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COMMISSION

Recycling

Volume I: Recycling in Australia

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INDUSTRY
COMMISSION

22 February 1991

The Honourable P J Keating, M.P.
The Treasurer
Parliament House
CANBERRA   ACT   2600

Dear Treasurer

In accordance with Section 7 of the Industry Commission Act 1989, we submit to you the report on Recycling.

Yours sincerely

M L Parker	R G Mauldon	T Hundloe	D R Chapman
Presiding Commissioner	Commissioner	Commissioner	Associate Commissioner

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Acknowledgement

The Commissioners wish to thank those staff members who assisted them preparing this report. The staff team was led by Dr Geraldine Gentle.

Terms of reference

I, PAUL JOHN KEATING, in pursuance of Section 23 of the Industries Assistance Commission Act 1973 hereby:

1. refer the question of recycling of products for inquiry and report by 28 February 1991

2. specify that the Commission report on

   (a) the current level and possible costs and benefits of recycling, both in terms of economic and environmental considerations

   (b) any institutional, regulatory or other arrangements subject to the influence of governments in Australia which affect the incentives to recycle or re-use products, and advise on their effects and on any appropriate changes to these arrangements

3. specify that the Commission is free to hold public hearings in advance of releasing a draft report and to take evidence and make recommendations on any matters relevant to its inquiry under this reference.

P.J. Keating

18 October 1989

THE REPORT

This report is in two volumes:

Volume I: Recycling in Australia - an analysis of the incentives to recycle and the prospects for further recycling. The Commission's findings and conclusions are in this volume.

Volume II: Recycling of products - information on the recycling of particular products, and some of the costs and benefits.

Recycling has many links with waste management. The Commission has therefore issued a separate information paper which examines waste management practices and draws upon a survey of local government authorities in Australia.

In a separate reference (see Appendix A) the Commission was asked to prepare an interim report on the effects of government policies on, and the economic and environmental costs and benefits of, recycling of paper products. That Interim Report on Paper Recycling was completed on 21 May 1990. Public hearings to receive comment on the Interim Report and on the draft report for this inquiry were held during November and December 1990.

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OVERVIEW AND FINDINGS

The reprocessing and re-use of metals and some other materials has occurred for thousands of years. Where used materials have a high value relative to the costs of collecting and reprocessing them, they have found a ready market. Most of the gold that has ever been refined is still in use around the world.

The last two decades have seen growing community involvement in recycling, associated with concerns about the environment and resource conservation. There has been pressure on governments to force the pace of recycling, and governments at all levels have been keen to respond in a positive way.

There is no doubt that governments can engineer higher recycling rates. But should they? Would it make the community better off, both economically and environmentally? These are questions to which this report is addressed.

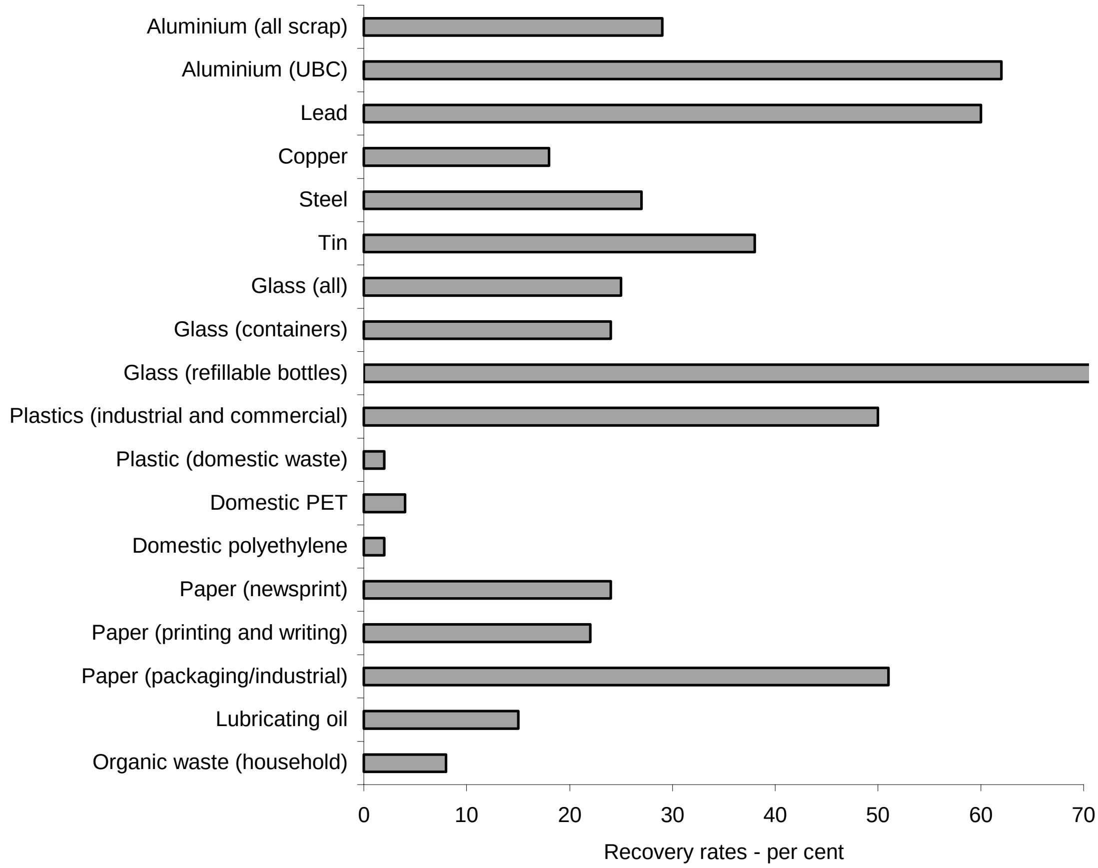
Substantial recycling is occurring

Australia recovers for reprocessing about a third of all paper and aluminium and a quarter of all glass consumed in this country (see Figure 1). About a quarter of Australia's tyres are retreaded. Materials with low values relative to costs of collection and processing do not find such ready markets.

Sometimes materials are technically recyclable, but reprocessing is uneconomic compared with production from virgin materials. In other cases technical constraints limit the use of reclaimed materials. This helps explain the comparatively low levels of reprocessing of old newspapers and plastic containers.

The high recovery rate for aluminium beverage cans (62 per cent) reflects the ease and cost effectiveness with which uncontaminated metal can be remelted for further use. In glass manufacture costs rise more than proportionately where recycled glass (cullet) exceeds about 50 per cent. The recycling of paper is inevitably a downgrading process unless new or higher quality fibre is added.

Figure 1: Extent of recycling in Australia



For many years Australian paper manufacturers have been using substantial quantities of wastepaper; recycled wastepaper is a good substitute for virgin fibres up to certain proportions. However, packaging papers and boards which contain a high proportion of waste have not been labelled ‘recycled’. They have been produced to conform with performance specifications. For packaging papers the consensus is that Australia is close to the economic limit for the use of recycled pulp.

The bulk of recyclables come from industrial sources. This is to be expected because collection costs are low and the quality of the scrap is high, being homogeneous and clean. Reprocessors have a long tradition of collecting scrap metals and other wastes from industry, and some now have their own post-consumer collections (eg paper, glass).

Less than 1 per cent of plastic from the household waste stream is reprocessed.

This is partly because it has to be downgraded when reprocessed, so it becomes less valuable, and partly because costs of collection from households are high.

Householders have shown a willingness to sort glass, newsprint, PET (polyethylene terephthalate) and used aluminium beverage containers, but are not prepared to clean used steel food cans - a prerequisite at present for their reprocessing. The community's growing interest in making recyclables available for collection, means that supplies sometimes outstrip demand - as with old newspaper during much of the past two years.

About 60 per cent of Councils throughout Australia are involved in the collection of recyclable materials from households. Some Councils provide, or pay contractors for, kerbside collection schemes; many provide drop-off facilities for paper, glass, aluminium, plastics and oil. Some 'subsidise' the collection of recyclables as part of their waste management. However, kerbside collections can be quite marginal operations and swing from boom to bust with fluctuations in prices of used materials, as recently seen with the price of old newspapers.

New initiatives

The main opportunity to increase the volume of paper recycling is to make newsprint using old newspapers and magazines. If plans to produce recycled newsprint go ahead, the recovery rate for newsprint in major cities on the eastern seaboard will need to rise to about 55ÿper cent within two years. The de-inking and recycling plants proposed by Australian Newsprint Mills at Albury (New South Wales) and Boyer (Tasmania) will not do much to assist paper recycling outside the eastern seaboard. But there are already large scale mills using wastepaper in the production of packaging and industrial papers in all States other than South Australia and Tasmania. A third of the waste newsprint recovered in Australia is exported for recycling overseas, and the export market will remain a preferred disposal outlet for some supplies.

Small but increasing quantities of high quality wastepaper are used in the production of printing and writing papers. Australian Paper Manufacturers has recently announced successful trials with 100 per cent recycled photocopy paper. Western Australia has a new plant producing tissues on a small scale from high quality wastepaper.

Other pulp-based projects are planned in several States.

The commercial incentive to invest in recycling is strengthened by the perception of some firms that their existing markets would be more secure if they were seen to support recycling. This helps to explain new investments in the recycling of PET, HDPE (high density polyethylene) and PVC (polyvinyl chloride). It also underlies the support which Australian newspaper publishers have given to the export of old newspapers pending the establishment of new facilities to recycle newsprint.

By taking these initiatives, firms have set out to forestall what they have seen to be more costly government initiatives such as container deposit legislation or mandatory recycling requirements. Nevertheless, there is a danger that the recycling of some products will be pushed with the acquiescence of the principal firms to the point where there are considerable net costs to society. This appears to be the case with the recycling of PET bottles.

In South Australia, deposit legislation has applied to certain containers since 1975. While reuse of glass bottles is high in that State, the container deposit arrangements inhibit the use of other beverage containers which could be recycled and may reduce incentives to collect a wider range of used household materials.

Large quantities of recyclable materials still remain in the waste stream. However, greater recovery of paper, glass, aluminium and plastics could make only a limited contribution to reducing waste as these materials make up a comparatively small proportion of the waste stream. A major inroad would require more recycling of industrial waste, organic materials such as garden refuse, and building materials.

Recycling an integral part of waste management

In 1989, government waste management authorities, primarily local Councils, disposed of 12.8 million tonnes of waste. About 3 per cent was diverted to recycling.

Amongst the potential benefits of recovering more of this waste are the avoidance of waste disposal costs, including a reduced call on increasingly scarce landfill space near major cities.

Recycling is also a useful means of preventing pollution from waste.

Many Councils and waste management authorities may not be charging enough to cover the real costs to the community of waste disposal and provide for site replacement and environmental costs. If the charges for waste disposal are too low, there is an incentive to discard rather than recycle used materials. Disposal charges in Sydney, Melbourne, Brisbane and Perth - the major recycling centres - have been increasing in response to the higher costs of new landfill sites and tighter environmental requirements. This trend is expected to continue. Rising costs will increase the incentives to divert materials for recycling.

The net costs to Councils of arranging for the kerbside collection of recyclables can be set against the avoided costs of waste disposal. In many parts of Australia these costs are likely to be low, but they exceed $30 per tonne in inner Sydney and Melbourne. Some Councils, particularly in Melbourne, have spent more on developing and running recycling schemes than they have saved through avoided disposal costs. Ratepayers may of course support these higher levels of recycling, but at present few ratepayers would be aware of the real costs of waste disposal or the real costs and benefits of recycling schemes.

Charges for *industrial waste* are normally levied according to the quantity. In most Australian cities, charges for liquid wastes and some solid wastes such as tyres vary with the type of waste and the cost of treatment. This provides a direct link between the waste generated and the cost of disposal. However, if the charge is less than the real cost of waste disposal, including environmental costs, too much waste will be disposed of and recycling will not be encouraged.

Charges for *household waste* collection are normally levied through property rates. Waste charges therefore bear no relationship to quantities or types of waste and there is no direct financial incentive for households to reduce waste. This means that firms and households have very different incentives to manage their waste efficiently.

In the right circumstances volume-based household garbage charges, in conjunction with collection of recyclables at lower charges, could significantly reduce waste disposal and increase recycling.

Councils which face high costs for waste disposal, in particular, could benefit by replacing rate-based charges with volume-based charges. Their residents would then have an incentive to make recyclables available in order to reduce their disposal costs. Individual Councils are in the best position to assess the worth of particular recycling/waste management strategies in their own localities.

Volume-based household garbage charges could affect the profitability of firms collecting recyclables. Increased participation would tend to reduce the cost per unit of material collected, but an increase in the proportion of bulky material (eg newspapers) could add more to costs than to returns.

Where disposal costs, including site replacement and environmental costs, are low, the preferred option from both an economic and environmental/ conservation viewpoint can be to dispose of waste in secure landfills. This is likely to be the case in many rural areas. While it may seem wasteful to dump materials which could be recycled, it can be sound to do so if the transport and associated energy costs are too high to profitably move the material to a reprocessor or export market. For this reason, efficient levels of recycling vary between States and between regions within States.

Recycling has environmental benefits

Recycling can defer or avoid altogether some waste materials entering the natural environment. For instance, in Australia the recycling of about 90 per cent of old car batteries avoids some dangerous pollution in landfill. Used oils, solvents and many other chemicals and dangerous substances are treated for further use. Until such time as the use of CFCs (chlorofluorocarbons) is eliminated, recycling of CFCs can avoid further damage to the ozone layer.

Recycling can also help in litter abatement, but bigger anti-litter gains may be achieved by other means. Problems of plastic in the marine environment, for instance, are not likely to be overcome by recycling.

Compared with production from virgin materials, the processing of recovered materials can lead to less use of energy and less pollution. This is because reprocessing starts with a material which is already refined.

Energy savings are possible through the recycling of many materials from many sources. Indeed, the savings in energy during reprocessing help to determine whether the recycling of many products is commercially worthwhile.

But the manufacturing stage is just part of the process. A considerable part of the energy needed to recycle paper, for example, is in collecting and transporting the wastepaper. Thus, striving for uniform levels of recycling, regardless of location, does not make good economic or environmental sense.

Recycling can reduce the emission of greenhouse gases. Whether the benefits are significant in global terms, or there are more effective ways of reducing these emissions, are issues which extend well beyond this report.

The reprocessing of recovered materials is not always pollution free. Certain reprocessing technologies create residues which are difficult to treat. The acid-clay process for rerefining waste oil is one example where the residual sludge has contaminated land. Whether the use of recycled material is less polluting than virgin material can only be assessed on a project by project basis.

The effects of de-inking and repulping wastepaper are relatively benign, using currently available technology and modern inks which do not contain heavy metals, but de-inking does produce salt in effluent. The location of de-inking facilities and the policies adopted to manage salinity problems are therefore important in assessing the environmental effects of paper recycling. These issues, which are associated with the proposal to establish de-inking facilities at Albury, illustrate the trade-offs that the community has to make in deciding whether to recycle significantly greater quantities of paper.

Part of the incentive to recycle waste is the perception that it will help to conserve resources. The recycling and reuse of packaging, in particular, is encouraged by many in the community who see value in promoting a more frugal and less wasteful society.

The emphasis upon packaging means that a great deal of effort goes into extending the recycling of materials which account for only one tenth of total urban waste by weight. It also means that the focus is upon products such as PET bottles which are conspicuous in litter, even though they form a small part of the waste stream and do not have major adverse environmental effects. Some of these recycling schemes may bring no net gain to the community.

This is not to say that recycling cannot contribute to the community's broadly defined objective of conserving resources. As well as saving energy, the recycling of materials such as copper, aluminium and glass may help to extend the life of some mineral deposits. However, as most of our minerals are exported, more recycling in Australia will not significantly slow down the rate of extraction in this country.

The assessment of 'environmental friendliness' requires much more information than is generally available. The findings in this inquiry, though based on inadequate environmental information point to the danger of policies which focus on purported environmental attributes of particular materials or processes with scant regard to economic criteria. Such an approach is just as dubious as one which focuses too narrowly on commercial criteria to the exclusion of important environmental considerations which should be part of any economic evaluation.

Recycling and forests

The argument that recycling conserves natural resources can, of course, extend to renewable resources such as trees.

Pulp and paper can be produced from wood and many non-wood fibres, including recycled fibres. Developments in paper making technology are extending the range of products in which wastepaper can be used in the fibre mix while maintaining paper quality. However, it is unlikely that more paper recycling will do much to conserve Australia's native forests. There are several reasons for this:

- Over half the wood used in the production of pulp and paper in Australia is softwood, largely plantation pine.

- Apart from plantation pine, much of the wood fibre used in paper manufacture is a by-
linters are considered as well, only one quarter of the total fibre used in Australian paper manufacture comes from broadleaved (mainly eucalypt) pulpwood.

- Hardwood is a significant input into the production of printing and writing paper. However, production. These forests are managed for sawlog production with pulpwood produced as a by-product.

The main opportunity to increase paper recycling is by reprocessing newspapers and magazines into newsprint. But even if firms proceed with current recycling proposals, the main effect will be to substitute recycled fibre for imported pulp and paper. There will be little effect on Australia's native forests. It may help to preserve forests abroad.

It is nevertheless important that Australia's forests (and mineral resources) are properly priced. If they are underpriced they will be used in preference to recycled materials. But the rationale for proper pricing is not to encourage recycling, or even resource conservation per se. Rather it is to ensure that resources in their totality are used efficiently and where they are most valuable.

Most States require that their forest services earn a 3 or 4 per cent real rate of return. This is lower than the long term bond rate. Changes in forestry management practices and pricing policies are needed if the community is to earn even the required rate of return. This could mean higher royalties for some hardwood sawlogs, or shorter rotations, or some combination of these approaches. It is unlikely that either change would much alter the incentives to use recycled fibre. However, increasing competition from overseas softwood producers, plus the possible shortening of softwood rotations resulting in a greater supply of pulplogs at the expense of sawlogs, point to a likely decline in the cost of producing softwood pulp. This may make paper recycling less commercially attractive.

What should governments do?

Although recycling in Australia is primarily in the hands of the private sector, governments at all levels have some influence:

- local governments influence recycling indirectly through their waste disposal policies and directly through their collection systems;

- State Governments influence recycling through their environmental and industry development initiatives, their own purchasing policies and their controls over local government. South Australia has deposit legislation applying to certain beverage containers and Victoria has negotiated recycling targets with industry; and

- the Commonwealth Government can have an influence through its co-ordinating role in environmental matters, and its powers over customs and excise duties and sales tax.

Governments are also involved in community education about recycling. But the effects of government mostly come about unintentionally by conditioning the ways in which various recycling-related markets work.

The incentives for efficient recycling are influenced, for example, by the ways in which governments enforce standards for pollution control. Given the right environmental controls, and waste disposal charges that cover the full costs of disposal (including environmental costs), people would be well placed to make the right social decision when it comes to discarding their waste. Recycling may be their preferred option.

Inappropriately priced services (electricity, transport, water supply) or resources (minerals, forests) can influence incentives to re-use waste materials rather than virgin materials. Whether this favours or penalises recycling, there is a cost on the community. Improvements in these areas, for example in transport and on the waterfront, would benefit the community in their own right. Their effect on recycling would be indirect.

To date, governments in Australia have refrained from using measures of the type which have brought major imbalances and inefficiencies in some parts of the United States - for instance the requirement that publishers use a specified proportion of recycled newsprint. Nevertheless, there is considerable support in Australia for the view that producers and consumers should be induced to undertake more recycling. Differential sales tax arrangements, compulsory deposits and voluntary targets already apply to certain products and there is growing interest in the use of environmental policies aimed at making producers responsible for their products ‘from cradle to grave’. The Commission has examined the various measures proposed.

The scope for special sales taxes in Australia is limited by the Constitutional division of powers and the requirement that Commonwealth taxes be uniform throughout the country. The sales tax exemption that already applies on certain 100 per cent recycled papers has some adverse effects. While promoting additional recycling of the targeted papers, it increases the costs of those papers that have traditionally relied on recycling.

Deposit schemes work best when the costs of improper disposal are high and cheaper alternatives are ineffective. The Commission has not found a convincing case for compulsory deposit schemes in the Australian context for any products reviewed in this report.

Retreading can defer the disposal of used tyres. But retreading is a declining activity in Australia. Given the problems of disposal in landfill or by incineration, and the risk of severe environmental damage if dumps of used tyres catch fire, consideration of an environmental tax as part of a regulatory framework for disposing of old tyres could have merit. The funds raised could go towards shredding and landfill charges and to support alternative means of disposal. However, governments should first attend to environmental controls over the storage and disposal of tyres. With reforms in these areas and in disposal charges there is likely to be no compelling need for an environmental tax.

Most advocates of the ‘from cradle to grave’ concept propose its introduction for products such as packaging. However, most packaging does not impose high environmental or other social costs. Liability for waste disposal should rest where the costs to the community are lowest, not necessarily at an arbitrary stage in the production or consumption process. Where illegal or thoughtless disposal of packaging is a significant problem, it should be addressed in the least-cost way.

These special measures aside, there are areas where governments can make a positive contribution to efficient recycling:

- Some regulations which inadvertently constrain the use of recycled products or recovery of recyclable materials warrant review. Changes in health regulations, for example, may be needed to accommodate new technologies which could enhance the prospects for reprocessing PET.

- Building and construction regulations need review where they unnecessarily impede the use of second-hand and demolition materials.

- Minor changes in the design of buildings could help in the segregation and collection of recyclables.

- The setting of standards for some recyclables could play a role in improving consumer choice. But standards should not be used to secure markets for recyclables which could not be sustained in a more competitive environment.

- Governments could speed up decision making and help the community resolve the environmental and other trade-offs involved in proposals such as establishment of de-inking facilities at Albury.

In some areas it is sufficient that governments take the lead in testing recycled products or buying them where this is warranted on price and quality grounds. However, governments need to be better informed, and assist the community to be better informed, about:

- the performance characteristics of recycled products such as paper, oils, tyres, building materials;

- the full costs of disposing of products such as tyres, batteries, oil, chemicals and used chemical containers; and

- the prices at which users gain access to the community's natural resources.

Recycling is not costless. When environmental and other goals can be achieved more efficiently by other means, there is no case for governments to force the pace of recycling. Recycling should not be seen as an end in itself.

Findings

The reference asks the Commission to report on current levels of recycling, possible costs and benefits, government arrangements which affect incentives to recycle and appropriate changes to these arrangements.

Current levels of recycling

Levels of reprocessing are given for specific products in Volume II and are summarised in Chapter 2 of this Volume. The levels vary from industry to industry, product to product, place to place and over time.

The actions of governments have an influence on incentives, but ultimately the level of recycling is the outcome of decisions made by large numbers of people in firms and households.

Benefits and costs

The benefits and costs, both economic and environmental, of recycling specific products, are discussed in Volume II. Chapters 3 to 6 of this Volume deal with them in the broad.

Appropriate changes to government arrangements

Governments cannot be expected to determine efficiently how much recycling of each product should occur now or in the future. But, by changing arrangements in some areas, governments can contribute to more efficient recycling:

Waste management and collection of recyclables... - Chapters 3 and 4

1. Recycling is an alternative to waste disposal. Consequently reforms in waste management can have an immediate effect on recycling. There is evidence that waste management charges in many areas are:

- too low to allow Councils to meet the financial costs of waste disposal and make adequate provision for site replacement and environmental costs;
- poorly structured because they do not vary with the quantity of waste disposed by individual ratepayers.

Both reduce the incentive to recycle.

2. Councils should observe the following principles in relation to waste management and recycling:

- kerbside collections for waste disposal and for recycling to be treated as integral parts of waste management;

- waste disposal charges to reflect the real costs (including environmental) of waste collection and disposal and, in areas where waste disposal costs are high, vary with the amount of waste collected for disposal;

- charges for recycling collections to be set with reference to costs of collection, less the value of the collected material to reprocessors, and to vary with the volume collected for recycling.

3. Where volume-based charging is too costly to implement, it is appropriate for Councils to provide financial support for the collection of recyclables, up to the avoided waste collection and disposal costs.

Environmental Controls ... - Chapters 4 and 5

4. There is a need to clamp down on waste disposal practices which impose significant environmental costs. If the 'price' of disposing of harmful materials is too low, the incentive to recycle will also be too low. But the pollution and litter control policies of governments should be based on the real net costs of environmental damage and not driven by recycling objectives.

5. Efficient recycling is not advanced where governments give priority to readily identifiable, but not significant, elements of the household waste stream (as with South Australia's container deposit legislation and Victoria's recycling targets).

Resource pricing ... - Chapters 6 and 7

6. Where natural resources are appropriately priced, markets can provide a reasonable guide as to what makes good conservation sense. However, if governments underprice resources such as forests, electricity or water, some producers are likely to have an incentive to use more virgin and less reprocessed material.

7. The Commission has not found evidence of underpricing of pulpwood that would have significantly affected the decisions of Australian paper manufacturers to use wood rather than reprocessed fibres.

8. Changes are needed in the management and pricing policies of Australia's forest services in order to bring about a higher return to the community's forest resources.

The changes would have major implications for the *sawlog* industry. However, their effect on *paper recycling* is likely to be small. Some strategies for raising rates of return could discourage recycling.

Other matters ... - Chapter 7

9. Governments need to:

- review legislation and regulation which unnecessarily disadvantages recycled materials or favours one form or level of recycling at the expense of another (such as the Commonwealth's sales tax exemption for 100 per cent recycled paper);

- ensure that when promoting recycling they accord with sound principles of public administration.

10. The important question for governments and the community alike is not whether recycling rates in Australia could be increased, but whether the community would be better off if they were.

1 THE RECYCLING INQUIRY

The Commission has been asked to report on the current level and possible costs and benefits of recycling, both in terms of economic and environmental considerations, and on any arrangements subject to the influence of governments which affect the incentives to recycle or re-use products. It is to advise on appropriate changes to these arrangements. The Terms of Reference are on page v.

The Commission was also asked to prepare an *Interim Report on Paper Recycling*. This was presented in May 1990.

This inquiry attracted interest from a wide spectrum of the Australian community. Industries, conservation and consumer groups, individuals, and Commonwealth, State and local governments and agencies contributed. They are listed in Appendix B.

Recycling is an economic activity driven by individuals and firms acting in their own interests. However governments also affect incentives to recycle. Many people view recycling as different from other activities and worthy of special encouragement. The Commission has examined the extent to which particular benefits and costs of recycling are reflected in market incentives, and how governments can best ensure that all relevant benefits and costs of recycling are taken into account in decisions by manufacturers, consumers and those responsible for waste management and collection.

1.1 What is ‘recycling’?

In this report the term ‘recycling’ refers to the recovery of used products and the reprocessing of materials back into their original form or into new forms or products, and to the reuse of products after cleaning or similar treatment. Several measures are used to assess rates or levels of recycling (refer Box 1.1). Examples of how these measures are computed are given in Volume II. Present rates and levels of recycling in Australia are summarised in Chapter 2 of this volume.

Box 1.1 Measures of the rate or level of recycling

In this report, measures related to recycling include the *recovery rate*, the *quantity reprocessed* and the *utilisation rate.*

The *recovery rate* is the proportion by weight of consumption of a product recovered in Australia in a particular year. Used goods which are recovered may be exported as scrap for reprocessing or reuse overseas; used goods and scrap may also be imported for reprocessing or reuse in Australia.

The *quantity reprocessed* is the quantity of a product recovered in Australia, plus imports or minus exports of scrap, reprocessed or used in manufacture. The influence of changes in stocks of scrap or used goods, data for which are not available, is not accounted for.

The *utilisation rate* is the proportion by weight of new production which is from recovered materials.

Metals and glass are generally reprocessed back into similar metal and glass products. But recycled materials are more commonly used to produce a different product. Plastics used in one product are mostly transformed by reprocessing into different products. The degradation of fibre during recycling usually means that higher quality papers are reprocessed into lower quality products. Used lubricating oil may be refined back into lubricating oil, recycled into process oil, or used as fuel. Seeking a 'closed loop' (eg using old newspaper exclusively to produce more newsprint) can be a very expensive way to use resources.

The use of the same product again after some treatment, for example where bottles are refilled after collection and washing, is referred to as reuse rather than recycling. Generally the reuse of materials within a particular establishment is not considered as recycling for the purpose of this report.

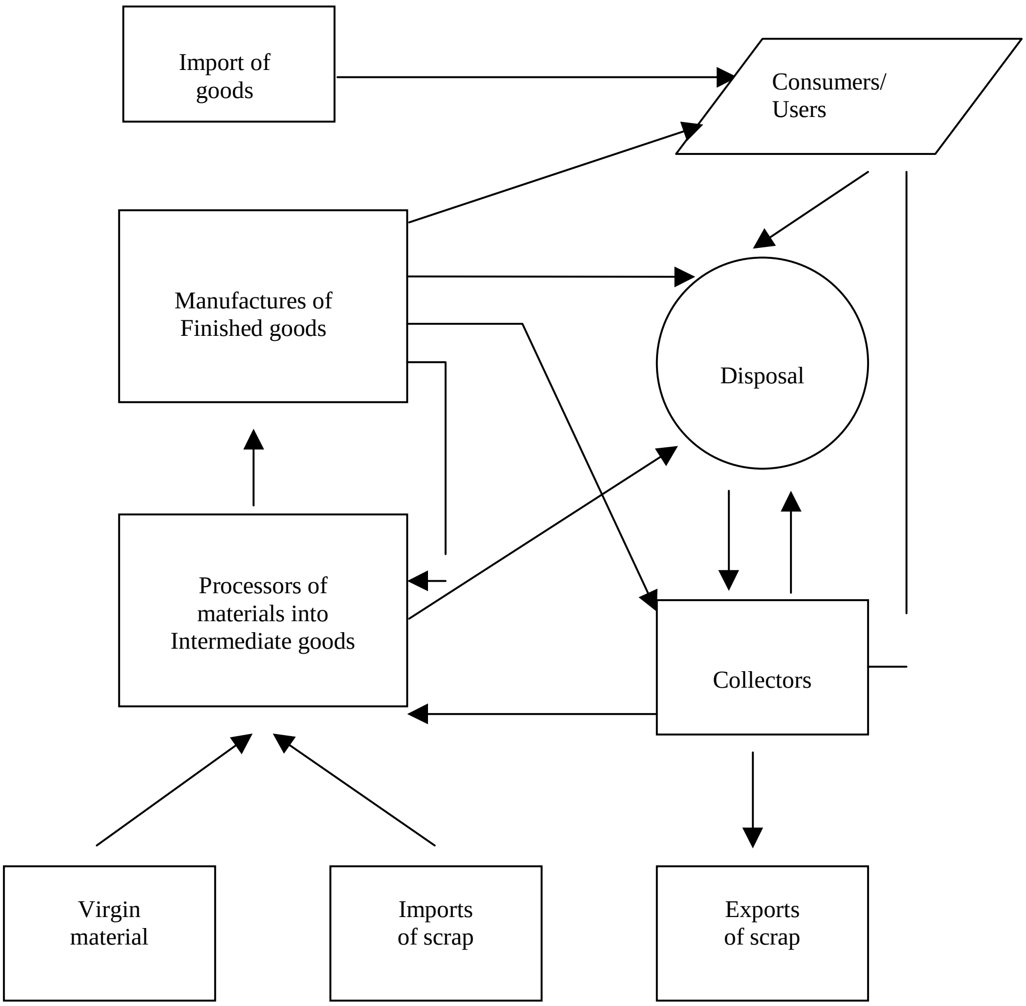
1.2 The recycling network

Figure 1.1 illustrates the flow of materials in the recycling network. Consumers and industrial users can either dispose of used products into the waste management stream (disposal) or the recycling stream (collection). Collectors then sell recyclable materials to reprocessors or manufacturers (in some instances the reprocessors and manufacturers are one and the same).

Manufacturers can choose between virgin or recycled materials for their manufacturing processes. Once manufactured, the sale of goods to consumers completes the recycling network. Other links that affect the flow of materials are those with other countries, through imports and exports of finished goods, as well as recyclable materials.

When consumers have finished with a product they can dispose of it as waste or make recyclable materials available for collection. Decisions about disposal of used materials have an important bearing on how much recycling takes place. In Australia most consumer waste is disposed of through local government Councils and paid for indirectly, through Council rates.

Figure 1.1: **The recycling network**



Councils and waste management authorities sometimes sort recyclable materials at disposal facilities such as tips and transfer stations. Nonetheless many people sort recyclables and take them to collection points - kerbside, drop off points and buyback centres.

Householders can sell used aluminium beverage cans at buyback centres at many shopping centres and service stations in Australia. In this case, and when commercial collectors pay for industrial scrap, market transactions facilitate recycling.

However not all of the supplies of recyclables to collectors come forward as responses to monetary payments. Businesses frequently give away or pay for the removal of recyclable materials as a least cost way of disposing of their waste. Consumers participate in recycling activities even when it is at some inconvenience to them. Such participation is likely to be greatest when costs to them are lowest and the alternative to participation is expensive.

When alternatives to recycling are apparently cheap there is little incentive to participate in recycling. This will be the case when Councils charge for garbage disposal through general rates, subject to rate pegging, and fail to pass on the full costs of disposal though 'user pays' charges. Councils, in discharging their responsibilities for waste management, significantly influence recycling decisions. Recycling for them is a means of avoiding some waste disposal costs. The relationships between waste management and recycling are discussed in Chapter 3 and Appendices D and E.

Kerbside collection is the cheapest recycling option available to households for materials such as glass, paper and plastics. But the incentives for collectors to provide such a service may not be strong if the costs are high compared with the prices received for materials collected. Collectors are intermediaries in the recycling network and are subject to fluctuating market forces. They take materials from industry and commercial premises, waste disposal facilities (tips and transfer stations) and depots, as well as from kerbside collections. They then sell these used materials to reprocessors in Australia or overseas. Collection systems are the subject of Chapter 4.

Recycling works best when it is a relatively cheap option both for waste managers as an outlet for used materials and for manufacturers as a source for material inputs.

In most industrial processes the raw materials comprise a less important component of total costs than other inputs such as labour and capital. Nevertheless, recycling may be the best option from the community's point of view even when it is not the cheapest option for the individuals who make the decisions about whether or not to recycle. For example, an individual who chooses to dump used oil illegally passes the pollution costs on to the community. Recycling may have been a cheaper option for the community because of its lower environmental costs. Disparities between private and social benefits and costs of recycling are considered in Chapter 5.

If disposal choices are based on private costs which fail to reflect all the costs of using the community's resources, as in the case of illegal dumping, there may be a bias against the supply of recyclables. There can also be a bias against the demand for recyclables if the private charges for virgin materials fail to reflect all the costs of using the community's resources. This is because recycled materials can be substituted for virgin materials in manufacture. The pricing of resources, such as forests and minerals, by governments is discussed in Chapter 6.

Because of the many interconnections that characterise recycling activities, inappropriate waste disposal and resource prices find their way back through other markets, affecting the prices paid to collectors of recyclables, altering their incentives to provide collection services and ultimately influencing participation of households and businesses in recycling. Where markets underpinning recycling activity are impeded, governments need to identify the impediments and, where feasible, assist in their removal.

The use of recycled materials in manufacture depends not only on their relative costs but also on the demand for the products of the manufacturing process. Sometimes the characteristics of the final product depend little on whether recycled or virgin materials are used (eg glass). For other products the mix may be important (eg some paper products). A closed loop system (which requires that the same resources are used to produce the same products) may reduce the value of the product to the consumer. Consumers therefore require information about the inputs used and the product characteristics in order to express their preferences. If consumers are ill-informed, it is likely that markets will not work efficiently and there may be a role for government in filling information gaps.

The focus of Chapter 7 is on ways in which governments can help markets to work better through improved consumer information as well as by action on waste management, resource pricing and pollution. The chapter also explores the implications of policies which seek to encourage recycling directly by assistance or regulation.

2 RECYCLING IN AUSTRALIA

The recycling and reuse of used products represents a significant sector of industry in Australia. This chapter presents some recent facts and figures about the recycling and reuse of a range of materials or products in Australia. More detailed information on individual products is available in Volume II.

This report discusses mainly glass, plastics, paper, metals, lubricating oil, chemicals, tyres, composting, sewage recycling, and road and building material reuse. Paper recycling was also the subject of the Commission’s *Interim Report on Paper Recycling*.

2.1 Levels of recycling

The proportion of consumption which is recovered and recycled or reused varies considerably between products. Estimates of recovery, scrap exports or scrap imports and the proportion of consumption reprocessed for major products for the most recent year available, in most cases 1988-89 or the 1989 calendar year, are given in Table 2.1. The estimates are based on the more detailed information in Volume II.

Because the average life of recyclable products differs between materials (for beverage containers it is a few months while for construction materials it is many decades) caution is needed when making comparisons between products.

Most reprocessing is undertaken in major capital cities, especially Sydney and Melbourne, and in inner New South Wales and Victoria. Significant quantitities of used paper are reprocessed in all States except South Australia and Tasmania. Glass is reprocessed in all capital cities. Aluminium is reprocessed both in smaller foundries on urban fringes, and in the major smelters which are located away from the major centres. The same is also true of lead and copper. Tin and iron and steel reprocessing is more concentrated, taking place in New South Wales but away from the Sydney area.

State Governments also influence the location and extent of recycling. The high level of reuse of glass beverage bottles in South Australia can be attributed to the deposit structure adopted under that State's Container Deposit Legislation (CDL), as can the low level of recycling of glass and aluminium in that State. The effects of CDL are discussed in Chapter 7 and in Volume II.

The information below draws on the discussion of major products in Volume II, and on the Commission's Interim *Report on Paper Recycling*. Other details are given in Table 2.1.

Metals

Many metals share the common characteristics that they can be recycled back into the original metal, they degrade slowly over time, and have a relatively high intrinsic value as scrap. They become available for recovery and recycling over variable periods of time, decades in the case of some construction materials.

Aluminium

About 31 per cent of the 325 000 tonnes of aluminium consumed in Australia each year is recovered for reprocessing in Australia or exported as scrap. The amount of aluminium reprocessed has been equivalent to about 15 per cent of consumption in Australia in recent years but the utilisation rate has been only about 4 per cent. Returned used beverage cans (UBC) account for some 28 000 tonnes or around a quarter of all the aluminium recovered. In 1989, 1.6 billion UBC were recovered, a recovery rate of 62 per cent. This is the same as or slightly higher than the rate attained in the United States.

The world average utilisation rate for aluminium is 26 per cent. Assuming no changes in world stocks, ie world production equals world consumption, the world average recovery rate is also 26 per cent.

Table 2.1: **Recovery and reproprocessing of products, Australia**[a]

Product or commodity	*Quantity recovered*	*Recovery rate (proportion of consumption recovered)*	*Net quantity of scrap exported (-) or imported (+)*	*Scrap exported (-) or imported as a proportion of consumption*	*Quantity reprocessed*	*Proportion of consumption reprocessed*
	'000 tonnes	*per cent*	*'000 tonnes*	*per cent*	*'000 tonnes*	*per cent*
Aluminium						
- all scrap	99	31	-51	-16	48	15
- UBC	28	62	-5	-10	23	52
Lead	36	60	-20	-33	16	26
Copper	24	19	+3	+2	27	21
Steel	1 616	26	-791	-13	825	13
Tin	<1	37	0	0	<1	37
Glass						
- reprocessed						
all glass	290	25	0	0	290	25
containers	204	24	b	b	204	24
- reused (refillable bottles)	<13	65	0	0	<13	65
Plastics						
- industrial and commercial	65	50	+2	+3	67	53
- plastic in domestic waste	1	<1	0	0	1	<1
- PET	<1	3	0	0	<1	3
- polyethylene	<1	<1	<+1	<+1	<1	<1

Table 2.1 (Cont'd): **Recovery and reprocessing of products, Australia**[a]

Product or commodity	*Quantity recovered*	*Recovery rate (proportion of consumption recovered)*	*Net quantity of scrap exported (-) or imported (+)*	*Scrap exported (-) or imported as a proportion of consumption*	*Quantity reprocessed*	*Proportion of consumption reprocessed*
	'000 tonnes	*per cent*	*'000 tonnes*	*per cent*	*'000 tonnes*	*per cent*
Paper						
- newsprint	151	24	-48	-8	103	16
- printing/writing	164	22	–48	–6	116	16
- packaging/ industrial	720	51	0	0	720	51
Lubricating oil[b]	84	18[c]	0	0	84	18
Organic waste						
- household	210	9	0	0	210	9
	'000 units		*'000 units*		*'000 units*	
Tyres	4000	24[d]	+207	+1	4225	25

Note: Totals may not add due to rounding.

a) Estimates are for 1988-89 but may refer to different years (both calendar and June), and are intended only as a guide. b) Reprocessing here refers to both rerefining and recycling into heating and other oil.). c) Of total oil consumption: about half of all lubricating oil consumed is not available for recycling. d) Proportion of used tyres recovered in Australia for retreading.

Source: IC estimates based on information from industry, government authorities and the Australian Bureau of Statistics, as detailed in Volume II, and Van den Broek (1989).

Lead

Australia has a high level of recovery of used lead. About 36 000 tonnes or 60 per cent of consumption was recovered in 1989-90. However, 20 000 tonnes were exported as scrap in that year. This meant that production of secondary refined or reprocessed lead in Australia was only 16 000 tonnes or 26 per cent of consumption.

About 90 per cent of the lead scrap generated in Australia is in the form of used lead-acid batteries from vehicles. Batteries and other scrap lead which is not recovered can present major environmental problems.

The world average utilisation rate for lead (and also the recovery rate) is about 50 per cent.

Copper

Around a fifth of all the copper consumed in Australia is recovered for reprocessing, equivalent to some 24 500 tonnes. Another 2500 tonnes of scrap copper were imported for recycling in 1988. Nevertheless, production of reprocessed copper accounted for only 12 per cent of total copper production. This is because Australia exports substantial quantities of copper.

Recycling is undertaken at smelters located outside the main urban areas, for example at Port Kembla and Townsville, and at specialised scrap copper melting plants. The high value of copper is a strong incentive to recover and reprocess the scrap. The removal of the export embargo on scrap copper in 1990 means that Australian recyclers have to meet international competition for access to scrap.

The world copper utilisation rate (and recovery rate) is about 52 per cent.

Steel

Around 26 per cent of the steel consumed in Australia is recovered as scrap each year, equivalent to about 1.6 million tonnes. This does not include scrap, amounting to around 1 million tonnes a year, recovered directly and used in-house by the steel producing industry. Over half the scrap collected is exported.

The utilisation rate of reprocessed steel in Australia is therefore around 13 per cent of iron and steel production, not including in-house scrap use.

Steel scrap accounts for some 1 to 5 per cent of household waste in Australia, mainly in the form of steel cans. Contamination problems and high collection costs have led to an insignificant level of recycling of these cans. Scrap metal generated by households in the form of used car bodies, refrigerators, washing machines and other appliances is widely collected by scrap metal merchants directly or from tips. Greater use of plastics in components and as a coating reduces the metallic yield of vehicles and components, and hence the incentive to recycle.

Tin

About half of the tin consumed in Australia is used in tinplate manufacture and hence is potentially available for recovery. The other half is used in chemicals, solder and alloys. Over 250 tonnes of tin are recovered each year in Australia from the detinning of commercial tinplate scrap, equivalent to some 37 per cent of total tin consumption in 1989.

About 220 000 tonnes of tinplated post-consumer scrap are disposed of in the waste stream each year. Only insignificant amounts are recovered for recycling, due mainly to collection costs and problems with contamination. The amount of tin which could be recovered is small, since detinning of 1 tonne of cans produces only about 4 kg of tin. Technological changes have led to a reduction in the amount of tin embodied in cans.

Glass

The level of recovery and reprocessing of used glass in Australia is 25 per cent, with 24 per cent of all glass containers being recovered for reprocessing. Glass containers are the most commonly reprocessed articles from the post-consumer waste stream, of which they account for about 10 per cent by weight. Higher levels of reprocessing are achieved for particular glass products; for example the recovery rate for non-refillable glass bottles in Australia in 1989 was around 30 per cent.

