Issues and Experimental Estimates 1989-1992,* ABS Catalogue No. 5241.0 (AGPS: Canberra)

ABS 1996a, *Australians and the Environment,* ABS Catalogue No. 4601.0 (AGPS: Canberra)

ABS 1996b, *Projections of the Populations of Australia, States and Territories, 1995-2051,* ABS Catalogue No. 3222.0 (AGPS: Canberra)

ABS 1996c, *Taxation Revenue Australia,* ABS Catalogue Number 5506.0 (AGPS: Canberra)

ACT Government 1996, *No Waste by 2010: A waste management strategy for Canberra* (Department of Urban Services: Canberra)

Anderson, J. M. 1995, 'Water Conservation and Recycling in Australia: Scenarios for Sustainable Urban Water Use in the 21st Century', Paper to the AWWA 16th Federal Convention

Auditor-General 1996, *Passenger Movement Charge: Australian Customs Service Performance Audit* (AGPS: Canberra)

Barker, Terry 1995, 'More Jobs, less Pollution', *New Economy*, Vol. 2, No. 3 (Autumn) Institute for Public Policy Research, London

Barker, T. & Johnstone, N. 1993, 'The Interdependence of Equity and Efficiency Objectives in Fiscal Policies to reduce Carbon Emissions in the Domestic Sector', Energy-Environment-Economy Modelling Discussion Paper No. 6, Department of Applied Economics, University of Cambridge

Bertram, Geoff *et al.* 1993, *Energy and Carbon Taxes: Reform Options and Impacts,* Report prepared for the New Zealand Ministry of the Environment by Simon Terry Associates and BERL (Wellington)

Bouma, W. J., Pearman, G. I. Manning, M. (eds) 1996, *Greenhouse: Coping With Climate Change* (CSIRO Publishing: Melbourne)

British Wind Energy Association 1997, 'Employment in Wind Energy in the UK' (BWEA website)

Bureau of Industry Economics 1995, *Economic Impact of Reducing Greenhouse Gas Emissions in Australia: A Survey of Recent Studies,* Occasional Paper 24 (AGPS: Canberra)

Bureau of Tourism Research (BTR) 1996, *International Visitor Survey 1995* (BTR: Canberra)

Bureau of Transport and Communication Economics (BTCE) 1996a, 'Costs of reducing greenhouse gas emissions from Australian cars: An application of the BTCE Carmod model', *Working Paper 24,* BTCE April 1996

Bureau of Transport and Communication Economics (BTCE) 1996b, *Transport and Greenhouse: Costs and options for reducing emissions*, Report 94, (AGPS: Canberra)

Clark, Judy 1995, *Australia's Plantations: Industry, Employment, Environment* (Environment Victoria: Melbourne)

Common, M. & Hamilton, C. 1996, 'The economic consequences of carbon taxation in Australia' in *Greenhouse: Coping With Climate Change*, edited by W. J. Bouma, G. I. Pearman and M. Manning (CSIRO Publishing: Melbourne)

Common, Michael & Salma, Umme 1992, 'Australian carbon dioxide emissions and energy use', Report to the Energy Research and Development Corporation (Centre for Resource and Environmental Studies, ANU: Canberra)

Cornwell, Antonia & Creedy, John 1995a, 'Carbon Taxation, Prices and Inequality in Australia', Research Paper Number 481, Department of Economics, University of Melbourne, September

Cornwell, Antonia & Creedy, John 1995b, 'The Distributional Impact of Fuel Taxation', Research Paper Number 462, Department of Economics, University of Melbourne, May

CSIRO 1995, 'Australia's Environmental Futures: Brief report to workshop participants', (CSIRO Division of Wildlife and Ecology: Canberra) September (prepared by Barney Foran)

CSIRO 1996, *Wastewater Re-use, Stormwater Management and the National Water Reform Agenda* (CSIRO: Canberra)

DEST 1996a, *Subsidies to the use of Natural Resources*, Environmental Economics Paper No. 2 (DEST: Canberra)

DEST 1996b, *Australia: State of the Environment 1996* (CSIRO Publishing: Collingwood)

DLGP (Department of Local Government and Planning, Queensland) 1997, 'COAG Urban Water Resource Policy Reform', Discussion Paper, February

Dragun, Andrew 1995 'The Subsidisation of Logging in Victoria' (mimeo, La Trobe University)

DRI 1994, *Potential benefits of Integration of Environmental and Economic Policies: An incentive-based approach to policy integration*, Report prepared for the European Commission (Graham & Trotman Ltd: London and Kluwer Academic Publishers: Norwell, USA)

Environment Protection Agency (EPA NSW) 1996, *Load-Based Licensing Scheme: Draft Operational Plan*, Environmental Economic Series, May

Gee, David 1995, 'Notes on Environment Taxes and Economic Tax Reform', London, July

Gee, David & Tindale, Stephen 1995, 'Thinking Green: Eco-nomic Tax Reform', *Public Policy Review*

Goulder, Lawrence 1995, 'Environmental Taxation and the Double Dividend: A Reader's Guide', *International Tax and Public Finance* 2: 157-183