About 65 per cent of refillable bottles are recovered for reuse. The recovery rate is higher (about 73 per cent) in South Australia, where it is encouraged by CDL. The rate is believed to exceed 60 per cent in Victoria, Queensland and Western Australia, and 50 per cent in Tasmania, but none is recovered for reuse in New South Wales. Because of the deposit structure for containers in South Australia, over 90 per cent of glass bottles used in that State are of the refillable type.

The recovery rate for all glass is high in Australia (25 per cent) compared with the United States, where 15 per cent was recovered in 1987. In the United Kingdom, Japan and Sweden reported recovery rates for reprocessing are 20, 17 and 15 per cent respectively. Higher recovery rates are reported in some European countries, for example 30 per cent in West Germany. Enough glass was recovered in Switzerland in 1986 to meet 75 per cent of the raw material required by the glass industry. However, this reflects the small size of the domestic glass industry in that country. The European Community is drafting regulations which would require 70 per cent of all soft drink containers, including glass, to be recovered and reprocessed or reused.

The reuse of glass containers varies considerably between countries. In the Netherlands over 90 per cent of retail soft drink and beer sales are in refillable bottles. In Japan, 66 per cent of all glass bottles are collected and reused on average three times.

Plastic

Plastics account for about 8 to 11 per cent by weight of the household waste stream of Australia's three largest cities. Around 1 million tonnes of plastic resins are consumed in Australia each year, and some 450 000 tonnes of plastic products are discarded annually. While around 15 per cent of plastic waste is recovered and reprocessed, this consists mostly of industrial and commercial scrap. Only some 1000 to 1500 tonnes or less than half of 1 per cent of plastic in household waste is recovered. Polyethylene accounts for some 750 tonnes or over half the amount recovered, but this is less than 1 per cent of polyethylene in post-household waste. The rate of recovery of polyethylene terephthalate (PET) is significantly higher at 3 per cent, but this still accounts for only 600 tonnes of the 20 000 tonnes discarded by consumers in Australia each year. Industry schemes are being developed for collection and reprocessing of post-consumer high density polyethylene (HDPE) and polyvinyl chloride (PVC).

The recycling of plastic at the industrial and commercial level is much higher. Over 90 per cent of plastic waste generated in production processes, and some 50 per cent of plastic waste generated by industry, is reprocessed. However, it could be argued that in-house use of process waste is part of the production process rather than recycling as such. The 65 000 tonnes of plastic waste recovered from industry each year includes 26 000 tonnes of low density polyethylene (LDPE), over 2000 tonnes of HDPE, at least 5000 tonnes of polyurethane foam and 5000 tonnes of PVC.

The high volume to weight ratio of plastic containers, and the problem of potential contamination which prevents the recycling of post-consumer plastic containers for food and beverages, act as disincentives to recycling. However, plastic accounts for a significant (around 10 per cent by weight, more by volume) and mainly nondegradable component of the household waste stream.

New processes for recycling consumer plastics are being developed. In Australia these include the Smorgon ‘Syntal’ mixed plastics recycling facility, PET recycling plants operated by Australian Consolidated Industries (ACI), the planned Brickwood Holdings HDPE plastic milk bottle recycling plant, and ICI’s PVC recycling scheme. At present, the operators of these plants are, to some extent, incurring financial losses. They may do this to avert a possible extension of CDL or other regulatory requirements beyond South Australia, or to be seen to be making endeavours to recycle a product which is regarded as environmentally difficult to dispose of.

Recycling rates for plastics in Australia are comparable with those in other OECD countries. The level of recovery and reprocessing of plastics from the household waste stream in the United States has been estimated at between 1 and 3 per cent, and that in Western Europe less than 1 per cent.

Paper

Some 900 000 tonnes of paper of all types are recycled each year in Australia, equivalent to just under a third of all paper consumed. The level of recovery is higher for packaging papers at 51 per cent. Recovered packaging papers are mostly reprocessed into new packaging products.

The recovery rate for printing and writing papers is lower at 22 per cent. The newsprint recovery rate is about 24 per cent, a significant proportion of which is exported. Manufacturers' proposals could raise the recovery rate for old newspapers to about 55 per cent on the eastern seaboard. No tissue products are recycled, but some high quality printing and writing papers are reprocessed into tissue papers. Some printing and writing papers and used newspapers are also reprocessed into packaging.

Australia's paper recovery rate of about 31 per cent is lower than rates in Japan, the Netherlands and West Germany, but comparable with the United States. When proposed de-inking plants in the United States and Canada come on stream, utilisation rates in those countries are expected to increase. For packaging, the consensus is that Australia is close to the economic limit for the use of recycled pulp.

Other materials

Lubricating oil

Some 18 per cent of total consumption of lubricating oil in Australia is recovered for further use. This is equivalent to 35 per cent of recoverable lubricating oil. The major proportion, 93 per cent, is recycled into some form of fuel oil. Only 3 per cent is rerefined to a base lubricating oil. The oil not recovered is used directly in low grade applications as fuel, in dust suppression, and timber preservation, or delivered to tips. The small proportion disposed of illegally results in significant environmental costs.

The recovery rate for used oil in the United States is reported to be 56 per cent.

Chemicals

Chemicals are recycled to a very limited extent, largely due to technical constraints. Recovery and reprocessing is undertaken in some industries by contractors or on an in-house basis. Perchloroethylene is a common solvent recycled for reuse in dry cleaning. In the electronics industry another solvent, 1,1,3-trichlorotrifluoroethane (TCE), is commonly recycled.

Chlorofluorocarbons (CFCs) are recycled in order to reduce emissions of these gases into the atmosphere. They are removed from old air conditioning and refrigeration units and reinstalled in new and reconditioned units.

Tyres

About 4 million retreaded tyres went into use in 1989-90, equivalent to 25 per cent of the total tyre market. The demand for passenger vehicle retreads is diminishing due to the longer life now obtained from new tyres and consumer preference for the new product. About half of the retreads produced are for trucks. Demand for retreading of truck tyres is greater than for passenger vehicle tyres and likely to remain so.

In Australia the major form of recycling of used tyres is retreading. In Japan and the United States, used tyres are used to fuel some power and industrial plants. In the United Kingdom it is proposed to establish a power station fuelled by used tyres.

Building waste

Building waste represents by weight between 10 to 30 per cent of total waste going to landfill in Australia. Scrap structural steel is re-used or exported. Brick and concrete rubble is crushed for such uses as foundations, road base, retaining walls and aggregate for concrete. In Sydney about four-fifths of such rubble is recycled in this way.

Organic waste

Two to three million tonnes of organic waste in the form of food scraps and garden refuse are disposed of in Australia each year, equivalent to 100 to 200 kg per person. About 9 per cent is estimated to be composted by householders. Some Councils encourage domestic composting through the distribution of information on home composting and the subsidised or at cost provision of compost bins. Non-domestic composting in Australia is confined to source separated tree, garden and park waste . This includes Councils' tree and park waste and garden waste deposited by householders or left out for collection.

Some councils provide access to shredders or chippers for residents.

In Sweden 25 per cent of solid waste is composted. In West Germany there are 71 facilities processing organic waste, and Munich council is setting up a scheme to compost a third of the waste currently going to incinerators and landfill sites.

Mixed combustables

One form of recycling widely practised overseas is the recovery of energy through burning of municipal waste to generate electrical power or for use in some other industrial process. In Australia this is done only on a small scale. The 'Neutralysis' process involves the production of an inert lightweight aggregate for use as a fuel. The process has been developed in Australia and the economic viability is still being evaluated.

2.2 Australia's recycling performance

The previous section provided some comparisons between recycling in Australia and that overseas. Compared with other developed countries, Australia has a high rate of recovery of used and waste materials for some products and materials. For others, the recovery or utilisation rates are relatively low. For example, Australia makes substantial use of wastepaper in the production of packaging materials and some printing and writing papers, but little in tissue papers and none as yet in newsprint. Many other countries make extensive use of waste paper in the manufacture of newsprint and tissue paper. Some participants saw this as an indication that major opportunities exist for the increased use of recycled fibre in the production of paper in Australia.

Comparisons of recycling activity between countries can provide useful insights for some products. For others, they can be misleading. For example, international comparisons are of limited use in indicating options for paper manufacture using waste paper. Each country is unique in terms of its fibre supply, the level of imports and exports of paper, waste paper availability, arrangements affecting the relative prices of its fibres, paper product mix, production facilities, population densities and distances between population centres.

Aluminium is another example where international comparisons are not very meaningful. The world recovery and utilisation rate for aluminium is about 26 per cent. Australia’s recovery rate for aluminium is around 30 per cent, higher than the world average. However, because 75 per cent of Australia’s primary aluminium production is exported (and not available for recovery in Australia), and about half of the aluminium scrap recovered in Australia is also exported, the quantity of secondary aluminium reprocessed in Australia is equivalent to only 4 per cent of Australia's production.

What is important for Australia is that it should recycle that level of waste materials which is most beneficial for the country. It is not important how that level compares with levels abroad. The important question is whether there are impediments and distortions which, if removed, would result in a different level of recycling that would bring with it net economic and environmental gains.

3 WASTE MANAGEMENT AND RECYCLING

Almost all of Australia's solid waste is disposed of in landfill operated mainly by Local Government Councils and Regional Authorities such as the Waste Management Authority (WMA) of New South Wales. Based on the Commission's survey of waste management[1], Councils and Authorities across Australia disposed of 12.8 million tonnes in 1989, or just over 776 kg per person per year[2]. Of the total amount, 12.3 million tonnes were disposed of by landfill, 379 000 tonnes by recycling and 143 000 tonnes by incineration (refer Appendix D).

Existing waste management and disposal facilities are having to cope with a substantial growth in waste. The WMA expects the total amount of waste requiring disposal in Sydney to increase from 3.8 million tonnes in 1989 to over 7 million tonnes in 2011. Potential landfill sites in close proximity to major urban areas are becoming increasingly scarce and face opposition as disposal facilities by local neighbourhood communities. Alternative disposal methods such as incineration are still more expensive and may cause environmental problems.

Large quantities of recyclable materials still remain in the waste stream. Whether this imposes social costs depends on the extent to which waste management charges and practices address the full costs (including environmental costs) of waste management.

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1. The Survey of Local Government Councils was undertaken by the Industry Commission with the assistance of the Australian Bureau of Statistics between January and September 1990. Questionnaires were sent to 447 out of a total of 833 Councils and replies were received from 329. The Councils that replied represented about 76 per cent of the population of Australia, implying a high degree of reliability in the results. The survey and the results obtained are detailed in a separate IC information paper *Waste Management and Recycling: Survey of Local Government Practices,* 1991. A summary is in Appendix D in this volume.

2. The term 'disposed of' includes waste recycled by Councils. If the waste recycled is excluded, the amount disposed of would be 12.4 million tonnes or about 753 kg per person (ie about 23 kg of waste per person was recycled by the Councils).

Recycling can address some of the problems of waste management. It defers permanent disposal, thereby avoiding the costs of immediate disposal and conserving valuable landfill space. In the process it treats waste and provides a significant source of reprocessable materials.

3.1 Waste management alternatives

Traditionally governments have had the responsibility for managing waste in industrialised societies. While it is not essential for governments to assume such a role, it has been a reasonably effective means of avoiding and reducing costs that individuals would otherwise incur and in ensuring that health and environmental safeguards are adopted.

Local Government Councils are responsible for organising the collection and disposal of the bulk of the wastes in their locality. Many provide a comprehensive waste management service to residential premises, the objectives being the convenient removal of waste, the recovery of recyclables, conservation of landfill space, and reduced littering and illegal disposal.

Councils frequently employ private contractors to collect waste and to operate landfill sites on their behalf. According to the waste management survey, payments to contractors constituted about half of the total waste management costs of Councils in 1989.

Private operators are the major providers of collection services to non-residential premises. Most of the waste collected by them is disposed of in landfill sites operated by Councils or Regional Authorities. In Sydney and Adelaide, private operators accounted for around 25 per cent of the total amount of solid waste (mainly non-putrescible) disposed of in Council or regional tips in 1989. The corresponding estimate for Melbourne is less than 10 per cent. The proportion of waste disposed of by private operators in these cities is declining; from 26 per cent to 23 per cent in Sydney over the three years to 1989.

Pioneer International, Whelan the Wrecker and some other participants claimed that private waste disposal operations are restricted by Authorities even when private operators could provide such services more efficiently.

Pioneer International argued that the high cost of waste disposal in Sydney compared with Melbourne may be due in part to the exclusion of private operators[3]. The WMA of New South Wales stated that it had a monopoly on the disposal of putrescible waste in Sydney but encouraged the private sector to develop waste disposal facilities for other waste.

Consumers, producers and waste management authorities can manage their wastes in various ways. In addition to recycling they include:

- *choice of materials* to reduce waste and its impact;
- *self-treatment* to reduce the amount, or to alter the type, of waste to be disposed of;
- *permanent disposal* as by *landfill* or *incineration*; and
- *illegal dumping* (including littering and unauthorised burning).

Choice of materials to reduce waste

Consumers can purchase goods which are more durable or in a form which generates less waste. In doing so, they may provide producers with an incentive to change product characteristics.

Producers can lower their own waste management costs by using different inputs or by changing production processes. They can also avoid the use of deleterious inputs - for example by using hydrofluoroalkanes (HFAs) instead of the ozone-depleting chlorofluorocarbons (CFCs), or by using hydrogen peroxide instead of chlorine in the bleaching process in paper manufacture thereby avoiding organochlorines in waste effluent.

Self-treatment/pre-treatment

Industry can reduce the amount of waste or vary the type disposed of by treating the waste. If it is toxic, pre-treatment is generally required before discharge. This is carried out by private contractors, generators of waste or by State authorities. The purpose of treatment is to convert waste into a form that presents no hazard when discharged into the environment.

The Victorian EPA lists 28 private companies involved in chemical waste recycling and disposal in Victoria. The MMBW, through Vicwastes, processes chemical wastes not processed by private companies.

The WMA operates a chemical treatment plant at Lidcombe (Sydney), with a capacity of 55ÿ000 tonnes each year. The plant is not able to process sludges, drummed residues and solid material. These materials are put into landfill disposal. The plant cannot accept wastes with high levels of organochlorines.

Other States have their own means of dealing with such wastes. In Western Australia, for example, a non-hazardous industrial liquid treatment plant is operated by the Department of Health. Treatment is kept to a minimum, and disposal charges comparatively low, by imposing conditions on producers of industrial liquid waste to encourage pre-treatment and segregation at source.

Landfill

Landfill is the major final disposal method used in Australia. Councils and the Regional Authorities disposed of an estimated 12.3 million tonnes by this method in 1989 compared with only 143 000 tonnes by incineration.

Because of the increasing distances to landfill sites, many Councils and Authorities are making use of local transfer stations. The waste is compacted and loaded onto large trucks for transport to the landfill site. In this way transport costs are reduced. Recyclables can also be separated at these locations for delivery to reprocessors.

Waste disposal authorities in major cities provide special 'secure landfill' disposal facilities for liquid and sludge wastes. In New South Wales, charges for disposal range from $50 per tonne if collected in sludge bins to $200 per tonne for waste in drums. Some Authorities require a detailed and costly chemical analysis of the waste.

Incineration

In Japan and some European countries municipal waste is incinerated as landfill space is very scarce. These countries also recover the heat value of the waste to drive steam turbines to generate electrical power.

In Australia, municipal waste is generally not incinerated, since the cost of disposing of waste by incineration is significantly higher than for landfill. In New South Wales, the WMA charges Councils $14.50 per tonne direct to landfill and $32 through a transfer station. This compares with an estimated $85 per tonne by incineration meeting the latest environmental requirements. The cost of incineration provides a guide to the maximum financial costs that can be avoided by recycling. But incineration may also lead to environmental damage.

Incineration at high temperature is also a means of destroying intractable waste. Currently there are no high temperature intractable waste incineration facilities in Australia. Intractable wastes are transported to facilities in the USA or the UK, although facilities do exist in other European countries. The Melbourne Metropolitan Board of Works (MMBW) now sends about 500 tonnes of its intractable waste for incineration at a high temperature facility in Wales at a cost of $4000 per tonne (this includes transport and handling costs). This is expected to rise to approximately $7000 per tonne in 1991.

A joint Commonwealth, Victorian and New South Wales Government Taskforce has recently reported on the establishment of high temperature incineration facilities for intractable wastes (Joint Taskforce on Intractable Waste 1990). The operation of the incinerator was seen to pose no greater, and often considerably less, risks than those arising from commonly accepted industrial processes. Potential sites are being considered. It would take 10 years to incinerate the 93 000 tonnes of wastes identified by the Taskforce as requiring incineration (Moore, McCutcheon and Kelly 1990). The operating costs of the proposed Australian facility were estimated by the Joint Task Force to be $1100 per tonne in 1988 dollars, on the basis of a throughput of 12 000 tonnes per year of waste.

Alternatives to high temperature incineration were brought to the Commission’s attention. The Commonwealth Scientific and Industrial Research Organisation’s (CSIRO) Division of Manufacturing Technology, has developed a plasma arc furnace operating at about 20 000 degrees Celsius (compared with 1200 degrees for high temperature incineration). This process is claimed to have significantly lower risk of toxic emissions compared with traditional high temperature incinerators.

Research is continuing towards the development of an on-site system which can be used where the wastes are generated, thereby reducing costs. The system is expected to be ready for commercial use in 1993.

Super critical fluid technology is an alternative to high temperature incineration and particularly suited to the destruction of intractable waste such as hexachlorobenzine (Foster 1991). Its advantages over high temperature incineration include operation at a lower temperature and therefore a reduction in the risk of toxic dioxin by-products being released into the environment. In the United States a mobile pilot plant is being tested in different applications. A mobile plant would reduce the risk in transporting toxic wastes and help to overcome the NIMBY (not in my backyard) syndrome.

Illegal dumping

Illegal dumping, littering and unauthorised burning do not reduce the costs of waste disposal for society. They are options which transfer and sometimes escalate the costs of waste management to others.

3.2 Environmental damage costs

If the type and amount of waste exceeds the capacity of the environment to assimilate it, the benefits from other environmental services are reduced. Litter can also reduce the aesthetic value of the landscape and be detrimental to wildlife. (Plastic litter in marine environments was of particular concern to some participants and is discussed in Chapter 5.) Toxic wastes discharged into waterways can adversely affect the environment several years after discharge.

Environmental damage can also be incurred with landfill - for example leachate and heavy metal contamination, the generation of methane[3], the release of CFCs, odours and litter, noise and traffic congestion, and disease transmission by pests.

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3. Methane’s contribution to the greenhouse effect is estimated to be 27 times greater than that of a comparable tonnage of carbon dioxide. According to the Western Australian Government, each tonne of domestic waste produces 400 cubic metres of landfill gas (about half carbon dioxide and half methane). The methane is increasingly being trapped at major metropolitan sites and used as an energy source, or flared to reduce environmental damage. On burning, it produces carbon dioxide and water.

Incinerators can cause environmental damage as a result of stack emissions and the disposal of ash residues in landfill. Emissions may include dioxins, hydrochloric acid, sulphuric acid, sulphur dioxide, heavy metals and dust. These and other harmful substances may also be present in the residual ash and be a source of environmental damage when disposed of in landfill. The ash constitutes about 10 per cent by volume, or 25 per cent by weight, of the original waste.

There are many examples of environmental damage from past disposal practices. Leachate problems have been encountered at the Homebush Bay landfill site in Sydney, with high levels of dioxins, PCBs and heavy metals being detected. PCB-contaminated oil is believed to have leaked from electrical transformers dumped at the site, with other contaminants coming from used batteries and household chemicals. Acid sludge from used oil rerefining (involving the acid/clay filtration process) is a major contributor to soil contamination and leachate toxicity problems at the Kingston dump in Brisbane.

The CSIRO Division of Fisheries (CSIRO 1990) has identified the generation of leachates from coastal landfill sites as a significant problem for the tourist and fishing industries. It is estimated that 40 per cent of the mangrove and salt marshes in New South Wales has been indiscriminately used for waste disposal. Important fish breeding and nursing grounds have been lost.

The landfill site operated by the City of Melville (Perth) has caused significant pollution of groundwater. According to the Western Australian Government, the costs of this damage are not being met by users. This and a number of other sites in Perth may be closed because of environmental damage. The costs of lining sites to prevent contamination of Perth's groundwater is estimated at $3 per cubic metre of tipping capacity (or about $6 per tonne of waste).

The incinerator operated by Waverley and Woollahra Municipal Councils in Sydney (the largest operating in Australia) would not comply with emission guidelines for dioxins and furans for new incinerators and older plants which have been upgraded. This is also true for many incinerators overseas. The Netherlands disposes of 40 per cent of its household waste by incineration. However, three of its twelve incinerators were closed during 1990 (with the prospect of a further three to close), because of dioxin and other emissions. These have contaminated surrounding soils and pastures and resulted in unacceptable levels of dioxins in dairy products.

Apart from the risk of long-term adverse environmental consequences, there is also the immediate loss of amenity from unsightliness, smell, noise, and increased traffic. People are increasingly demonstrating by their actions that they are not prepared to accept these risks and costs as reflected in the NIMBY syndrome. A number of Councils said that it is becoming increasingly difficult to obtain approval to operate landfill sites, especially in urban areas. For example, the proposal for a domestic garbage landfill at Londonderry on the outskirts of Sydney is meeting some resistance from residents.

The above instances also illustrate the extent to which environmental damage costs are not always met by those disposing of waste. This can lead to increased waste, greater amounts being disposed of, and fewer materials being recycled than would be optimal.

Environmental regulations

Regulations are the main means used to limit environmental damage. For incineration, the regulations may stipulate where incinerators can be built; the maximum allowable emission levels for different substances; the fuel to be used to fire the incinerator; operating temperature; and emission control devices (such as gas scrubbers and monitors) which have to be installed.

Regulations may require operators of landfill to implement measures to prevent or alleviate environmental damage. For example, landfill sites in New South Wales, Victoria, and South Australia have to comply with air and water quality standards and with health regulations. Similar requirements are proposed in Western Australia, particularly for new landfill sites on the Swan Coastal Plain. The requirements can be adjusted for differences in the type of waste and for specific environmental considerations between locations.

Environmental control requirements have been strengthened significantly over recent years. For example, Victoria is implementing a policy on the siting and management of landfills receiving municipal wastes which requires all new sites to be evaluated fully for their economic, social, and environmental effects before a licence will be issued. The approval process involves the preparation of a site management plan and may require an environmental impact assessment under the State's *Environmental Effects Act, 1978.*

These changes increase both the development and operational costs of landfill and should be reflected in increased disposal charges and rates in many instances. However, it is too early to assess the effectiveness of the measures in reducing or alleviating environmental damage.

Existing sites are inspected for compliance with health and environmental regulations; more so in some States than others. As a result many smaller landfills, particularly in rural areas, have been closed. Further rationalisation of landfill sites is expected. This will reduce potential sources of environmental damage and ease the task of enforcing health and environmental regulations.

Operational practices at existing sites have also been tightened. The once common practice of burning tips is no longer acceptable and the use of backyard incinerators has been, or is being, banned or severely restricted in most major metropolitan areas. Other measures to control wind-blown litter and the development of breeding grounds for flies, mosquitoes, birds, and rodents are also frequently required.

The above measures are relatively recent and mainly apply to new landfills in the major metropolitan areas. There is still the possibility that environmental damage may arise in the future and that more stringent measures may be required. Alternatively, new disposal technologies could be developed which would ameliorate the problem.

There has been little monitoring of environmental damage caused by past landfill operations, but instances of leachate contamination were drawn to the Commission's attention. The Councils concerned were required to undertake remedial treatment work. The initial costs of the remedial work were generally less than $20 000, with ongoing expenditure of less than $8000.

For example, Baulkham Hills Shire Council (Sydney) had to construct two additional leachate ponds at a cost of $10 000; ongoing maintenance costs were estimated at $5000 per year.

The long time during which environmental damage can occur may mean that it is difficult to make those responsible pay for the damage. Periods of 30 to 50 years may be required for leachate and methane releases from landfill sites to return to normal background levels.

In response to this problem Victoria has proposed a system of ‘financial assurances’ whereby current operators are held liable for future damage costs. The arrangements are to apply both to Councils and private operators. Because they are ongoing entities, the liabilities may be easier to enforce for Councils. Councils could provide for such contingencies in current charges and rates. The payment of monies into a trust account is one way of ensuring that private operators are liable. This approach has already been applied to a private disposal facility in Melbourne. Monies held in trust will be returned if not required.

State governments have in recent years introduced stricter regulation of the discharges of industrial liquid waste into waterways.

To overcome legal enforcement difficulties the State Pollution Control Commission (SPCC) in New South Wales has amended its arrangements for licensing pollution emissions and introduced more severe penalties. Previously, where companies were unable to meet target levels of emissions, the levels could not be legally enforced. Companies could be prosecuted under pollution laws but not for breaches of their licence. Under the new arrangements, an enterprise is given an initial permissible level, based on present ability to comply. An ultimate target and deadline for its achievement is also set. The company is required to undertake the necessary investment to ensure that it is able to meet the target. It can be fined if it does not meet its present licensed level or does not proceed with the necessary investment. The SPCC also issues licences to the Water Board setting out the levels of pollutant emissions allowable from the sewerage system into the environment. The Water Board then controls industry sewerage discharge levels accordingly.

3.3 Covering waste management costs

Disposal charges should be set to ensure that the full social costs of disposal are met, including environmental damage. If this is not achieved, there is an undue incentive to consume rather than to conserve or to dispose of used products rather than to recycle them. However, estimating the full social costs of waste disposal is not straightforward since it requires knowledge not only of the operational costs, but also of the values of landfill sites and of the costs of developing them, meeting environmental guidelines, rehabilitating sites once full, and site after-care.

Two market-based indicators can be used to measure the value of a landfill site and changes in its value: the initial purchase and development value of the current site (adjusted to current prices) and the purchase and development value of a replacement site (or a new method of disposal) of a similar capacity.

The longer-term site-related costs tie up capital funds which Councils or Authorities could use in other ways. The returns (either monetary or as services to ratepayers) which could be obtained from these other uses are guides for setting disposal charges and bench-marks for assessing the returns which Councils or Authorities receive from their waste management services. There is a considerable range of real (inflation adjusted) rates of return. The real rate of return on 10 to 20 year Treasury bonds has averaged around 5 per cent over the last 10 years (Reserve Bank, 1990). If an allowance is made for risk (especially given the potential for future environmental damage costs), the appropriate real rate of return from waste disposal would be higher than this.

Councils may choose to set waste disposal charges on either the purchase value or the replacement value of landfill sites. The former basis is likely to lead to lower disposal charges, but could also result in inadequate allowances being made for replacement, thus shifting some current costs to future users.

Box 3.1 illustrates the situation of Berwick City Council (Melbourne). It shows that the rate of return on capital invested in the Council's current site (based on initial purchase price and development costs) was greater than the long term bond rate in 1989 but that inadequate allowance was made for replacement.

Box 3.1: **The Berwick site**

The regional refuse site operated by the Berwick City Council for the Eastern Regional Refuse Disposal Group in Melbourne was purchased in October 1982 for $1.12 million using a bank loan. Development costs of $100 000 were incurred in meeting the requirements to operate as a landfill site, and a further $100 000 was estimated for the costs of rehabilitation on completion. The site is fully licensed (to receive hazardous wastes) by the Victorian EPA and is operated by contractors.

Adjusted for the increase in the value of land, the total purchase value (including development and rehabilitation costs adjusted for inflation) was $3 919 000 as at 30 September 1989. Net operating profit for the year ended at this date was $292 000 (before loan repayments). The rate of return achieved, based on the adjusted value of the initial purchase price, was 7 per cent (real) in 1989. The net operating profit was more than adequate to meet interest and principal payments of $207 000. A surplus of $85 000 was transferred to a reserve to cover future potential liabilities associated with the site.

The amount of waste disposed of at the site during the year ended 30 September 1989 was 232 000 tonnes, and gross income was $1 353 000. Average income was therefore $5.80 per tonne.

The estimated replacement value of the site as at September 1989 was $8 million - $7 million for the purchase of the site and $1 million for development and rehabilitation. If this value is used the rate of return was 4 per cent (real).

The Commission has also estimated the real rate of return achieved for the WMA (Sydney) and the City of Springvale (Melbourne). Available data meant that the rates of return had to be calculated using estimates of replacement value for their current disposal facilities. The rate of return for the WMA in 1989 was 13 per cent following a sharp rise in disposal charges in that year. Previously charges were subject to a policy of the New South Wales Government which limited increases to the consumer price index. As a result the WMA incurred an operating loss in 1988. It has reported a real rate of return for 1990 of 8.5 per cent. The City of Springvale reported a real rate of return in 1989 of 8 per cent. This is some indication that existing disposal facilities are realising an adequate return.

The Commission has estimated the total replacement value of assets used for waste disposal in Australia during 1989 at $799 million: $569 million for landfill sites and $230 million for plant and equipment. Total income was estimated to be $515 million and direct running expenses (including payments to contractors but excluding interest costs) to be $465 million, providing a net operating profit of $50 million. This gives an average rate of return on existing waste management assets of about 6 per cent (real). There is no way of knowing whether there is adequate allowance for environmental risk.

However, the aggregate picture hides the wide variation among Councils.

Where a Council records a 'low' rate of return on waste disposal assets this may be due to:

- inefficiency in use of the resources involved in waste disposal in the sense of failing to minimise the cost of providing the services;
- inappropriate (under) pricing of waste disposal services;
- both of the above.

However, a 'low' measured rate of return on waste disposal assets may be due to:

- efficient provision of services which have not been charged for directly, eg the elimination of odours from waste, 'eyesore' from litter or noxious chemical waste; or
- the arbitrary assignment of a relatively low proportion of Council rate revenue to waste management.

Likewise some Councils achieving better than average financial rates of return may have set a high garbage-related component of general rates or provided a low level of services.

The Commission's waste management survey found that the average provision for depreciation/acquisition of a new site by Councils and Regional Authorities in 1989 was 4.7 per cent of estimated replacement cost. If made every year this would represent an adequate provision if the average landfill site life were 21 years. (The Commission was not able to collect information on accumulated financial provisions by Councils.)

However, about 62 per cent of Councils made no financial provision in 1989 for rehabilitating or replacing their existing landfill sites. Of the total of $27 million set aside by Councils, 32 per cent ($8.6 million) was for site replacement in Melbourne. The estimated replacement value of sites in Melbourne was $50 million, giving a provision for replacement of 17 per cent. With an expected remaining site life of 5 years, this provision (if it had been made every year) would be sufficient to accumulate funds to cover the acquisition of new sites without a dramatic increase in charges. The financial provisions in some other regions appear too low to cover average remaining site lives (the average remaining site life across Australia was 12 years).

A guide to the variation among Councils is provided by Table 3.1. It details disposal charges for major regional refuse sites in the main capital cities for the three years 1988 to 1990, and the estimated life of existing disposal facilities as at 1 January 1990. Also shown are disposal charges for the use of transfer stations associated with some of these refuse sites.

The substantial increases in disposal charges in Sydney and Melbourne reflect the higher cost of replacement facilities and the relatively short remaining life of current sites.

The WMA estimates that disposal charges in Sydney could increase to $70 per tonne (in 1989 dollars and excluding the cost of land) when current facilities are full in 1998. This estimate is based on the use of transfer stations combined with long-haul to new sites outside the Sydney Metropolitan area.

Landfill sites in the Melbourne Metropolitan area are becoming increasingly scarce; 32 of the 55 Councils in the Melbourne Region no longer have sites within their municipality. This has resulted in the greater use of transfer stations and cooperation between Councils - a trend which is likely to continue. As can be seen from Table 3.1, the costs which can be avoided by diverting materials for recycling are higher when Councils have no access to tips and have to use transfer stations. The greater use of transfer stations would increase the incentives to recycle. Convenience and ease of collecting different types of materials at transfer stations may be a positive incentive also.

Table 3.1 **Council disposal charges and life of current landfill sites**

	Charges			*Current Site Life*	
	1988	*1989*	*1990*	*Total*	*Remaining*
				(at 1 January 1990)	
	$ *per tonne*			*years*	
Sydney					
WMA				18	8
Councils	10.80	13.00	14.50		
…..Commercial	10.80	16.00	18.00		
Via Transfer Station (TS)					
…..Councils	25.40	30.50	32.00		
…..Commercial	25.40	37.50	39.00		
Melbourne					
Berwick				11	3
…..Councils	2.85	2.12	3.50		
…..Commercial	7.00	8.50	16.00		
Via Nunawading TS	22.50	30.00	45.00		
Whittlesea				4	2
…..Councils	6.70	8.10	13.50		
…..Commercial	9.90	12.15	16.90		
Via Heidelberg TS	21.00	24.00	31.00		
Brisbane					
Brisbane City Council				15	3
…..Commercial	9.00	12.00	17.00		
Perth					
Redhill				20	10
…..Councils	9.00	10.00	10.00		
…..Commercial	10.00	12.50	12.50		
Via Bayswater TS	30.00	32.50	32.50		
Brockway				20	2
…..Councils	1.45	1.45	1.45		
…..Commercial	12.50	12.50	12.50		
Adelaide					
Pedler Creek				28	15
…..Councils	5.20	5.60	6.30		
…..Commercial	6.50	7.20	8.00		
Hobart					
McRobies Gully	(charges set but yet to be implemented)			45	30
Canberra					
…..Council	na	9.70	10.10		

Source: Survey of waste management and communications with Councils.

Better management of tip resources might increase the life of existing tips and constrain rising costs and charges. Whelan the Wrecker claimed that the management of existing tips can be significantly improved through techniques such as separating materials and using better compaction processes.

Pioneer International claimed that the scarcity of available waste disposal sites is partly government induced. It argued that potential landfill sites are common around major cities, and there is plenty of space to accommodate both inert materials such as excavation and building wastes, as well as normal household and putrescible waste. Regulations and environmental controls and limits imposed on private sector activity in waste disposal (especially for putrescible waste) were said to account for the apparent scarcity of landfill sites. Reserving quarry excavations to create recreational amenities means they cannot be used as landfill.

In planning for the landfill needed for the growing volumes of waste in the major metropolitan areas, authorities need to consider the scope for greater private sector provision of waste disposal services.

3.4 The form of charges

Charges for waste disposal can take several different forms. These include charges which are based on the volume of waste handled, general access charges such as property rates and two-part charges which incorporate both fixed and variable components.

An important factor in deciding the best form of charging is the extent to which costs vary with the quantity of waste collected and disposed of. Where costs increase with greater use of services, charges based on the extent of usage tend to be more efficient than access charges. The principles involved were explained in the Commission's report on government charges (IAC 1989, particularly Volume 3, pp. 1-5)

Most of the costs involved in waste disposal do vary with the quantity of waste collected. This is most obviously so for the costs of labour, fuel and equipment involved in waste collection and the operation of landfill sites.

There is also a cost involved in using up space in a landfill site. Charges are levied for use of the space in privately owned landfill sites. In the case of publicly owned sites the cost of using space becomes apparent when a new landfill site has to be found. Alternative uses of land have to be forgone and additional transport costs are usually involved in taking waste to new sites.

Where charges for waste disposal do not vary with the volume of waste collected, those generating waste have little incentive to take into account the cost to the community of the space used up in waste disposal sites. If it costs little or nothing to discharge effluent into the environment, firms will clearly have little incentive to invest in other more costly, but less environmentally detrimental, means of waste disposal such as incineration or recycling, or to minimise the production of waste in the first place.

However, volume based charges involve greater administrative costs in recording and billing. As discussed below, volume based charges are likely to be of greatest benefit where waste disposal costs are high.

Existing charges

Councils raised 55 per cent of their income for waste management services in 1989 through specific garbage rates and 33 per cent through general property rates (refer Appendix D). Most of the remainder was from gate charges. Specific garbage rates were the main source of revenue for most Councils in all States except South Australia and the ACT where general rates were the major source. General rates were also the major source of revenue for Councils in the Melbourne Region.

Councils are responsible (collectively in the case of regional groups) for setting disposal charges. Exceptions to this are Councils in New South Wales served by the WMA or subject to ‘rate pegging’. During 1991, the WMA will levy a surcharge on waste disposal fees which will be refunded to Councils in proportion to the quantity of materials they extract from the waste stream for recycling.

Charges for use of landfill sites are frequently imposed according to the amount of waste (by volume and increasingly by weight). However, because most waste is mixed, it is not practical to fine tune disposal charges for each type of waste.

Variation in charges for solid waste is generally only made according to the type of waste for products such as tyres and car bodies, and for general waste - putrescible and non-putrescible. Specific charges may also be applied for the disposal of hazardous wastes. The disposal of other products such as car batteries, tyres and lubricating oil is banned by many Councils.

Several Councils vary their charges according to the source of waste. Residents may be given ‘free’ tipping vouchers. Councils may charge themselves a lower amount than the charge applying to commercial deliveries as illustrated by Berwick in Table 3.1. However, the source of waste is not a determinant of disposal costs *per se.*

Costs are increased if waste is delivered in small amounts by many vehicles since a wider tip face is required and a larger area must be worked and covered. The compaction achieved is also lower, decreasing site life and increasing the potential for environmental damage. For these reasons and to reduce traffic congestion, many Councils have banned access to landfill sites by small vehicles where residents have access to transfer stations. Some Councils are also seeking to reduce direct deliveries (and illegal dumping) by providing a comprehensive waste management service involving big bins, kerbside recycling, and hard rubbish collections.

General garbage charges

Where waste disposal is funded from general property rates, the amount raised to cover waste management costs is not made explicit. Users of the services are unaware of the actual costs of collecting and disposing of their waste. No adjustment is made to the amount paid by users for the type and quantity of waste collected. This means there is no direct financial incentive for householders to reduce the amount of waste they put out, and Councils may have to impose arbitrary limits on amounts and types of waste they will collect (say one 240 litre bin of general household waste per week with no garden waste).

More information is provided if a separate garbage rate is struck. However, the costs of waste collection and disposal are still not made explicit and no adjustments are made for the amount of waste collected.

Separate rates, therefore, do not provide any greater direct incentives for people to alter the way they use waste management services.

Businesses are frequently charged according to quantity removed. This means that the household and business sectors have very different incentives to manage their waste efficiently. Clearer signals are provided to commercial/industrial enterprises about the costs of managing their waste.

Direct charging provides an incentive for consumers to reduce their use of waste disposal services, through purchasing goods which involve less waste or which are made from materials that can be recycled.

Volume based charging

Even though Councils may be earning a market rate of return on their capital, there may be significant cross subsidization of high waste households by low waste ones. Cross subsidisation is avoided where the costs of disposing of additional waste, irrespective of source, are built into charges.

North Sydney Council is implementing a scheme whereby residents can put out more garbage, but only if they pay a higher service fee. The standard service is two 55 litre bins per week. Each extra bin attracts a surcharge of $106 per year. The Council is also considering other options to increase the incentives to recycle. Currently around 25 per cent of the waste stream is diverted for recycling. The Council is planning to increase this to over 35 per cent within the next three years in order to avoid disposal costs.

Volume based charging systems are used in a number of communities in the United States. Two basic systems are in use: a variable bin system and a prepaid bag/tag system. Under the variable bin system, customers/householders select the level of service in terms of number of bins of garbage they wish to dispose of each week. With the prepaid system, customers purchase special garbage bags (or tags) from their Council, the price of which includes the cost of disposal. Prepaid bag systems are easier to understand, and simpler to administer and to enforce. There is no need for a complex billing system and a simple distribution network could be set up through, for example, newsagencies. Both systems should be supported by comprehensive recycling facilities (including composting/mulching) and adequate provisions against illegal dumping and burning.

With both systems the more waste that people put out, the more they pay. Both can be combined with a separate minimum charge to cover fixed costs such as landfill closure, administration and interest on capital borrowings. The variable bin system can also cover these costs in the ‘first-bin’ rate. Covering these costs can ensure the waste disposal agency’s solvency. The approach would put waste management services on a similar footing with the pricing of water and electricity.

Volume based garbage charges provide a direct incentive for households to reduce the amount of waste they dispose of. This may be achieved by generating less waste through careful buying, by home composting, or by making materials available for recycling. No one method of waste reduction is favoured and people are treated fairly in that those who dispose of similar amounts of waste pay about the same.

In the United States, Seattle introduced a variable bin rating system in 1981 (refer Box 3.2). The structure of the variable rate was changed and additional recycling programs implemented at the beginning of 1989. The quantity of waste disposed of in 1989 fell by 24 per cent compared with 1988 levels. The City considers that the variable rating system is its most effective recycling program and now aims to reduce the amount of solid waste for disposal by 60 per cent by 1996.

Similar declines in the amount of waste for disposal have been achieved with the bag/tag system. For example, Perkasie, Pennsylvania, reported a 35 to 45 per cent decline in the amount of waste delivered to its transfer stations in the year following the introduction of a prepaid bag system in conjunction with extensive recycling facilities.

With volume based charging systems, people who reduce their waste avoid costs of waste collection and disposal directly. In Australia, where most Councils rely on garbage or general rates, the avoided costs accrue mainly to Councils ie, all ratepayers.

The other essential component of the Seattle program is a comprehensive recycling service. These services incur considerable costs and there is the question of how they should best be met in Australia.

Charging for

Box 3.2: **Seattle's volume based garbage rates**

Seattle introduced its variable bin rating system in 1981 following the closure of the City's landfill sites for environmental reasons. To dispose of its waste, the City used the facilities of a neighbouring County which increased costs significantly. The least-cost option was to invest heavily in recycling programs to reduce the amount of waste requiring permanent disposal.

Under the variable bin rating system, residents choose the number of standard (30 US gallons or 114 litres) bins to dispose of their weekly waste. Smaller service levels (19 and 10 gallons) are also provided. The greater the volume requested, the higher the service charge. There is also a charge for the garden wast collection service but at a lower rate than for garbage collection. Householders also pay a separate minimum charge which covers fixed costs and the cost of kerbside collection of recyclables. Low income earners pay lower rates.

The City also provides a kerbside recycling program and a garden waste composting program. The former is used by 75 per cent of residents and the latter by over 60 per cent. The volume based rates have proven to be an extremely effective recycling incentive. The average number of bins used fell from 3.5 in 1981 to just over 1 in 1989.

The City of Seattle considers that the benefits of its variable charging system outweigh the high administrative costs. It is more efficient and equitable than those financed by general rates and the reduced demands on landfill have allowed more time to develop new disposal facilities. Seattle has not experienced any significant increase in illegal dumping and burning as a result of these volume based charges.

recycling services may be necessary to maintain the financial stability of the total waste management system. If the waste reduction program is successful, the revenue base from garbage collection under a volume based system will decline. Thus, continued payments to collectors of recyclables would involve subsidisation from general rate revenue. Alternatively, recycling services could be provided on a fee for service basis. The fee for removal of sorted recyclables would be much lower than that for removal of garbage. This would be consistent with the general principle of making people pay for what they use and of allowing them to influence the size of their waste management bill.

The payment of a recycling fee would also remove a potential source of discrimination against others involved in recycling, such as community groups and private collectors.

The WMA stated that some Sydney Councils have linked recycling fees to avoided waste disposal costs. They have, however, not factored in the savings associated with waste collection costs and the other less tangible benefits such as the reduced social and environmental costs of landfilling or other waste disposal activities, resulting from recycling activities.

Volume based charging systems are more costly to administer than funding from either garbage or general rates. Significant costs may be incurred in developing and implementing the systems, especially in gaining support for their introduction. These costs need to be weighed against the benefits of volume based charging. The benefits are a more efficient waste management system and extension of the life of existing disposal facilities.

Volume based charging is likely to be of most benefit where disposal costs are high, where there is strong community support for recycling, or where the existing services are perceived to be unfair. Individual Councils are in the best position to assess which system will best suit their needs.

Weight can also be used as a basis for charging. Such a system could allow people to make better decisions concerning the way in which they dispose of their waste, but would be more costly to implement in most cases than volume based charges. Trials are being carried out in Germany and the United States to assess the feasibility of weighing garbage from each residence. Separate accounts would be sent to each based on the amount of garbage collected. A similar trial is being conducted in Sydney by Transport and Waste Technologies in conjunction with the Fairfield City Council. The WMA is supporting research into the technology of recording the weight of individual garbage bins. The authority proposes to assess the attitudes of householders to paying by weight. The Melbourne City Council said it is also investigating the application of a ‘pay by weight’ system.

Costs of illegal dumping

Waste disposal charges which are directly related to quantity of waste may provide an incentive to dump waste. Increased surveillance, fines and penalties may be a deterrent but involve additional costs. These costs need to be considered in assessing the extent to which charges should be increased.

However, most Councils indicated that illegal dumping of solid waste would not be a major problem if disposal charges were increased (refer Appendix D). About half the Councils considered that an increase in disposal charges would have no effect on the extent of illegal dumping, and a further 38 per cent said that there would be only a moderate increase. Only 12 per cent said there would be a significant increase. Both the Cities of Berwick and Springvale increased their disposal charges by more than 50 per cent in December 1989 and reported no increase in illegal dumping as a consequence.

This does not mean that illegal dumping is currently not a problem for Councils. It is, especially on the urban/rural fringe. Significant resources are devoted to prosecuting offenders and to cleaning-up illegally dumped waste as soon as it occurs thereby removing the temptation for others to dump illegally.

Illegal dumping of waste is influenced by many factors other than disposal charges. Most people are probably socially responsible about the way they dispose of their waste. Ready access to convenient and reliable disposal and recycling services can reduce illegal dumping. Many Councils indicated that people are more likely to dump illegally out of frustration (for example, in finding disposal facilities closed) than in response to the charge that would have been paid.

Recycling has become an integral part of the waste management strategy of many Councils. It is a means of avoiding disposal costs, conserving landfill space, and a source of materials for use in other municipal activities. And for some, the sale of recyclables is a source of revenue.

4 MARKETS FOR RECYCLABLES

This chapter examines the way market and non-market factors come together to produce the recycling outcomes seen in Australia today. Details of markets for individual products are in Volume II.

Materials become available for reuse or recycling at various points in the flow of production, consumption and waste disposal. The off-cuts and scrap from production processes are a major source. The household waste stream includes significant quantities of glass, plastic, paper and aluminium which can be recovered for reprocessing. Used transport and other machinery, consumer durables and old buildings and construction are also significant sources of scrap. Small amounts of scrap materials are imported.

4.1 The supply of recyclables

Whatever their source, if materials are to be recycled, they have to find their way to reprocessors. Although some waste generators contract directly with reprocessors, intermediaries such as waste management authorities and various types of collectors and scrap merchants are usually involved.

Mismatches between supply and demand are eventually eliminated by changes in the prices of materials. However, there can be delays and disruptions. Problems most commonly occur where the used material has a low value to reprocessors or where the cost and price information has not been passed on or acted on quickly.

Sources of materials

Commercial and industrial firms

The bulk of materials reprocessed come from industrial and commercial premises. The incentive to make these materials available for recycling is usually the price which can be received for the materials themselves.

Generators of less valuable waste materials may make them available to collectors free of charge to avoid waste disposal costs or to help in pollution control.

Production processes often generate offcuts and clean and homogeneous wastes on a regular basis. These materials require minimum preliminary treatment before reprocessing and generally do not enter the waste disposal stream. Rather, collection contracts are negotiated directly with commercial collectors or reprocessors.

Large quantities of used paper products are generated by newspaper publishers, printers, supermarkets and offices. Unsold newspapers returned from newsagents are a clean bulk supply of used newsprint for use in packaging. Supermarkets also find a ready market for their cardboard boxes which are returned for reprocessing into further packaging. Waste office paper is often collected by office cleaners on contract to commercial operators. APM operates, and is further developing, a scheme to collect waste office paper from high rise office buildings in capital cities.

Glass bottles are generally picked up from hotels and restaurants free of charge on a sorted basis. Collectors usually provide appropriate containers as an inducement to separate materials.

Major oil refining companies operate their own collection systems to secure waste oil for their fuel oil blending and, in some cases, rerefining operations. Small waste oil rerefiners operate their own collection systems but supplement their supplies with used oil from independent collectors. Collectors may not always pay for the waste oil which they pick up from service stations and other waste oil generators.

Large manufacturers of chemicals mostly reprocess and reuse their own waste. Others contract out the collection, reprocessing and return of the reprocessed material to specialised chemical waste reprocessors.

In some cases, manufacturers have grouped together to provide recycling facilities. For example, the soft drink manufacturers who use polyethylene terephthalate (PET) bottles contribute a voluntary levy which supports the collection and reprocessing of PET. Firms involved in the beverage and packaging industries have also supported State and local Council collection of recyclables through the Litter Research Association.

The Publishers' National Environment Bureau, formed by News Ltd, the John Fairfax Group, Australian Consolidated Press, Marinya Media Holdings and Regional Dailies of Australia, intends to provide $4 million over two years to assist recycling and disposal of old newspapers until ANM's de-inking plant at Albury comes on stream.

Box 4.1: **Empirical evidence: steel scrap supply**

Steel scrap supply is largely influenced by activity in the construction sector and the price of scrap (which in Australia is set by export prices). Those two factors alone explain about 95 per cent of the variations in scrap supplies observed between 1978 and 1988.

Supply expands if the scrap price increases or if there has been a fall in the scrap price since the previous year. Supply in any year is estimated to increase by only 0.44 per cent if the price during that year increases by 1 per cent. However, the large scrap price variations observed in practice can have sizable effects on scrap supply in spite of the relatively low sensitivity of supply to price changes. The price extremes observed during the 1978 to 1988 period would have resulted in a supply change of about one fifth during this period, if all other factors had remained constant.

The construction sector is the largest user of steel products. Those products become a large source of steel scrap when old constructions are demolished. This often occurs when new construction is undertaken, so that scrap supply expands with increased construction activity. The sensitivity of scrap supply to changes in construction activity is high, a 1 per cent increase in construction activity resulting in a 2.3 per cent increment in scrap supply. Thus, growth in the construction sector is itself a powerful incentive for increasing steel recycling. On the other hand, recycling is one of the first casualties of a downturn in construction.

Source: Industry Commission, *An analysis of the factors affecting steel scrap collections*, forthcoming.

Demolition activities are a source of used materials such as marble, period fittings, non-ferrous metals and structural steel. Brick and concrete rubble is also recovered for reprocessing, particularly in Sydney and Melbourne. Used road material is recycled or reused to a limited extent in Australia. Box 4.1 provides some empirical evidence relating to the factors influencing the supply of steel scrap.

Households

In the absence of volume based charges for waste management, a number of surveys have shown that household participation is determined largely by convenience factors, the frequency and reliability of collections, and an awareness of the benefits of recycling. Convenience factors are related to the effort involved. Householders are generally prepared to sort materials such as glass, newsprint and PET, but are not prepared to clean steel cans - a pre-requisite at present for their reprocessing. As a result the recovery rate of used steel cans remains low.

Some participants said that the community's willingness to participate in recycling goes beyond the collection phase. It was suggested for instance that voluntary labour could be used for sorting, transporting, crushing, containerising, loading and even reprocessing of some materials. Aspley Special School, which operates a recycling station, suggested that people in sheltered workshops, various social welfare recipients including age pensioners, and minor offenders serving prison sentences, could be involved in sorting recyclables.

The arrangements for collecting recyclables from households vary among materials and between regions. At drop-off centres people place materials in the appropriate containers for commercial collectors or voluntary groups to collect. On the other hand, people can sell used beverage cans (UBC) at buyback centres, and at some shopping centres and service stations.

Many reprocessors themselves provide facilities for the collection of used products from households. Comalco, which smelts both primary and secondary aluminium is extending its network of UBC buyback centres. Cans are bought on a per kilogram basis, at prices related to those of new aluminium. Local collecting firms also operate as buyback centres, selling the cans in bulk to aluminium smelters for reprocessing. ACI operates a network of bottle banks at shopping centres and landfill sites and also buys cullet for reprocessing. The prices it is able to pay are adequate to maintain recovery levels.

Materials collected at kerbside include bottles, aluminium cans, plastic and paper. Kerbside collections may operate for one or more than one material. Where multi-material collections operate, householders may have to sort their recyclables and place them in separate containers.

The materials are transported to recycling facilities for preliminary processing and sold to reprocessors.

The convenience of being able to dispose of a large quantity of waste in big bins is alleged to be an impediment to greater collection of recyclables from households. However, some Councils have reported that increased collection rates have been achieved through community education despite the introduction of big bins. While big bins are likely to lead to changes in waste disposal habits, the evidence relating to their effect on recycling is by no means clear (refer Appendix D).

Van den Broek (1989) reported on a number of house-to-house trials conducted in Sydney. More materials were collected when a single bag was provided for all recyclables, than when sorting was required, and/or when householders had to provide their own container. Participation rates were higher for kerbside collections than where materials had to be taken to a central depot. Before the introduction of special bags monthly collections resulted in 11 per cent of households participating. When householders were given a collection bag, participation rates increased to 35 per cent and the amount of material collected increased by 288 per cent. More materials were also collected when recyclables were picked up on garbage collection day. Multi-material weekly schemes were found to collect on average three times more glass and paper than separate material collections.

Collections from households generally take place weekly, fortnightly or monthly. Many participants said fortnightly collections led to the largest quantities collected. Others, including the Victorian Environment Protection Authority (EPA), said that a weekly collection on the same day as the normal garbage collection was best as householders were in no doubt about when to put out their recyclables. Some favoured monthly collections. The Western Australian EPA said that the lengthy period between monthly collections means that only dedicated households participate regularly and to capacity, and that weekly collections are preferable.

Costs vary with frequency of collections. The Institution of Engineers said that higher unit costs would result from more frequent collections because of the higher labour component. The Newcastle City Council said that monthly house to house collections under contract arrangements were likely to cost $80 000 annually. Similar arrangements for fortnightly and weekly collections were estimated to cost $200 000 and $450 000 respectively. The optimal frequency will depend on local conditions and can only be determined by individual Councils.

Participants stressed the need for reliability, regularity and continuity. Where kerbside collections cannot be relied on or are irregular, interest in recycling wanes. Materials left on the kerb for days are unsightly and create health hazards and eventually have to be stored until the next collection day. Continuity is important because once collections have been interrupted or discontinued they may be difficult and costly to re-establish.

Some participants said that families with school age children are more likely to participate than singles and young marrieds because the benefits of recycling are promoted in schools and children encourage parents to participate. However, D.J. Hawkins & Associates claimed that their research in Tasmania indicated that family units with children under 18 are less likely to recycle than those with no children. Areas with a high proportion of migrants may have low participation rates if services are promoted only in English.

There is generally no direct link between the amount of waste put out for collection and the rates charged by local councils (refer Chapter 3). Furthermore, the introduction of a recycling scheme is not usually accompanied by a reduction in the garbage rates. This means there is little incentive for households to recycle as a means of reducing waste disposal costs. Less material is likely to be made available by households than would be the case if such a direct link did exist.

Intermediaries between generators of recyclables and reprocessors

Councils and collectors provide a link between the suppliers and the reprocessors of many recyclable materials. Councils are involved because they are responsible for waste disposal and recycling has become an integral part of the waste management strategy of many Councils. Collectors may be independent operators, or operate under contracts to Councils and/or reprocessors. Some reprocessors operate their own collection facilities.

Councils

The Commission’s survey of waste management (IC 1991a) indicates that 61 per cent of Councils were involved in recycling during 1989. In the capital cities 83 per cent were involved. The involvement of rural Councils in New South Wales and Victoria was 74 and 68 per cent respectively. The proportion involved in other regions was much less.

Council involvement frequently takes the form of financial support for kerbside collection of recyclables, or the provision of drop-off centres. Many Councils also conduct educational and promotional programs aimed at encouraging recycling activities (refer Appendix D).

Of the Councils which replied to the Commission's survey, 28 per cent said that the main reason for their involvement was in response to community pressure; 24 per cent to reduce waste management costs; 22 per cent to save natural resources; and 16 per cent to reduce pollution. Only 3 per cent of Councils said that increased revenue was the major reason for their involvement in recycling.

In negotiating new waste management contracts, some Councils have introduced an integrated garbage/recycling collection service. Concord City Council (Sydney) has a single contract for the kerbside collection of both garbage and recyclables. The cost of the combined contract is $373 000 per year, compared with the previous cost of collecting household refuse only of $344 000. The increase of $29 000 (part of which will reflect inflation) is offset by savings in disposal costs of an estimated $41 000, thereby providing a net benefit to Council of $12 000 per year. Revenue from the sale of recyclables is retained by the contractor.

Tweed Shire Council (NSW) has an integrated garbage/recycling collection service based on the multi-use of the 240 litre bin. On designated days, the bin is used to collect garbage and on other occasions it is used in the collection of recyclables. A combined service for garbage and recyclables is one of the ways by which North Sydney Council hopes to divert for recycling 35 per cent of materials in the waste stream.

Gosford City Council has also used an integrated system since it started to collect recyclables in November 1989. The service is similar to that of Concord Council except that ownership of the recyclables is retained by Gosford Council.

Income from the sale of recyclables covered about 36 per cent of the costs of collection during the first six months of the scheme's operation. The other costs were offset from general Council revenue equivalent to $6 per tenement per year (or about 12 cents per weekly service). No explicit allowance was made by Gosford Council for avoided disposal costs in assessing the financial performance of its recycling scheme.

By recycling, Councils conserve landfill space. Reductions of around 10 per cent in the amount of waste for disposal were reported by a number of Councils following the introduction of collection facilities for paper, glass, aluminium, and PET; the greatest reduction has been for paper which makes up about two thirds by weight of these materials. North Sydney has achieved a 25 per cent reduction in the domestic waste for disposal; the relatively high avoided costs of disposal ($32 per tonne through a transfer station) have been a major factor in this reduction. Some of the reduction could be ascribed to a reduction in waste generated, but some is likely to have occurred through an increase in recycling.

There is a limit, however, to the extent by which recycling of these materials can reduce the amount of waste requiring permanent disposal. They make up only 8 to 15 per cent of the total waste stream. In recognition of this, a number of Councils have turned their attention to other materials. Encouragement is being given by several Councils and the WMA to households to compost vegetable scraps and garden refuse. Some Councils provide domestic composting bins at a subsidised cost. Some Councils have commenced composting and/or mulching of garden refuse and street prunings. Others, such as the City of Marion in South Australia, have depots where householders can deposit garden waste in exchange for mulch or chippings. Crushing of concrete and bricks is being undertaken by an increasing number of Councils. In addition to avoided waste disposal costs and conserving landfill space, savings may be realised from using the mulch in municipal parks and gardens and the crushed material in road works.

The collection of recyclables from the residential waste stream is generally not self-financing because the costs of collecting, sorting and transporting exceed the returns received from collected materials. These costs are of course influenced by the quantity of materials collected, the extent to which they have to be sorted and graded, and the collection distance travelled. Many Councils pay collectors to provide a service.

Many Councils justified their involvement in recycling through reductions in waste disposal costs and conserved landfill space. A guide to the potential cost savings per tonne of diverted materials for Councils in the State Capitals and the ACT can be obtained from Table 3.1 in Chapter 3. For example, Councils using the Whittlesea regional refuse facilities avoided costs of $13.50 per tonne in 1990 for waste delivered direct or $31 per tonne if delivered via the Heidelberg transfer station.

The Commission's waste management survey indicates that, by recycling, Sydney Councils saved about $0.5 million on waste disposal costs in 1989, equivalent to about 14 cents per person, but made a loss of $0.4 million (refer Appendix D). These figures do not take into account the returns from the sale of recyclables, which usually accrue to collectors rather than Councils. This meant that expenditure on the collection of recyclables was recorded but the quantity of materials collected was not. Thus, the total tonnes diverted for recycling and avoided costs are likely to be underestimates.

The survey suggests that many Councils in Australia spend more on developing and running recycling schemes than they save through avoided waste disposal costs. For instance, Council recycling schemes in Melbourne, in 1989, operated at an overall financial loss of $0.7 million, equivalent to 23 cents per person. The proposed recycling strategy of the City of Marion in South Australia will carry a net annual cost of about $84 000 after allowing for avoided waste disposal costs of $69 000.

Many Councils with low disposal costs said that the cost of recycling schemes exceeded avoided waste disposal costs to such an extent that recycling was not justified economically. This is likely to be the case in many rural areas.

Where disposal costs, including environmental costs, are low, the preferred and environmentally sound option can be to dispose of waste by landfill instead of making materials available to recycling markets.

Expenditure on recycling which exceeds avoided waste disposal costs can be justified only where ratepayers are willing to incur this expense. A number of participants quoted surveys which indicated ratepayers' willingness to make an annual payment towards recycling.

In periods of low prices, some Councils have increased their payments to contractors in order to maintain the service.

In doing so, Councils avoid the costs of developing new arrangements and rekindling the enthusiasm of residents. The Lane Cove Municipal Council said that it was forced to pay $30 per tonne of wastepaper to the contractor to maintain the service. Under the Council Recycling Rebate Scheme to be introduced in 1991, the New South Wales Government, through the Waste Management Authority, will pay Sydney Councils about $17.50 for every tonne of material recycled. The scheme will be funded by a surcharge on waste disposal fees.

Payments to collectors result in increased quantities of recyclables collected and thus increase the supply of recyclables to reprocessors. This reduces prices paid by reprocessors and consequently their costs. It leads in turn to higher rates of reprocessing. This effect is discussed in Appendix E.

However, with collapsing demand for a material, a point is eventually reached where the costs of maintaining the collection service outweigh the costs of re-establishing it at a later date. Many Councils which maintained the collection of old newspapers in spite of falling prices, eventually ceased collections during 1990.

Although Council payments to collectors are likely to take into account estimates of quantities which can be collected, the payment is often a set amount per household per material, and not directly related to quantities collected. One participant said that he received a payment of 3 cents per household per week to maintain glass collections averaging a quarter to a third of a kilogram per household per week. To extend the collection to take in aluminium and plastics, he required a further 3 cents per household per week, while collecting only about 50 grams of both materials combined.

It could be argued that basing payments on quantities collected would make a greater contribution to avoiding waste disposal costs. However, apart from the difficulty of monitoring, the administrative cost of payments based on quantities is likely to be higher than that based on households.

Brickwood Holdings argued that Council subsidies perpetuate small, inefficient collections. This is because such payments allow some collectors to stay in business who would otherwise be forced out or rationalise, perhaps by merger.

Many Councils are involved in recycling as a response to ratepayers' demands. However, even without this pressure it would be efficient for Councils to make payments to collectors, so long as those payments result in savings in waste disposal costs.

Collectors

The collection of recyclables is frequently carried out by small operators. Some undertake household collections, whereas others collect from commercial and industrial premises, for example solvent reprocessors and scrap metal merchants, and from local tips. Some are involved in all of these activities. They may operate single or multi-material kerbside collections and/or collection depots and buyback centres. Many collect materials under contract to local Councils or reprocessors.

Voluntary organisations also participate in kerbside collections of recyclables and in collection centres. Some sheltered workshops carry out sorting and baling of materials. These are generally small scale operations which sell the materials to Councils, larger commercial collectors or directly to reprocessors.

Collectors reported substantial variability in their total returns. They attributed this largely to fluctuations in the sale price of aluminium cans, a decline in the number of bottles collected from hotels and restaurants over the past two years due to reduced economic activity, and reduced prices for plastic and old newspapers. The volatility of kerbside collectors' returns together with high marginal costs can lead to opportunistic entry and exit and a low level of capitalisation, making them vulnerable to any price fluctuations. In turn this can mean that supplies of recyclables are not sustained at levels which justify long term investments on the part of reprocessors.

One large collector, Simsmetal Limited (Simsmetal), dominates the scrap metal industry. The company collects scrap from industry and households and also purchases scrap from smaller scrap collectors. It also collects some plastic waste. There are a number of large wastepaper merchants who purchase wastepaper for export or delivery to paper manufacturers for reprocessing.

Recovery costs

The quantity of recyclables collected at any particular price is influenced by recovery costs. So long as the additional (marginal) revenue received for one more unit collected exceeds the additional (marginal) cost of collecting that extra unit, it will be profitable for collectors to expand their operation. As with most commercial activities, because of the investment in plant and equipment required, the marginal cost of collection of recyclables at first declines with increasing quantities collected. Eventually, however, a scale of operations is reached where costs begin to rise for each additional unit of material collected.

The point at which marginal costs of collection start to rise will depend on the material concerned and also on the mix of materials collected. APM has long standing collection arrangements for packaging papers, but has recently moved into specialised collections of used office paper at a higher cost. BHP and other steel reprocessors have not sought to obtain used steel cans from the domestic waste stream because of the high cost of collection and the low quality of the product due to contamination. A study carried out by the Litter Research Association assumes that, in order to increase the recovery of UBC to 70 per cent, a different collection system would be required, and this would increase collection costs from $850 per tonne to $1180 per tonne (refer section 1.1, Chapter 1, Volume II). However, Comalco, News Limited and ACI each said that owing to improved collection systems their marginal costs of collection are still declining.

The extent to which a collection firm is able to take advantage of decreasing marginal costs will depend on the availability of recyclables, its capitalisation, cost structure and the technology employed. Increases in costs and wildly fluctuating prices can cause the optimal size of operations to change. Clearly, uncertainty about costs and prices present problems for the efficient planning of collection systems.

The payments which collectors make to waste generators are usually a residual, after allowing for the costs of collection, preparation and transport. Thus, prices of materials such as non-ferrous metals are low in areas remote from smelters.

Fuel, labour and equipment make up a high proportion of collectors' costs. Transport costs are affected by the distance which has to be travelled as well as by the weight and volume of materials collected.

The cost of kerbside collections is generally higher than that of collection depots.

Box 4.2 illustrates the costs and returns of a typical small collection firm. Labour is by far the largest component of cost.

Transport costs

In Australia, most generators of industrial waste materials are concentrated in major cities. Where reprocessors are also located in these cities, transport costs are low. However, where reprocessing is large scale and capital intensive, materials may be drawn from all over the country (eg UBC). In some cases where processing facilities have been located in country areas close to sources of virgin raw materials (eg newsprint), reprocessing of used materials may be very costly because transport is a major element of recovery costs. Some participants said that when the proposed Wodonga PET processing plant comes on stream, the additional transport costs may severely affect the viability of collections.

Transport costs tend to rise as the area covered increases and as the quantities of material collected decrease. Poor participation was identified by 26 per cent of Councils as a major impediment to recycling. As recovery rates within a region increase, transport costs per unit collected tend to fall.

Unless backloading is possible, the costs of long distance transport of recyclables can be prohibitive. The Tasmanian Freight Equalisation Scheme (TFES) was introduced in 1976 to compensate Tasmanian industry for transport disadvantages relative to the mainland. Wastepaper is an eligible northbound commodity and several claimants receive assistance under the scheme.

The viability of ANM's proposed de-inking plant at Boyer in southern Tasmania would depend on the availability of considerable quantities of waste newsprint and magazines. Since these are not available in sufficient quantities locally, they would need to be imported from the mainland at considerable cost. ANM currently receives about $4 million annually under the TFES, and appears to be eligible to have the subsidy extended to its proposed de-inking activities.

Box 4.2: **Costs and returns of a collection firm**

The firm employs fewer than 10 people including the owner. The equipment required to service several suburbs includes a number of 4-tonne trucks, which are used to collect recyclables such as glass, paper and PET, and forklift trucks. Sorting and storage of materials take place at the firm's depot.

Operating costs:

Source	**Proportion**
Labour, including operator	48 per cent
Repairs and maintenance, land rent, interest on capital	27 per cent
Payments for recyclables	15 per cent
Fuel for trucks and forklifts	10 per cent

Returns (including Council payments):

Source	**Proportion**
PET	4-8 per cent
Refillable beer bottles	16-23 per cent after payment to the public of 10-60 cents per dozen
Cullet	14-18 per cent
Aluminium cans	0.5-5 per cent
Lubricating oil (collected less often)	na
Council payments	40-60 per cent depending on fluctuations in product prices and individual Council payments

Income from sales varies widely as a proportion of total returns due to fluctuating prices.

Source: Discussions with collectors.

Comalco and Tredex provided information about transport costs for full semi-trailer loads with a legal load of 22 tonnes, based on normal rates and backloading. Normal rates from Melbourne to Sydney and Sydney to Brisbane were the highest at about 7 cents per tonne per kilometre. The lowest backloading rates were available from Perth to Sydney and from Darwin to Sydney at 2 to 2.5 cents per tonne per kilometre. Brickwood Holdings Pty Ltd said that post consumer baled plastics can be freighted from Perth to Melbourne for about $70 per tonne. This is equivalent to less than 2 cents per tonne per kilometre.

Pratt Group said that rail transport from Adelaide to Melbourne in February 1990 was 20 per cent higher than road transport. The City of Geraldton, on the other hand, said that rail freight from Geraldton to Perth is cheaper than road freight, but additional costs may be involved for handling at both ends and pick-up and delivery. In Queensland ACI has negotiated concessional rates for transport of cullet by rail, allowing more glass to be reprocessed than would otherwise be viable. Smorgon Glass, referring to Victoria and New South Wales, said that road transport was the most cost effective means of transport, at between 4 and 6 cents per tonne per kilometre.

Transport costs for non-ferrous scrap are less relevant because the bulk of scrap metals is generated in major cities where reprocessing also occurs. Moreover, because the value of non-ferrous scrap is high, transport costs even from remote areas do not significantly affect recycling. The prices paid for non-ferrous scrap in remote areas are lower and reflect higher transport costs.

In the last few years, freight costs have not been an impediment to ferrous scrap recycling as metal prices have been relatively high. Simsmetal said that car bodies are transported from Darwin to Adelaide for processing on the basis of current scrap prices in the order of $US140 to $150 per tonne. It said that a drop in price to $US100 would make recycling of remote area scrap unviable. Car bodies can be left to accumulate until prices are high enough to warrant this transport.

Collection technologies

Not all waste materials have the same density and value. Kerbside collectors are naturally reluctant to pick up materials which take up space but from which they get low returns.

Most Councils and many members of industry (collectors, beverage container manufacturers etc) said that one reason why kerbside collections are not very widespread in South Australia is that Container Deposit Legislation (CDL) removes the more valuable materials from the waste stream. The South Australian Government disputed this, saying the materials remaining in the household waste stream make kerbside collection viable, even after the removal of beverage containers.

Collectors would prefer to collect the most valuable materials only. However, limited supplies of these may not allow pick-up trucks to be used to capacity, encouraging collectors to pick up other materials also. In addition Councils employing collectors on contract usually specify a range of materials to be collected.

Manual sorting is highly labour intensive. Some kerbside collection systems require householders to sort their recyclables before putting them out, others allow a range of recyclables to be put in one container together. Brickwood Holdings Pty Ltd said that most collectors do some sorting but that most are too small to justify the investment required for mechanical sorting. Some participants said that, since the composition of materials collected differs between regions and also between seasons, pre-sorting by householders does not allow efficient use to be made of available truckspace.

Adding to the range of materials collected from households may even increase costs by more than the additional revenue. Waste lubricating oil is not usually collected from households. The quantity available does not warrant the cost of the extra equipment and truckspace required.

Where householders take their recyclables to a central collection depot, they absorb some of the costs which would be incurred in kerbside collections. However, this requires more effort and it is likely that smaller quantities will be made available. If it were possible to quantify the individual efforts made by householders to transport materials to collection depots, the total (social) cost might be higher than that for kerbside collections at all levels of collection. This is because many individual trips, each transporting small quantities, are a costly mode of transport.

Some participants, including the Plastics Industry Association, said that a co-ordinated national collection system is needed. However, it seems clear from the above that there is no single optimal collection system for all materials and regions.

Councils and collectors are aware of this and experimentation with various systems is occurring. Even for the larger cities there is no agreement as to the best system. The Victorian EPA and Brickwood Holdings argued in favour of mixed collection and centralised sorting.

Preliminary treatment of materials

Before it can be reprocessed, many materials require crushing, shredding, briquetting or palletising to reduce volume and improve handling. Items such as ships' propellors, which cannot enter the furnace whole, may need sectioning. In the case of household collections the preliminary treatment required (for instance sorting and baling of used newspapers) can be labour intensive, also contributing to higher costs. The incentives for collection of post-consumer recyclables are therefore often weak or non-existent, particularly for materials such as steel food cans or plastic packaging which may be contaminated.

Quite sophisticated preparation may be necessary for some recyclable materials. For example tinplate requires de-tinning before it can be remelted. While de-tinning is driven mainly by the value of the steel scrap, the tin produced is itself a valuable commodity (refer Chapter 1 of Volume II). Where metal has been bonded with plastic, as is increasingly the case in vehicle manufacture, the plastic bonding needs to be removed before reprocessing of the metal can occur. Because recovered glass containers are contaminated to a certain extent, the higher the utilisation rate of cullet, the more refining and purification is necessary (refer Chapter 2 of Volume II).

4.2 The demand for recyclables

The demand for recyclables is influenced by the cost of used materials and the costs of processing them compared with new materials, the substitutability of recycled products for new products. Box 4.3 provides an example. Changes in technology and consumer tastes also influence demand, as do conditions in export and import markets. Increasingly, producers of materials which are conspicuous in the waste stream (such as plastic packaging and old newspapers) are taking initiatives to increase the demand for these materials.

Prices of recyclable materials as inputs

Prices paid for recyclables fluctuate. However, they do not all fluctuate to the same extent and at the same time. Therefore, within limits, the losses which collectors make on one material can be offset by profits on other materials until prices once again rise. Some Councils provide financial support in order to maintain kerbside collections.

The highest prices received by collectors are for homogeneous, post-industrial, clean recyclables for which there is a ready demand. The incentives to recycle post-industrial waste are mostly market driven and generally unsupported by government subsidies.

Box 4.3: **Empirical evidence: steel scrap demand**

Scrap demand is a function of three main variables: the scrap price, the activity level of the steel industry and scrap exports. These three variables, Smorgon's 1983 entry in the scrap market and BHP's discontinuance of the open hearth technology in the early 1980s can explain about 97 per cent of the variations in scrap demand during the 1978 to 1988 period.

During the 1982 to 1988 period, a 1 per cent change in scrap prices resulted in a 0.46 change (in the opposite direction) in the amount of scrap demanded. A negative but much lower sensitivity was estimated for the 1978 to 1981 period. The large scrap price variations possible in practice mean that prices can have a significant effect on demand despite the low price sensitivity. For example, scrap demand would have almost doubled if the scrap price were to fall from the maximum to the minimum values observed between 1978 and 1988, other things being equal.

The steel making industry is the main domestic user of scrap. Not surprisingly, the demand for scrap is sensitive to changes in the amounts of steel produced, a 1 per cent change in steel production resulting in an almost identical per cent change in scrap demand during 1978 to 1981. Smorgon's entry and the discontinuance of the open hearth technology increased the sensitivity of scrap demand to changes in the amounts of steel produced to 1.4 per cent for the 1982 to 1988 period.

Because the scrap price in Australia is set in the international market, exports can adjust to separate changes in price and domestic supply or demand. Price or supply increases boost exports while domestic demand expansions have the opposite effect.

Source: Industry Commission, *An analysis of the factors affecting steel scrap collections,* forthcoming.

Refillable 750 ml beer bottles are a valuable source of cashflow to some collectors. From November 1988 stubbies in Victoria ceased to be accepted for washing and reuse. This meant substantial losses of revenue to the collection industry, only partially compensated by a slight increase in the cullet price. Further reductions in revenue from refillable bottle returns are expected as the trend is away from 750 ml returnable bottles to non-returnable stubbies. Returns from sales of non-returnable bottles which are sold as cullet, depend on the colour of glass.

Returns from UBC depend on prices paid by the smelting company, which in turn depend on primary aluminium prices. Early in 1990 prices to the public at buyback centres were 50 cents per kilogram after being as high as $1 per kilogram in 1989. Around the middle of 1990, prices at buyback centres rose to 60 cents per kilogram, with collectors receiving 90 cents per kilogram delivered to the smelter. Low prices reduce the incentive for the public to deliver cans to buyback centres. More may be collected from kerbside.

Returns from PET make up a large proportion of some collectors' total returns. The quantity collected and consequently the returns are highest during the summer school holidays. The highest price paid for used plastics is $700 a tonne for PET and PVC. The recovered bottles are transformed into other products. Prices received for other plastics vary considerably but are mostly much lower than for PET. Mixed plastics, containing relatively clean and uncontaminated materials from the household waste stream, can attract prices as low as $17 per tonne.

Prices on offer for wastepaper vary considerably with the quality and quantity. Good quality printers' offcuts fetch several hundred dollars per tonne. Little or nothing was obtained for used newspapers in some parts of Australia during 1989 and 1990, but the market has now improved (refer Chapter 4 of Volume II).

The paper, metals, glass and plastics reprocessing industries are characterised by a small number of large firms. Most of these also produce goods using virgin materials. Many are involved in collection of recyclables, either directly, or through contractors.

When many small collectors sell used materials to only a few reprocessors, the reprocessors are likely to have some power to set prices. This power is tempered to the extent that collectors have the option to export some materials.

The constraint implied by the option of exporting can be seen from the lifting of the embargo on the export of copper scrap in January 1990. While the embargo was in place, local reprocessors were able to purchase copper scrap at prices lower than those offered on the world market. The Electrolytic Refining and Smelting Company of Australia Limited acted as purchaser of last resort. When the embargo was lifted, local reprocessors had to pay higher prices for copper scrap, in order to compete with overseas refiners for supplies.

Some participants claimed that the major oil companies have bought used oil to prevent competition from rerefiners.

Where economies of scale exist, increased concentration may enable a higher recovery rate to be achieved. For instance, the proposed purchase of the Smorgon glass containers division by BTR Nylex Ltd would result in a larger market share for ACI (owned by BTR Nylex Ltd). To the extent that it allowed higher prices to be paid to collectors, and to the extent that ACI found this to be profitable or desirable, additional glass could be recovered.

The manufacturers capable of using recycled materials frequently have ready access to or control of substitute virgin materials. Vertical integration is apparent in pulp and paper manufacture and clearly favours the use of virgin materials. This was a cause of concern to a number of participants. However, technical constraints and mills being located close to forests also contribute to a stable fibre input use. With new investment, such as ANM's proposed de-inking facilities, there will be scope for considerably more recycling of wastepaper.

Processing costs

Relative processing costs are an important determinant of the decision to used waste materials rather than virgin materials. In comparing processing costs of reprocessed and virgin materials, producers take into account private costs and such social costs as regulation forces them to consider. Different outcomes might be expected if all social costs were taken into account.

Where reprocessing costs are higher than the costs of using new materials, other factors may still favour the use of recycled materials. For instance consumers may be prepared to pay a higher price for the recycled product.

The 100 per cent recycled writing paper now in demand generally retails at a higher price than the traditional product.

The use of waste materials in many cases allows considerable saving in energy (refer Chapter 5). However, a trade-off may be involved. In the case of glass, the use of cullet means that less energy is required in the melting process, but recovery and other processing costs increase. In estimating energy savings the energy used in transporting waste materials to the reprocessor's gate must also be taken into account, or at least offset against energy used in delivery of raw materials to the plant.

Box 4.4 sets out the collection, transport and processing costs and returns for three different plastics. The collection of these plastics is subsidised by the industry. The figures indicate that while it may be commercially viable (with the subsidy) to reprocess high density polyethylene (HDPE) and polyvinyl chloride (PVC), recycling of PET at this stage is not viable.

The assessment in Box 4.4 draws on data from Cryo Grind (1990), ICI, and other participants, and Commission estimates based on these data. It provides a rough guide only.

Even allowing for savings in landfill space (and PET has a significantly higher volume to weight ratio than most other waste), PET recycling appears to impose considerable net costs on society. This comes about through industry and government subsidies, and consumer transfers through the levy on PET users. A social benefit in the form of less litter would need to be set against these costs.

In the longer term, developments which allow recycled PET to be sandwiched between layers of virgin material in the manufacture of new PET bottles could provide a more economic outlet for recycled PET. PET recycling is reported to be profitable in the United States, where over 50 per cent of carpet backing is made of recycled PET.

In South Australia, up to 54 per cent of PET bottles are returned. This implies that the users of 46 per cent of PET bottles consider 5 cents per bottle, some $1050 per tonne, to be less than the inconvenience cost of returning the bottle and reclaiming the 5 cent deposit under CDL arrangements. Persons who return PET bottles and recoup the deposit value the inconvenience cost of doing so at less than 5 cents per bottle. In either case the implication is that there is a cost of about $1000 per tonne in South Australia involved in the return of used PET.

Box 4.4: **Recycling of PET, HDPE and PVC in Australia: costs and revenues**

	PET	*HDPE*	*PVC*
	$/tonne	*$/tonne*	*$/tonne*
Collection and transport cost[a]	700	300[b]	700
Processing cost	800	700	700-900[c]
Total cost	1500	1000	1400-1600
Receipt from sales	500-1300	100-1500	1200-2200
Net loss or gain	-1000 to -200	0 to +500	-200 to +600

a) Assumes savings in waste disposal cost equal Council subsidy to collectors. b) Assumes collection from retail outlets and by milk vendors. c) Costs decline with larger throughput.

PET

Cryo Grind (1990) identifies markets for PET as a feedstock for polyester resins, with $500 a tonne being the best price available. The extrusion of compounded alloy is a potential market for about 300 tonnes of PET clean and free of metal contamination, for which a price of $1300 per tonne is achievable. Some 600 tonnes, or 3 per cent of post-consumer PET, is recovered and reprocessed.

HDPE

Receipts are estimated by Cryo Grind to be $1000 to 1200 per tonne for injection moulding of dark coloured articles (for example toys) and $1500 per tonne for over 500 tonnes a year for extrusion as irrigation pipe. Less than 1 per cent of post consumer HDPE, some 750 tonnes, is currently recovered and reprocessed.

PVC

Cryo Grind states that PVC is suitable for the manufacture of sewer fittings, for which the ground PVC powder has a value of some $1400 per tonne. However, ICI reports that virgin resin is available at around $1200 per tonne, and this is preferred to PVC powder by sewer pipe manufacturers. ICI states that potential uses of recycled PVC include sunscreen, detergent and household cleaner bottles, for which $2200 per tonne would be received for the compounded PVC. The post-consumer PVC waste collected by ICI is currently 6 to 7 tonnes per month, and products are still at the trial state. Only 8 per cent of PVC is used for packaging and hence enters the post-consumer waste stream. Over 5000 tonnes of post industrial PVC, mainly from cables, is recovered and reprocessed each year.

Source: ICI estimates. Inquiry participants. Cryo Grind (Australia) Pty Ltd 1990, *Processes and Market Assessment for the Recycling of Plastic Beverage Containers*, prepared for the Victorian Government Recycling and Anti-Litter Program, Environment Protection Authority, Melbourne.

To date the PET collected in South Australia has been subsequently dumped in landfill. If it were recycled, there would be further costs associated with transport from South Australia and processing.

Product substitutability

Some reprocessed products can substitute for products made from the same new material. For example, smelted scrap steel has essentially the same characteristics as new steel of the same type. Indeed, most recycled metals are close or perfect substitutes for primary metals and attract comparable prices. Some glass bottles can be reused as beverage containers after collection and sterilisation. Other (non-refillable) bottles can only be used as glass cullet to produce new bottles.

Contamination problems limit the reprocessing of paper into food packaging such as milk cartons, and the degradation of the fibres means that used paper is generally 'downgraded' as it is recycled. Thus, old newspapers cannot be used to produce high quality printing and writing papers, but they can be used in applications requiring mechanical pulp, such as newsprint and tissue. Most paper applications other than packaging require de-inking if they are to be suitable for large scale marketing. There is a small market for wastepaper to be recycled into moulded products, insulation and animal bedding. These products have to compete with products serving a similar function made out of more traditional materials.

The major application in Australia for reprocessed PET is in the resins used to form fibreglass for uses such as insulation, boat building and swimming pool construction. The extent to which it is used depends on its substitutability for fibreglass from other sources, and the price at which it can be made available. Overseas, reprocessed PET is used to make a variety of products including carpet backing, fibre fill for ski jackets, pillows and sleeping bags, audio cassettes and non-food containers.

ICI is using PVC bottles, sourced from households and kerbside collections, to manufacture a compound consisting of 30 per cent reprocessed PVC. It will be used for sunscreen, detergent and household cleaner bottles. Nylex SRM in Victoria reprocesses PVC from electrical cable. The compound is used in a range of applications, including garden hose. Brickwood holdings and several other companies reprocess HDPE milk bottles.

The risk of contamination precludes use of the recycled resin in food or drink containers.

The markets for particular recycled materials are considered in Volume II.

Prices of reprocessed products (outputs)

The prices users are willing to pay for recycled products reflect the qualities of those products relative to products made from virgin materials. Where the recycled product is very different from the original, and not substitutable for it, much lower prices may apply. This is the case with products made from post consumer plastic. Recycled lubricating oils also sell for lower prices than those made from virgin oils. However, some categories of refined copper, or products with a positive 'recycled' image (such as some 100 per cent recycled writing paper) sell at a premium.

Where products are recovered and reused in their original form, they are likely to sell at a discount. For example, some of the steel recovered in demolition is in the form of structural shapes. If reused, it must compete with newly made steel, and sells for about one third of the price.

The export market

Used materials exported from Australia include wastepaper, aluminium, steel, lead and copper scrap.

Exports are the only way of marketing significant amounts of our excess supplies of waste newsprint since additional paper recycling cannot be brought on stream in the short term. This market has been depressed, but there are now significant exports from the major capital cities.

Developing countries in particular provide a market for used magazines and newsprint, and scrap metal. Many participants referred to transport, handling and shipping difficulties, including delays and high costs on the Australian waterfront.

High freight and wharfage charges in Australia were said to be a constraint on the export of wastepaper. Tredex Pty Ltd said that the cost of freighting old newspapers to Asian ports could be more than half of the cost and freight price obtainable.

Wharfage costs are around 5 per cent of this price. According to Tredex freight rates from the United States to Asian ports can be up to 50 per cent less than those from Australia.

The cost of collecting, sorting and transporting wastepaper to ports for export is $60 to $80 per tonne. A high proportion is labour costs. One participant, Take & Tip Pty Ltd, said it can profitably export to India and Singapore as much paper as it can collect, provided it is shipped mixed, and sorting and baling and any other treatment is carried out in the country of destination. Strict censorship laws in some countries, however, may constrain the exporting of unsorted newsprint and magazines.

Exporters have been impeded by the availability of shipping services and delays in scheduling and loading consignments. Charter vessels have to be used where conference lines decline to ship low value cargo.

Export prices are influenced by the policies of other countries. For instance, legislation introduced in the United States to encourage recycling of used newsprint led to larger quantities recovered than could be reprocessed in the short term. The export of this surplus, made possible in part by backloading, contributed to the low prices paid for used newspapers in some Asian countries.

5 RECYCLING AND THE ENVIRONMENT

Recycling is often seen as a means of reducing pollution, the production of greenhouse gases and atmospheric ozone depletion. These issues are considered in this chapter, largely in relation to energy savings and ways in which recycling can reduce pollution. Other links between recycling and the use of natural resources are examined in Chapter 6.

Some participants saw energy saving as the driving force behind recycling. The Australian Conservation Foundation (Brisbane) submitted that:

> environmentalists believe that only cost estimates that include energy sums reflect the true costs and benefits of recycling.

Underlying this viewpoint is a concern that current fossil fuel sources of energy are finite and the use of energy contributes to the 'greenhouse effect'.