Grubb, Michael *et al.* 1993, 'The Costs of Limiting Fossil Fuel CO2 Emissions: A Survey and Analysis', *Annual Review of Energy and Environment* 18:397-478

Hamilton, C. 1994, 'A Comparison of Emission Sources and Emission Trends Among OECD Countries', *Background Paper No. 1,* The Australia Institute (December)

Hamilton, C. 1995, 'The Economics of Logging High Conservation Value Native Forests', *The Economic and Labour Relations Review*, Vol 6, No 2, December

Hamilton, C. 1996a, 'Ecological Tax Reform', Paper to 'Visions for a Greener Future' Conference, Environment Protection Authority, Melbourne, April 1996

Hamilton, C. 1996b, 'Generational justice: the marriage of sustainability and social equity', *Australian Journal of Environmental Management,* Vol 3 No 3, September 1996, pp. 163-73

Hensher, D. & Young, J. 1991, 'Demand Forecasts and Demand Elasticities for Australian Transport Fuel', Occasional Paper 103 (Bureau of Transport and Communications Economics: Canberra)

HORSCERA 1994, *Working With the Environment: Opportunities for Job Growth*, Report of the House of Representatives Standing Committee on Environment, Recreation and the Arts (AGPS: Canberra)

Industry Commission 1991 *Costs and Benefits of Reducing Greenhouse Gas Emissions,* Report No. 15 (AGPS: Canberra)

Industry Commission 1992, *Water Resources and Waste Water Disposal*, Report No. 26 (AGPS: Canberra)

Industry Commission 1993, *Environmental Waste Management Equipment, Systems and Services*, Report No. 33 (AGPS: Canberra)

Industry Commission 1996, *Tourism Accommodation and Training*, Report No. (AGPS: Canberra)

Keyworth, Scott 1996 'The Allocation Challenge' (Draft) Murray-Darling Basin Commission

Leane, William 1995, 'Issues in pricing Re-use Water in the ACT', Paper to the Ecological Economics Conferences, Coffs Harbour, November

McDougall, R. A. & Dixon, P. B. 1996 'Analysing the Economy-wide Effects of an Energy Tax: Results for Australia from the ORANI-E Model' in *Greenhouse: Coping With Climate Change*, edited by W. J. Bouma, G. I. Pearman and M. Manning (CSIRO Publishing: Melbourne)

McMichael, A. J. et al. (eds) 1996, *Climate Change and Human Health* (World Health Organisation, Geneva)

Morrison, M. and Bennett, J. 1997, 'Water Use Trade-offs in the Macquarie and Gwydir Valleys', *Choice Modelling Research Report No. 2*, University College, UNSW (Canberra)

Murray-Darling Basin Ministerial Council (MDBMC) 1995, *An Audit of Water Use in the Murray-Darling Basin* June 1995 (MDBMC)

National Biodiversity Council 1996, 'Statement on the Implications for Biodiversity of the Commonwealth-State Forest Policy', 18th January

National Greenhouse Gas Inventory Committee (NGGIC) 1996, *National Greenhouse Gas Inventory 1988-1994: Summary and Analysis of Trends* (DEST: Canberra)

Neutze, Max 1995, 'Comments on "The Social Impacts of Pricing and Institutional Reforms within the Sydney Water Board" by the Tasman Institute', Report Commissioned by EPAC (The Australia Institute: Canberra)

OECD 1996, *Implementation Strategies for Environmental Taxes* (OECD: Paris)

Pearce, D. W. *et al.* 1995 'The Social Costs of Climate Change: Greenhouse Damage and The Benefits of Control', Draft paper for the Intergovernmental Panel on Climate Change, Working Group III

Read Sturgess and Associates 1992, 'Evaluation of the Economic Values of Wood and Water for the Thomson Catchment', Report prepared for Melbourne Water

Read Sturgess and Associates and Tasman Economic Research 1994, 'Phase Two of the Study into the Economic Evaluation of Wood and Water for the Thomson Catchment', Report prepared for Melbourne Water and Department of Conservation and Natural Resources

Repetto, R., Dower, R., Jenkins, R. and Geoghegan, J. 1992, *Green Fees: How a Tax Shift Can Work for the Environment and the Economy* (World Resources Institute: Washington)

Sorensen, Bent (1997) 'Impacts of Energy Use' in M. Diesendorf and C. Hamilton (eds), *Human Ecology, Human Economy: Ideas for an Ecologically Sustainable Future* (Allen & Unwin: Sydney)

Streeting, Mark and Hamilton, Clive 1991 *An Economic Analysis of the Forests of South-Eastern Australia*, Resource Assessment Commission Research Paper Number 5 (AGPS: Canberra)

Tourism Forecasting Council 1996, *Forecast*, Vol 3, No 1, November

Treasury 1996, 'Hypothecation' in *Economic Roundup*, Summer 1996 (Commonwealth Treasury: Canberra)

US Department of Energy 1996, 'The Jobs Connection: Energy Use and Local Economic Development' (US DOE website)

Wilkenfeld, G., Saddler, H. and Hamilton, C. 1995, 'Australia's Greenhouse Strategy: Can the Future Be Rescued?', Australia Institute *Discussion Paper* Number 3 (The Australia Institute: Canberra