5.1 Energy and the greenhouse effect

Consumers may wish to give preference to products which have a minimal impact on the environment in their production, distribution and disposal. They can also give preference to packaging material which can be recycled or reused. However, to make a rational choice consumers must have knowledge of the effects of their choices.

This section examines the contribution which recycling of various types of packaging can make in reducing energy consumption and GHG emissions.

Greenhouse gases (GHGs), principally carbon dioxide (CO_2), are released when the energy produced by burning fossil fuels is used in manufacturing. There is evidence that in some cases recycling can lead to less production of GHGs. Whether there are more effective ways of reducing these emissions is an issue beyond this report. The Commission is currently conducting a separate inquiry into *Greenhouse Gases Emissions*.

Energy savings through recycling

The energy saved by recycling was highlighted by many participants. Energy savings for metals are considerable. They can be over 90 per cent for reprocessed aluminium and steel. Energy savings in reprocessing copper and lead are less but still considerable.

The Commission's *Interim Report on Paper Recycling* identified a saving of 83 per cent in electricity use in the production of newsprint from recycled paper compared with wood pulp. The energy required was 400 kilowatts per tonne of recycled pulp compared with 2400 kilowatts per tonne of wood pulp.

A common practice in the manufacture of glass is to include a proportion of cullet in the materials for each batch. For every 10 per cent of cullet included there is a 5 per cent saving in energy. The proportion of cullet is usually around a quarter in Australia.

The reuse of refillable glass bottles uses energy both in the production of the bottles, and in washing them. Refillable bottles take 30 to 40 per cent more energy to produce than non-refillable because they are 30 to 40 per cent heavier in order to withstand repeated use.

Friends of the Earth (Fitzroy) reported that with bottle return legislation in Maine in the United States the use of refillable bottles led to 12.5 per cent less energy use in the brewing industry, and 45 per cent less in the soft drink industry. These figures assumed 10 trips per bottle, which is thought to be a conservative estimate of trip rate, and included energy used in transport of empty containers. One third more truck trips were estimated to be made by the beer industry due to the greater space required to transport returnables rather than disposable bottles and cans.

Tetra Pak Pty Limited reported that a European study (Sundstrom 1979) indicated that a one pint refillable glass bottle with a life of 30 trips required 0.7 megajoules of energy per litre of milk to make, 0.43 megajoules per litre for washing etc. at the dairy, and 0.6 megajoules per litre in distribution. This represented an overall energy use of 1.8 megajoules per litre. This was comparable with energy use of 1.5 megajoules per litre for a non-refillable polyethylene (PE) coated paperboard container.

A number of studies, including Evans (1990), suggest that there are significant energy savings in recycling plastic, although the extent of the savings depends on whether energy used in collection and the final energy value locked into the material used in the product are included. Industry submissions indicate savings of 95 per cent in recovery and reprocessing of plastics.

The National Packaging Guidelines (draft report), Australian and New Zealand Environment Council (ANZEC 1990) argues that energy and resource considerations, requiring '...a significant exercise in natural resource accounting' (p. 8) are essential in setting recycling targets for industry.[1]

A study by the Western Australian Environmental Protection Authority (EPA, 1989) indicates that substantial savings in energy can be achieved through recycling of metals and plastics. However, the data are presented in terms of proportions to total energy used and are not easily compared with details from other studies or industry sources. Nor are there details of the methodology used to estimate the energy required in the collection of recyclables, or energy savings.

Reduction of greenhouse gas emissions through recycling

Methodology

Measuring GHG emissions: Various gases are released in the process of energy generation from fossil fuels, each having a warming potential in the atmosphere, the most important being CO_2. Other gases such as nitrous oxides, sulphur oxides and water vapour are released in smaller quantities. In this section, the contribution which recycling of various types of packaging can make in reducing GHG emissions is examined using CO_2 as an indicator. Other gases such as CFCs and methane are important GHGs (contributing 55 per cent to the greenhouse effect) but are not released from the combustion of fossil fuels.

1 ANZEC (1990, p. 7) gives estimates of the energy used in the production of packaging from virgin materials. Some of the findings are not consistent with data provided to the Commission by industry sources. No source is given by ANZEC for the published estimates.

Different processes generate different quantities of GHGs. For instance, the amount of carbon dioxide generated is related to: the type of fuel used (eg brown coal, black coal, natural gas, petroleum); how the fuel is used (eg to run a small vehicle, large vehicle, vehicle speed); and whether fuel is used as a primary or secondary energy source (eg as coal used in steel production, or as coal used in electricity generation). Estimates of CO_2 emissions are presented in Tables 5.1, 5.2 and 5.3.

Energy: Energy data for materials used in the packaging of beverages is presented per litre of beverage contained. The information is expressed in terms of, *megajoules per litre (MJ/L).* The approach takes into account the energy efficiency of light containers in production of the packaging and distribution of the beverage compared with heavier containers.

Fuel: The energy values for manufacture of containers are taken from Evans (1990). These values are converted into grams of CO_2 emissions by using the corresponding values in Box 5.1. The energy values for manufacturing given by Evans assume that energy used for a manufacturing process is from a single fuel so that the simplifying assumptions are: High density polyethylene (HDPE) is manufactured using natural gas, PE coated cardboard is manufactured using wood by-products as fuel (through the Kraft chemical pulping process) and glass is manufactured using coal as the energy source.

In practice, other fuel sources and inputs are used such as electricity and diesel for manufacturing and transport. PE coated paperboard requires the production and lamination of polyethylene to the paperboard. The CO_2 generated in this process is small and was not considered by Evans and it is not considered here. Tetra Pak has indicated that it is difficult to determine where the raw materials and intermediate inputs originate. Paperboard is produced in North America where a variety of fuels is used to generate electricity, ie nuclear, gas, coal or waste derived fuel. The manufacturing process itself may vary from country to country resulting in different energy consumption rates. It is even more difficult to determine the origin and manufacturing process (thus energy used) for other inputs such as chemicals.

ACI provided alternative energy requirements for glass production and said that its production process is based on natural gas as an energy source. Tetra Pak provided an alternative energy consumption rate for manufacturing of paperboard which takes into account recent energy efficiency increases within the industry. The findings using these different assumptions, are shown in the second column of Table 5.3.

Coal-fired electricity has a high CO_2 emission rate relative to other energy sources. This is because of the low energy conversion efficiency involved in generating electricity from coal and the losses during electricity distribution.

Box 5.1: **Carbon dioxide (CO_2) generation by combustion of fuel types**

Fuel	*CO_2 grams/MJ*[a]
Natural gas	55
Wood	79
Bituminous coal	104
Electricity[b]	390

a) Based on net calorific values. b) Based on data for Victoria, which generates electricity from brown coal and has an energy conversion rate of 24 per cent.

Note: Emission rates are average values and will vary according to the grade of fuel and combustion conditions.

Source: Adapted from Evans 1990.

Distribution of HDPE and PE coated paperboard cartons: Distribution of food and beverages entails the use of energy for handling and packaging at the factory, transport to the point of sale and refrigeration. The figure used here, 0.3 megajoules per litre, of which 0.2 megajoules is electrical energy and 0.1 megajoules other energy, is from Evans (1990). The rate of CO_2 production is taken as 390 grams per megajoule of electrical energy generated which is calculated by Evans and based on the electricity generation efficiency for Victoria. Evans assumes the rate of CO_2 production from 'other' energy at 100 grams.

Distribution of glass bottles: For glass bottles, Evans (1990) calculates the energy requirement for distribution as 0.8 megajoules per litre consisting of 0.3 megajoules of electrical energy and 0.5 megajoules of 'other' energy.

Disposal: Energy used in disposal of used packaging was not taken into account by Evans and Egerton (1988) and Sundstrom (1979). It was considered that specific packaging material contributes only a very small proportion of disposal energy when it is included in municipal waste collection and disposal. It is not taken into account in the following calculations.

Collection: The collection of recyclables involves the use of energy and the production of exhaust gases, including GHGs. The Commission has not been able to determine energy consumption and CO_2 emissions in collection and sorting of recyclable beverage containers on a per litre basis. Therefore, collection energy estimates have been derived from Evans' (1990) calculations of energy used in distribution. For milk bottles, collection is by 'reverse distribution' therefore collection energy is small and taken as zero. Refillable beer bottles require separate collection runs of empty bottles, therefore energy consumption is greater than for collection of milk bottles or glass cullet.

Collections from households to depots require more energy per unit of material than is used in collection from commercial and industrial sources. The energy used for long haul transport has been estimated by the Commission at 460 megajoules per tonne per 100 kilometres (from data received from industry). The energy use for local collections of recyclables is estimated by Evans and Egerton (1988) at around 0.5 megajoules per kilogram of recyclables for collections within a 30 km radius. These calculations do not include energy used in vehicle and road construction and maintenance: if this is included the energy used for collection rises to some 736 and 0.8 megajoules respectively, based on Boustead's criteria (1981, p. 33). However, to maintain consistency with other studies the following calculations do not include energy used in vehicle and road construction and maintenance.

Where recyclables are 'backloaded' from remote areas little or no additional net energy may be used, since the vehicle would have made a return trip regardless.

Some environmental costs and benefits of recycling

Results are summarised in Tables 5.1, 5.2 and 5.3.

Metals: Very large savings in energy and CO_2 emissions from recycling are evident from Table 5.1. Based on long haul arrangements, 153 megajoules and 10.1 kg of CO_2 emissions are generated per tonne of material collected, assuming a 30 km collection radius. Based on Evan's calculation for local collections, 500 megajoules and 33 kg of CO_2 emissions are generated per tonne of material collected, assuming a 30 km collection radius. Within this range of energy consumption and CO_2 emissions it can be seen that collection impacts only slightly upon the results presented in Table 5.1.

Paper: Very large percentage savings in energy and CO_2 emissions from recycling are evident from Table 5.1, but in absolute terms these savings are less than for metals. As for metals, the energy and CO_2 emissions due to collection activities reduce the net savings made in recycling. Significant savings can nonetheless result from recycling paper.

Whereas glass, metals and plastics are manufactured from finite resources paper is usually produced from wood, a 'renewable resource'. In effect, whether paper is burnt, composted or landfilled, a natural cycle is completed by forests absorbing CO_2 from the air and nutrients from the soil. This cycle occurs in a relatively short time frame, whereas the time frame for renewing resources such as oil and minerals is so great that they are referred to as 'non-renewable'.

Lubricating oil: Three considerations relevant to the rerefining of used oil are resource savings, CO_2 emissions and other pollution. This section considers resource savings and reduction in CO_2emissions. Other pollution from rerefining is considered in a later section.

The energy used in collecting and processing or burning used oil is very small compared with its energy content and thus the resource recovery is very high. Some participants claimed that burning of used oil as a fuel is a waste of energy resources and that it should be rerefined back to a lubricating oil. However, this view is tenuous if based on either energy or finite resource grounds. The energy required to refine crude oil is less than the energy required to rerefine used oil. This is because refining crude oil uses energy mostly derived from the oil itself, while rerefining used oil requires the use of relatively inefficient energy sources such as electricity for distillation, or inputs such as sulphuric acid which require energy to produce and transport. When used as a fuel, used oil substitutes for virgin energy resources and therefore does not increase net CO_2 emissions.

Table 5.1: **Carbon dioxide (CO_2) emissions and energy consumption (gigajoules) in manufacture and reprocessing of various materials**

Material	*Activity*[a]	*CO_2*	*Savings*	*Energy*	*Savings*
		Kilograms per tonne	*per cent*	*GJ per tonne*	*per cent*
Steel	Manufacture	2392-2912	93-96	23-28	
	Reprocessing	104-208		1-2	93-96
Aluminium[b]	Manufacture	85 800	95	220	
	Reprocessing	3900		10	95
Paper[c]	Manufacture	71	79	0.9	
(Kraft)	Reprocessing	8		0.1	89
Lubricating	Energy content	-		46	
oil[b]	Reprocessing	0.3		0.9	97
	Transport	0.03		0.5	

a) Estimates for reprocessing and manufacturing do not include energy use and CO_2 emissions in collection and transport (see text). b) Manufacture and reprocessing requires electricity. The CO_2 emission rate is that for Victoria where brown coal is used to generate electricity. Where hydroelectricity or nuclear power is used such as in Japan and the United States, the CO_2 emission rate is lower. c) CO_2 emissions may be higher than stated here, as some coal-fired electricity may be used even in the Kraft process.

Source: Industry Commission estimates based on data from BHP, Comalco, ANM, and Bourcier (1982).

HDPE: HDPE is commonly used in packaging beverages. However, due to contamination concerns, used HDPE cannot be reprocessed into food or beverage containers but can be reprocessed for other uses such as agricultural pipes. The energy used when HDPE is reprocessed into resin is 0.1 megajoules per litre (Table 5.2). There are major savings when compared to HDPE containers manufactured from virgin materials, 1.9 megajoules per litre (Table 5.3).

The collection of used HDPE containers and their reprocessing into resin generates a total of 119 grams of CO_2 per litre (Table 5.2). Manufacturing HDPE containers from virgin materials produces 104 grams of CO_2 (refer Table 5.3). Thus the total CO_2emissions in reprocessing HDPE is greater than for manufacturing from virgin materials.

However, less energy is used to reprocess HDPE into resin than to manufacture it from virgin materials. This outcome reflects the high CO_2 emissions involved with collection systems.

The findings are sensitive to assumptions regarding energy used and CO_2 released during collection. An accurate assessment of collection energy would take into account the many variables which determine the collection efficiency, including the number of small vehicle trips, age and type of vehicle used etc. These factors are highly variable. Having regard to the small differences between reprocessing and manufacture, in CO_2 emissions, reprocessing of HDPE is at best a marginal advantage in terms of reduction of CO_2 emission, although there is some energy saving. Commercial aspects of HDPE recycling were considered in Chapter 4.

Table 5.2: **Carbon dioxide (CO_2) emissions and energy consumption in reprocessing used HDPE containers into resin**

Activity[a]	*CO_2*[b]	*Energy*
	grams per litre	*MJ per litre*
Collection	80	0.3
Reprocessing	39	0.1
Total for reprocessing	119	0.4

a) Refers to the energy required and CO_2 emissions on a per litre basis for a 2 litre container. b) CO_2 emissions depend on type of fuel used, see Box 5.1.

Source: Adapted from Evans 1990.

PE coated paperboard cartons: Recycling of PE coated paperboard containers has not been carried out on a large scale in Australia. Some used cartons are exported to South Korea where they are processed into tissue paper. Currently APPM (Nowra, NSW) processes ex-factory PE coated paperboard waste and is undertaking trials to include post-consumer waste. Tetra Pak said that these containers can be composted and that because the PE portion is very thin and does not contain toxic stabilisers it can be degraded in a relatively short time and not be discernible in soil.

Table 5.3: **Carbon dioxide (CO2) emissions and energy consumption in manufacture, recycling, and disposal of beverage packaging material**

Material		*Evans 1990*		*Other data*[b]	
		CO_2[a]	*Energy*	*CO_2*[a]	*Energy*
		grams per litre	*MJ per litre*	*grams per litre*	*MJ per litre*
HDPE[c]	Manufacture	104	1.9		
	Distribution and disposal	80	0.3		
	Total (1 trip)	184	2.2		
PE coated[d] **paperboard**	Manufacture	221	2.8	95	1.2
	Distribution and disposal	80	0.3	80	0.3
	Total (1 trip)	301	3.1	175	1.5
Glass bottle[e]					
Refillable	Manufacture (raw materials)	1373	13.2	390	7.1
	Distribution and filling	167	0.8	167	0.8
	Total (1 trip)	1540	14.0	557	7.9
	Reused (25 times)[f]	52	0.5	16	0.3
	Distribution and filling	167	0.8	167	0.8
	Total for each trip	219	1.3	183	1.1
Non-refillable[g]	Reprocessing (25% cullet)	842	8.1	242	4.4
	Collection	167	0.8	167	0.8
	Distribution and filling	167	0.8	167	0.8
	Total (1 trip)	1176	9.7	576	6.0

a) CO_2 emissions depend on type of fuel used, see Box 5.1. b) Estimates from Tetra Pak for PE coated paperboard produced in North America (manufacture is mostly using wood by-products) and includes sea transport to Australia; estimates for glass from ACI (manufacture is mostly using natural gas). c) Refers to the energy required and CO_2 emissions on a *per litre* basis for a 2 litre container. d) Refers to a 1 litre container. e) Refers to the energy required and CO_2 emissions on a *per litre* basis for a 0.6 litre bottle. f) 25 trips based on ACT Milk Authority weighted average of household and retail trip rates. g) Assuming non-refillable bottles weigh 30 per cent less.

Source: Adapted from Evans 1990, Sundstrom 1979, ACI, Tetra Pak and ACT Milk Authority.

Alternatively containers can be burnt as an energy source for electricity generation or some other industrial use. If used as a fuel, minimal separation and sorting is required. The cartons can be burnt with other combustibles or modified by neutralysis or other processes. If used as a fuel the CO_2 generated would substitute for the CO_2 generated from burning fossil fuel and would therefore not add to net CO_2 emissions. Furthermore, plastic (or paper) burnt as fuel can substitute for virgin energy resources and save finite resources.

Tetra Pak argued that to the extent that the paperboard industry (abroad) is involved in tree planting, the CO_2 emissions from manufacturing and distribution must be offset by the CO_2 absorption capacity of forests. Plantation forests are generally harvested at a young age and have a greater CO_2 absorbing capacity than mature forests.

Glass bottles: Glass bottles can be reused after washing, or melted to produce new bottles. Energy use and GHG emissions are critically related to the number of times a bottle is reused. In Victoria, the number of times glass milk bottles were used declined from about 80 to 12 before the use of refillable bottles was discontinued (Evans and Egerton 1988). In the ACT, refillable milk bottles are used 25 times, based on a weighted average of 32 trips for household deliveries and 6 trips for retail sales. The estimates in Table 5.3 use the ACT rate of 25, but this is generally regarded as higher than is achieved elsewhere. The CO_2 emission rate for returnable glass bottles is therefore likely to lie between 183 grams and 557 grams.

Reduction of GHG emissions through recycling

Clearly the recycling of some materials, particularly aluminium, can bring energy savings and reduce CO_2 emissions. For other materials such as HDPE any savings may be marginal at best. Relative to total CO_2 emissions in Australia, and globally, these savings make a very small contribution to reduction of GHG emissions (refer to Box 5.2).

The energy savings vary with the underlying assumptions regarding manufacturing processes, fuel type, the country of manufacture etc, and the extent to which the estimates have regard to all energy used in manufacture, collection and reprocessing. Where industry has provided evidence of energy savings, the Commission could not directly substantiate the data provided.

Box 5.2: **Aluminium and steel recycling can reduce GHG emissions**

Aluminium: Smelting of aluminium requires large amounts of electrical energy, generating large amounts of CO_2. In Victoria, brown coal is used to generate electricity resulting in a high rate of CO_2 emissions, ie 390 grams per megajoule. Tasmania relies almost entirely on hydroelectric power which does not generate CO_2. Electricity is also generated using natural gas where the CO_2 emission rate is lower, ie 229 grams per megajoule. Since secondary aluminium is produced in small smelters across Australia, the average CO_2 generation rate must be less than 390 grams per megajoule. Therefore the CO_2 estimates for aluminium in this box represent upper limits.

Production of secondary aluminium in Australia was estimated at about 48 000 tonnes in 1989-90 (about 28 000 tonnes being UBC). To the extent that secondary aluminium substitutes for production of primary aluminium, the processing of scrap and UBC reduces CO_2 emissions by 1.5 per cent of total anthropogenic sourcesa of CO_2 emissions in Australia (0.02 percent globally). In terms of the greenhouse effect[b], the reduction is approximately 0.7 and 0.01 per cent respectively.

Steel: About 825 000 tonnes of steel scrap was processed in Australia in 1988. To the extent that steel derived from scrap substitutes for production of primary steel, processing of scrap reduces CO_2 emissions by 0.8 per cent of total anthropogenic sourcesa of CO_2 emissions in Australia (0.01 per cent globally). The reduction in greenhouse effect is approximately 0.3 and 0.004 per cent respectively.

a) Derived from human activity; 255 megatonnes of CO_2 per year generated in Australia and 20 000 megatonnes of CO_2 per year generated globally (from CSIRO 1990, cited in Industry Commission 1991). b) Consideration of CO_2's relative contribution to the greenhouse effect (44%, from CSIRO 1990, cited in Industry Commission 1991[b]).

GHG emissions and the choice of packaging

Whether beverages are distributed in PE coated paperboard cartons, HDPE containers or reusable glass bottles (25 times) they appear to generate similar quantities of CO_2 [2] Refillable glass bottles used only once and non-refillable glass bottles generate the highest CO_2 emissions and use the most energy (refer Table 5.3).

The reuse of refillable glass bottles uses the least energy on a per trip basis. Even so, manufacturing of the container is only one step in the process of delivering a packaged commodity to the consumer. Light materials use less energy and generate less carbon dioxide in the distribution of the product, so HDPE and PE coated cardboard use about half of the energy in distribution and disposal that glass does.

Any assessment of 'environmental friendliness' would need to consider many aspects of resource use and pollution beyond energy savings and CO_2 emissions. The limited analysis here indicates the complexity of the task, the data limitations, and the sensitivity of the findings to the assumptions used.

The evidence suggests that beverages distributed in PE coated paperboard cartons, HDPE containers or reusable glass bottles (25 times) generate similar quantities of CO_2. Considering the difficulty in maintaining a high return rate for glass bottles, distribution of beverages in glass bottles is not necessarily the best system, in terms of reducing CO_2 emissions. If non-refillable, a glass bottle requires more energy and produces more CO_2 in its manufacture and distribution than PE coated paperboard cartons and HDPE containers.

All of this highlights the danger of policies which focus exclusively upon the purported environmental attributes of particular packaging materials or processes rather than economic criteria. Measurement problems aside, environmental damage costs or benefits of particular materials assessed in terms of units of CO_2, organochlorines or metallic ore, are difficult to relate to each other in meaningful terms and are not per se measures of how much society values this or that activity.[3]

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2 Since production is in North America, CO_2emissions from production of PE coated paperboard cartons do not contribute directly to Australia's total CO_2emissions

3 .Diakoulaki and Koumoutsos (1990) examined the environmental impacts of various containers in terms of the consumption of natural resources; air, water and ground pollution; litter and solid wastes. Their method relied on notional quantities of natural resources used relative to beverage content. Although water and air pollution vary substantially on a qualitative basis between products, they were assessed in standard quantities. No attempt was made to assign economic values. The study provides no valid basis for the authors' conclusion that 'the overall performance of the glass bottle is significantly greater than that of the next best solution...the plastic PET bottle' (p. 251).

5.2 Recycling and pollution

Recycling is one way of removing environmentally harmful wastes. However if it is cheaper to dispose of waste, reprocessing is unlikely to be the preferred course of action. If waste management authorities provide disposal services which are underpriced, if there is little regulation of emissions, or if there is little policing or enforcement of pollution regulations, then recycling is unlikely to be used much as a pollution control measure.

There is evidence that pollution associated with the disposal of some products goes largely unchecked and the costs are borne by the community. It may be that the standards are outdated, the penalties are inadequate, or there is a lack of monitoring or enforcement. In a recently reported case, it was alleged that the State Pollution Control Commission (NSW) had allowed the discharge of pollutants into the Shoalhaven River in excess of pollution licence limits for a number of years. This could ultimately cause economic losses to oyster growers and tourist operators in the area. There have been recent steps to tighten enforcement (refer Chapter 3).

Some current problems are a legacy of inadequate controls over tipping in the past. This might be the situation with some coastal pollution. Leachates contaminated through contact with heavy metals, PCBs, and other chemicals, have been identified by the CSIRO Division of Fisheries as a cause of problems for Australian fisheries. The implication is that the full costs of using land, water and air as a waste sink are not considered in the decisions to discard waste rather than recycle.

Metals

The collection and reprocessing of metals can result in savings in water use, reduced water pollution, and lower emissions of air pollutants, such as sulphur dioxide and nitrous oxides, when compared with the use of virgin materials.

However, any consideration of air pollution should have regard to vehicle exhaust emissions from transporting the material, as well as pollution during processing. Where greater use has to be made of transport, because more trips are required and the trips take longer than equivalent waste collection runs, emissions during collection of recyclables are likely to be greater than in disposal.

The production of steel from scrap metal is estimated to use 40 per cent less water and produce less than one quarter of the water pollution than steel production from virgin materials. The reprocessing of used aluminum is estimated to produce 97 per cent less water pollution than production from new materials (Miller 1990, p. 473).

The smelting of scrap metals produces less air pollution than the smelting of metals from new materials. It has been estimated that the savings in emissions of air pollutants from reprocessing are, for steel, 85 per cent, and for aluminum, 95 per cent, compared with production of primary metal (Miller 1990, p. 473).

Heavy metals and chemicals

The recycling of toxic materials such as heavy metals, solvents and some other chemicals, can reduce or make unnecessary their release into the environment. While a high proportion of lead is recycled, and some recycling of solvents is undertaken, much toxic waste is disposed of by burning, as landfill (where it can lead to dangerous leachates), or into watercourses and sewers. The focus below is on those pollutants that have the potential to be recycled if the right incentives are in place.

Leachate contaminated through contact with lead-acid or dry cell batteries in tips is avoided if batteries are recovered and reprocessed. Reprocessing of refined lead does not result in emissions of sulphur dioxide; with primary lead production these emissions are controlled through the use of flue gas scrubbers, but they are not entirely eliminated.

Metals, including heavy metals, can be removed from effluent before it is discharged. The traditional method of removal is through precipitation of the metal, and disposal of the precipitate in landfill. Technological progress is likely to make recycling of some of these metals economically viable.

For example, the CSIRO has developed a 'magnetic particle technology' which is expected to substantially reduce metal recovery costs and increase recovery levels.

Chlorofluorocarbons (CFCs)

CFCs are organic compounds containing chlorine and fluorine. They have been identified as having the effect of depleting stratospheric ozone, thereby increasing the level of harmful ultraviolet irradiation.

In March 1989 the Commonwealth Government passed the Ozone Protection Act, which implements the requirements of the Montreal Protocol, an international agreement to halve the use of CFCs by the end of the century. From December 1989, Commonwealth legislation came into effect banning the use of CFCs in aerosol cans, polystyrene insulation and packaging and dry cleaning equipment.

Emission control measures have centred around substitution of CFCs with more benign materials. Recovery and reuse of CFCs is generally seen as a second best option and a stopgap measure which reduces the need to use new CFCs. Use of CFCs is expected to be phased out for most uses over the next five years and completely phased out by 1998, subject to the development of acceptable substitutes. Recycling of CFCs will become less relevant, but it will be important to control emissions from old refrigeration and air conditioning equipment for some years to come.

CFCs are recovered from compressor coils during servicing of refrigerators and air conditioners. The cost of recovery exceeds the value of CFCs by a factor of five and is part of the servicing charge to clients. The industry concerned is undertaking recycling in order to forestall the introduction of more restrictive legislation and mandatory recovery requirements.

Polychlorinated biphenyls (PCBs)

In recognition of their serious environmental effects, PCBs have been banned since the early 1970s. Their improper or illegal disposal is associated with damage to human and other mammalian health. They remain a problem in marine environments.

PCBs are present in old electrical machines, generators and transformers. They are released when there are fires involving PCB-filled electrical transformers. Leachate problems with PCBs have been encountered at the Homebush Bay tip site in Sydney where PCB-contaminated oil is believed to have leaked from electrical transformers.

Presently, PCBs are not recycled, but are stored, destroyed by high temperature incineration, or dumped with the products which contain them. A plasma arc furnace being developed by CSIRO could eventually be used to recycle PCBs into commercially useful chemicals.

The use of a government mandated or voluntary industry recycling scheme for PCBs similar to the one for CFCs could possibly have reduced the environmental problems currently arising from disposal of PCB-contaminated products. Their use is now banned, and their correct disposal is required by law, but the high cost of correct disposal is an incentive for improper disposal.

Chlorine-containing wastes

Chlorine-containing wastes, including polyvinyl chloride (PVC), can be landfilled or incinerated if recycling is not a viable option. High temperature incineration of PVC and other high chlorine wastes is necessary but expensive if the products of incomplete combustion, such as dioxins and furans, are to be avoided. Dioxin emissions have resulted in the closure of a number of the main household waste incinerators in the Netherlands (refer Chapter 3). Notwithstanding technological advances, such as flue gas scrubbing, environmental problems remain with incineration.

Some recycling of PVC from electrical cable is undertaken in Australia. More will be undertaken when ICI commences collection and reprocessing of PVC from households to manufacture a product consisting of 30 per cent reprocessed PVC. The company's plans were announced in July 1990.

Plastic

The growth of plastic waste is a concern to participants. In Victoria the proportion of plastic in household waste increased from 3 to 10 per cent between 1974-75 and 1984-85. In Sydney it increased from 1.8 per cent to 7 per cent over the period 1979 to 1989. Less than 1 per cent of plastic in the household waste stream is currently recycled, a proportion similar to that in the United States and Europe.

Degradable plastics, which consist of minute pieces of plastic held together by a bonding agent which disintegrates in sunlight, water or air, are becoming increasingly available. But since plastic in landfills is already compacted, degradability may not achieve much change by way of saving landfill space. The reported view of one specialist on rubbish tips (Rathje) is that the PET bottle is the ideal disposable material because it is inert and compactable; and plastic and foam are not a growing problem in United States' landfills. His research indicates that in the United States plastic accounts for less than 5 per cent of contents of landfills by weight and 12 per cent by volume, much less than paper which accounts for 10 to 28 per cent by volume (Dourado 1990, p. 26). Earlier estimates indicated that plastic accounts for 7 per cent by weight of landfill contents, and 12 to 13 per cent by volume (Congress of the United States 1989, p. 83).

Plastic in the marine environment

A number of participants submitted that recycling can help to prevent plastic litter at sea. Since the marine environment is common property, individuals who use it have few economic incentives to protect it.

Waste plastic is widespread in the marine environment and recovery is virtually impossible. There are various sources of this litter. Drift-nets and bait ties are lost by commercial fishermen. Fishermen and others discard items such as plastic six-pack container rings, bottles and other containers. A range of items is discarded from ships. Plastic litter can enter the marine environment through the sewerage system.

Larger sea creatures can be injured from ingesting plastic, and this has been reported as a cause of death of dolphins, sharks and other fish in Australia. [4]

Friends of the Earth (Sydney) submitted that many sea-birds and marine mammals die each year by ingesting or becoming entangled in plastics. Polystyrene was said to be a particular problem as beads float in waterways and are mistaken for food by birds. The Australian Conservation Foundation said that marine mammals are killed by ingesting plastic bags. Plastic bait ties used in shark fishing can slip from the bait round which they are fastened and lead to the eventual strangulation of sharks and other marine creatures.

In the Commission's view, recycling is unlikely to provide an answer to the problem of plastic litter in the marine environment. The solution may be found in changing attitudes to litter and the provision of better information to fishermen and others responsible. The Great Barrier Reef Marine Park Authority requires all vessels using reef waters to return all garbage to land. Technological advances and the use of substitute materials may also help. In the United States, at least five States have banned six pack container rings which are not biodegradable.

Organic wastes

Composting by households and Councils or Waste Management Authorities can reduce the quantity of household food wastes and garden waste going into tips. As well as saving tip space, composting can reduce leachate problems from tips, as decomposing organic waste is a major source of leachate and GHGs. The compost produced can be used as soil conditioner, and may have a commercial value. However, composting can itself produce GHGs. Moreover, experience in Western Europe suggests that because of heavy metal contamination, municipally produced compost is not suitable in agricultural use.

Discharge of wastewater from sewage treatment into the marine environment can lead to health problems and loss of swimming and recreational amenity in some parts of Australia.

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4 While sea creatures such as dolphins may not have a commercial value, their existence can be attributed a value in environmental economics. The nature of these values and means of estimation are discussed in Appendix F.

Pollution from this source may also reduce commercial and recreational fishing opportunities. Recycling of wastewaters could reduce these costs.

Wastewater from sewage is used to a limited extent in Australia for irrigation and industrial uses. Sewage sludge can be used in composting, and wastewater from sewage for irrigation (refer Chapter 5, Volume II).

Pollution from recycling

While recycling can reduce or prevent pollution, it can itself be a polluting process. For example, approximately 1.15 litres of water are used to wash each refillable glass bottle. The used water is discharged into the sewer system together with products of caustic soda and product residues.

With some types of recycling, residual pollutants remain to be disposed of. For example, toxic acid sludge from waste oil rerefining, where the acid/clay filtration process is used, has contributed to the leachate toxicity problems at the Kingston tip site in Queensland, and may also be a contributor in the Homebush Bay site.

Burning of waste oil can result in the emission of pollutants where controls are not adhered to. Discarded tyres have been used to generate energy in furnaces in Japan and the United States, but emissions of pollutants are one reason why this means of disposal has not been more widely adopted.

The reprocessing of paper can result in water pollution. Australian Newsprint Mills Ltd has proposed the installation of a brightening plant in Albury, which would discharge salt, chemicals and microbial nutrients into the Murray River. The environmental impact is claimed to be 'minimal' or 'insignificant'. Furthermore, ANM has proposed a salt interception plant downstream from Albury to extract at least an equivalent amount of salt. De-inking at inland locations such as Albury would also result in the release of a small amount of salt into inland waterways.

A survey undertaken in Sweden (Rappe, Glas, Kjeller, Kulp, de Wit and Melin 1989) indicated that when paper is recycled any organochlorines and dioxins present in the waste paper may be retained and concentrated in the effluent and new paper. This would not be a problem with Australian produced newsprint.

6 RECYCLING AND CONSERVATION

Many people have argued that recycling should be encouraged as a way of reducing the resources used by the ‘consumer society’.

Participants such as the Tasmanian Conservation Trust, Friends of the Earth, and the Australian Conservation Foundation, argued that the market does not take proper account of all the costs of resource use, such as the impact on wildlife habitats of logging in native forests, or the impact of energy use on pollution levels.

Other participants were concerned about the impact of current resource use on the availability of resources for future generations. The North Queensland Conservation Council considered that ‘virtually all natural resources are being exploited without a thought to what will be left for our children in a thousand years, let alone a hundred years’.

Concerns to save natural resources can be addressed by ensuring that Australia’s resources are priced to reflect their full value to society. For example, the Hunter District Water Board estimated that the introduction of user-pays for water would reduce the rate of growth for water by 20 per cent, thereby delaying the need for a new dam with a capital cost of over $50 million by at least 10 years (Hunter District Water Board 1982).

Even if appropriate prices were adopted, however, additional recycling in Australia would not appreciably slow down the rate at which resources are extracted. This is because Australia is a major exporter of raw materials, and the rate of extraction of many of them depends more on world conditions than on domestic consumption levels.

This Chapter looks at the effect of prices on the rate of resource use and conservation. Forest conservation and paper recycling are also considered in detail.

6.1 Finite resources

In a physical sense, current extraction of finite resources such as minerals must reduce the amount available for use by future generations. For some minerals, this will lead to higher costs of extraction in the future, as only lower quality, or more remote, deposits are available. Depletion of finite resources can therefore be said to impose a scarcity cost on future generations as extraction costs rise (Pearce, Markandya and Barbier 1989).

Increasing scarcity will be reflected in rising world minerals prices. Rising prices will make recycling more attractive, and encourage exploration for new stocks and the development of alternative resources and new technologies. New technology can also make it economic to extract minerals from lower quality deposits which were previously too costly to mine.

In many cases, however, deposits of finite resources, such as coal, bauxite and iron ore, are sufficiently large that increasing scarcity is not expected to exert any substantial economic pressures for many generations, either in Australia or overseas.

Appendix G presents evidence that prices for several important minerals fell in real terms over the century to 1970, suggesting that relative scarcity was falling over that period. In the early to mid 1970s, some of these minerals experienced sharp price increases, although for many of them prices still declined in the 1980s. It is too early to tell whether the changes in the 1970s represent short term fluctuations or the start of a sustained period of greater scarcity.

Thus the concept of finiteness, and its implications, are not clear cut. It can refer to known quantities available, to the technologically extractable reserves, to the economically extractable reserves, and so on.

Experience suggests that price pressures will operate to both limit demand and facilitate additional supplies in the future. While these future supplies may be more costly, it is precisely this higher cost which will lead to greater recycling and the development of conservation strategies such as through the use of substitute materials. There appears to be no justification for governments to force the pace of recycling as a means of conserving stocks of finite resources.

6.2 Renewable resources

The link between recycling and the conservation of finite resources is clearer than that between recycling and the conservation of renewable resources.

Renewable resources, such as forests, can, when wisely managed, provide a never-ending supply of wood and/or environmental values. The size of these flows, and the balance between wood and environment, is determined by the rate at which old trees are harvested relative to the rate at which new trees grow. It is this rate at which forests are harvested which will influence the incentive to recycle. An inappropriate harvest rate, for example that produces 'too much' wood, will make paper recycling less attractive than it should be.

Native forests

Much of the pressure for more paper recycling is driven by the desire to 'save' native forests. The link between recycling and the use of native forests is, however, not as simple as some have suggested. There are a number of factors which limit the extent to which more paper recycling would conserve native forests.

Around three-quarters of the pulp used in Australia is either imported or sourced from pine plantations, sawmill residues and other fibres. Of that sourced from hardwood, only pulpwood from native forests in Victoria and Tasmania is used in domestic pulp and paper production, although New South Wales does export a considerable volume of woodchips from native forests.

Recycling in Australia would thus have little impact on harvests in most native forests. Even in Victoria and Tasmania, forests are currently managed for sawlog production with pulpwood produced as a by-product. Although pulpwood is a considerably greater proportion of the harvest than sawlogs, lower demand for pulpwood may lead to this material not being utilised rather than to reduce harvest rates.

Even if government policies to encourage more paper recycling did conserve forests, there is still the question of whether there could be better policies for achieving this.

The objective of forest conservation might also be achieved by ensuring that forest users face the ‘right’ prices for using forests for pulpwood or sawlogs.

Native forests are gifts of nature and did not `cost' anything to produce. They are, nevertheless, valuable and should not be squandered. Trees should not be harvested if they are more valuable as a source of recreational or other environmental outputs. Nor should they be harvested for one sort of log if they would be more valuable for another. Inappropriate prices send the wrong signals about the value of conservation relative to wood production, and about the values of sawlogs relative to pulpwood production.

Harvest rates and royalties are negotiated between State forest services and mills. This apparently close relationship between forest services and mills has led some to believe that hardwood royalties are lower than they should be. The perception is that low royalties subsidise virgin pulp production at the expense of paper recycling, and contribute to over-logging at the expense of resource conservation.

Forest management and rates of return

Effective management of native forests cannot be achieved unless forest managers have clear and appropriate objectives. In the past the objectives have been primarily to produce wood. Environmental and other values have been vaguely specified, and commercial criteria neglected.

Some participants in the current debate on forest use argue that the priority given to wood production is no longer appropriate. In the absence of market prices for non-wood uses, however, and with doubts about whether royalties are appropriate, it is impossible to know whether non-wood uses really are more highly valued by society than the supply of wood.

Until very recently, commercial criteria such as achieving a target rate of return, were not included in State forest services' operating guidelines. Thus the traditional emphasis on wood security, in order to maintain employment and regional development objectives, is not surprising.

To ensure that the values of forest resources are maximised from society’s point of view, and to ensure that forest managers choose the ‘right’ management objective, they should be subject to commercial criteria and given financial incentives to maximize the value of forest outputs to society as a whole.

Commercial criteria would include the requirement to earn a target rate of return on the assets they manage. Environmental values should be clearly recognised by either levying explicit user fees or by making budgetary allocations transparent. Budgetary components to reflect environmental values are becoming more explicit in some States.

Some participants in this inquiry argued that the target rate of return which should be required of forest managers is around 2 per cent. This is considerably lower than real market rates of return. The real rate of return on 10 and 20 year Treasury bonds, the usual standard of comparison, has averaged around 5 per cent over the last 10 years (Reserve Bank of Australia various years). It has also been reported that the required real rate of return in the manufacturing sector is in the range of 10 to 13 per cent after tax (Australian Manufacturing Council 1990).

Unfortunately, participants in this inquiry did not provide the Commission with evidence on the real rates of return currently required by private plantation owners. This might have been a good guide as to the appropriate return to require of State forest services.

Most States now require forest services to earn a 3 or 4 per cent real rate of return. The capital base on which such returns are to be made is not always clear-cut. Not only should this return be earned on the capital invested in forest management, it should also be earned on the biological ‘capital’ represented by the stock of trees. The Commission has examined whether harvesting practices are consistent with meeting this target rate of return on the standing forest.

The analysis assumes that wood royalties are the only source of revenue for forest services. The potential contribution of non-wood charges to these rate of return requirements is considered in Appendix H.

If forests are being managed to earn a target rate of return on the stock of trees, and if royalties are charged at a fixed rate per cubic metre so that old trees are worth no more than young trees, then the optimal harvest age depends only on the trees’ growth rates. Thus under flat rate royalties it is relatively easy to determine whether forests are meeting the requirement to earn 4 per cent.

Young trees grow quickly, increasing their wood volumes rapidly. For these trees, waiting an extra year before harvesting would earn a return greater than 4 per cent in additional wood. As trees age, their growth rates slow down and the number of defects starts to rise. Once the additional wood volume from waiting an extra year is only increasing at 4 per cent, the tree should be harvested and a new tree allowed to take its place. If trees are harvested at a much older age, then the management regime is earning less than 4 per cent.

Optimal final harvest ages have been derived for three native hardwood species - alpine ash in NSW, mountain ash in Victoria, and Tasmanian regrowth in Tasmania, which give a 4 per cent real rate of return to the standing forest under existing sawlog and pulplog royalties. Under these royalties it would be optimal to harvest alpine ash at around 50 years, mountain ash at 40 years and Tasmanian regrowth at 30 years.

The results, shown in row 3 of Table 6.1, suggest that under current royalties the optimal harvest ages for mountain ash and Tasmanian regrowth are considerably lower than the actual harvest ages adopted in these native forests. This implies that they are earning less than 4 per cent as wood-producing forests.

Whether this is the case for alpine ash is less clear. Because pulplogs can be harvested much earlier than sawlogs, the pulplog royalty is an important factor in determining the optimal harvest age. The absence of a pulpmill, however, means that there is no market for the pulpwood from alpine ash, produced as a by-product of the sawlog harvest. The pulplog royalty was therefore assumed to be zero for the purpose of calculating the optimal harvest rate for alpine ash.

The options available for raising returns in Tasmania and Victoria to 4 per cent are either to maintain the current harvest ages while changing the structure of royalties to ensure that older trees attract a higher sawlog royalty, or to leave the structure of royalties unchanged while reducing harvest ages.

Certain qualifications should be noted. The costs of managing native forests have been excluded from the calculations. Also, optimal harvest ages will depend on local climatic, topographic and soil consitions, and thus cannot be determined as precisely as might be suggested here. Finally, there is some question as to whether the yield tables used (see Table H.2 in Appendix H) overstate actual yields obtained. If this is the case, then optimal harvest ages may have been underestimated.

The implication is that the royalty increases required, discussed in the next section, may have been overestimated.[1]

Raising rates of return through higher royalties

If current harvest ages are considered desirable from a silvicultural or environmental point of view, then royalties for larger trees need to be higher in order to justify the long rotation.[2] That is, if royalties increase with tree age, forest services would have a financial incentive to delay harvesting until the forest is more mature because not only can more wood be harvested, it would also be more valuable per cubic metre.

As younger trees produce better quality pulp, there would seem to be little justification for charging higher royalties for pulpwood from older trees. There is reason to believe, however, that sawlog royalties should be higher for older trees, because up to a point larger logs allow a higher yield of more valuable sawntimber.

This suggests that only sawlog royalties should increase with the age of the trees, in order to justify long rotations.[3]

The fifth row in Table 6.1 shows how much higher the sawlog royalty needs to be for 80 year old trees in comparison with trees harvested at the optimal ages, in order to earn the same return. That is, the sawlog royalty from an 80 year old mountain ash harvest would need to be around 3 times the sawlog royalty from a 40 year old harvest, in order to warrant waiting the extra 40 years.

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[1] The implications of excluding land values from the calculations are more subtle. The optimal harvest ages are those which maximize the net present value of the harvest. This net present value (shown in Table H.2) is the implicit value of the land plus the stock of trees. If these land values are higher than the current market value of land, for example in agriculture, it indicates that more trees should be planted. It does not imply a bias in the estimate of optimal harvest ages.

[2] Non-wood charges could also be increased - see Appendix H.

[3] The Commission has some anecdotal evidence that in most States sawlog royalties do increase with log quality, of which size is one component, but could not obtain details on the extent to which this is the case. The Commission has therefore been forced to use flat rate royalties, which are published in State forest services' annual reports, in its calculations. This will have biased downwards the estimates of optimal harvest ages.

The sawlog royalty from 80 year old Tasmanian regrowth would need to be 17 times higher than that for 30 year old trees.

This analysis allows the appropriate relative sawlog royalty to be determined between young and old trees. It is not much of a guide as to the actual royalties needed. It is difficult to determine whether, for example, sawlog royalties should be $20.75 per cubic metre for 40 year old, and $60 per cubic metre for 80 year old mountain ash, or $50 and $150 respectively, etc.

Given the importance of the base from which the royalty increase for larger trees is calculated, the Commission has been cautious and used the current pulpwood royalty as the starting point. While the uncompetitive pulpwood allocation system may mean that pulplog royalties are too low (IC 1990b), they can be used as a 'lower bound' market value of, for example, 30 year old Tasmanian regrowth. Sawlogs may have a higher market value per cubic metre because of their end use, but this higher value is likely to be small for 30 to 40 year old trees. Using the pulpwood royalty as the base thus implies that sawlog royalties would rise by 93 per cent for 90 year old alpine ash, by 26 per cent for 80 year old mountain ash, and by 1650 per cent for 80 year old Tasmanian regrowth.

The ability to raise royalties might be constrained by competition from imported sawntimber. ABARE has reported, however, that a more competitive harvest licensing system could allow forest services in Victoria to raise sawlog royalties by around 40 per cent without any reduction in the size of the sawmill sector (ABARE 1990[b]). In other words, sawmills could improve their productivity sufficiently to allow them to pay 40 per cent more for sawlogs without any overall increase in their costs of production. Thus a 26 per cent increase in sawlog royalties in Victoria would seem achievable.

A royalty increase of up to 93 per cent in NSW might be more difficult to achieve, although considerable efficiency improvements in sawmilling might again be possible. For Tasmania the royalty increase required would probably lead to the closure of a large part of the sawmill industry in that State.

These royalty increases represent an average increase, for the three States shown, of between 260 and 300 per cent over current sawlog royalties.[4]

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4 Shares of sawlogs produced by State used to calculate the weighted average are from ABARE 1990a, *Australian Forest Resources 1989*, AGPS, Canberra, August.

The royalty increase required is much larger in Tasmania than for other States and considerably raises the average even though Tasmania is a relatively small supplier of sawlogs. Thus, while 300 per cent will be used to illustrate the effects of raising sawlog royalties, it significantly overstates the effects for all States except Tasmania.[5]

Table 6.1: **Optimal harvest ages and increase in sawlog royalties needed to raise returns on forests to 4 per cent**

	Alpine ash (NSW)	*Mountain ash (Vic)*	*Tasmanian regrowth (Tas)*
Current sawlog royalty ($/m^3)	25.06	20.75	14.76
Current pulplog royalty ($/t)	11.32[a]	9.00	13.54
Optimal harvest age (years)[b]	50	40	30
Current harvest age (years)	50-90	80	80
Ratio required between sawlog royalties at current vs optimal harvest age[c]	1:1-4:1	3:1	17:1
Increase in current sawlog royalty to justify current harvest age (%)	0-93	26	1650

a) Assumed zero in calculating optimal harvest age as no pulpmill currently available. b) These are the harvest ages which maximize the harvest's net present value under a 4% discount rate. c) The sawlog royalty for 90 year old alpine ash should be 328% higher than the sawlog royalty for 50 year old alpine ash in order to earn the same return from the longer rotation. Similarly, the sawlog royalty for 80 year old mountain ash (Tasmanian regrowth) should be 190% (1650%) higher than for 40 (30) year old mountain ash (Tasmanian regrowth).

Source: Commission estimates.

The increases in royalties required to justify long rotations could be moderated by charging recreational and other non-wood users for the use of the forests.

5 The reader is reminded of the qualifications on page 6, which means that the optimal harvest ages may have been under-estimated, and therefore that these royalty increases may be over-estimates.

This would provide a return to the forest services while the trees are still growing, thereby providing some pay-off from letting the trees reach the age of 80 or 90 years.

Tasmania has just announced a new forest accord, and several other States are expected to do so in the near future. These changes could result in the adoption of new royalties and harvest rates, which could affect the above estimates of the changes required to earn higher rates of return.

Finally, the Commission's analysis does not incorporate environmental values in its conclusions due to lack of information. A discussion of the effect of environmental values is however given in Appendix H. The Resource Assessment Commission's Inquiry into Forestry and Forest Products may provide further guidance on these factors and allow more detailed analysis in the future.

Raising rates of return through shorter rotations

In the absence of non-wood charges, or the ability to raise sawlog royalties sufficiently, another option for meeting the requirement to earn 4 per cent would be to shorten the rotations. This would mean harvesting Tasmanian regrowth at 30 years, and mountain ash at 40 years rather than at 80.

Given the more frequent harvests, and greater growth rates of younger trees, shorter rotations would increase the supplies of logs per hectare from Tasmanian regrowth by 68 per cent, and of mountain ash by at least 14 per cent. [6] If these changes were representative of those States in general, they would represent an increase in national pulpwood supplies of around 42 per cent, as Tasmania and Victoria are the main pulpwood suppliers. They would also represent an increase in total sawlog supplies of around 12 per cent. Although the volume of sawlogs would increase, there could be a significant reduction in the supply of high quality sawlogs given the smaller diameter of the trees being harvested. Smaller sawlogs are more costly to process than larger logs, possibly leading to increased production costs for the sawmilling sector.

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[6] Yield data for mountain ash do not extend to 80 years. Thus reducing the harvest age from 60 to 40 years would increase log supplies by 14 per cent.

The increase in the supply of logs per hectare, resulting from shorter rotations, would give forest services the choice of maintaining existing levels of output whilst reducing the area of native forest required for logging, or of trying to place this extra volume on the market. The option of managing native forests on shorter rotations would thus not necessarily be at the expense of conservation, since fewer forests would need to be logged. It would, however, imply a move towards single-use forest management rather than the multiple-use management practised today.

The implications of higher royalties or shorter rotations for recycling

The analysis above, based on purely commercial considerations, suggests that the current long rotations used in native forests in Victoria and Tasmania mean that these forests are earning less than 4 per cent. Long rotations are not required for good quality pulplogs. Thus returns to forests could be raised by raising sawlog royalties relative to pulpwood royalties, or by shortening rotations.

The implications of these options, as well as a a change in the pulplog royalty for illustrative purposes, have been modelled using a modified version of the ORANI model of the Australian economy (IAC 1987). The modifications represent the first steps in the development of an 'environmental' ORANI, and are a significant advance in the Commission's ability to take account of the economic effects of environmental policy changes in an economy-wide context.[7]

Hardwood sawlog royalties

A 300 per cent royalty increase would reduce the sawlog harvest volumes contracted for by sawmills. Under the current sawlog regimes, the supply of pulpwood is closely related to the size of the sawlog harvest. Thus a lower sawlog harvest would also reduce the availability to the pulp and paper industry of pulpwood from native forests. Even though pulpwood royalties may not be directly affected, changes in sawlog royalties could still have significant implications over the longer term for the costs of producing virgin pulp.

[7] The essential features of the Recycling version of ORANI are described in Appendix I. Full details are available from the Commission on request.

However, in the short to medium term there may be limited scope for greater use of waste paper instead of pulpwood. Substantial changes in the fibre mix would require major investments in new or modified plant and machinery, which could take time given that existing mills are located close to forests, and are under long term supply contracts with forest services. Thus reduced pulpwood availability would be more likely to be met through greater use of imported pulp rather than waste paper.

Over the longer run, many of the constraints imposed by mill location and plant and machinery could be overcome as re-investment occurs. In particular, new investment in de-inking facilities, and new paper-making machinery which can handle greater shares of waste paper in the fibre mix, could significantly reduce the constraints evident today, which are limiting the extent to which recycling can increase. The need to maintain paper quality may still, however, impose a constraint on the extent to which the share of waste paper in the fibre mix can be increased, even in the long run.

The model’s results, shown in Table 6.2 (column 1), reflect the current state of technology, and in particular the absence of de-inking facilities for newsprint. This means that at present it is easier to switch to using imported pulp than waste paper, when prices of domestic pulplogs rise.

Consequently, the effect of reducing pulpwood supplies on the level of pulp imports is far more pronounced than its effect on the level of recycling. The use of hardwood by the pulp and paper industries was projected to fall by over 5 per cent, and softwood by around 4 per cent. The use of waste paper was projected to increase by around 1 per cent, and imported pulp by over 2 per cent.

Sawmills would, of course, be directly affected by higher sawlog royalties. Higher hardwood sawlog royalties were projected to lead to a reduction in the sawmilling industry's output of over 2 per cent, although the effect on Tasmanian sawmills would be considerably more severe.

The increase in the costs of sawntimber, resulting from higher sawlog royalties, would raise the costs of construction throughout the economy.

Table 6.2**:** **Long run effects of changes in royalties and harvest ages**[a]

	300% increase in hardwood sawlog royalties (1)	*Reduced harvest ages in native forests (2)*	*50% reduction in softwood pulplog royalties (3)*
Input usage in pulp production		*Percentage change*	
Recycled wastepaper	1.2	-6.4	-2.4
Hardwood pulplogs	-5.4	68.1	-0.2
Softwood pulplogs	-4.2	4.4	13.0
Imported pulp	2.4	-19.7	-4.0
Selected Industry Output Levels			
Hardwood forestry	-2.0	8.5	..
Softwood forestry	-1.2	1.9	3.7
Agriculture	..	..	..
Mining	-0.1	0.1	-0.1
Newsprint	-0.2	1.1	0.4
Printing and writing paper	-0.1	1.3	0.1
Packaging paper	-0.3	1.0	0.2
Other manufacturing	..	0.1	..
Sawmilling	-2.4	4.5	..
Construction	0.1	..	..
Utilities	..	0.1	..
Services	..	..	..
Land used for			
Waste disposal	..	-0.1	..
Hardwood forestry	-3.2	-15.1	..
Softwood forestry	-1.2	1.9	4.0
Macroeconomic effects			
Real GDP	..	0.1	..
Real household consumption	..	..	..
Real private investment	-0.1	0.1	..
Exports (volume)	-0.1	0.1	..
Imports (volume)	0.1	-0.4	..
Trade balance	..	0.1	..
CPI	..	-0.1	..

a) The results are in percentage change except for the trade balance, which is expressed as a percentage of base case GDP. They can be thought of as deviations from an underlying growth trend. They show how the variable in question would differ from what it would otherwise have been, after adjustments have been made to changes in royalties or harvest ages. The results have been computed using a 'large change' facility. This minimises linearization error associated with `large' changes, but means that the results are no longer linear.

.. Negligible change occurs - ranging from -0.05 to 0.05.

Source: Industry Commission (ORANI projections).

As construction costs are a major component of investment costs, higher sawlog royalties were projected to lead to a very small reduction in aggregate investment. Overall, the effect on real GDP was projected to be negligible.

The number of hectares of native forests used for wood production was projected to fall by over 3 per cent as a result of higher hardwood sawlog royalties.[8]

Shorter rotations in native forests

Another option for raising rates of return in native forests would be to shorten the rotations used, thereby harvesting younger trees more frequently. As discussed earlier, this would involve reductions in harvest ages from 80 to 30 years for Tasmanian regrowth, and from 80 to 40 years for mountain ash.[9]

The effect of such an increase in allowable cuts has been modelled under the assumption that other native forests could be left for conservation, with enough forests being removed from logging so as to roughly maintain existing sawlog supplies. The supply of hardwood pulpwood has thus been allowed to increase by almost 30 per cent (not shown in the table).

This increase in supplies would place downward pressure on hardwood pulpwood prices, thereby inducing the domestic pulp and paper industries to expand whilst reducing pulp imports. Expansion of the pulp and paper industries would also increase the demand for softwood. This was projected to lead to a slight increase in log supplies from plantations. As sawlogs and pulpwood are assumed to be produced in fixed proportions, the increase in softwood supplies would increase the availability of softwood sawlogs, allowing an expansion in sawmilling.

[8] Lower demand for sawlogs leads to a smaller harvest because sawlogs and pulpwood are assumed to be produced in fixed proportions. If the proportions were more flexible, eg by removing constraints on clearfelling (which would lower harvest costs), and removing regulatory restrictions on what constitutes a sawlog, then these forests might still be harvested, but for pulpwood rather than sawlogs.

[9] Alpine ash is currently harvested between 50 and 90 years. Thus alpine ash would not necessarily require shorter rotations.

The greater incentives to use pulpwood from both native forests and plantations were projected to reduce the use of waste paper by over 6 per cent. Thus shorter rotations would reduce the incentive to recycle paper.

The increase in pulpwood supplies resulting from the increase in allowable cuts would also place downward pressure on the domestic price level. A lower CPI would improve Australia's international competitiveness, leading to a slight improvement in the trade balance. GDP was projected to increase slightly.

If harvest ages were reduced, fifteen per cent or more of native forests currently used for wood production could be set aside for conservation. Thus shorter rotations can allow some native forests to be removed from wood production without any overall costs to the economy. While some forests could be left completely unharvested, however, other forests would be managed on shorter rotations, resulting in less mature forests. Thus there is a choice between protecting the conservation values of forests through leaving some of them unharvested, or through the use of long rotations.

In practice it seems likely that rates of return would be raised through a combination of higher royalties and shorter rotations. For example, royalties could be increased by around 40 per cent through improved efficiency in sawmills (ABARE 1990b) with the rest of the increase in rates of return achieved by shortening rotations. If this occurred, then the 'combination' option, by increasing allowable cuts, seems likely to lead to increased supplies of pulpwood and a weaker incentive to recycle paper.

Softwood plantations and pulplog royalties

Governments have a long history of investing in pine plantations. The objectives have included the encouragement of local wood-based industries, and the promotion of regional employment and development. Plantation managers were generally not required to manage their forests with the objective of earning a competitive rate of return on the public's investment, and it is unlikely that these plantations are today earning the sort of return that would be required if they were privately owned.

The prospects for improving rates of return by increasing royalties will be limited in the future.

Large investments in pine plantations in New Zealand are expected to lead to a considerable increase in the supply of softwood available in Australia over the next few years. This will probably put downward pressure on the royalties which may be charged for domestically grown softwood.

It may thus be difficult for government-run plantations to meet new commercial criteria without changing the mix of timber produced. This could be done by moving to shorter, and thus more profitable, pulplog rotations, which would weaken the traditional emphasis on sawlog production. Achieving increased rates of return might also require improvements in the efficiency with which these forests are managed. If improved rates of return cannot be achieved, some level of dis-investment in State pine plantations may result, with harvested land not being re-planted.

Over half of the wood used in the production of pulp and paper in Australia is softwood, largely plantation pine (Jaakko Poyry 1990). The increasing competition from overseas softwood producers, plus the possible shortening of rotations resulting in a greater supply of pulplogs at the expense of sawlogs, point to a likely decline in the cost of producing softwood pulp in the future. This may make paper recycling less commercially attractive, but could also reduce the usage of hardwood, thereby relieving some of the ‘pressure’ on native forests.

The Commission has not attempted to estimate the effect that the expected increase in softwood supplies from New Zealand might have on domestic royalties. The effects on the incentives to recycle paper can, however, be illustrated by modelling a 50 per cent reduction in softwood pulplog royalties.

The size of this reduction is completely arbitrary and does not reflect the Commission's beliefs regarding the actual effects of greater softwood supplies from New Zealand. Nor does it reflect evidence that softwood royalties should be reduced. The Commission has not found any evidence to suggest that pulpwood royalties are currently too high. A reduction in softwood pulpwood royalties has been modelled purely as an illustrative tool for highlighting the fact that, without new investment , the recycling rate will not respond significantly to changes in pulpwood royalties.

The results are shown in Table 6.2 (column 3). Lower royalties would make the use of pulpwood more economic for pulp and paper production. The use of waste paper was projected to decline by over 2 per cent.

As royalties only account for a small share of the costs of producing paper, the projected effect on pulp and paper manufacture was negligible.

The results serve to highlight the fact that even a considerable reduction in pulplog royalties may only lead to a slight reduction in the recycling rate. Even dramatic underpricing of wood cannot be said to lead to a significant impediment to recycling given the present structure of the industry.

6.3 Conclusion

Interest in recycling is in part driven by the desire to avoid the wasteful use of natural resources. While recycling has a part to play, it is a very indirect means of achieving what appears to be the main concern, that of resource conservation.

The efficient use of natural resources is better served by ensuring that resources are priced and managed appropriately, rather than by encouraging recycling as an end in itself. Prices can help ensure that resources are used where they are most valuable, and are therefore a prerequisite for the incentive to conserve them.

While there are indications that forest pricing and management practices in some States are not cosistent with meeting the 4 per cent rate of return required of them, there is little rationale for raising pulplog royalties for more mature trees. Returns to forests could be raised by increasing sawlog royalties for larger trees, by shortening rotations, or by a combination of the two.

The approach chosen would depend in part on whether the community wants to maintain the current emphasis on multiple-use forest management, or was prepared to accept a move toward single-use management. The former would suggest that sawlog royalties (and/or non-wood charges) should be raised. The latter would suggest that harvest ages should be reduced.

Raising royalties and shortening harvest ages would have quite different implications for paper recycling. The overall effects would, however, be small given current technology. Higher sawlog royalties would indirectly make paper recycling - but also imported pulp - more attractive. In this case the incentive to conserve forests also provides an incentive to recycle more paper.

However, the Commission’s estimates suggest that even significant sawlog royalty increases may only lead to a small increase in the area of native forest ‘saved’. In fact, in Tasmania’s case the royalty increases required to justify the current long rotations are so high as to suggest that it would be necessary to shorten rotations instead. This would weaken the current emphasis on managing native forests for sawlogs.

While shorter rotations may seem to be at odds with resource conservation, this need not be the case. Shorter rotations can increase the harvest per hectare, and this would make it possible to withdraw forests from wood production whilst maintaining log supplies to industry. While this would not encourage more recycling, it would allow more native forests to be left completely unharvested.

Thus forest conservation does not always imply that we should recycle more paper. Whether we have too much or too little paper recycling at present depends on which option for improving forest management is more desirable or achievable.

Even if forest management practices were changed, it seems unlikely that there would be much change in the recycling rate. The responsiveness of paper recycling is at present constrained by, for example, the lack of a de-inking plant, which is reflected in the Commission's results. This puts a limit on the amount of waste paper that can be used in pulp production instead of wood. Given this limit, even significant royalty increases will not lead to much of an increase in recycling.

The royalty increases required to raise rates of return may have been over-estimated, for the reasons discussed. This means that the effects on recycling and the economy of higher royalties or reduced harvest ages may also have been over-estimated. As these effects were shown to be relatively small, however, more precise estimates would serve to strengthen the Commission's conclusions. Overall, the Commission considers that the way in which our native forests are managed has not been a significant impediment to paper recycling.

7 IMPROVING RECYCLING

Although recycling in Australia is extensive, there are strong feelings in the community that individuals, industry and governments should do better.

This chapter considers ways in which governments can help recycling markets to work better and generally set recycling on a surer footing.

7.1 Government administration

Governments at all levels are keen to be seen to respond to public concerns about waste, conservation and recycling, but government agencies which have an influence in this area are frequently not open in their public communication. In matters of waste management, pollution control and forestry in particular, secrecy has been interpreted as evidence of underhand dealing and questionable motives. Public debate conducted in the dim light of partial knowledge does not favour rational argument.

This was evident in the Commission's attempt to assess the economic and environmental benefits and costs of paper recycling. Of all the reasons for public concern for recycling, the feeling that increased paper recycling will save Australia's native forests is one of the most potent. The secrecy surrounding the commercial deals between State forest services and purchasers of pulpwood, coupled with the limited information in the public domain about forestry concessions and royalties has promoted the view that pulpwood must be underpriced and hence recycling discouraged.

Better information from government agencies and some companies might have dispelled some of the myths and contributed to more informed discussion of both recycling and conservation issues. The Commission too was unable to get full details about the pricing of pulpwood and sawlogs, but there is sufficient information to say that increased paper recycling will bring little benefit in terms of native forest conservation.

The dearth of information is an impediment to better recycling in Australia. Governments tend to be driven by community perceptions about recycling.

However, community perceptions, based upon very incomplete information can encourage responses which impose net costs on society.

In this report the Commission has included even fragmentary information in the belief that it is important to begin the task of building a data base on the extent of recycling and on the benefits and costs of particular activities. It is understandable that some policies are developed with incomplete information. However, at times not enough use is made of the information that is available.

A plethora of government agencies can have a bearing on recycling decisions. This creates problems in many directions - not the least being undue delays in approving new investments. This is illustrated by the response of government agencies to ANM's plans to establish a newsprint brightening facility at its paper mill at Albury, as a first step towards recycling wastepaper into newsprint on that site. The proposal requires consultation with about 10 Commonwealth, State and local Government departments and agencies.

The division of powers and responsibilities among the various levels of government stems from Australia's federal system and contributes to the number of agencies involved in such decisions. The Commonwealth's coordinating role through the Australia and New Zealand Environment Council (ANZEC) will be enhanced when the federal Environmental Protection Agency comes into being. Increasingly, industry, the Commonwealth and the States are cooperating in voluntary recycling programs which avoid jurisdictional disputes.

There is a need for greater accountability for the funds contributed by industry to support recycling schemes such as those operated through Victoria's Environment Protection Authority. The funds come from bodies such as the Litter Research Association and the Plastics Industry Association. The donors may impose restrictions on the use of funds, as the Publishers National Environment Bureau has done. But without clear criteria about their use, it would be possible for funds to be applied to the day-to-day running costs of the Authority, rather than to a specific program with which the donor can identify. If this happens, industry support is likely to wane.

Where a regulatory body is also a service provider, it is difficult for regulations to be seen to be even-handed. During this inquiry it was alleged that the Waste Management Authority of New South Wales uses its powers to approve landfills to prevent competition from private operators. Regardless of the merits in this case, assertions of this type have been so common that it has become a tenet of good public administration to separate the regulations from those who provide services. Some States have been moving in this direction, but there is still a way to go. As the powers of government are used more forcefully in environmental matters, this issue will assume increasing importance.

Favoured treatment of particular firms, for instance in access to wastepaper generated by government, was also alleged. If recycling is to be an established part of commerce and industry it must be seen to be open to free and fair competition. Administrative arrangements which allow substantial administrative discretion or arbitrary decisions, or which are not clearly defined, are more likely to lead to inconsistencies and inequity than systems based on simple and clearly defined rules. The rules can become obscure when recycling is made a tool of other policies - for instance industrial development.

Some of the devices employed by the States seem at variance with conventional good government. Appendix J reports a letter from the then Victorian Minister for Planning and Environment to major newspaper publishers in Victoria. It illustrates the nature of pressures brought to bear upon the publishing industry, leading to a $4 million fund established by the Publishers National Environment Bureau to support old newspaper exports and recycling.

The threat of container deposit legislation has been a considerable inducement for other segments of industry to set up or contribute to recycling programs, some of which appear to make less than efficient use of Australia's resources.

The greater weight now given to the environment has raised community expectations that governments will intervene in environmental matters. But greater access to the coercive powers of the State brings a need for greater care and responsibility in their use. The well-founded principles of good public administration should apply in the environmental policy area as in any other.

7.2 Making the market work better

Recycling in Australia is generally growing, but some markets for used materials and reprocessed products are not working as well as they could. Many government policies influence these markets, particularly those relating to waste management, resources and pollution control.

Waste management

There is scope for improving the way councils charge for waste disposal so that users bear the true cost of disposal and can judge whether disposal or recycling is the right option for them.

Chapters 3 and 4 discussed a number of problems in waste management which can adversely affect recycling: poor enforcement of industrial waste and pollution regulations, landfill disposal charges which fail to cover the real costs (including environmental) of waste disposal and charging systems which provide little incentive to reduce waste. These can all act as disincentives to the use of waste minimising technologies including recycling.

Councils need to adjust charges to reflect the full costs of waste management. To the extent that some Councils can bring about other improvements (eg in tip engineering), the need for higher charges may be reduced or at least deferred.

Charges

Many Councils are too small to undertake the necessary research into appropriate systems of waste management and pricing or to reap the economies of scale that are available from modern waste management technologies. Local government amalgamation is one way to overcome this. Another is for Councils to band together in regional groups. Another is the development of a central agency like the Waste Management Authority which operates all tips and transfer stations in Sydney.

Because household waste management charges are collected as Council rates, few people have any idea of the costs incurred.

Some of the costs of waste management services could be met from quantity-based user charges. What proportion depends on the cost of waste collection and disposal, the costs of administering quantity-based charging systems, the responsiveness of users to a pricing system and the costs of controlling and dealing with illegal disposal. In principle, it would be desirable for rates to cover fixed costs, with charges to users covering variable costs.

Councils which moved to a quantity-based system of charging for waste management would need to review the way in which they finance household collections of recyclables. This is because households, not Councils, would save the waste disposal costs avoided through recycling. Councils would no longer have the same incentive nor the same means to pay collectors. Any net costs of recycling services would have to be charged for, either in rates or in collection fees.

Individual Councils are best placed to determine a charging system that suits their area. In areas where disposal costs are high, a combination of direct charging based on volume, the use of general rate revenue to meet fixed costs of waste collection, and payments to collectors to assist them in providing an integrated service may be the best approach.

Collecting recyclables

Collection systems around Australia are in a state of flux. Some paper collection schemes were abandoned following the fall in the price of old newspapers, but new collection schemes have been developed for other products.

Specialised office paper collections reflect the growing demand for high quality wastepaper and the greater preparedness of office workers to sort paper for recycling. APM is expanding collections from central business districts of major cities. In Western Australia, high quality wastepaper is now collected and reprocessed into tissue by AusTissue.

The bulk of Australia’s used materials are sourced from industry and this provides a relatively stable base for reprocessing. However, integrated kerbside collections have been growing, and with the improved systems, greater reliability and convenience, participation rates and the quality of pre-sorted materials have also improved.

The cost of collecting additional amounts of wastepaper, aluminium cans and PET bottles is declining. With new initiatives in plastic recycling, a wider range of materials is now collected. There are new facilities for reprocessing HDPE milk bottles and PET.

Some Councils pay collectors to provide kerbside services. This is in recognition that revenue from sales of recyclables (to reprocessors) is not generally adequate to ensure that collectors provide frequent integrated collection services. The costs of supporting a collection scheme can be set against a Council's avoided disposal costs. However some Councils, particularly in Melbourne, have spent more on developing and running recycling schemes than they have saved through avoided disposal costs.

Recycling is a service for which many residents are prepared to pay, but unless Councils take explicit account of the costs and benefits of their recycling collections, there is a danger that they will not be provided in a way which best contributes to the welfare of their residents. Charging for waste management in ways which make costs more visible to residents would do much to ensure that the level and type of recyclables collected is 'right' for the particular circumstances of each Council.

Industry schemes

Most of the long-standing collection systems, such as those for paper and glass, have been organised by industry for purely commercial reasons. Some new schemes are not commercially viable, but are maintained by industry for public relations reasons or to forestall State government legislation, such as mandatory recycling levels or container deposits, that would be more expensive to the industry concerned.

Companies have an incentive to deal with problems which affect their profitability. For example, in order to maintain their image in the marketplace, companies have an incentive to contribute to schemes which control litter caused by their products. The Litter Research Association's voluntary levy to support Council kerbside collections, the PET recycling levy and the newspaper publishers' arrangement to collect old newspapers for reprocessing overseas are examples of schemes where benefits can accrue to the companies concerned. However, prominent brand names are not attached to most of the material disposed of as waste so there is no incentive for most producers to voluntarily support recycling schemes.

The focus of much community pressure for increased recycling has been on such highly visible products as PET, PVC and HDPE bottles and newspapers, even though they form a small part of the waste stream and do not create leachate pollution when landfilled. At the same time industrial waste disposal and pollution control practices often survive for long periods even when they impose significant environmental costs. Government environmental policies, including recycling strategies for industry, should be based on an assessment of benefits and costs including costs of environmental damage.

Resource conservation

There is no simple relationship between recycling and conservation. While recycling often does conserve natural resources, energy and water, it also uses resources - particularly in transport, sorting, cleaning and materials preparation. From a conservation point of view, it is important that all of these uses of resources be taken into account.

There are a lot of misconceptions about recycling and how products are made. For example, it has not been generally understood that more paper recycling within Australia will not do much for the conservation of our native forests. Most wood fibre used in Australian paper pulp manufacture comes from pine plantations, by-products of sawlog production or sawmill residues.

Where resources are priced appropriately, the market can provide a reasonable guide to what makes good conservation sense. However, if governments underprice resources such as forests, electricity or water, some producers are likely to have an incentive to use more virgin and less reprocessed material.

If Australian forest resources were being sold to domestic producers for less than world prices, this would be prima facie evidence of underpricing. The available information on prices does not allow such a comparison to be made for eucalypt pulpwood.

However, there is evidence of unutilised softwood pulpwood at current domestic prices - prices influenced by the considerable international trade in pulp. The Commission has not found evidence of underpricing of pulpwood that would have affected the decisions of Australian paper manufacturers to use wood rather than reprocessed fibres to a significant degree.

Whether prices on international markets fully reflect the value to future generations of these resources is an issue which goes well beyond the scope of an inquiry into recycling. In any event, profligate use of resources caused by underpricing cannot be corrected by forcing the pace of recycling.

Increased recycling would have little effect on extraction if resources ‘saved’ were simply transferred to exports. Because Australia is a large exporter of natural resources, their extraction depends more on the relationship between world export prices and costs of production in Australia than on domestic consumption. If Australia were to conserve its resources by increasing prices locally, the effect would be to encourage higher imports and thus merely transfer the use of resources overseas. The case study in Chapter 6 shows that increasing royalties for sawlogs would increase imports more than it increases recycling.

Assigning liability for pollution

In this inquiry, the Commission has concentrated on pollution control measures which are directly relevant to recycling, including direct regulation of pollution, deposit schemes, waste taxes and making producers responsible for their products ‘from cradle to grave’.

Pollution control

When visible pollution damages the image and sales of companies, they are often prepared to incur costs to reduce it. The conditions are there to allow market incentives to reflect pollution costs in private decisions. However, for most waste, market incentives are not sufficiently strong for pollution costs to be reflected in private decisions.

Governments can impose direct controls upon pollution, such as regulations on emissions, bans on particular products or processes, and various types of pollution charges. All of these measures can induce producers to find ways to reduce pollution. Recycling is one way. Whether producers choose recycling or other means will depend on the costs of various options.

The cost to industry of pollution abatement will be low if pollution control standards are low, if standards are not effectively enforced, if penalties for illegal disposal are small, or if legal forms of disposal are underpriced. With the price of legal disposal of harmful materials in ‘secure’ landfill as low as $100 per tonne, there is little incentive for producers to use more expensive pollution minimising technologies, including recycling. Building environmental damage costs into waste management charges is therefore an important step in reducing pollution and encouraging recycling. All costs are unlikely to be covered where harmful materials can be disposed of for $100 per tonne.

Reprocessing can be a useful means of controlling pollution. In Australia it is used effectively for lead, CFCs, oil and some chemicals. But it is only one means of achieving pollution control objectives.

Deposits

Deposits provide a mechanism to prevent harmful materials being discharged into the environment. They can be voluntarily operated by industry or imposed by governments.

In South Australia, deposits have applied on certain containers since 1975. The legislation has wide community support, but many participants said that it is not a good model for deposit schemes as it is discriminatory, expensive and a deterrent to the development of integrated collections of recyclable materials.

Mandatory deposit schemes provide a financial incentive to return used goods for approved disposal or reprocessing. However, as the analysis of South Australia's container deposit legislation in Volume 11 shows, they can impose high costs on both producers and consumers. Legislated deposit schemes are unlikely to be an efficient option unless the costs of introducing waste materials into the environment are large. There are other ways of encouraging the return of recyclables.

The reduction in litter throughout Australia illustrates the potential benefit of public awareness campaigns. Comalco's buy-back scheme for UBC is another example.

In Victoria, a scheme to recycle containers used for agricultural chemicals has met poor farmer response in returning containers. Given that these containers pose an environmental risk, deposits may be an efficient method of ensuring their return.

Used lubricating oil also has environmental costs high enough to warrant consideration of a deposit scheme. However, existing regulatory approaches achieve high recovery rates for oil from all sources except householders and small businesses. Imposing deposits would increase costs to the major part of the oil market while bringing dubious gains. A voluntary deposit scheme directed solely at the 'do-it yourself' market might increase recovery rates, but it is not clear that it would do any more than would be achieved by improved public awareness of the problem and making collection facilities more readily available.

There is the complication that lubricating oil, once used, cannot be returned in the form and quantity in which it was purchased. In order to return the full deposit, an allowance would have to be made for the proportion lost, on average, in consumption. Another option is to refund the deposit only on the quantity returned but this would be equivalent to imposing a tax on consumption. Furthermore, there would be an incentive to adulterate the used oil, thereby reducing its value for reprocessing.

Would a deposit scheme work better for other materials? A recycling scheme for CFCs is already in place. Up to 90 per cent of car batteries scrapped in Australia are already recovered for export or reprocessing. A deposit scheme might work for dry cells which are not currently recovered to any degree and which can cause heavy metal pollution in leachate. However, it is not apparent that a deposit scheme would be any more effective than providing facilities for the separate collection of dry cells. It would be more expensive.

Deposit schemes are expensive to operate. They work best when the costs of improper disposal are high and cheaper alternatives are ineffective. The Commission has not found a convincing case for government deposit schemes for any products reviewed in this report.

waste taxes

Environmental charges or taxes could be a means of discouraging production and consumption of products harmful to the environment. Some participants advocated a disposal tax built into product prices which could provide funds to Councils to offset costs of collection and sorting. Several participants proposed that taxes be imposed to discourage unnecessary packaging. Some proposed higher taxes on non-recyclable packaging.

The scope for special sales taxes in Australia is limited by the Constitutional division of powers and the requirement that Commonwealth taxes be uniform throughout the country. The Commonwealth's taxation powers are not suited to finely discriminate among products and places. Dedicating the revenue from such taxes to State and local government waste management programs would be a matter for negotiation between the Commonwealth and the States.

Even if taxes on packaging could be introduced, they are not likely to be an efficient means of correcting environmental or waste management problems which occur at the local level. People in country areas, where waste management is less of a problem, would pay more for their products, without obtaining the same benefits as city dwellers.

There is a danger that by targeting packaging, governments would contribute to greater use of resources in other ways. Packaging adds to convenience and consumer choice and lessens waste through spoilage. Encouraging manufacturers to use less packaging may increase waste through breakage or spoilage. Some forms of recyclable/reusable packaging are heavier and increase energy used in product distribution. And much paper and glass packaging already contains substantial quantities of reprocessed material. Furthermore, exemptions for recycled, recyclable or reusable packages are not easy to police, as experience with the sales tax exemption on certain 100 per cent recycled papers attests (see sales tax section below).

There is a stronger case for an environmental tax as part of a regulatory framework for disposing of used tyres. There are problems in disposing of tyres in landfill or by incineration, and there is the risk of severe environmental damage from fire.

In Western Australia, where a dump containing 500 000 used tyres caught fire, the clean-up costs were estimated to be $700 000 to $900 000, or $1.40 to $1.80 per tyre.

Some retailers of new tyres charge about $1 per tyre to offset the costs to them of disposing of worn tyres. The used tyres are dumped in landfill, in some cases after shredding. However, Councils are sometimes reluctant to accept tyres in landfill and their subsequent stockpiling adds to the risk of fire.

An environmental tax, or a levy could apply on sales of tyres as an advance disposal fee. The money could be held as a fund to cover shredding and landfill charges, and to support the development of alternative means of disposal such as the use of scrap tyres for fuel in power generation. The Western Australian Department of Health referred to the possibility that the Electricity Commission in that State might be required to make use of scrap tyres as a fuel in its coal fired power station. While funds raised through an environmental tax on tyres could be used to support this form of disposal, overseas experience has shown the high unit cost of electricity produced in this way (refer Volume 11).

With greater attention to environmental controls over the storage and disposal of tyres, and with disposal costs built into disposal charges, industry would itself have the incentive to levy an appropriate disposal fee. At least until reforms are introduced in these areas, there is no compelling reason to apply an environmental tax.

Cradle to grave liability

A number of participants argued that producers should be responsible for their products 'from cradle to grave'. Such an approach would be a departure from current property rights where, once goods are sold, the new owner becomes responsible. It is difficult to justify such a change for the multitude of goods produced throughout the economy for which disposal does not entail significant environmental costs.

Most advocates link the concept to products such as packaging, which can be identified with particular manufacturers. As discussed elsewhere in this report, most packaging does not impose high environmental or other social costs.

Where illegal or thoughtless disposal of packaging is a significant problem, it should be addressed in the least-cost way.

While the cradle to grave concept sounds simple, in practice it would not be. Most products are produced from a variety of materials, some locally produced and others imported. Would the liability for disposal of the plastic insulation around a wire in a piece of electrical equipment lie with the producer of the plastic, the wire, or the equipment? Should liability for disposal of a magazine rest with the paper mill, the publisher, the newsagent or the reader? Would a farmer be responsible for his produce through all stages of distribution, processing and consumption?

Such trite examples highlight the costs of such a change in liability and its impracticality for most products. The principle should be that liability for waste disposal rests where the costs to the community of disposal are lowest, not necessarily at an arbitrary stage in the production or consumption process.

Building design and health regulations

Some regulations designed for other purposes inadvertently constrain the use of recycled products or recovery of recyclable materials. For example building regulations intended to support safety or engineering standards can impede the use of secondhand and demolition materials. The recovery of recyclables such as paper could be made more cost-effective by closer attention to the design of large buildings. For example, the new Parliament House has no provision in its waste system for paper to be segregated for recycling.

Health regulations prohibit the reuse of plastics in food and beverage packaging. There is some question about the justification of such bans for plastics such as PET which undergo substantial chemical change in the course of reprocessing. Because used PET bottles cannot be reprocessed to make more PET bottles, this potentially valuable material is downgraded when recycled (see Chapter 4). Changes in health regulations may be needed to accommodate new technologies which, for example, allow PET bottles to be made of a thin layer of reprocessed PET sandwiched between layers of new PET. Even so, some manufacturers may choose not to use it.

If they are not really justified by health and safety risks, regulations can impede the development of efficient markets for used materials and recycled products.

Consumer Information

Markets work more effectively if buyers and sellers are well informed about the products on offer. This inquiry has revealed that accurate information about recycling and recycled products is scarce. Governments too, need to be better informed.

Better information is need about the technical suitability of recycled products. Enthusiasm for 100 per cent recycled printing and writing papers has contributed to its inappropriate use and has provided an incentive for high grade waste paper to be used in less efficient ways. For other products such as lubricating oil, consumers lack the information to make informed choices which might favour the recycled product.

A number of participants advocated that governments provide better information to consumers about recycled products. Commonwealth and State Governments are beginning to do so. Indeed, this inquiry is part of that process.

At the Commonwealth level, the Department of Administrative Services (DAS 1990) has looked at government procurement policies and the use of recycled paper. It advised on appropriate technical applications for recycled paper, on the establishment of a Commonwealth Government office paper recycling scheme, and an education campaign for Commonwealth employees.

Some participants called for standards for recycled products. However, some advocates of mandatory standards saw them as a way of securing markets for recycled products which could not be sustained in a more competitive environment. Standards Australia is developing some standards for recycled products, but the Commission understands that its work is at an early stage. If standards were to improve understanding of the performance of reprocessed products without unduly restricting their use, they could play a useful role in improving consumer choice.

Several participants suggested that better labelling of products is required. There is much confusion in the community about environmental effects of products and production processes which is exploited by advertisers. Labelling, as with all marketing and promotional material, is subject to the Commonwealth Trade Practices Act and State and Territory Fair Trading Acts which prohibit false or misleading representations and deceptive conduct. In December 1990, the Trade Practices Commission published draft guidelines on environmental claims in marketing. These are intended to assist companies to conform to existing legislation.

Although some consumers and consumer groups are reluctant to accept that information supplied by industry is objective, industry can and does provide accurate information, particularly to schools, about recycled products. It could do more by accurate labelling of the recycled content of products and by providing better information about the specifications of products.

The ‘green spot’ endorsement has been proposed as a way to reduce misleading statements. However, the green spot is of limited value to consumers as it is not based on objective criteria. It would be difficult to implement in a way which recognises the benefits and costs of recycled content of particular products or their packaging.

7.3 Direct incentives

Is it enough to make markets work better? Could the same results be achieved more certainly or more efficiently by policies which target recycling specifically?

Many participants advocated policies which would assist recycling directly, or compel industry to undertake more recycling. Assistance measures proposed included tax concessions of various kinds to reduce the costs of recycled products, and stimulate demand for them, government procurement policies directed at recycled products and assistance with research and development. Some also advocated recycling requirements or targets.

Recycling targets

Targets can be voluntary or mandatory, and apply to the recovery rate for a product or the level of incorporation of recycled material.

‘Voluntary’ targets apply in Victoria for certain beverage containers. The Victorian Government referred to the possibility of applying recovery targets for other products. The Tasmanian Conservation, Trust proposed mandatory minimum recycled content levels for some products, which would be gradually increased until 'optimum' recycling levels are achieved. The Department of the Arts, Sport, Environment, Tourism and Territories (DASETT) supported the adoption and if necessary, imposition, of recycling targets by governments. The Victorian RAL-AC recommended that plastic beverage containers be subject to a 10 per cent recovery and reprocessing target by 1991.

The analyses of particular products in Volume II indicate how difficult it is to measure the level of recycling achieved, let alone work out the 'best' targets to be set. Efficient levels of recycling will vary between States and regions within States. Overseas levels are not much help either; not only are there problems in finding comparable measures, but comparisons of recycling activity between countries reveal little about the policies needed to encourage efficient resource use and protection of the environment in Australia. It is almost impossible to fine-tune targets to take account of differences in economic circumstances between firms and regions.

The Australian and New Zealand Environment Council (ANZEC 1990) has proposed a targeted reduction of 5 per cent per annum in the weight of packaging 'waste' between 1991 and 2000. Such a reduction could have the unintended effect of encouraging the use of lighter virgin kraft paper and board in place of the currently used recycled packaging papers. Lighter forms of packaging such as plastic and coated paperboard could be substituted for heavier forms such as glass and metal.

Targets can require goods (eg paper) to be produced with a certain content of waste material. More commonly, they require consuming industries (eg publishers) to use certain proportions of reprocessed products in their final products. In some countries they have been set with little attention to the practicalities of producing goods, especially if substantial investments are required.

Australia can gain some insights from the imbalances and distortions which mandatory targets have brought to the pulp, paper and publishing industries in the United States.

If producers were to respond by setting up production which could not be justified without a mandated market, production inefficiencies would be added to the consumption inefficiencies. Other concerns were expressed by the Printing and Allied Trades Employers Federation:

> ... if there were to be regulations that required a printed or paper converted product to be manufactured from 100 per cent or indeed some other percentage of recycled fibre, then there is every incentive to act as highly protected manufacturers often do - that is, less efficiency, at higher cost, charging higher prices.

There are additional problems in a federal system when targets are set by the States but the economy is integrated nationally. The available information on consumption of materials within individual States is an inadequate base on which to set recovery rate targets. But, measurement problems aside, targets which mandate the use of certain proportions of reprocessed inputs in goods sold within a State could create barriers to trade. Such targets could lead to inefficient industrial structures and be a back-door way of requiring industries to establish in the State.

Targets do not address the reasons why some recycling levels may be lower than is socially desirable. Mandating certain recycled contents in products or of consumption could encourage inefficient forms of recycling and make us worse, not better off.

Assistance for recycling plants

The Victorian Government’s $150 000 grant to ACI early in 1990 for equipment for its new PET recycling plant in Wodonga has been seen by some as a signal of State preparedness to directly assist recycling ventures. In 1989-90, the WMA in Sydney earmarked $400 000 to support garden waste composting and mulching schemes of Councils. In 1988 the Western Australian Government granted $200 000 to AusTissue Pty Ltd to produce tissue paper from wastepaper.

State Governments frequently offer incentives for firms to set up within their State, 'particularly in non-metropolitan regions.

A number of participants advocated special assistance for new recycling ventures ranging from grants and loans for recycling plant and equipment to electricity and rail freight subsidies.

Subsidising inputs to recycling, such as electricity or transport, is likely to lead to more but not better recycling. If one of the benefits of more recycling is less energy use, the way to conserve energy is hardly to subsidise electricity and transport!

Encouraging the establishment of enterprises dependent on government support does not make good sense, especially in a period of microeconomic reform when the expectation is that assistance is to be reduced. However, there may be circumstances where wider environmental or other objectives may justify some government support. Local collections of recyclables are supported by Councils; there is no intrinsic difference between paying collectors and paying manufacturers who use recycled materials. However, payments should be closely tied to the avoided costs of disposing of materials as waste.

Recycling has occurred for centuries for sound commercial reasons. For some projects, however, the commercial incentive is strengthened by the perception that existing markets will be more secure if producers are seen to respond to the community's concern for recycling. Where this community pressure upon producers is an efficient means of implementing the polluter pays principle, there is no justification for government subsidies.

If producers have been induced to undertake recycling schemes for which the costs to industry bear little relation to community benefits, the appropriate response for government is to re-examine its policies, not subsidise inefficient recycling. It is important that policies affecting recycling be designed with the real costs and benefits in mind. It is not clear that at present governments are well informed about the objectives, benefits or costs of recycling.

Some participants advocated reducing tariffs or providing concessional entry for equipment used in recycling. Many items of equipment are probably eligible for tariff concessions under the normal criteria. It would be inconsistent with the purpose of tariff concessions and tariff reform to make exceptions for particular end-uses.

Some other participants argued that tariffs should be increased for certain recycled products to encourage their recycling in Australia. However, the thrust of tariff policy is for lower and more uniform levels of protection in order to encourage efficient production generally rather than disparate rates to encourage particular types of activity.

More favourable depreciation provisions for recycling equipment were proposed by a few participants. The Treasurer in his 1990-91 Budget Speech announced a review of tax provisions that have adverse environmental effects. That review is the appropriate forum to consider this issue.

Governments can help recycling by the reform of approval and other regulatory procedures which impose excessive costs and delays. Many layers of regulation have been added piecemeal and can be a sizeable impost on development projects. The problems are compounded where several tiers of government are involved, as with ANM's proposed de-inking plant at Albury.

ANM has offered to fund and operate or to financially contribute to a salt interception project downstream at an approved site on the Murray River, to extract at least the equivalent of the salt discharged by it to the river. The proposal is supported by a number of agencies and opposed by others. In a recent report to the relevant Minister in New South Wales, the Commissioners appointed to make recommendations relating to environmental aspects of ANM's proposed newsprint brightening facility (the first stage in the Albury development) were critical of the approach taken by some agencies. The Commissioners noted that '... the Applicant has not received assistance but rather obstruction from the government agencies in relation to developing a suitable "private" salt interception project' (Commission of Inquiry for Environment and Planning 1990, p. 6).

Research and information

Many participants argued that publicly funded research is needed to assist industry to overcome technical constraints and develop new products.

Others argued for more information about potential uses for and users of waste materials and recycling opportunities. Some proposed that a full study be carried out into industrial and commercial waste generation and that a comprehensive register should be established commencing with industries with large volumes of valuable by-products.

Where particular firms are likely to be able to appropriate the benefits, they have an incentive to pursue promising lines of research without government support. Research of this type is already quite extensive. Indeed, a number of industry groups in the paper and plastics industries have been formed to support or undertake research into products and processes, including recycling, or into environmental research specifically. News Ltd has an Environmental Secretariat which operates a newspaper recycling database and provides information on recycling of old newspapers. Newspaper publishers, including News Ltd, John Fairfax Group Pty Ltd and the Australian Consolidated Press, have established the Publishers National Environment Bureau. The Bureau will provide financial assistance to paper recycling schemes, fund research into new methods of recycling newsprint, and collect data on the use, collection and disposal of paper in publications.

In 1990 the Plastics Industry Association introduced a 'Looking Ahead' program. It has an annual budget of $750 000 for a three year period. A data base has been established on plastics and the environment, and research into the collection, separation and recycling of plastic has been funded.

Where the benefits of research cannot be appropriated privately, the private sector does not have a strong incentive to undertake it. Research into environmental effects can fall into this category. There is some publicly funded research into recycling as a means of controlling discharge of harmful agents into the environment. Whether its current priority in funding of environmental research is appropriate is difficult to judge in the context of an inquiry into recycling.

Indirect taxation

Tax concessions for particular activities or recycled products were advocated by several participants. However federal taxation measures are fairly blunt instruments for achieving objectives which vary from place to place and product to product.

Wholesale sales tax, excise and company tax cannot vary from place to place. Also, fine distinctions between products can be costly to administer and create anomalies for other policy objectives.

Wholesale sales tax

A number of participants advocated wider sales tax exemptions for reusable or recycled products in order to reduce selling prices and stimulate sales relative to products made from virgin materials. Others proposed exemptions for inputs and equipment used in recycling and waste management processes in order to reduce costs.

Sales tax is levied on the wholesale price of goods sold in Australia. The complex nature of exemptions provides a mixed and confusing set of signals to recyclers.

The sales tax system

Used goods or reprocessed goods which retain their identity are generally exempt from sales tax on the grounds that the tax should only be levied once. However, because such products are tax exempt, reprocessors are generally denied the tax exemptions on materials and plant and equipment which other manufacturers enjoy.

If used products are reprocessed, so that the identity of the original product is lost, any subsequent product that is produced is not considered to be ‘used’. They generally are subject to sales tax. However, their manufacturers are entitled to the 'aids to manufacture' exemptions on materials and plant. Where a product is specifically exempted from sales tax, for example certain 100 per cent recycled papers, the manufacturer retains all of the general exemptions applying to manufacturers, even though the product is exempt from tax. An exemption for a product does not carry through to other products in which it may be incorporated. For example, if recycled paper is used to package a taxable item, the tax is levied on the wholesale value of the packaged product - no deduction is made for the packaging component. These are general principles only. The strict wording of the law as it applies to particular products makes the picture more complex.

Should recycled products be exempt?

Since January 1990, certain 100 per cent recycled papers have been exempt from sales tax. Many participants wanted this extended to other recycled products. However, some manufacturers argued that this is not an efficient way to encourage recycling because it distorts product markets and diverts waste materials into less productive uses.

For example, APM argued that the sales tax exemption for 100 per cent recycled paper increases the already large demand for high quality wastepaper, increases its price, and encourages its use in inefficient ways. A number of paper companies said that papers with a high proportion of recycled input, but containing some virgin fibre, are technically more suited to most applications than 100 per cent recycled paper. This is particularly important in printing and writing grades. Participants also pointed to the difficulties of enforcing the provision.

APPM said its 100 per cent recycled paper is not suitable for high-speed conversion into stationery products or envelopes. The company said government initiatives to increase the use of wastepaper should focus on increasing the demand for paper products with wide applications and which are suitable for recycling.

Similar considerations apply to many recycled products such as glass. If the aim is to stimulate demand for used materials, the tax system should not be used to favour the use of products with a particular content of recycled material. In recognition of this, a number of participants proposed that a sales tax exemption apply to goods with a recycled content over a certain threshold, eg 50 per cent. Others suggested a sliding scale of exemptions based on recycled content.

Sales tax exemptions which were applied according to the recycled content of products would be very difficult to enforce without major controls similar to those that apply to the production of excisable goods. As many firms producing goods of goods from recycled materials are small, this would be virtually out of their reach. It would be very expensive even for large businesses. If few firms could use the exemption, it would be not just a hollow gesture but a source of irritation.

Sales tax exemptions can have unforeseen consequences; are unlikely to enhance the efficiency of resource use; and are even less likely to be equitable.

Most importantly, they do nothing to address the underlying causes of inappropriate levels of recycling. The Commission therefore does not favour the introduction of sales tax exemptions for recycled products.

For similar reasons the Commission favours the abolition of the sales tax exemption on certain paper products wholly made from recycled paper. It is unlikely to do much to increase the utilisation of wastepaper. Indeed, it has some adverse effects by favouring products such as tissues that have no potential for further recycling. It disadvantages the use of papers with significant, but less than 100 per cent, recycled content and does nothing to encourage greater recycling of newsprint. If it were to stimulate more paper recycling, it would result in higher prices being paid for high grade wastepaper and higher production costs for industrial and packaging papers. Inefficient uses of high grade waste paper are encouraged at the expense of more efficient uses.

A few participants argued that where a sales tax exemption exists, such as 100 per cent recycled paper, the exemption should flow through to other goods in which the exempted products are incorporated. They argued that the value of the tax exempt goods should be deducted from the taxable value of the product in which it is incorporated. Separate tax treatment of components of a product would be a radical departure from the current sales tax system and would require administrative and compliance arrangements quite different from those which currently exist. Fundamental changes of this nature are properly the subject of the current Treasury review of the sales tax system.

The sales tax position of refillable bottles has been subject to disputation recently. Following the introduction of sales tax on beer in August 1988, the Cascade Brewery Co Ltd of Tasmania applied for refillable bottles to be exempt on the grounds that levying sales tax on reused bottles constituted double (or triple etc according to the number of trips) taxation, and that the property which the bottles constitute is not passed to the purchaser. The Australian Taxation Office ruled against Cascade on the grounds that a hiring charge for the use of the bottle still forms part of the sales value of the bottle of beverage. The Taxation Office assumed that the sale value of the bottle is amortized over the life of the bottle, and therefore the sales tax applicable would be spread over the number of trips per bottle.

While refillable bottles are taxed every time they are refilled and sold, the amount which is taxed is equal to the proportion of the sale value of the bottle allocated to each refill. Hence there is no double taxation or discrimination in the sales tax treatment of non-returnable bottles compared with returnable ones.

Exemptions on inputs and plant

Because of restrictive definitions of the word 'manufacture', many reprocessors are denied tax exemption for their inputs and capital equipment as they are not deemed to be 'aids to manufacturer'. Some firms have been engaged in extensive litigation on this issue in attempting to maintain the benefits of manufacturing status as well as tax exemption on their product.

A number of participants advocated that collectors of recyclables be eligible for sales tax exemption on their equipment to make it cheaper for them to expand and re-equip. Generally, the transport and materials handling sectors are not eligible for exemptions for 'aids to manufacture'. Nor are they eligible for the exemptions that apply to State and local government equipment purchases even when they are under contract to governments.

The issue of exemption for ‘aids to manufacture’ has been fraught with disputation for many years. As long as the sales tax legislation exempts from tax goods used in particular production processes, such as ‘manufacture’, rather than all production processes, disputes over where the line should be drawn are inevitable. Arbitrary divisions between taxable and exempt products are to be expected where similar products are classified to different sales tax categories and attract different rates of tax. The tradition in the sales tax legislation of tying the taxation of capital goods to that of the final product underlies the wholesale tax system. It is not specific to recycling.

These broad issues cannot be resolved in this inquiry. They would be more appropriately addressed in the current Treasury review of the wholesale sales tax system.

Excise

The wholesale sales tax system enshrines the principle that goods should be taxed only once in their lifetime. The excise duty system does not. As most excisable products are totally used up in the process of consumption, that is not surprising.

The main oil refineries are bonded under the Excise Act, with close Customs supervision of production. Because all excisable products coming out of bonded refineries are subject to a high tax, there is an incentive to use used oil in such a way that it does not have to re-enter bonded premises. This tax treatment means that blending of fuel oil must take place outside main refineries and thus contributes to duplication of treatment plants and blending and storage facilities. Virgin oil for blending with used oil must be transported to blending facilities outside the refinery.

Given the extensive Customs controls over refinery operations, it is likely that excise exemption for used oil could be accommodated with minimal administration and compliance costs. Since the publication of the Commission's draft report on this inquiry, the Australian Customs Service has agreed to the principle that excise tax be waived on the used oil portion of blended fuel oil at refineries and terminals. To facilitate the application of the exemption, the Australian Institute of Petroleum is developing a system which will account for used oil entering bonded areas. This should lead to more efficient recycling of used oil.

Government procurement policies

Many governments in Australia use or are investigating the use of their procurement arrangements to stimulate their own demand for recycled products. Recycled paper is used in many Commonwealth and State government offices. The Queensland Government is examining ways to use recycled lubricating oil in its car fleet. The Governments of New South Wales and South Australia have announced an intention to purchase recycled products even if this involves higher cost.

Governments, like other consumers, purchase significant quantities of recycled products without being aware of it. Recycled materials are incorporated in building materials such as structural steel, which can have almost 100 per cent scrap content, and window glass which can also have a significant input of cullet. Industrial and packaging papers have a high recycled content.

The 1990 DAS report concluded that changes in government purchasing policies are unlikely to change paper recycling significantly in Australia. Even if this were not the case, government promotion of recycling for its own sake would be likely to encourage production which could not be sustained without government support. Purchasing policies which discriminate in favour of recycling are likely to lead to a structure of industry which is inefficient. So will regulations which discriminate (usually unintentionally) against recycled products.

Government procurement policies should aim to use recycled products wherever this is justified on price and quality grounds.

APPENDIX A: TERMS OF REFERENCE OF INTERIM REPORT ON PAPER RECYCLING

I, PAUL JOHN KEATING, in pursuance of Section 23 of the Industries Assistance Commission Act 1973 hereby:

1. specify that as part of its inquiry into recycling of products, the Commission shall prepare an interim report by 30 April 1990* on the effects of government policies on, and the environmental and economic costs and benefits of, recycling of paper products.

2. without limiting the scope of the reference, specify that in its interim report the Commission shall:

   (a) assess the economic prospects for further recycling in Australia based on local waste paper, including the economic viability of green field and integrated developments

   (b) examine the economic viability of a world scale recycling plant processing imported waste paper, taking into consideration global sources and markets for recycled paper

   (c) identify economic, environmental and and technological constraints to further recycling, eg segregation of waste paper into grades, removal of impurities, de-inking and treatment of resultant effluent, etc

   (d) identify products able to be produced, wholly or in substantial part, from recycled paper which satisfy technical requirements of strength, brightness, etc

   (e) examine community attitudes to the use of various grades of recycled paper products

   (f) assess the success of existing Government initiatives in promoting waste paper recycling, taking into account the recent report by the Minister for Administrative Services.

3. specify that the Commission is free to take evidence and make recommendations on any matters relevant to its inquiry under this reference.

P.J. Keating
28 December 1989

* At the Commission’s request, the Treasurer extended the report date for the inquiry until 21 May 1990. The report was completed by that date.

APPENDIX B: LIST OF PARTICIPANTS AND SUBMISSIONS

Company\Organisation	Sub No
ACI Glass Packaging Australia	181,339
ACI Plastics Packaging.	216
ACT Recycling Campaign	7
Advertiser Newspapers Ltd (News Limited)	65
Agricultural & Veterinary Chemicals	50
Alcoa of Australia Limited	239
Aldermen Alty and Bell - Hobart City Council	37
All Seasons Home Insulation Pty Ltd	232
Ankal Pty Limited	168,223
Arisa Ltd	23,317
Aspex Paper Australia Pty Ltd.	172
Aspley Special School Recycling Station	192,283
Associated Liquidpaperboard Converters	97
Associated Pulp & Paper Mills - Victoria	158,364
Associated Pulp and Paper Mills (Sydney)	193
Associated Pulp and Paper Mills (Tasmania)	221
Association of Fluorocarbon Consumers and Manufacturers	19
Association of Liquidpaperboard Carton Manufacturers Inc	310
Atherton Greenhouse Information Network	258
AusTissue Pty Ltd	21,318,363
Australian Chemical Industry Council	119
Australian Conservation Foundation (Brisbane)	88,297
Australian Conservation Foundation	134,304
Australian Conservation Foundation (Portland Branch)	185
Australian Conservation Foundation (Albury\Wodonga)	236
Australian Consolidated Press Limited	167
Australian Consumers’ Association	145,313
Australian Council of Recyclers	179
Australian Customs Service	279
Australian Glass Workers’ Union	177
Australian Groundwater Consultants Pty Ltd	53

Company\Organisation	Sub No
Australian Institute of Environmental Health	248
Australian Institute of Petroleum Ltd.	154,347
Australian Newsprint Mills Limited - (TAS)	90,194,218,323
Australian Newsprint Mills Ltd (NSW)	224
Australian Paper Manufacturers	144,157,222,275
Australian Recycling News	277
Australian Red Cross Society	71
Australian Refined Alloys Pty Ltd	92,290
Australian Soft Drink Association Ltd	131,373
Australian Tyre Manufacturers’ Association	272,341
Axtens, Mr Jon M.	282
Balranald Shire Council	4,291
Bathurst Conservation Group	136
Bayley, Mr John	325
BHP Steel	162,289
Bluhdorn Ply Ltd	195
Bob Jane Corporation Pty Ltd, Vic	340
Bowater Tissue Ltd	93
Bradken Consolidated\Commonwealth Steel Company Limited	251
Brambles Records Management	249
Brian Stafford & Associates Pty Ltd	39
Brickwood Holdings Pty Ltd	72,295
Brisbane City Council	254,294
Broken Hill City Council	141
Bunge Bioproducts Pty Ltd	215
Bunnings Ltd	22
Bureau of Rural Resources	147
Cabinet Office of NSW	178
Caring for Creation	197
Carter, Ms Patricia J	208
Cellulose Industries Pty Ltd	81
Centre for Education and Research in Environmental Strategies (CERES)	267
Centre for Human Aspects of Science and Technology	121
City of Altona	241
City of Box Hill	98
City of Brunswick	84
City of Croydon	205
City of Devonport	126
City of Fitzroy	109
City of Footscray	44
City of Fremantle	30
City of Geraldton	263

Company\Organisation	Sub No
City of Gosnells	29
City of Happy Valley	35
City of Malvern	9
City of Marion(316 Confidential Supplement)	315,316
City of Melbourne	329
City of Nedlands	253
City of Prahran	91
City of Melbourne	349
City of Salisbury	365
City of South Melbourne	96
City of St Kilda	229
City of Wagga Wagga	129
City of Waverley	75
City of Werribee.	17
Clough Engineering; Group (now Green Recycling)	33,337
Coca-Cola Amatil Limited	180,265,299,374
Columbus Corporation Pty Ltd	54
Comalco Limited	146,351
Commercial Polymers Pty Ltd.	184,319
Concrete Recyclers Pty Ltd	305
Confederation of Australian Industry - ACT	358
Conservation Council of SA	63
Conservation Council of the South-East Region and Canberra Inc	58
Coolum Wastebusters	128
Corkhill Bros Sales Pty Ltd	42
CRA Limited	169
Crooks Michell Peacock Stewart Pty Ltd	100,209
CSIRO - Division of Building, Construction and Engineering	108
CSIRO - Division of Forestry and Forest Products (Dr G Gartside)	107
CSIRO - Division of Forestry and Forest Products	83
CSIRO - Division of Tropical Crops and Pastures	182
CSR Ltd	14
D.J. Hawkins & Associates	332
David Syme & Co. Ltd	86,344
Davies Bros. Ltd (News Ltd - Hobart)	64
Department of Administrative Services	61
Department of Immigration, Local Government & Ethnic Affairs	190
Department of Primary Industry & Fisheries (Northern Territory)	166

Company\Organisation	Sub No
Department of the Arts, Sport, the Environment, Tourism and Territories	24,242,293
Department of the Premier, Economic and Trade Development	261,370
Department of State Development of NSW	244
Department of State Development of W.A.	367
District Council of Minlaton	6
District Council of Orroroo	10
Dr J.T. Vnuk & Associates	276
Drum Reconditioners NSW) Pty Ltd	201
Duaringa Shire Councli.	296
Eastern Regional Refuse Disposal Group	135
Ecopaper Pty Ltd	106,311
Engineering and Water Supply Department	257
Enterprise Metals (CRA) (confidential)	105
Environmental Protection Authority - Perth	353
Environment Protection Authority, VIC	352
Esperance Shire Council	55
F.T. Wimble & Co. Limited	163
Forestry Commission of NSW	155,362
Fractionated Cane Technology Ltd	124
Friends of the Earth (Fitzroy)	73,238,255
Friends of the Earth (Perth)	183,342
Friends of the Earth (Melbourne)	101
Friends of the Earth (Sydney)	103,191
GNB International Battery Group	262
Geelong West The Heritage City	176
Gosford City Council	110
Great Lakes Environmental Association	246
Greater Western Education Centre Ltd, NSW	268
Greenhouse Action Australia	102
Green Recycling (formerly Clough Engineering)	33,337
Hastings Environment Council	140
Health Department of W.A.	321
Herald and Weekly Times Ltd	
Higgins Trading Company Pty Ltd	115,161,359
Hobart City of	27
Holroyd Municipal Council, Merrylands - Mr Peter Rimmer	48
Hosking A.J. & Associates - N.T.	355
Intershred Pty Ltd.	152
John Fairfax Group Pty Ltd	60,153
John H. Gleason Consultant	266
Katelaris, Dr Andrew J.	114
Keep Australian Beautiful Council (Qld)	68

Company\Organisation	Sub No
Kempsey Shire Council	13
Kesab Inc	16
Kimberly-Clark Australia Pty Limited	170,220,309
Kuhne, Mr David	18
Ku-ring-gai Municipal Council	143
Lane Cove Municipal Council - Sydney	331
Leighton Group (Process Services Division)	226
Litter Research Association	256,335
Litchfield Shire Council	113
Loumbos Pty Ltd - NSW	281,368
Mackenzie, Ms Janet	207
Mackay Sugar Co-operative Association Ltd	133
Makin, Ms Susan	252
Maleny Waste Busters	120
Manly Municipal Council	230
Marine Collectors Association	204
Ma-Refine Oil International Pty Ltd (formerly SPREE International)	142
Maroochy Shire Council	260
Marrickville Municipal Council	12
Motorway Tyres Pty Ltd - Victoria	333
MIM Holdings Limited	259
Minister for Natural Resources (Dept. of Lands, NSW)	202
MR1 Pty Ltd	187
Municipal Association of Victoria	345
Municipality of Deniliquin	233
Murdoch University - Dr Ho	200
Muswellbrook Shire Council	5
Nambucca Valley Association	77
National Association of Forest Industries Ltd	237,346
Neutralysis Industries Pty Ltd	112
Newcastle City Council, N.S.W.	300
Newcastle Regional Waste & Pollution Advisory Panel (now The Hunter Waste Advisory Panel)	312
News Limited - Adelaide	65
News Limited - Hobart	64
News Limited - Perth	31,32
News Limited - Sydney	171,198,328,369
News Limited - Melbourne	99
News Limited - Sydney. (Mirror Australian Telegraph)	159
Nonferral Pty Ltd	206,278
Norstar Steel Recyclers	188
North Coast Environment Council	186
North Queensland Conservation Council Inc	271

Company\Organisation	Sub No
North Sydney Municipality	139
Northern Regional Refuse Disposal Group	52
NSW Recyclers Association	70
Oil and Chemical Industries Pty Ltd.	148
O'Reilly, Mr R J	59,225
Outer Eastern Municipalities Association	247
Pacific Waste Management	125
Packaging Council of Australia Inc	212,371
Paper Converting Group	270
Paper & Pulp International W.A. (Confidential)	26
Paper-go-round	175
People Against Dioxins in Sanitary Products	156
Pioneer International Limited	280,356
Plastics Industry Association Inc - Melb.	89,360
Plastopan - Vic	288
Pratt Group	150,227,334
Public Record Office of SA	25
Public Record Office of Victoria	51
Public Transport Corporation - Melbourne	330
Publishers National Environment Bureau - Sydney	326
Queensland Bagasse	45
Queensland Press Ltd (News Ltd - Brisbane)	151
Queensland Wilderness Society	104
R.A.G.E. Londonderry Residents Action Group for Environment	302
Rainbow Alliance	78
Re-Solv Liquids	231
Recycle Aid	47
Recycling & Treatment Industries Assoc	34,336
Regional Dailies of Australia Ltd	217
RMIT - Faculty of Environmental Design & Construction	366
Robinvale Co-ordinating Group	15
Safety-Kleen (Worton Services Pty Ltd)	273
Shire of Ballarat	82
Shire of Eltham	117
Shire of Gisborne	43
Shire of Hastings	213,264
Shire of Marong	189
Shire of Rochester	74
Shire of Swan	56
Shire of Victoria Plains	11
Shire of Wangaratta	1
Simpson, Mr Lance C.	127
Simsmetal Ltd	122,285
Smorgon Glass	240

Company\Organisation	Sub No
Smorgon Plastics	160
South Australian Government	307
South Australian Waste Management Commission	67,250
South Coast Co-operative Dairy Assoc. Ltd	85
South Eastern Regional Refuse Disposal Group	235
South PacificTyres (ATMA)	292
Southern Region of Councils	79
Southern Tablelands; Regional Councils	149
Stationery Manufacturers of Australia	138
Stokes, Ms J B	199
Superburn	214
Sutas, Mr Algis	76
Sydney Earthmoving Pty Ltd	338
Take & Tip Pty Ltd, NSW	287
Tasman Pulp & Paper Company	46
Tasmanian Conservation Trust	28
Tasmanian Government	49,327
Tetra Pak Pty Limited	210
The Australian Brass Extrusion Industry Group	196
The Brady Group of Companies	173
The City of Noarlunga	234
The Council of the City of South Sydney	87
The Council of City of Lismore	80
The Council of the City of Sydney	130
The Council of the Shire of Culcairn, NSW	372
The Cuddly Company - Dorrigo	357
The District Council of Lameroo	57
The Environment Centre NT Inc	8
The Hunter Waste Advisory Panel	312
The Institution of Engineers, Australia	36
The National Paper Marketing Council of Australia	132
The Printing and Allied Trades Employers Federation of Australia	165
The Pulp & Paper Manufacturers' Federation of Australia Ltd	94,95,219,274,343
The River House Group Pty Ltd	20
The Wilderness Society	69
The Women's Environment Action Group	245
Tom's Trash Paks Pty Ltd	2
Toxic Chemicals Committee	137
Trans Asia Trading Co Pty Ltd.	164

Company\Organisation	Sub No
Trifoleum Pty Ltd	350
Tyremag Group of Companies	269
Tredex	66,286,303
Universal Understanding	118
University of Tasmania	38
Urquhart, Mr Max	284
Victorian Government (Premier of Victoria)	243
Victoria University of Technology	354
Victorian Waste Management Association	211
WA Municipal Association	40
Waste Management Authority of N.S.W.	298,320,348
Waste Not Pty Ltd _	174,322
Watkins, Dr Glenn (University of WA)	62
Wedderburn & District Environment Protection Association	203
Western Australian Government	228
Western Region Waste Management Authority	123
Western Regional Refuse Disposal Group	116
WestPaper Pty Ltd	314,320
Whelan the Wrecker Pty Ltd - Vic	324
Wingecarribee Shire Council	3
Woolworths Supermarkets N.S.W.	301
Wollongong City Council	111
Women s Abode	41

APPENDIX C: ORGANISATIONS, COMPANIES AND INDIVIDUALS CONSULTED

NAME	DATE	VENUE
ACI Glass Packaging	8 November 1989 27 November 1989	Melbourne Sydney
ACI Petalite	8 November 1989	Melbourne
ACI Plastics Packaging	8 November 1989	Melbourne
Aspex Paper Australia Pty Ltd	22 January 1990	Sydney
Associated Pulp and Paper Mills	8 November 1989 6 February 1990	Melbourne Melbourne
Austissue	8 February 1990	Perth
Australian Conservation Foundation	19 November 1989	Melbourne
Australian Conservation Foundation	27 November 1989	Sydney
Australian Conservation Foundation	9 February 1990	Perth
Australian Consumers Association	27 November 1989	Sydney
Australian Council of Recyclers	8 November 1989	Melbourne
Australian Newsprint Mills Ltd	23 January 1990	Hobart
Australian Paper Manufacturers	29 November 1989 7 February 1990 8 February 1990	Sydney Melbourne Perth

NAME	DATE	VENUE
BHP Steel	9 November 1989	Melbourne
BHP Steel International Group	9 November 1989	Melbourne
Bowater Tissues Ltd	24 January 1990 9 February 1990	Melbourne Melbourne
Bridgestone Aust Ltd	8 November 1989	Melbourne
Dr Bob Brown, MHA Tasmania	23 January 1990	Hobart
Brisbane City Council	28 November 1990	Brisbane
Bunnings Ltd	9 February 1990	Perth
Carlton & United Breweries Ltd	19 November 1989	Melbourne
CSIRO	24 January 1990 8 February 1990	Melbourne Melbourne
City of Brunswick	8 November 1989	Melbourne
Coca-Cola Amatil Beverages	27 November 1989	Sydney
Comalco Aluminium Ltd	27 November 1989	Sydney
Comalco Ltd	27 November 1989	Sydney
Commercial Polymers Pty Ltd	5 April 1990	Melbourne
Conservation Council of SA	7 February 1990	Adelaide
Containers Packaging	8 November 1989	Melbourne
CRA Limited	1 December 1989	Canberra
Department of Manufacturing and Commerce(Queensland)	5 February 1990	Brisbane
Department of Administrative Services (ACT)	17 January 1990	Canberra

NAME	DATE	VENUE
Department of Environment & Planning, South Australia	24 November 1989 7 February 1990	Canberra Adelaide
Department of Industry, Technology and Commerce	15 January 1990	Canberra
Department of Premier & Cabinet	23 January 1990	Hobart
Department of State Development (NSW)	14 February 1990	Sydney
Department of Environment and Conservation (QLD)	5 February 1990	Brisbane
Department of the Arts, Sport, the Environment, Tourism and Territories	2 November 1989	Canberra
Ecopaper Pty Ltd	27 November 1989 14 March 1990	Sydney Sydney
Environment Protection Authority (Victoria)	9 November 1989	Melbourne
Forestry Commission of NSW	22 January 1990 14 February 1990 14 March 1990	Sydney Sydney Sydney
Forestry Commission of Tasmania	23 January 1990	Hobart
Friends of the Earth (Fitzroy)	19 November 1989	Melbourne
Friends of the Earth (Sydney)	27 November 1989	Sydney
J. Gadsen Pty Ltd	6 February 1990	Melbourne
Golden Australia Paper Manufacturers Pty Ltd	9 February 1990	Perth
Green Recycling Company of WA	8 February 1990	Perth
ICI Chemicals	29 November 1989	Sydney
Inner Metropolitan Regional Association	9 February 1990	Melbourne

NAME	DATE	VENUE
Institution of Engineers	29 November 1989	Sydney
Kimberly-Clark Australia Pty Ltd	22 January 1990	Sydney
Leighton Group Process Services Division	3 May 1990	Canberra
Litter Research Association	27 November 1989	Sydney
Local Government Association of NSW	28 November 1989	Sydney
Melbourne City Council	8 November 1989	Melbourne
Melbourne Metropolitan Board of Works	9 November 1989	Melbourne
News Limited	22 January 1990 30 November 1990	Sydney Sydney
NSW Recyclers Association	29 November 1989	Sydney
Pasminco Metals Pty Ltd	8 November 1989	Melbourne
Philip Morris Ltd	6 February 1990	Melbourne
Pratt Group of Companies	8 February 1990	Melbourne
Queensland Cane Growers Council	5 February 1990	Brisbane
Queensland Forestry Commission	13 February 1990	Brisbane
Recycling Company of WA	8 February 1990	Perth
SA Brewing Company Ltd	7 February 1990	Adelaide
SA Department of Environment and Planning	7 February 1990	Adelaide
Simsmetal Ltd	28 November 1989	Sydney
Smorgon Consolidated Industries	19 November 1989	Melbourne

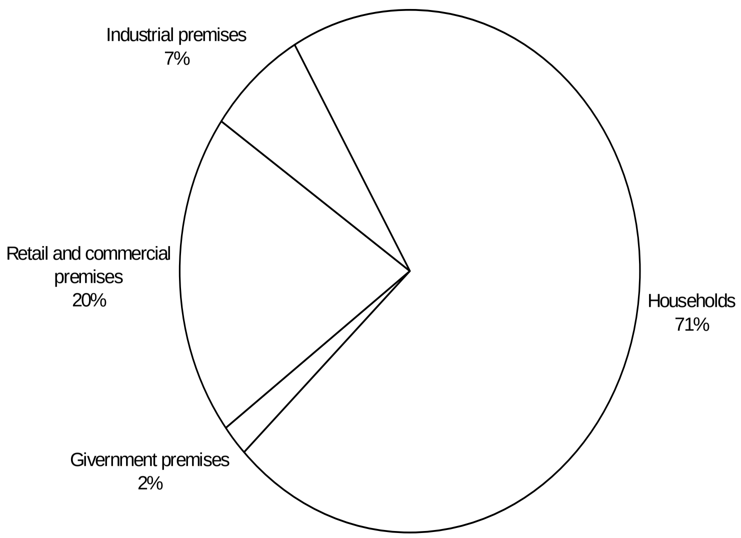
NAME	DATE	VENUE
Smorgon Glass	27 November 1989	Sydney
State Pollution Control Commission (NSW)	27 November 1989 14 February 1990	Sydney Sydney
Waste Management Commission (WA)	7 February 1990	Adelaide
Waste Management Authority (NSW)	28 November 1989 14 February 1990	Sydney Sydney
Western Australian Office of the Cabinet	8 February 1990	Perth
Western Australian Department of Resources Development	30 January 1990	Canberra
Western Australian Environmental Protection Authority	9 February 1990	Perth
Wilderness Society	6 February 1990	Melbourne
Woolworths Ltd	14 February 1990	Sydney
Smorgon Glass	10 September 1990	Sydney

APPENDIX D: COUNCIL WASTE MANAGEMENT

As part of the Inquiry into Recycling the Commission carried out a survey of the waste management practices of Local Government Councils and government authorities involved in waste management. The survey covered activities during 1989. A major focus, however, was on the involvement of Councils (or their contractors) in recycling and the place of recycling in waste management.

The survey is published in the Commission's Information Paper *Waste Management and Recycling: Survey of Local Government Practices*, released in March 1991. This Appendix contains a selection of the statistics and charts relevant to the discussions in this Report.

Figure D.1: Sources of waste collected by Councils, 1989



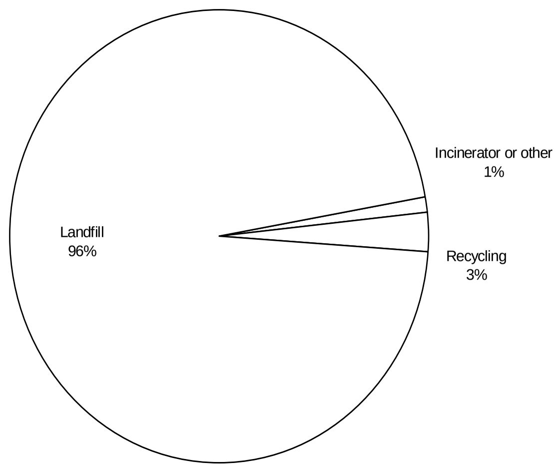
Source: Commission estimates

Table D1: **Waste collection and disposal, 1989**

	Waste collection: (1)				Waste disposal:				
	households	other	total	total per person	landfill	incineration	total	total per person	Waste recycled
	'000 tonnes	*'000 tonnes*	*'000 tonnes*	*kg*	*'000 tonnes*	*'000 tonnes*	*'000 tonnes*	*kg*	*'000 tonnes*
Sydney region	1272	454	1726	480	2796	113	2909	809	100
Inner NSW	390	135	525	454	811	0	811	702	17
Outer NSW	415	152	567	597	813	0	813	857	20
Melbourne region	1015	281	1296	432	1842	12	1854	618	92
Inner Victoria	341	86	427	487	482	9	491	560	5
Outer Victoria	208	46	254	660	353	5	358	930	8
Brisbane region	379	488	867	693	1262	0	1262	1009	71
Other Queensland	673	527	1200	804	1368	4	1372	919	31
Perth region	386	92	478	427	727	0	727	650	8
Other West Australia	245	79	324	761	395	0	395	927	0
Adelaide region	314	22	336	328	430	0	430	420	2
Other South Australia	152	63	215	576	261	0	261	699	2
Hobart region	108	13	121	645	126	0	126	671	0
Other Tasmania	119	13	132	506	189	0	189	725	2
Aust. Capital Territory	37	40	77	283	314	0	314	1152	21
Northern Territory	36	0	36	312	105	0	105	909	0
							0		
State capitals & ACT	3511	1390	4901	469	7497	125	7622	729	294
Other regions	2579	1101	3680	610	4777	18	4795	795	85
							0		
Australia	6090	2491	8581	521	12274	143	12417	753	379

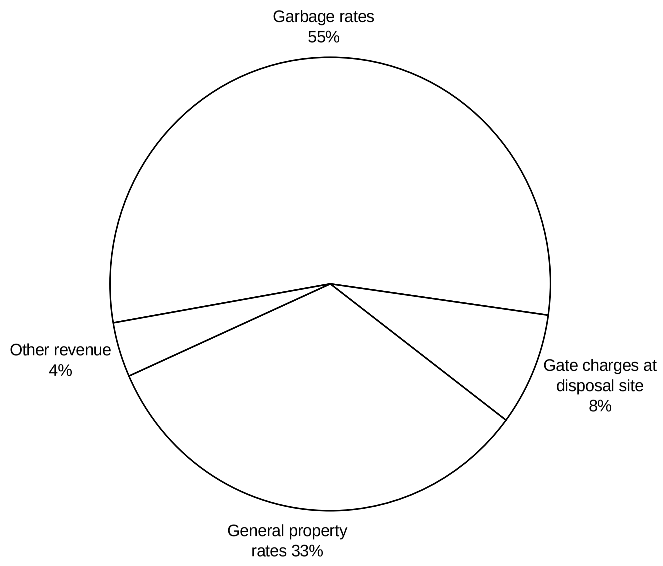
1 Includes recyclable waste collected separately or left at Council recycling centres as well as waste intended for landfill or incineration.
Source: Commission estimates

Figure D.2: **Methods of waste disposal by Councils, 1989, shares of waste by weight**



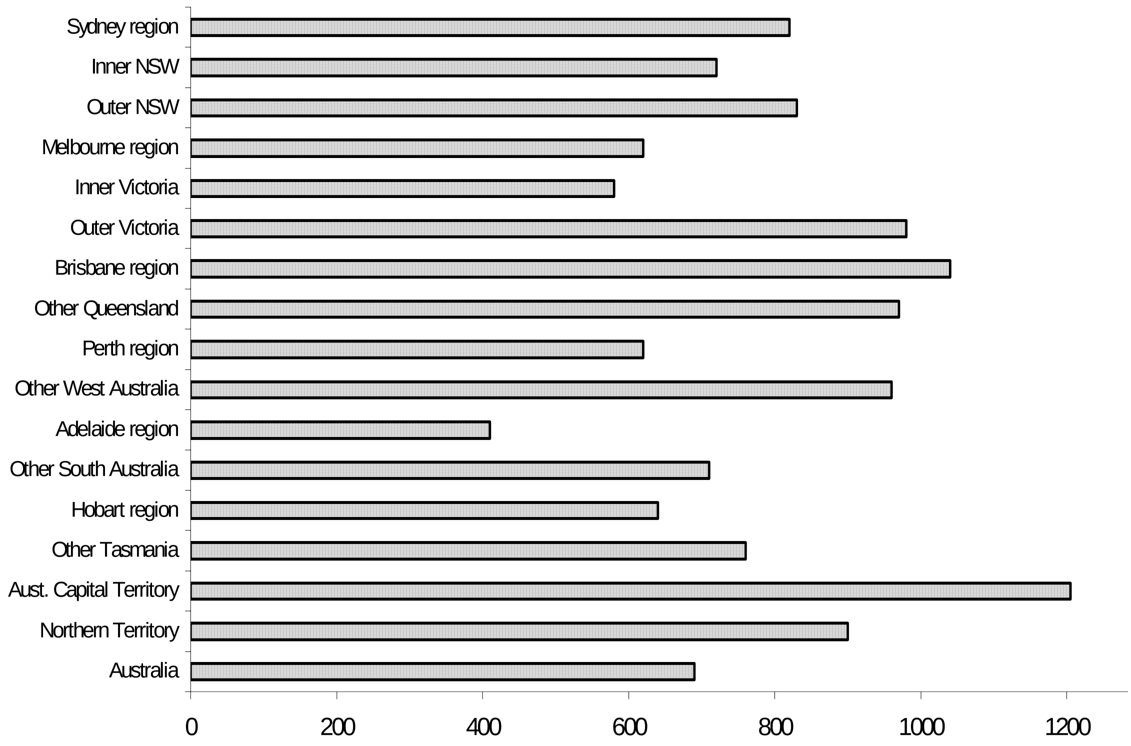
Source: Commission Estimates

Figure D.3: **Shares of Council waste management revenue, 1989**



Source: Commission estimates

Figure D.4: **Total waste disposal (including recycling) by Councils per person, 1989 (kilograms)**



urce: Commission estimates

Table D2: **Methods of waste disposal by Councils, 1989**

Region	landfill		Waste disposal through: inceration		recycling		Total waste disposal	Total disposal to landfill per person	Total disposal per person
	’000 tonnes	%	’000 tonnes	%	’000 tonnes	%	’000 tonnes	*kg*	*kg*
Sydney region	2796	93	113	4	100	3	3009	778	837
Inner NSW	811	98			17	2	828	702	717
Outer NSW	813	98			20	2	833	857	878
Melbourne region	1842	95	12	1	92	5	1946	614	649
Inner Victoria	482	97	9	2	5	1	496	550	566
Outer Victoria	353	96	5	1	8	2	366	917	951
Brisbane region	1262	95			71	5	1333	1009	1066
Other Queensland	1368	98	4	…	31	2	1403	916	940
Perth region	727	99			8	1	735	650	657
Other West Australia	395	100					395	927	927
Adelaide region	430	100			2	…	432	420	422
Other South Australia	261	99			2	1	263	699	705
Hobart region	126	100					126	671	671
Other Tasmania	189	99			2	1	191	725	733
Aust. Capital Territory	314	94			21	6	335	1152	1229
Northern Territory	105	100					105	909	909
							0		
State capitals & ACT	7497	95	125	2	294	4	7916	717	758
Other regions	4777	98	18	…	85	2	4880	792	809
Australia	12274	96	143	1	379	3	12796	745	776

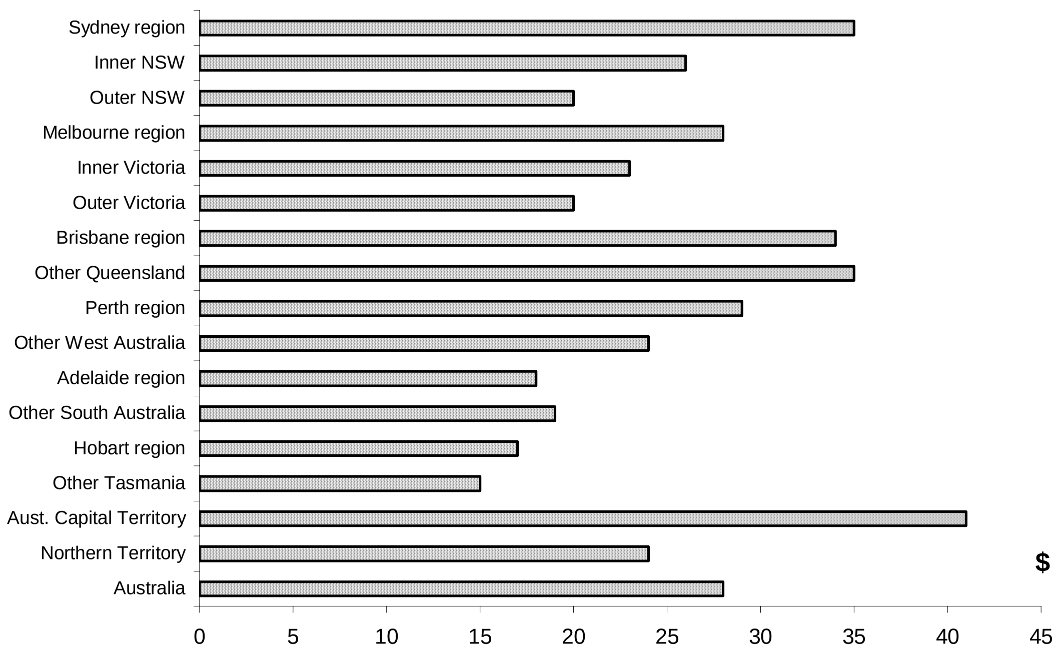
… Less than 1 per cent.
Percentages may not total 100 due to rounding.
Source: Commission estimates.

Table D3: **Waste management costs and revenues, 1989 (1)**

	Costs:					Revenue:			
	Collection (2)	transfer	disposal	total	total per person	garbage rates and other charges	property rates	total	total per person
	$'000	$'000	$'000	$'000	$	$'000	$'000	$'000	$
Sydney region	80127	12137	32604	124868	34.72	97434	48944	146378	40.71
Inner NSW	20735	171	9634	30540	26.44	26080	6575	32655	28.27
Outer NSW	13080	0	6038	19118	20.14	16370	3823	20193	21.17
Melbourne region	64054	4470	15410	83934	27.97	39565	48750	88315	29.43
Inner Victoria	11048	649	7620	19317	22.04	17220	3515	20735	23.66
Outer Victoria	5004	398	2359	7761	20.16	7058	627	7685	19.97
Brisbane region	31824	120	9804	41748	33.39	46787	301	47088	37.66
Other Queensland	35440	1536	14912	51888	34.75	45559	11031	56590	37.90
Perth region	22398	399	10221	33018	29.51	25084	11837	36921	33.00
Other West Australia	7269	0	2974	10243	24.04	10178	427	10605	24.89
Adelaide region	13644	1014	4104	18762	18.33	3084	14431	17515	17.11
Other South Australia	5005	251	1938	7194	19.28	1456	6042	7498	20.09
Hobart region	1803	34	1329	3166	16.87	3444	518	3962	21.11
Other Tasmania	1901	0	2096	3997	15.33	2111	1807	3918	15.03
Aust. Capital Territory	7181	180	3768	11129	40.84	1503	9626	11129	40.84
Northern Territory	1265	0	1471	2736	23.70	3127	276	3403	29.47
State capitals & ACT	221031	18354	77240	316625	30.30	216901	134407	351308	33.62
Other regions	100747	3005	49042	152794	25.32	129159	34123	163282	27.06
							0		
Australia	321778	21359	126282	469419	28.48	346060	168530	514590	31.22

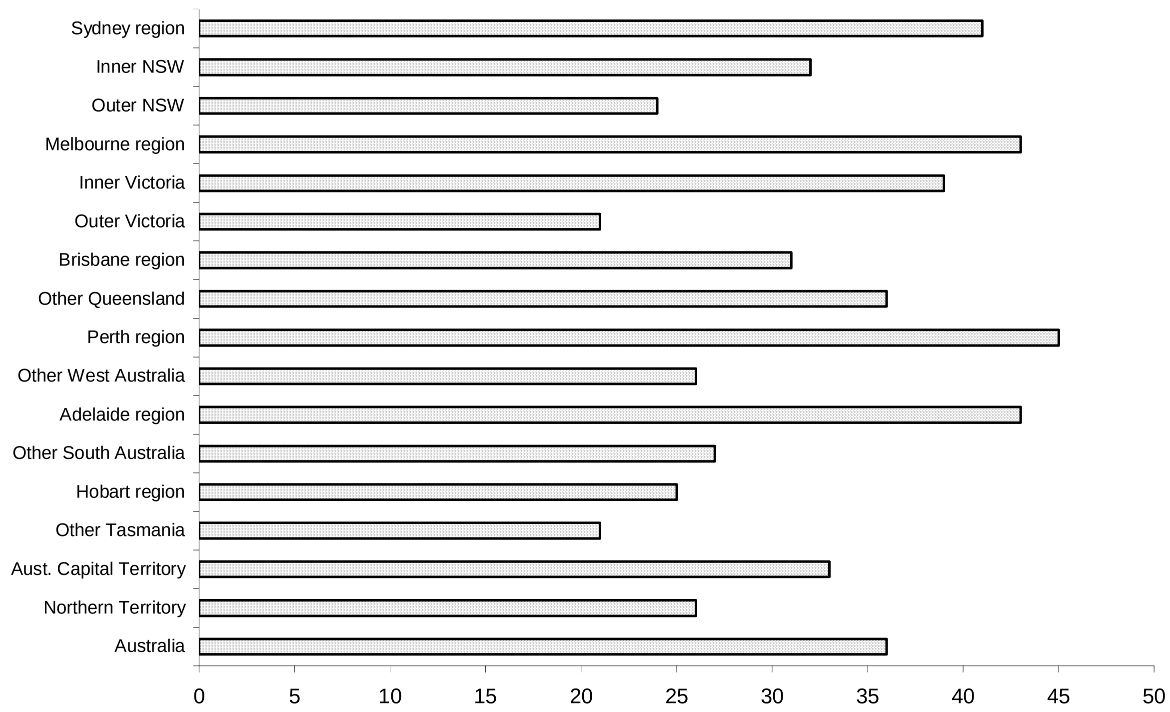
1 Costs and revenues are net of transfer payments by Councils to other Councils and waste management authorities.
2 Includes cost of separate collection of recyclable waste.
Source: Commission estimates

Figure D5: Council waste management costs per person, 1989



Source: Commission estimates

Figure D6: Council waste management costs per tonne, 1989



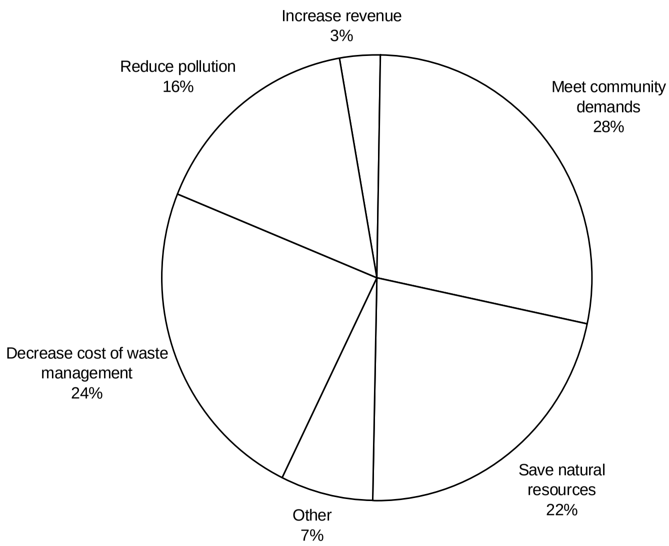
Source: Commission estimates

Table D4: **Council waste management cost factors, 1898**

Region	Payments to contractors		Labour		Fuel		Allowance for plant depreciation		Interest and leasing		Other costs	
	$'000	%	$'000	%	$'000	%	$'000	%	$'000	%	$'000	%
Sydney region	80579	65	23804	19	4344	3	5798	5	4631	4	5712	5
Inner NSW	12073	40	9422	31	1258	4	1996	7	161	1	5629	18
Outer NSW	8668	45	4657	24	660	3	625	3	1028	5	3481	18
Melbourne region	39056	47	27248	32	4456	5	2167	3	4038	5	6968	8
Inner Victoria	7923	41	5639	29	1496	8	446	2	677	4	3136	16
Outer Victoria	2860	37	3354	43	519	7	59	1	237	3	731	9
Brisbane region	30380	73	1778	4	165	…	36	…	399	1	8991	22
Other Queensland	33197	64	9796	19	1434	3	600	1	428	1	6431	12
Perth region	11146	34	10757	33	829	3	4345	13	1795	5	4147	13
Other West Australia	3900	38	3782	37	761	7	319	3	214	2	1268	12
Adelaide region	10705	57	4204	22	921	5	610	3	173	1	2148	11
Other South Australia	3120	43	2132	30	297	4	400	6	199	3	1048	15
Hobart region	1486	47	1471	46	56	2	36	1	20	1	98	3
Other Tasmania	1908	48	1044	26	155	4	40	1	74	2	776	19
Aust. Capital Territory	3400	31	2002	18	383	3			1278	11	4066	37
Northern Territory	2535	93	143	5	42	2					16	1
State capitals & ACT	176752	56	71264	23	11154	4	12992	4	12334	4	32130	10
Other regions	76184	50	39969	26	6622	4	4485	3	3018	2	22516	15
Australia	252936	54	111233	24	17776	4	17477	4	15352	3	54646	12

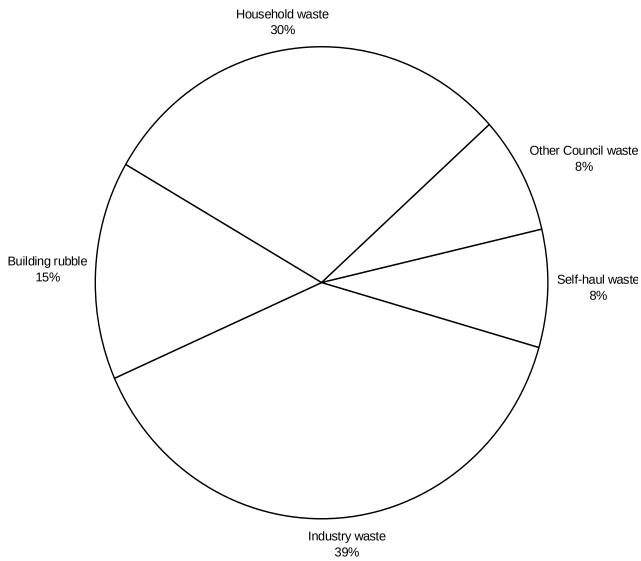
… Less than 1 per cent.
Percentages may not total 100 due to rounding.
Source: Commission estimates.

Figure D7: **Main reasons for Council involvement in recycling, 1989**



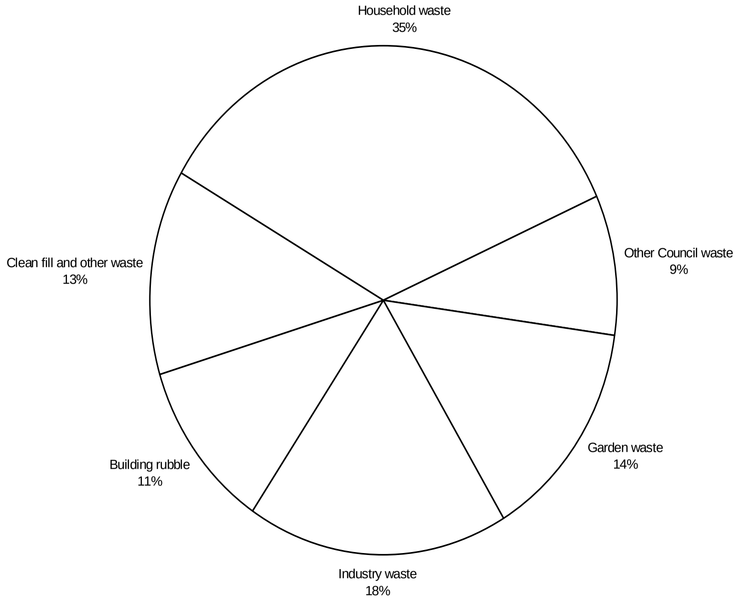
Source: Commission estimates

Figure D8: **Composition by weight, Sydney waste stream, 1988**



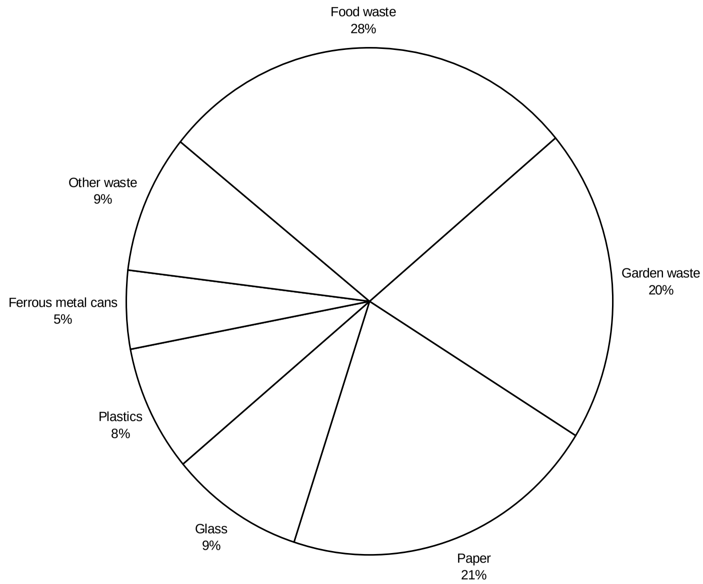
Source: Waste Management Authority of New South Wales (1990), *Sydney Solid Waste Management Strategy*

Figure D9: **Composition by weight, Melbourne waste stream, 1984-85**



Source: Environment Protection Authority (1990), *Municipal Waste Services in Victoria, Publication No. 239*, Melbourne

Figure D.10: **Composition by weight of household waste in Sydney, 1988**



Source: Waste Management Authority of New South Wales (1990), *Sydney Solid Waste Management Strategy*

Table D5**: Effect of higher disposal charges on illegal dumping**

(shares of Councils)

	Estimated increase in illegal dumping		
Region	insignificant	moderate	substantial
	%	%	%
Sydney region	27	52	20
Inner NSW	57	33	10
Outer NSW	44	44	12
Melbourne region	40	42	18
Inner Victoria	29	57	14
Outer Victoria	42	46	12
Brisbane region	29	43	29
Other Queensland	54	41	6
Perth region	84	12	4
Other West Australia	73	14	13
Adelaide region	61	26	13
Other South Australia	41	51	9
Hobart region	75	0	25
Other Tasmania	64	23	13
Aust. Capital Territory	0	100	0
Northern Territory	29	14	57
State capitals & ACT	48	36	16
Other regions	50	39	11
Australia	50	38	12

Percentages may not total 100 due to rounding.
Source: Commission estimates

Table D6: **Shares of Councils involved in recycling and main reasons for involvement 1989**

Region	Share of Councils involved in recycling	Main reason for involvement: (1) meet community demands	decrease cost of waste management	save natural resources	reduce pollution	increase revenue	other
	%	%	%	%	%	%	%
Sydney region	86	29	45	18	8		
Inner NSW	63	45	27	27			
Outer NSW	74	26	28	15	25		6
Melbourne region	93	38	26	26	2		8
Inner Victoria	90	22	31	27	7	12	2
Outer Victoria	68	33	18	18	15	3	15
Brisbane region	75	50		33			17
Other Queensland	37	23	16	27	14		20
Perth region	85	35	30	20	15		
Other West Australia	51	8	19		72		
Adelaide region	57	50		25	19	6	
Other South Australia	32	20	15	45		20	
Hobart region	100	43	29	29			
Other Tasmania	33	23	8	31	31		8
Aust. Capital Territory	100		100				
Northern Territory							
State capitals & ACT	83	37	28	23	7	1	4
Other regions	55	24	22	22	21	4	7
Australia	61	28	24	22	16	3	7

1 Shares by reason for involvement are of Councils involved in recycling only, not of all Councils. Many of the Councils involved in recycling did not provide estimates of the quantities of recyclable materials collected. The share of Councils actively involved in recycling might, therefore, be less than 61 per cent. Percentages may not add due to rounding.

Source: Commission estimates.

Table D7: **Quantities and average prices of collected materials, 1989**

Region	Quantities collected: paper and cardboard	glass	plastics	aluminium	other metals	Average price received by collectors: paper and cardboard	glass	plastics	aluminium	other metals
	tonnes	*tonnes*	*tonnes*	*tonnes*	*tonnes*	*$/tonne*	*$/tonne*	*$/tonne*	*$/tonne*	*$/tonne*
Sydney region	37174	18769	507	465	3359	47.51	66.46	599.03	846.36	20.26
Inner NSW	4852	1719	18	146	2060	49.29	79.23	700.00	875.47	40.00
Outer NSW	11591	3475	261	731	1953	65.65	58.56	236.94	833.42	39.55
Melbourne region	35356	36489	1682	1354	3109	45.89	73.99	677.03	851.95	19.96
Inner Victoria	3110	2253	76	50	26	47.67	71.08	686.44	948.19	89.00
Outer Victoria	4495	2257	141	334	207	33.13	60.20	468.39	673.55	30.00
Brisbane region	425	53			425	52.50				
Other Queensland	21382	3497	1124	388	2378	45.22	46.69	634.54	408.94	22.72
Perth region	4911	3182		2	202	35.20	16.88		850.00	9.89
Other West Australia	148	56		2		30.00	44.08		700.00	
Adelaide region	209	1176	1	49	877	47.83	48.19	700.00	117.07	19.71
Other South Australia					1939					6.00
Hobart region	77	406	8	3			25.96			
Other Tasmania	116	726		12	58	30.00	23.52		700.00	20.00
Aust. Capital Territory	14500	1230	30	516	2350	50.00	70.00	700.00	833.33	19.15
Northern Territory										
State capitals & ACT	92652	61305	2228	2389	10322	45.57	52.94	487.38	660.11	16.19
Other regions	45694	13983	1620	1663	8621	43.40	54.22	457.87	660.23	35.58
Australia	138346	75288	3848	4052	18943	47.64	66.05	615.93	780.43	22.67

Source: Commission estimates

Table D8: **Savings from recycling, 1989**

	Outlays for collection of recyclables	Transfer and disposal costs per tonne (1)	Savings from recycling: avoided costs (2)	net saving (3)
	$'000	$	$'000	$'000
Sydney region	1016	15.38	1538	522
Inner NSW	84	12.09	206	122
Outer NSW	0	7.43	149	149
Melbourne region	2668	10.72	986	-1682
Inner Victoria	295	16.84	84	-211
Outer Victoria	56	7.70	62	6
Brisbane region	21	7.86	558	537
Other Queensland	31	11.99	372	341
Perth region	330	14.61	117	-213
Other West Australia	14	7.53	0	-14
Adelaide region	202	11.90	24	-178
Other South Australia	0	8.39	17	17
Hobart region	0	10.82	0	0
Other Tasmania	0	11.09	22	22
Aust. Capital Territory	196	12.57	264	68
Northern Territory	0	14.01	0	0
State capitals & ACT	4433	12.54	3687	-746
Other regions	480	10.85	923	443
Australia	4913	11.89	4506	-407

1 Equal to expenditure on waste transfer and waste disposal divided by the number of tonnes of waste disposed of.
2 Equal to transfer and disposal costs per tonne multiplied by the quantity of waste recycled.
3 Equal to avoided costs less outlays for collection of recyclables.

Source: Commission estimates

Table D9: **Councils promoting recycling and main methods of promotion, 1989**
(shares of Councils)

Region	Media advertisment	Information to households	Talks to schools	Assistance to community organisations	Other methods	Some promotion (1)	No promotion
	%	%	%	%	%	%	%
Sydney region	53	50	26		45	79	21
Inner NSW	14	5	10	5	33	38	62
Outer NSW	22	9	13		25	53	47
Melbourne region	48	52	5	5	67	93	7
Inner Victoria	42	31	12	4	38	65	35
Outer Victoria	57	48	14	5	24	71	29
Brisbane region	57	14	14	14	71	100	
Other Queensland	14	9	3	9	23	34	66
Perth region	38	14	5		33	62	38
Other West Australia	11					11	89
Adelaide region	9	13			30	48	52
Other South Australia		12	6		29	24	76
Hobart region	20	20			60	60	40
Other Tasmania	8				8	17	83
Aust. Capital Territory	100	100				100	
Northern Territory							100
State capitals & ACT	40	36	10	2	49	76	24
Other regions	23	15	8	3	24	42	58
Australia	30	24	9	3	35	57	43

(1) The percentage undertaking some promotion in each region is less than the sum of the percentage using each method. This is because many Councils use more than one method of promotion.
Source: Commission estimates

Table D10: **Council expenditure on promotion, 1989 (1)**

		Average expenditure: (2)	
Region	Total expenditure	per Council	per person
	$'000	*$'000*	*cents*
Sydney region	214	5	6
Inner NSW	19	…	2
Outer NSW	19	…	2
Melbourne region	281	5	9
Inner Victoria	78	1	9
Outer Victoria	27	…	7
Brisbane region	59	7	5
Other Queensland	39	…	3
Perth region	29	1	3
Other West Australia	5	…	1
Adelaide region	11	…	1
Other South Australia	4	…	1
Hobart region	1	…	…
Other Tasmania			
Aust. Capital Territory	60	60	22
Northern Territory	0		
State capitals & ACT	655	4	6
Other regions	191	…	1
Australia	846	1	4

(1) Some Councils reported nil expenditure for their promotional activities, on the basis that any outlay could not be separated from other expenditure. For example, many Councils distributed literature to householders which contained information on a variety of matters besides the Council recycling scheme. For this reason, values given may underestimate actual expenditure.

(2) …: less than $1000 per Council or 1 cent per person.

Source: Commission estimates

Table D11**: Impediments to Council schemes**
(shares of Councils)

Region	Low avoided costs	Subsidy to contractor	Low participation by residents
	%	%	%
Sydney region	21	66	32
Inner NSW	59	50	27
Outer NSW	75	53	25
Melbourne region	24	93	33
Inner Victoria	50	77	38
Outer Victoria	43	67	14
Brisbane region	57	100	29
Other Queensland	54	51	23
Perth region	52	81	38
Other West Australia	56	22	28
Adelaide region	4	50	13
Other South Australia	35	53	12
Hobart region	20	60	0
Other Tasmania	33	58	17
Aust. Capital Territory			
Northern Territory	20	40	0
State capitals & ACT	26	75	28
Other regions	53	54	23
Australia	41	63	26

Percentages do not total 100.

Source: Commission estimates

Table D12: **Effect of big bins on collection of recyclables and general refuse**
(shares of Councils using big bins)

Region	Collection quantities unchanged	Collection of recyclables		Collection of general refuse	
		Increase	decrease	Increase	decrease
	%	%	%	%	%
Sydney region	56	8	16	40	4
Inner NSW	36	7	43	57	0
Outer NSW	50	13	6	19	6
Melbourne region	48	13	13	52	0
Inner Victoria	40	0	13	40	7
Outer Victoria	50	25	13	38	0
Brisbane region	40	0	60	20	0
Other Queensland	67	11	11	33	0
Perth region	63	13	13	38	0
Other West Australia	63	0	0	38	0
Adelaide region	45	9	9	55	0
Other South Australia	0	0	100	100	0
Hobart region	0	0	0	0	0
Other Tasmania	100	0	0	0	0
Aust. Capital Territory					
Northern Territory	100	0	0	0	0
State capitals & ACT	52	10	16	43	1
Other regions	52	8	16	36	2
Australia	52	9	16	40	2

Percentages do not total 100.

Source: Commission estimates.

APPENDIX E: MARKETS FOR RECYCABLES: THE UNDERLYING ECONOMIC STRUCTURE

This appendix provides an economic analysis of the inter-relationships between the markets for recyclables and for waste management services. In the process, it also briefly examines the relationship between waste disposal prices and virgin materials markets. Its purpose is to illustrate how a stylized version of present circumstances might look if there is ‘underpricing’ of waste management services and natural resources. It is also designed to help trace the interconnections between markets that influence the effectiveness of alternative policies - increased waste management charges, subsidisation of recycling schemes and the like.

Analytical framework

The basic tools of analysis are simple supply and demand diagrams and the economist’s notions of private and social costs and benefits that flow from various decisions underlying waste disposal and recycling.

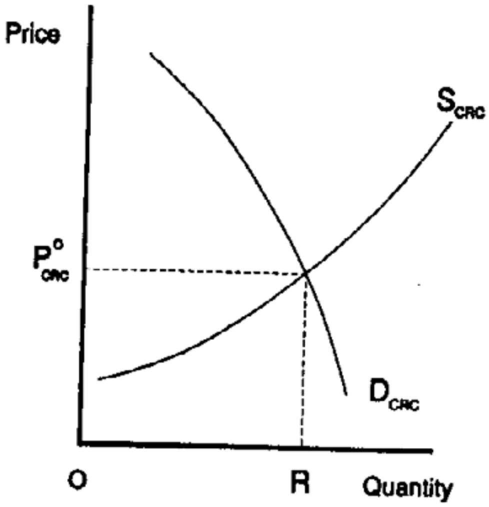
Some of the activities that are part of the waste disposal - recycling nexus are directly market-related. The demand for recyclables by metals reprocessors and the supply of scrap metals by scrap collectors is an example. In such cases, the private benefits and costs to the participants are transparent - being reflected in market prices for the recyclables. It is assumed that the `supply price' at which collectors will offer additional scrap to users reflects the additional costs (including a return on capital) that they must recover to make it worth their while. Likewise, the demand price that converters are willing to pay reflects the profitability to them of using another tonne of what is effectively otherwise a throw away resource.

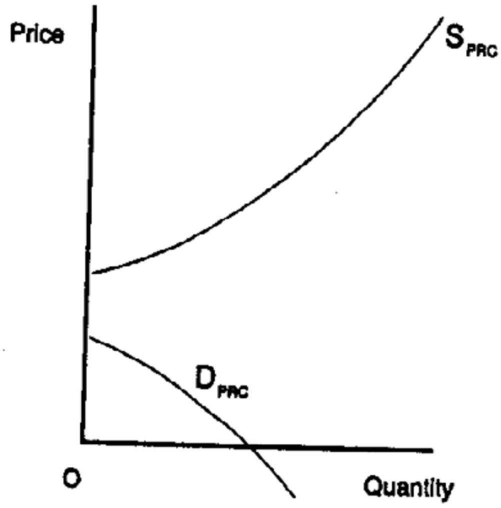
Such a situation is depicted in Figure E.1 where the demand curves D_{CRC} and D_{PRC} indicate reprocessors’ willingness to pay for recyclables. The curves S_{CRC} and S_{PRC} indicate the supply response from commercial collectors and other organisations operating collection schemes.

In Figure E.1(a), Commercial recycling, a price to collectors P^{o}_{CRC} ensures that an amount OR is diverted from other disposal into recycling.

Figure E.1: **The market for recyclables** (demands by processors, supplies from collectors)

(a) Commercial recycling *(b) Potential recycling*





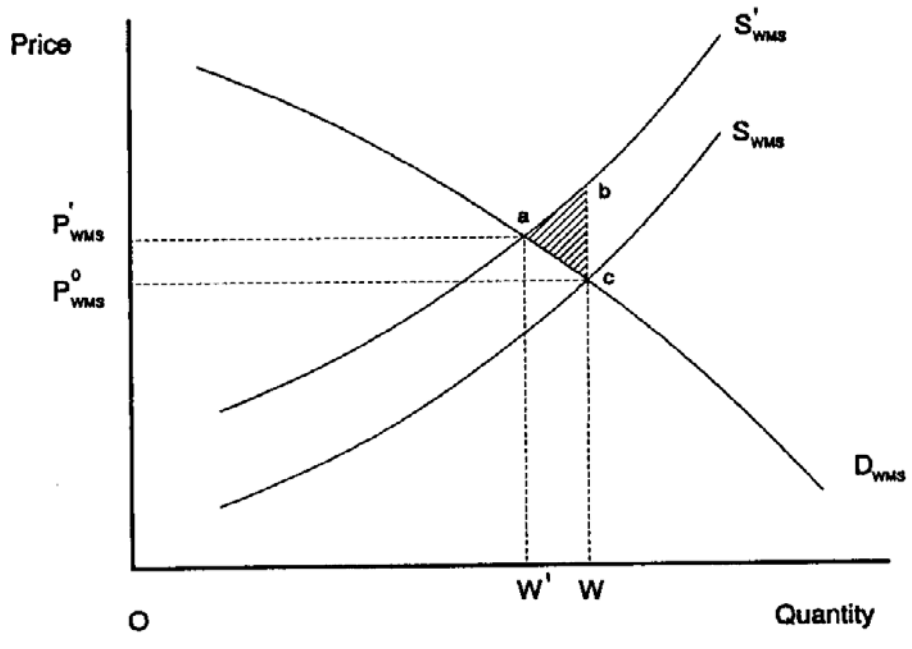
In Figure E.1(b), however, which illustrates potential recycling, demand is so weak relative to the conditions that would make supply profitable for collectors, that there is no price at which market exchange occurs. The kind of waste products illustrated here do not find a destination in profitable recycling, even though the technology to reprocess them may exist. These ‘potentially recyclable’ products end up in the waste stream. Certain kinds of plastics are an example. Their quantity, and that of the commercial recyclables diverted from the waste stream depends both on economic decisions at the level of individual households and businesses generating by-products from their consumption and production activities, and on those by collectors and reprocessors. Supply decisions by households in particular are only partially and indirectly the result of market forces.

From the individual waste generator's point of view, disposal by waste collectors (in landfill or by incineration) is only one way of disposing of waste. The other avenues open include self treatment, illegal disposal, and provision to collectors of recyclables. Each of these imposes real costs, some of which are implicit, on the waste generator. They also provide benefits. The following sections analyse each alternative in turn and then go on to examine the interaction between the waste disposal market and alternative disposal methods, and the effect on virgin materials markets of changes in waste disposal prices.

Waste disposal

Figure E.2 depicts the market for waste disposal services. The supply of waste disposal services is given by S_{WMS}. D_{WMS} indicates the demand for these services by households and businesses. With the given supply and demand conditions, a quantity OW will be disposed of as waste at a price P^{o}_{WMS}.

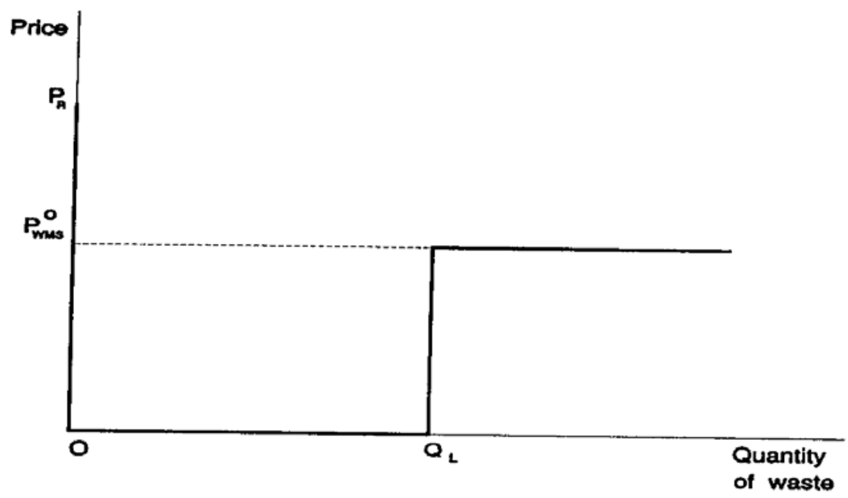
Figure E.2: **The market for waste disposal services**



This analysis simplifies two important real aspects of the economics of waste disposal. Providers of waste disposal facilities (tip operators, transfer stations) charge waste collection operators who collect commercial waste. They in turn charge waste generating businesses. The fact that there are two separate links between commercial waste generators and disposal charges, and not a single one, ÿis passed over here. The simplification assumes that disposal charges facing collectors are included fully in waste collection charges levied on commercial generators.

Furthermore, since a significant proportion of household waste disposal is organised by Councils, with charges being integrated into rate structures, the actual marginal cost of waste management services facing households is as shown in Figure E.3.

Figure E.3: **Marginal cost to households of waste management services**



P_R is the cost to householders for garbage collection in their rates. Because this is a fixed charge, the marginal cost to householders of the first unit disposed of is equal to P_R.[1] Marginal costs are zero thereafter until Q_L is reached. Q_L is the allowable limit of waste per household collected under Council arrangements. So P^o_{WMS} can be thought of as the personal transport costs and 'gate'charges for disposing of additional waste at controlled sites. For simplicity the analysis here assumes that each waste generator has a level of demand for waste management services which is equal to or exceeds Q_L.

Self treatment

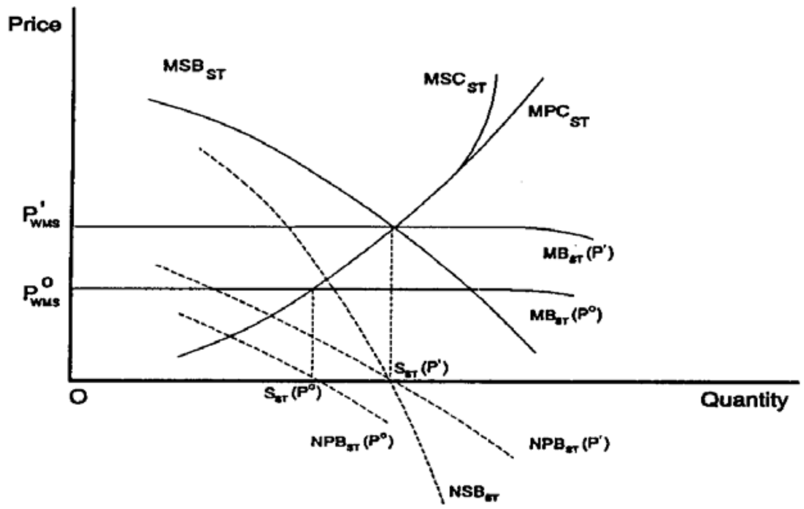
Figure E.4 illustrates the marginal costs and benefits, and the resulting net benefits, of self treatment. At a waste disposal price P^o_{WMS} per tonne, the private marginal benefits of self treatment will be as indicated by the curve marked $MB_{ST}(P^o)$. It is assumed that the private benefits never exceed the avoided waste disposal charges. This may not be so in cases where composting confers additional benefits on household gardeners or businesses reduce water purchase costs by reuse of waste water suitably treated. Marginal benefits may eventually decrease. The marginal social benefit of self treatment (MSB_{ST}) is the additional cost which society avoids in waste disposal when individuals self treat additional waste. When individuals are charged other than the true social cost of waste disposal, marginal private and social benefits of self treatment will diverge.

The marginal private cost of self treatment (MPC_{ST}) is assumed, after some level, to increase with increasing quantities treated and may include such items as the provision of storage space, equipment for treatment of compostables, industrial waste and the like. The marginal social cost of self treatment (MSC_{ST}) is assumed to exceed the marginal private cost of self treatment only at high quantities. For instance, in the case of household compost, odours and flies may not spread to neighbouring gardens until very large quantities are involved.

[1] In fact, householders have to pay this charge whether they make use of the service or not.

The **net** private benefits of self treatment (at waste disposal charge P^{O}_{WMS}) are indicated by the curve $NPB_{ST}(P^{O})$. The quantity self treated will be $S_{ST}(P^{O})$, at which point the marginal costs are equal to the marginal benefits, or net marginal benefits are zero. The net benefit curves so derived will shift as the price of waste management services changes from P^{O} to P^{1}. The net social benefit curve will not move, however, since it reflects avoided costs to society, not avoided charges on individuals.

Figure E.4: **Marginal costs and benefits of self treatment**



Illegal disposal

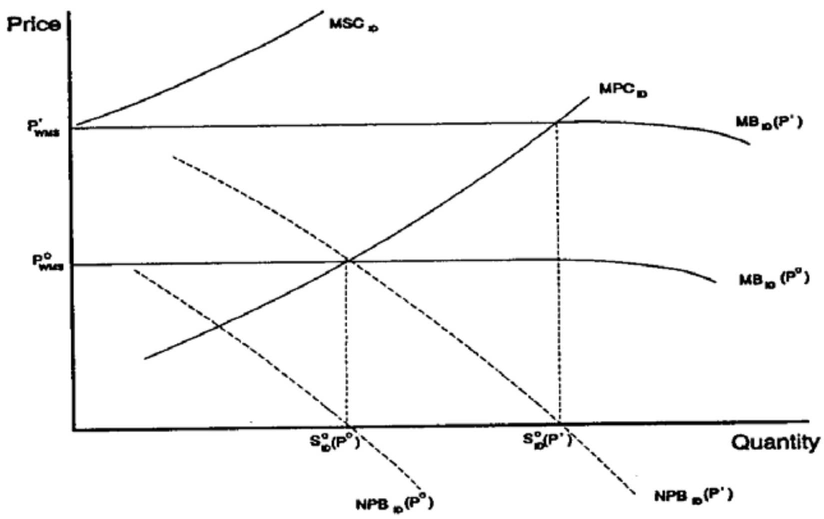
Figure E.5 shows how the decision to dispose of waste illegally is arrived at. The marginal private benefits of illegal disposal are assumed to be equal to those of self treatment and (at waste disposal charges P^{O}_{WMS}) are shown by the curve $MB_{ID}(P^{O})$.

The marginal private costs are again assumed to be increasing with increasing quantities and are indicated by the curve MPC_{ID}. These costs include the expected penalty to be paid on apprehension and transport costs.

In contrast to self treatment, the marginal social costs of illegal disposal are assumed to everywhere exceed the marginal private costs of illegal disposal and are indicated by the curve MSC_{ID}. This is a reasonable assumption because even a small piece of litter will require some effort on the part of someone other than the litterer to clean it up. When waste is disposed of illegally, individuals avoid waste disposal costs but society does not. For this reason there are assumed to be no marginal social benefits associated with illegal dumping.

The **net** private benefits and the **net** social benefits of illegal dumping (at waste disposal charge P^{O}_{WMS}) are indicated by the curves $NPB_{ID}(P^{O})$ and $NSB_{ID}(P^{O})$ respectively. An illegal dumper, taking into account only private costs and benefits, will dump a quantity $S^{O}_{ID}(P^{O})$. If social costs were taken into account in illegal dumping decisions, the quantity disposed of illegally would be zero.

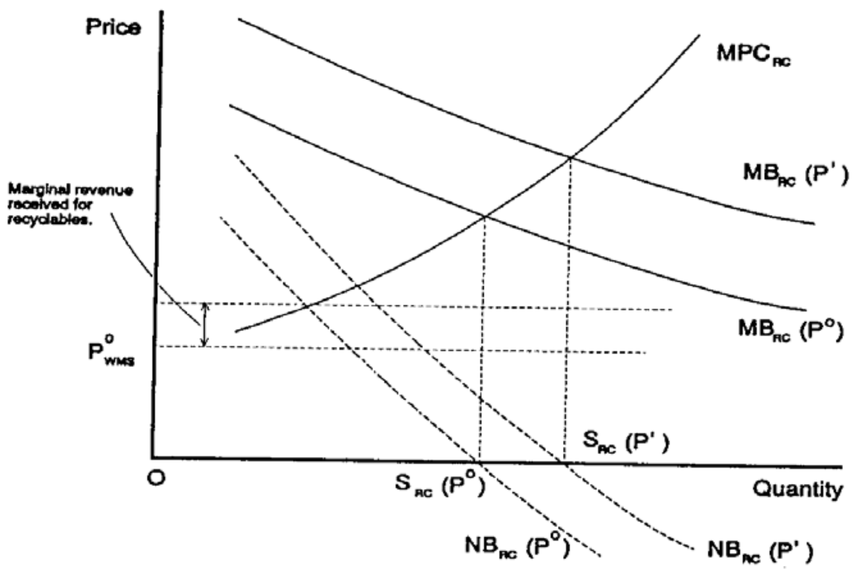
Figure E.5: **Marginal costs and benefits of illegal disposal**



Provision to collectors of recyclables

Figure E.6 depicts the marginal costs and benefits, and the net marginal benefits of supplying materials to collectors for recycling. The marginal benefits of supplying recyclables, $MB_{RC}(P^{O})$, are assumed to include avoided waste disposal costs, plus any revenue received for recyclables, as well as any other perceived benefits such as conservation of resources and the knowledge of contributing to a cleaner environment. While marginal avoided waste disposal costs and marginal revenue are assumed to be constant as before, other marginal benefits could be argued to be either upward or downward sloping, or upward sloping at low quantities and downward sloping at high quantities, or vice versa. For instance, in picking up aluminum cans from a littered recreation ground, initially increasing marginal utility may result from a cleaner looking ground, until the effect of picking up each next can becomes less obvious and marginal utility may start to fall. For simplicity in this analysis decreasing marginal utility is assumed.

Figure E.6: **Marginal costs and benefits of suppling recycling collectors**



As with self treatment and illegal disposal, the marginal costs of supplying recyclables to collectors (MPC_{RC}) are assumed to be increasing. However, in contrast to self treatment and illegal disposal, the marginal private and social costs incurred by waste makers of disposal to recycling collectors are assumed to be identical. The curve marked $NB_{RC}(P^{o})$ indicates the net marginal benefits from supplying recyclables at a waste disposal charge of P^{o}_{WMS}. The quantity supplied will be S^{o}_{RC}, at which point private marginal costs and benefits are equal. This level will be below the social optimum unless MB includes all the social benefits, including the true avoided cost of waste disposal.

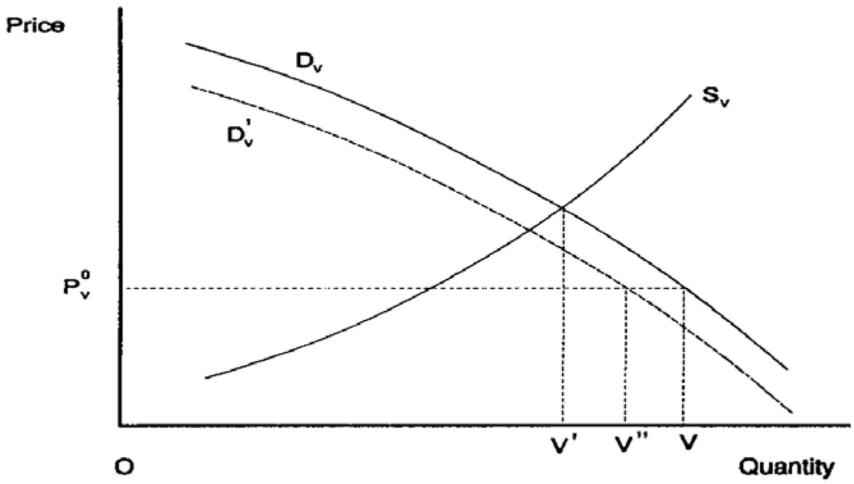
Virgin materials markets

Finally, it is assumed that in the background are some virgin materials markets such as depicted in Figure E.7 in which, for whatever reason, the prices charged do not reflect the full social costs of depletion of the resource. S_V indicates the full marginal social cost of supplying the virgin materials, and D_V indicates the demand by reprocessors for the materials from this alternative source. With prices at P^{o}_{V}, a quantity OV will be demanded and supplied. This will have the effect of over-exploitation of the resource by an amount $V^{1}V$.

The effect of increased waste disposal prices on alternative disposal methods

Diagrams E.4, E.5 and E.6 illustrate how the use of these alternative disposal routes depends on individuals equating the marginal private costs of waste disposal by these methods with their marginal benefits. As shown, the principal benefits from the use of these alternative disposal methods are the avoided explicit charges for access to waste management services. The higher these charges, the higher the perceived private benefits from the use of alternatives.

Figure E.7: **The market for virgin raw materials (substitutes for recyclables)**



Faced with disposal charges P^o_{WMS} for waste management services, waste generators will act efficiently from a private perspective if they balance their marginal private costs and benefits for each disposal method. This results in choices of OW to waste management (Figure E.2), $S_{ST}(P^o)$ self treated (Figure E.4), $So_{ID}(P^o)$ illegally dumped (Figure E.5) and S^o_{RC} made available to recycling collectors (Figure E.6). The one explicit charge, P^o_{WMS}, in combination with the implicit costs of other disposal methods helps to determine an efficient allocation of waste from a private point of view.

In the case illustrated, however, this allocation will not be socially efficient if waste receivers (tip operators and the like) are charging a price which, while it may cover the private costs of disposal (those of operating the tip, including depreciation or replacement allowance), does not cover all the costs to society. Long term reductions in options for use of the tip sites may go unpriced, as may the costs of untreated environmental contamination.

Such a situation means that each additional tonne of waste disposed of in this way is costing society in general more to dispose of than it is costing individuals.

That is, the marginal social cost of waste disposal, indicated by the curve S^1_{WMS} in Figure E.2, exceeds the marginal private cost given by the curve S_{WMS}. To operate efficiently, social costs should be taken into account when charging users for waste management services. As shown in Figure E.2, when this is done, a reduced quantity of waste (OW^1) will be disposed of at a higher price per tonne (P^1_{WMS}).

As a result of the higher price charged for waste management services, the private benefits received from using alternative methods of disposal will be increased. This is illustrated in Figures E.4, E.5 and E.6 by the curves $MB_{ST}(P^1)$, $MB_{ID}(P^1)$ and $MB_{RC}(P^1)$ respectively. The curves indicating net benefits will shift to $NPB_{ST}(P^1)$, $NPB_{ID}(P^1)$ and $NPB_{RC}(P^1)$ respectively. The quantity self treated will increase to $S_{ST}(P^1)$ (Figure E.4), the quantity illegally disposed of will increase to $OS_{ID}(P^1)$ (Figure E.5) and the quantity provided to recycling collectors will increase to OS^1_{RC} (Figure E.6). Clearly, higher waste disposal charges provide an incentive for increased disposal by alternative methods.

It should be noted that the analysis presented above is contingent on the share of waste diverted to alternative methods of disposal increasing. If increased waste management charges result in a reduction in the total amount of waste generated, in the first instance there may also be a reduction in the total quantity recycled. This is because some of the waste no longer produced would have previously been recycled. Increases in quantities self treated, illegally dumped and supplied to recycling collectors can only occur, if the share of each in total waste increases by more than the reduction in total waste.

One feature of this situation is that the demand schedule in the waste disposal market and each of the ‘supplies’ of waste to be disposed of by both self treatment and illegal disposal in Figures E.4 and E.5 may include an element of ‘unsuccessful recycling’ - the fact that the supply of some waste to recyclables collectors exceeds the demand for it. Excess supplies to collectors by households may also result. Possible ways of correcting this will be discussed in a later section of this Appendix.

The effect of increasing waste management charges on virgin materials markets

The demand for recyclables by collectors is derived from the demand by reprocessors for used materials. To the extent that used materials are a substitute for virgin materials, prices of virgin materials relative to those of used materials will influence the demand for used materials. The higher virgin materials prices are relative to used materials prices, the greater will be the demand for used materials.

The impact, if any, of increased waste management charges on virgin materials markets occurs indirectly through the prior effect on recycling markets. Only if recycled inputs experience a fall in price, and only if used materials are reasonable substitutes for virgin can any impact be expected on Figure E.7.

Under these conditions, a fall in price of recyclable materials, with virgin materials prices remaining at P^{o}_{V}, will result in a shift in the demand for virgin materials. This is shown in Figure E.7 as a shift to D^{1}_{V}. A reduced quantity will be demanded, indicated by V^{2} in Figure E.7.

Analysis of policy effects

Within the framework developed above, it is now possible to analyse the likely effects of some different recycling policy initiatives.

Raising waste management charges

As discussed above, increased charges for waste disposal will result in decreased waste disposal and increased supplies of recyclables to collectors, but will also lead to increases in illegally disposed waste. While it was also shown that the socially efficient quantity of waste illegally dumped is not necessarily zero, the increase in illegal dumping, together with the inability of making illegal dumpers pay the full social cost of their actions, will result in a welfare loss to the community.

Will a rise in waste management charges to P^{1}_{WMS} in the situation depicted raise economic welfare?

A more efficient outcome from simply raising waste disposal charges in this model is contingent on the reduction in losses from over-utilisation of waste management facilities and any other favorable effects more than compensating for possible increased ill effects of illegal disposal stimulated by the price rise. Moreover, if such increased charges succeed in increasing recycling at the expense of renewable virgin resource use such as plantation forests, the wider effects of reduced planting would have to be taken into account.

The waste disposal effect

The direct gains to the community from increasing waste management charges to include all social costs will be the area abc in Figure E.2. These gains will be greatest if:

- the marginal social costs of waste disposal increase rapidly with increasing quantities of waste;
- demand for waste management services (D_{WMS}) is highly responsive to price rises; and
- the spillover into increased illegal disposal is slight.

The second condition depends in turn on successful ‘substitution effects’ being brought about by the price rise encouraging self-treatment and viable recycling. It also depends on an overall tendency to reduce waste induced by these increased disposal costs. Each of these effects is likely to be stronger the more direct the link between the method for charging for waste disposal and the choice of disposal - the strength of the ‘user pays’ link.

The third condition will be satisfied if the marginal costs of illegal disposal as depicted in Figure E.4 rise steeply with increasing quantities.

The recycling effect

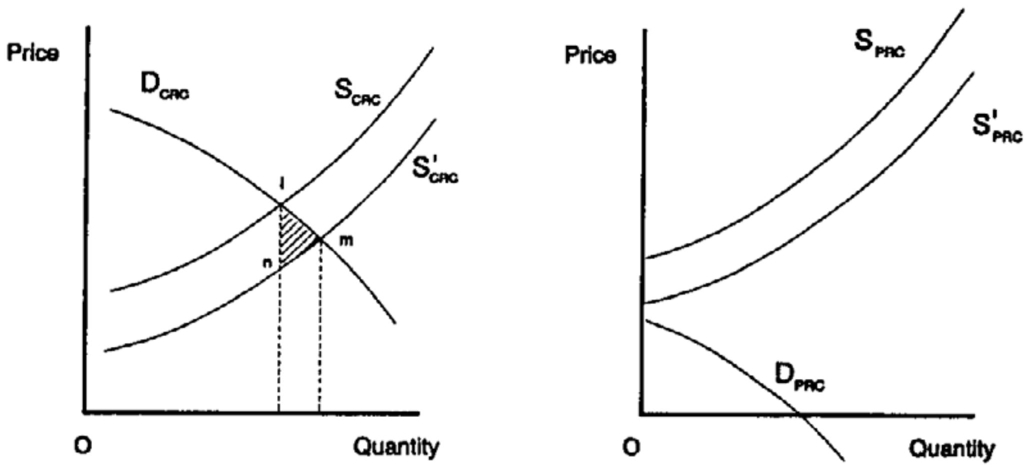
The forces promoting diversion of waste into viable recycling as a result of increased waste disposal charges may be weak. Of the increased quantities of waste materials supplied to collectors, some will be ‘commercial’ recyclables, shifting S_{CRC} in Figure E.8(a) to the right, as shown, with increased recycling occurring at a lower price. However, some will be ‘potential’ recyclables. While S_{PRC} in Figure E.8(b) shifts to the right, whether any recycling will occur depends on the size of the shift.

It is quite possible that no increase occurs as illustrated by the move to S^1_{PRC} in Figure E.8(b).

The second set of effects on economic welfare of increased waste management charges, P_{WMS}, are therefore the private gains from increased recycling (eg area lmn in Figure E.8(a)). Some of these will be returned to the wider community through increased funding of services made possible by the increased sale of commercial recyclables made available to Councils. Thus households and firms who, in the first instance suffer a welfare loss in trying to avoid increased waste charges by bearing greater recycling burdens are partially compensated.

Figure E.8: **The markets for recyclables: effects on recycling of increased waste management charges**

(a) Commercial recycling *(b) Potential recycling*



The effect on virgin resource markets

Where virgin materials are renewable and their demand shrinks due to increased recycling activity, resource extractors will be losers, as Figure E.7 suggests when the demand schedule moves to D^1_V.

However, when non-renewable resources are involved, welfare losses to present extraction activities must be set against welfare gains to future users. In either case, if present virgin material prices are artificially low, and over-extraction is occurring, there will be a tendency for demand contraction to correct this.

The total effect

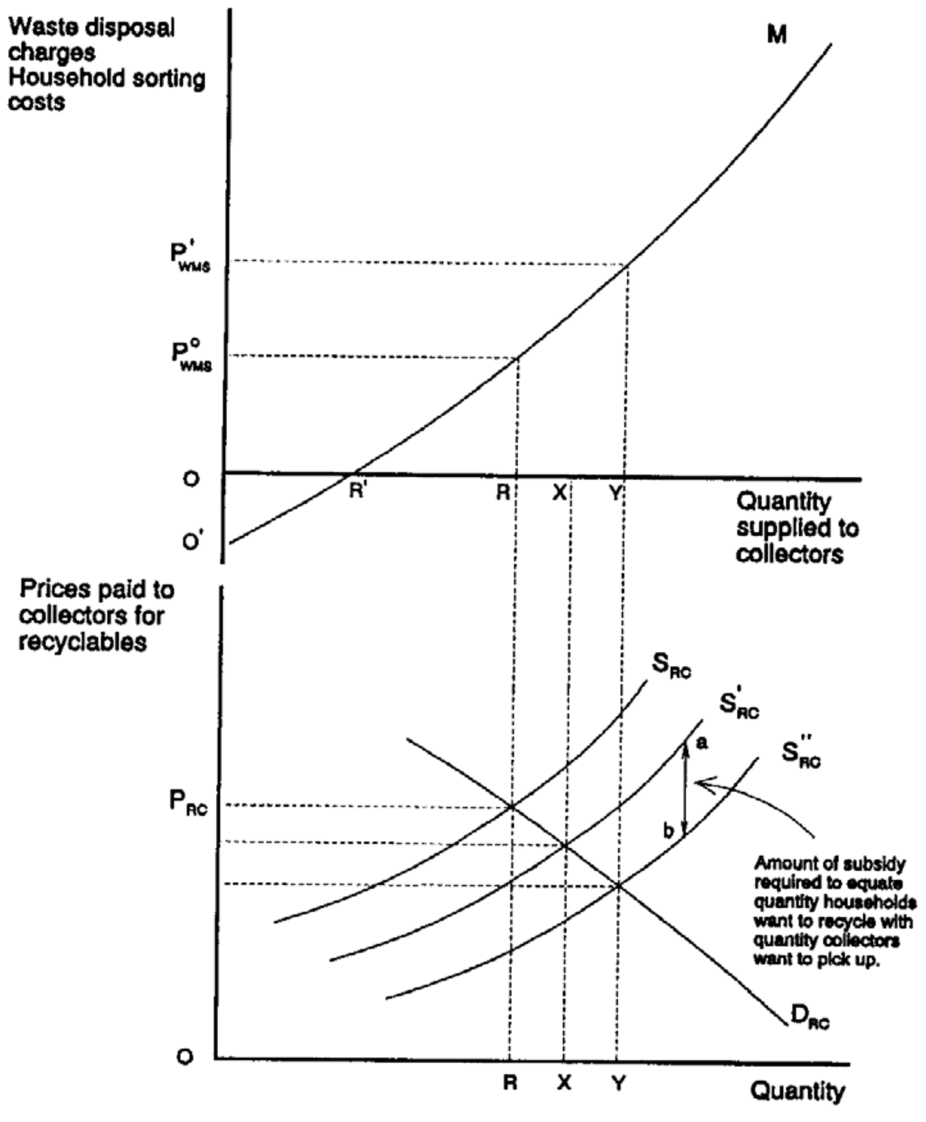
This analysis shows, through examination of the interconnected markets, that even though waste disposal services are underpriced, their correction does not bring unambiguous or automatic gains. There will be reverberations elsewhere with winners and losers. Welfare gains are likely, however, provided the conditions outlined are representative of reality.

Other policy effects - Council payments to collectors

The analysis so far has assumed that an increase in waste disposal charges would be transmitted to the recycling market with some increase in recycling activity as a likely result. Such an assumption is embodied in the shift in the supply curve of commercial recyclables in Figure E.1. Some such effect may indeed be expected where there are direct commercial links between waste generators and recycling collectors, as in the business sector where large businesses may be able to lower collectors' costs. In the household sector, however, such an effect is more problematic as the following analysis shows. It is in the household context that a role for Council payments to collectors has been mainly discussed.

In Figure E.9 the household supply of recyclable waste is redrawn as O^1M, indicating that in addition to a willingness to bear sorting costs (given the costs of other disposal methods), some households would be willing to pay a premium to participate in recycling because of its perceived benefits. Thus, even if waste disposal charges were zero, if there were a direct market link between households and collectors, an amount OR^1 would be voluntarily sorted for recycling and offered to collectors. However, such direct links do not exist because of institutional arrangements, whereby Councils typically act as intermediaries, arrangements which in part reflect high transaction costs.

Figure E.9: **Interlinkage of prices for waste management services and recyclables markets**



In the absence of this direct link, a rise in waste disposal charges from say P^{o}_{WMS} to P^{1}_{WMS} may result in a greater increase in supply of recyclables than collectors are willing to pick up. A short term stimulus to supply sorted waste for recycling will be provided (a movement along M) such that OY rather than OR is offered. The increased availability of recyclables is reflected in a change in the costs of collectors, shown in the lower part of the diagram in Figure E.9, (but it is assumed that picking up the increased quantity of recyclables would involve some increase in total cost) resulting in a shift of the supply schedule to S^{1}_{RC}. The price obtained by collectors falls as increased quantities are offered for sale. The result is that collectors would now be willing to pick up a smaller amount (OX) than householders would be willing to sort and make available (OY). If in the initial situation the 'effective recycling' ratio could be said to have been 100 per cent (OR/OR), it is now less than 100 per cent (OX/OY). A possible market solution would be for collectors to charge householders directly for removal of recyclables. This would have the effect of shifting $O^{1}M$ to the left. In the long run this would return the situation to equilibrium.

A payment to collectors from Councils or households would also shift the supply curve for collection services and hence recyclables offered to manufacturers to the right, directly stimulating that market.[2] In the case illustrated, a subsidy ab would shift the supply schedule to S^{11}_{RC}, bringing the quantity householders are willing to supply once more into balance with the quantity collectors are willing to pick up.

Two rationales for such a subsidy exist. One is the avoided tipping costs of Councils. Councils have an incentive to dispose of waste as cheaply as possible. If a dollar allocated to some part of the recycling chain can relieve waste receptors of an amount of waste that would cost more than one dollar to dispose (net of any revenue they can make themselves from sale of recyclables) Councils would choose the subsidy. Furthermore, each tonne recycled reduces social costs by more than it reduces social benefits so long as what Councils charge for waste disposal is less than its true marginal social cost.

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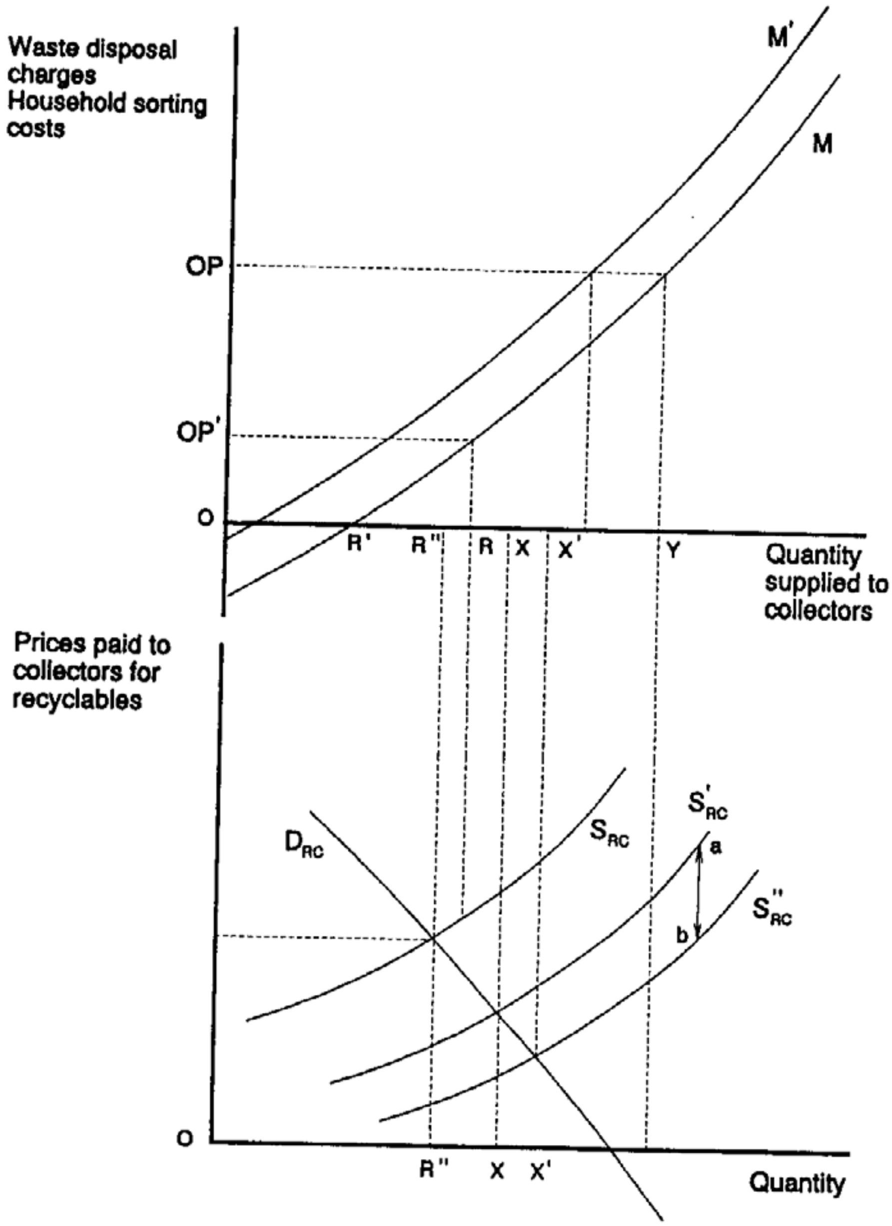
2 If this payment reduces waste management costs to Councils and does not lead to increases in rates charged to residents, payments to collectors will not result in a change in $O^{1}M$. Even if rates were increased, the invisible nature of the charge would mean the effect on household supplies of recyclables would be negligible.

Figure E.10: **The effect of subsidies on recycling**



The other incentive is household willingness to pay for recycling. But in this case Councils faced with differing willingness to pay among households may have no obvious method of collecting money from each.

The success of policies which combine increased waste disposal charges with collector payments can be seen from Figure E.10 to depend on the elasticities of supply and demand in the recyclables markets (lower diagram) and the sensitivity of the household supply curve of recyclables (M) to increases in waste disposal charges. Where, for instance, DRC is very inelastic while M is elastic, the short run effects of these policies, which will have the desirable effect of more efficient use of disposal facilities, may be to create some increase in commercial recycling but with the ratio of effective recycling actually falling. This effect is shown in Figure E.10. Initially the quantity householders are willing to supply is OR, the quantity collectors are willing to pick up is OR^{11}, resulting in a 'ratio of effective recycling'' of OR^{11}/OR. After the increase in waste disposal charges combined with a subsidy ab, the quantity recycled increases to OX^1, but the ratio of effective recycling falls to OX^1/OY.

Without Council payments to collectors, the long run effect of the imbalance between householders' supplies and collectors' requirements is likely to be a shift of the curve M to M^1 (a 'disappointed household' effect), resulting in a return to an equilibrium situation.

It should be noted that while payments to collectors may enhance recycling markets that already function, they may do little to create a market where none has existed.

The size of collector subsidies

From society's point of view it would seem that a subsidy at least equal to the avoided marginal social costs of waste disposal would be efficient, resulting as it would in increased effective recycling, a lower 'failure rate' for householders demanding recycling service and a shift to the left of the demand for waste disposal services in Figure E.2 (which is drawn to include given feedbacks from the market for recyclables into the waste disposal market, ie only those effects which depend on P_{WMS} itself). However, such analysis:

- assumes that the full social costs are measurable;
- ignores the financing constraints which Councils would face in paying such a subsidy if, as seems likely in some cases, they do not charge disposers the full cost of disposal; and
- ignores welfare effects in other markets (eg raw materials).

Volume-based waste disposal charges

Where the opportunity arises for volume-based charges for the removal of both general and recyclable waste, further issues in efficient pricing arise. Some of these are now addressed.

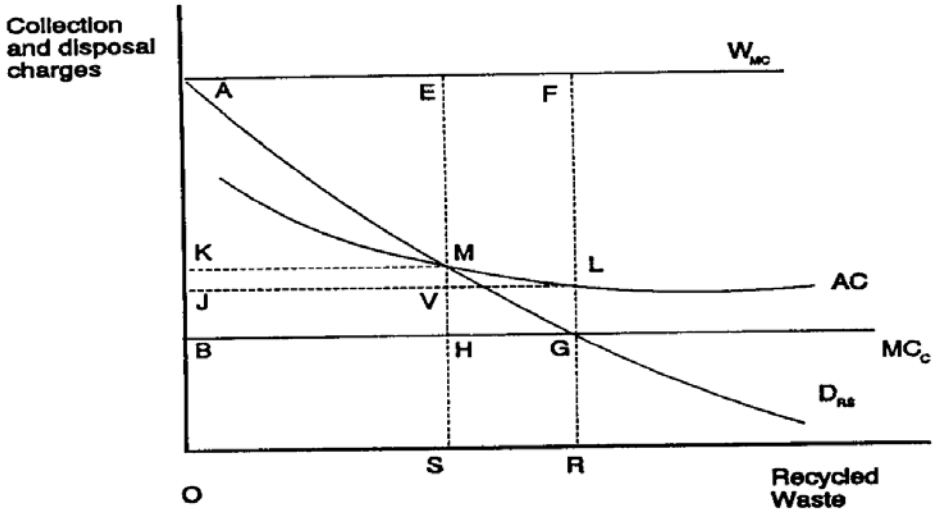
D_{RS} in Figure E.11 is the demand for recyclables collection services. For the purposes of this analysis it is assumed that, faced with volume based charges for both waste that is tipped and waste that is recycled, D_{RS} reflects the fact that Councils charge W_{MC} for removal and disposal of undifferentiated waste (hereafter referred to as 'black' waste). This charge incorporates an amount OB covering marginal collection costs and AB covering further disposal costs (landfill etc).

The simplifying assumption is made that the marginal collection costs are the same for recyclables ('green' waste) and for black waste. It is also assumed that transactions costs are too high for private collectors to establish contracts with individual households for the disposal of either type of waste, although collections of commercial recyclables which are currently profitable might continue free of charge to householders outside this framework. Councils are therefore responsible for setting both charges and rewarding collectors.

The question then arises of what is the appropriate charge to households for collection of recyclables given that collectors must receive payments to cover costs and given Councils are constrained to break even.

We first consider the implications of setting the volume-based component of removal services for green waste at its marginal cost OB. If this is paid to collectors and covers their unit costs **net** of what they receive from reprocessors, an amount OR will be diverted from landfill and onsold to reprocessors. The savings to the community in disposal costs would be AFGB. Householders enjoy a consumer surplus ABG.

Figure E.11: **Market for recyclables collection services with volume-based charges**



In principle, there would be a case for keeping the volume-based component of green waste collection charges at the level OB even if the **average** costs of collectors exceed OB. AC in Figure E.11 represents average costs of collecting recyclables. Increasing the volume-based component of green collection charges to equal average cost would lead to a reduced demand for these services (OS). However, since the average costs of green waste collection are less than the costs of black waste collection and disposal (W_{MC}), the community could be better off maintaining the volume-based charge at OB and making additional payments BJ (totalling JLGB) to green collectors, funding these out of fixed charges (garbage rates). The community would thereby save EFGH in avoided waste disposal costs. In net terms, EFLV is avoided for an outlay of JVHB. Provided the balance is favourable, the additional payments to collectors seem warranted.

Alternatively, Councils could charge household OK, the average cost of green waste removal, ensuring a viable service.

However, this would cost households KMGB in foregone consumer suplus and EFGH would continue to be incurred as black waste collection and disposal.

This analysis ignores any differences in **total** waste that might come about through these differences in charges. Furthermore, the issue of whether W_{MC} is the optimal black waste charge is not explored. Within these limitations the possible gains from supplementary payments to recycling collectors is apparent. A pricing structure which faced households with a volume-based unit charge of OB and payments of JLGB out of a general garbage rate could be used to achieve these gains.

The analysis also suggests that provided gains from avoided waste disposal are sufficiently large, there may be a case for subsidies that extend recycling collections beyond OR. Eventually, however, inability to divert large elements of black waste into green waste for which there is some commercial use, will limit that process.

APPENDIX F: ESTIMATING COSTS AND BENEFITS

In Chapter 5 the potential difficulties involved in estimating costs and benefits for goods and services which are not freely traded and hence for which market prices are not readily available are mentioned. This Appendix discusses some of the types of valuation which may be placed on environmental goods an services, and some methods of estimation. Valuation of environmental services can be undertaken from the perspective of both costs (environmental damage) and benefits (environmental protection).

Identification of costs and benefits

Opportunity cost

Central to the understanding of economic costs is the notion of 'opportunity cost'. Opportunity cost applies to all economic decisions, not just environmental ones. Some common examples of opportunity cost are: to spend money or to put it into an interest bearing savings account; to give up present employment or to undertake further education; to take a high cost vacation rather than purchase new furniture. As explained in Chapter 3, there is an opportunity cost in dedicating an area for a landfill site rather than using it for residential development or some other purpose.

The simple principle is, where the opportunity cost of a resource used for one activity prevents its use or lowers its value for other purposes for which it would otherwise have been used, the economic worth of the uses forgone or value lost represents the *opportunity cost*. For example, the pollution of water resources through their use to dispose of the output of industrial pollution may have an opportunity cost in terms of the loss of use of the water for drinking water supplies, industrial uses, commercial or recreational fishing, and swimming. Similarly, the output of sewage into coastal seas may have an opportunity cost in terms of the loss of facilities for sea bathing, swimming, and in terms of adverse effects on fish catches.

The opportunity cost of not recycling a product such as a glass bottle or an aluminium can is its value as a component of new glass or new aluminium (net of collection, transport and reprocessing costs). The full social opportunity cost of not recycling an item should also include the costs of its disposal as waste, including any resulting loss of option value from landfill use.

Option cost and option value

The use of a resource, or the undertaking of an activity, can result in *an option cost*, a form of social cost, where it diminishes the potential rather than actual value of the resource at some future time or for some other activity. The value of retaining a resource purely for its potential value is known as the *option value* of retaining the resource. As Fisher and Krutilla) (1985, p. 185) state:

> where economic decisions have an impact on the natural environment that is both uncertain and irreversible, there is a value to retaining an option to avoid the impact.

Preserving an area of wilderness from development, or a plant or animal species from extinction, have option values. An individual may never visit the area, but its continued existence provides him with the option to do so. As indicated by Tisdell (1990), the continued existence of different plant and animal species in the wild retains the option to use these species for purposes such as engineering their genes into cultivated plants or domestic animals or for the development of new medicinal substances.

Where recycling results in the saying of virgin materials, options for their future use are retained. Valuation techniques are available to measure types of option value. These are discussed below.

Intrinsic or existence values

Estimates may also be required for the values individuals and society place on the existence of goods and facilities from which direct benefits may rarely or never be obtained, for example the continued existence of untouched wilderness or rare species of fauna and flora, independently of the option value of having them available for potential use. If ocean pollution reduces the population of whales in it, then this imposes social costs to the extent that the community places an *intrinsic* or *existence* value on whale numbers. In a more mundane sense, if society places a value on not using potential landfill space as such, then the *existence value* of the unused landfill represents a potential social benefit from recycling. If natural resources, for example, forests are preserved because of recycling, there is a potential gain in existence value.

Bequest value

The community and individuals in it may also place a *bequest value* on retaining the option and existence or intrinsic value of resources as a *bequest* to future generations. Important natural environments and places of cultural significance are likely to have bequest value. Again, if recycling is able to allow some natural resources to be preserved, including landfill sites, the *bequest value off* these represents a social benefit from recycling.

Damage cost estimation

If market prices are distorted shadow prices must be calculated which reflect competitive market prices. If the shadow price is higher than the actual price charged for an environmental good, then there is risk that the good is being overused. Some estimation procedures for shadow prices are as follows.

Pearce, Markandya and Barbier (1989, p. 64) suggest that costs of pollution and other environmentally negative externalities can be measured in terms of a ‘dose-response’ relationship which looks at the amount of damage done per unit of output of pollution. However, they also note that such indirect procedures do not provide an estimate of willingness to pay on the part of individuals or society.

The estimation of a damage-cost function requires information as to the relationship between a specified amount or ‘dose’ of a pollutant and the consequent damage or ‘response’. An example of the estimation of a damage-cost function is given in Hufschmidt, James, Meister, Bower and

Dixon (1983, p. 141), where benefits from air pollution control are translated into monetary values with the aid of data as to resultant health improvements and estimates of the economic value of human life. Damage-cost functions can be derived in a similar manner for the effects of pollutants on agriculture and fisheries, for example the effect of turbidity (cloudiness) of water in reducing spawning of fish, and hence fish populations and returns from fisheries. Turbidity can be a result of sewerage discharges into the marine environment.

In some cases, the costs of environmental protection can be determined from the market prices of environmental protection inputs. These can be grouped under three main headings, representing preventive expenditures, replacement costs, and the costs of restoration (shadow project) approach (Hundloe 1990, p. 15).

As Hundloe (1990, p. 16) states:

> Where market values are not available we can undertake ... valuation by reference to surrogate markets; for example, the cost of sewage treatment as a proxy for water purification by a natural ecosystem. In this case a marketed good, the sewage plant, is the surrogate.

Benefits from the improvement of environmental quality can be estimated by valuing extra production at market prices, where appropriate. Conversely, the cost of a deterioration in environmental quality can be estimated by valuing the reduction in production at market prices.

Benefit valuation and estimation

The property value approach and the hedonic method of valuation

The property value approach and hedonic method of valuation can be used to assess the effect of variations in environmental quality, in association with other factors, on property prices, with the use of regression procedures. It has the advantage that it is based on people's actual behaviour, but it cannot be readily applied to many types of environmental services such as those related to national parks and endangered species. The hedonic valuation approach is potentially useful in measuring the loss of amenity value to residents residing near landfill sites.

The ’travel cost’ method of valuation

The travel cost approach can be used in cases where a demand schedule can be derived based on travel costs. This approach might be an appropriate one for estimating the loss of amenity value to society resulting from pollution of beaches by sewage effluent discharges.

Contingent valuation (CVM) or direct demand revealing method

Asking individuals about their willingness to pay for a benefit or to accept compensation for giving it up, is known as the *contingent valuation method* or *CVM*. With this technique hypothetical markets are formulated and respondents are required to make trade offs as they would in actual markets.

If the willingness to pay approach is used individuals are constrained by their ability to pay, that is their income. This is not the case with using the willingness to accept compensation. Which approach is used is determined by who has the original property rights.

APPENDIX G: SCARCITY CONSIDERATIONS

Introduction

Pearce and his colleagues (1989, p. xiv) have formulated the following prescription for sustainable development:

> …to leave to future generations a wealth inheritance - a stock of knowledge and understanding, a stock of technology, a stock of man-made capital and a stock of environmental assets - no less than that inherited by the current generation.

This prescription is made more precise by Pearce et al (1989) in terms of sustainable development as non-declining wealth and in terms of sustainable income. Their prescription can be summarised as follows:

> Sustainable development (as opposed to growth) involves at least all the things that impact on individuals' well-being (or `utility'), and, more loosely, factors such as freedoms and self-respect...Sustaining development in these broader terms involves providing a bequest to the next generation of an amount and quality of wealth which is at least equal to that inherited by the current generation (Pearce et al 1989, p. 48).

Recycling and other potentially resource-saving practices are often viewed as important means to help achieve sustainability because of real or perceived increasing scarcity of materials. For example, according to the ACF-Sydney:

> If we are to achieve the goal of ecological sustainability, then a priority must be to reduce per capita materials and energy use. It is crucial that we become far more conscious about the quantities and types of materials used for consumer goods, the production processes utilised and the methods employed for handling the waste stream.

This appendix examines various scarcity related issues and whether the concerns about the physical availability of materials are valid.

Sustainable development: two views

Sustainable development involves all things that impact on an individual's well-being. It involves providing a bequest to the next generation of an amount of wealth which is at least equal to that inherited by the current generation. (This `constant capital' bequest meets the requirement of inter-generational equity.) The bequest can comprise a mix of man-made and natural capital - in this case it is the aggregate quantity that matters. This requires considerable scope for substituting man-made wealth for natural environmental assets which may be lost over time. Alternatively, the bequest should be such that the next generation inherits a stock of environmental assets no less than the stock inherited by this generation. This stricter requirement will be required if there is not substitutability of natural assets and man-made ones.

In putting this constant wealth concept into practice there is a need to take account of certain constraints. These are irreversibility, non-substitutability and uncertainty. These are discussed briefly here (see Pearce et al 1989, pp. 37-38 for more detail).

Irreversibility means what the term implies: once an environment is changed irreversibly the effect is suffered by the next generation and all generations to come. Taking irreversibility into account means that the concept of sustainable development has to be modified to allow for practical avoidance of irreversible losses of natural assets or adequate compensation for their loss.

Non-substitutability means that we cannot switch between types of capital (natural and man-made). Substitutability can occur up to a point but many environmental assets have no substitutes: for example, the watershed protection functions of forests, the nutrient-trap functions of littoral environments. Where non-substitutability exists there is a need to protect natural environments if constant wealth is to be passed on.

Uncertainty comes in many forms. There is uncertainty about the precise nature of environmental impacts and about how ecosystems function. Because of uncertainty most people are risk averse. There is also uncertainty about technological advances, advances that could allow for greater substitution between natural assets and man-made capital. Most people believe taking risks is not worthwhile if losses are likely to be very large.

What irreversibility, non-substitutability and uncertainty suggest is that it is rational to take into account thresholds and protect essential environmental functions for which there are no substitutes. The situation is more complicated when exhaustible (non-renewable) resources are involved. Pearce et al (pp. 49-50) rely on the theorems developed by Hartwick and Solow to argue that:

> a society ... could enjoy a constant stream of consumption over time provided it invested all the 'rents' from the exhaustible resource

in some form of capital which would produce equal income in the future.

Pearce et al (1989, pp. 127-130) suggest means whereby sustainability can be incorporated in project appraisal (cost-benefit analysis).

This can be done by setting a constraint on the depletion and degradation of the stock of natural capital, but that would be completely unrealistic as few projects would be feasible. Their solution is that at the program level there should be some projects that enhance the natural environment to compensate for those that harm it. The overall result should be zero damage. The practicalities of implementing this compensating project approach require further consideration. As stated above, the achievement of sustainability is even more complex where the project is the exploitation of non-renewable resources (for example, minerals and oil). It is obvious that this type of project would not be permitted if a constraint was imposed which did not allow depletion; furthermore, it is impractical to argue for no depletion. The solution is, in principle, to use some of the profits (resource rents) for investments which bring continued sustainable income for society.

Notwithstanding the arguments advanced by Pearce and his colleagues, two conflicting views of sustainable development have gained currency. The broad interpretation is based on an assumption of a degree of substitutability of man-made and natural capital and the implementation of the compensating project approach. The narrow interpretation, which is argued for by some in the environmental lobby, is that future generations should not inherit less environmental capital than the current generation inherited.

Physical scarcity

Different views of sustainable development can give rise to diverging policy prescriptions. Certainly, as discussed in IC (1990c), the two views on sustainability presented above can have significantly different implications for the management of non-renewable resources (not to mention the biosphere). In a practical sense, however, both criteria agree that a sufficient, although perhaps not necessary, condition for sustainability of a particular resource is to ensure that the physical stock of that resource does not decrease with time. This would fulfil the broad view's requirement of 'providing a bequest to the next generation of an amount and quality of wealth which is at least equal to that inherited by the current generation' while also meeting the narrow view's requirement of 'passing of the natural environment from one generating to the next in a condition relatively unaffected by human activity'.

Preserving the physical stock of a resource is conceptually straightforward in relation to renewable resources. After all, by definition, those resources could be managed so as to produce a constant and unending flow of benefits. More difficult is to determine how such a principle could be applied to non-renewable resources. As argued above, a literal application of the narrow sustainability criterion to non-renewables leads to absurd conclusions. In a strict sense, preserving the services and quality of non-renewables requires forgoing their use altogether - an obviously impossible condition.

While the ultimate solution to the problem may be the application of the Hartwick rule, there is a need to determine the degree of urgency involved; that is, to determine the expected availability of non-renewable materials in the future. The empirical evidence concerning the amount of non-renewables available for use by society, is examined next.

In Australia, the Bureau of Mineral Resources, Geology and Geophysics (BMR) classifies known (identified) mineral resources according to both their degree of assurance of occurrence (based on estimates of tonnages and grades) and their economic feasibility of exploitation (based on variables such as commodity prices and operating costs). Assessments for major mineral commodities at various times are shown in Table G.1.

Table G.1 shows that not only demonstrated mineral resources did not significantly decrease, but in some cases grew at high rates in early years. This is particularly true for bauxite between 1954 and 1975, iron ore between 1959 and 1975, and tin between 1960 and 1975.

In each case, economic demonstrated resources increased at least tenfold[1]. In other cases, crude oil and natural gas, resources became available when before 1965 none had been identified. The phenomenon of growing economic demonstrated resources is not unique to Australia. Table G.2 shows that a similar process has taken place at a global level.

Table G.1: **Australian economic demonstrated resources, major mineral commodities**

Commodity	*Pre 1965*	*1975*	*1985*
	Mt unless otherwise indicated		
Bauxite	21(1954)	3 000	2 889
Black Coal (recoverable)	4 276(1962)	19 500	34 000
Copper (kt)	1 300(1960)	5 900	16 100
Crude Oil (10^6m^3)	n.a.	243	231
Gold (t)	250(1960)	156	959
Iron Ore	374(1959)	17 800	16 220
Lead (kt)	4 300(1960)	13 900	14 500
Natural Gas (10^6m^3)	n.a.	326 100	691 000
Tin (kt)	28(1960)	332	262
Uranium (recoverable)(kt)	n.a.	300	470
Zinc (kt)	4 000(1960)	15 700	11 500

Source: 1988 Yearbook Australia, ABS, p. 592 (BMR estimates).

Tables G.1 and G.2 clearly show that, for the major minerals and fuels included, significant growth in consumption has not led to reduced demonstrated resources. Instead demonstrated reserves have increased. In other words, the world has managed to increase consumption and the known quantity of minerals and fuels.

In relation to the apparent paradox of growing production and consumption accompanied by increased availability of non-renewable resources, Tilton (1977, pp. 9-10) has pointed out that:

[1] Economic demonstrated resources' is the BMR classification combining the maximum degree of geological certainty with the maximum degree of economic feasibility.

Reserves or some multiple of reserves are weak measures of the total available supply of a mineral, suggesting that a stronger measure might be mineral's resource base. The latter, by definition, encompasses all of the material found in the earth's crust and so does not change with new discoveries, technological progress, or fluctuations in prices.

Table G.2: **Growth of world reserves**

		Copper	*Lead*	*Zinc*	*Bauxite*
			millions of tonnes[a]		
	1940s	91	30-45	54-70	1 605
	1950s	124	45-54	77-86	3 224
	1960s	280	86	106	11 600
Reserves: % growth rate/yr 1950s-1970s		7.25	5.0-5.7	4.7-5.2	9.75
Production: % growth rate/yr 1950s-1970s		3.75	1.75	2.75	7.0

a) Near end of decade indicated (gross weight for bauxite).

Source: Crowson, P.C.F. 1982, 'Investment and Future Mineral Production', *Resources Policy*, Vol. 8, No. 1, pp. 3-12.

Table G.3 suggests that the resource base is large indeed. At current production rates, it would take millions of years to deplete that base. However, production of materials has not remained static in the recent past. For example, Table G.5 shows that mineral consumption in the United States grew at an exponential rate of 4.2 per cent over the 1870-1970 period. It is a characteristic of all exponential growth maintained over extended periods that quantities eventually become enormous. Thus, sustained growth in mineral consumption may eventually require dramatic increases in production rates and drastically shorten the life expectancy of the resource base.

For example, Table G.3 shows that a 4 per cent rate of growth in mineral production would reduce the life expectancy of the various minerals included there from several million years to only a few hundred years.

In reality, it is unlikely that all the minerals included in the earth's crust will ever be made available for consumption. Because a significant proportion of those minerals are highly dispersed, increasing production costs and prices would probably suppress consumption much before the depletion of the resource base became a physical constraint on production. Thus, the economic life expectancy of the minerals shown in Table G.3 could be significantly shorter than suggested by the last column in that table. This points to the crux of the problem analysing the availability of materials: the sustainable use of a material is as much an economic issue as a physical one.

Table G.3: **The resource base for selected minerals**[a]

Mineral	*Resource base*	*Life expectancy*	
		Nil growth in consumption	*4 % growth in consumption*[b]
	tonnes	*years*	*years*
Aluminium	1.95×10^{18}	1.22×10^{11}	558
Copper[c]	1.32×10^{15}	2.04×10^{8}	398
Gold	9.6×10^{10}	7.07×10^{6}	371
Iron Ore	1.2×10^{18}	1.28×10^{9}	444
Lead[c]	3.12×10^{14}	1.29×10^{8}	386
Nickel	1.8×10^{15}	2.32×10^{9}	459
Uranium[c]	4.32×10^{13}	1.15×10^{9}	441

a) Based on a total weight (tonnes) of the earth's crust of 24x1018. Average crust abundance from Brooks (1976). b) Continuous rate of growth. c) Estimation based on Western World mine production only.

Source: Commission estimates.

Economic scarcity: early evidence

The economic view of scarcity is concerned with whether the real production costs of materials rise as producers are forced to turn to lower quality materials sources and whether this will force society to curtail consumption.

In their seminal work, *Scarcity and Growth: The Economics of Natural Availability,* Barnett and Morse (1963) found that, with the exception of forestry, from 1870 to 1957 the index of labour-capital input per unit of material produced fell in the United States. Table G.4 shows a summary of those results.

Table G.4: **Movements in real unit costs**
(1929=100)

Years	*Total Extractive*	*Agriculture*	*Minerals*	*Forestry*
1870-1900	134	132	210	59
1919	122	114	164	106
1957	60	61	47	90

Source: H.J. Barnett, 1979, Scarcity and Growth Revisited, Resources for the Future, Washington D.C.

In a later study, Myers and Barnett (1985) examined mineral price patterns to try to detect evidence of increasing mineral scarcity. Table G.5 shows a summary of those results which according to Myers and Barnett (1985, p.10) demonstrate that:

> Despite an extraordinary rise in consumption of minerals, their relative prices generally fell during the 100-year period...[Mineral] prices show no evidence of increasing scarcity; indeed the contrary is true, because each major mineral category reveals a decline in relative price for the entire period.

Other authors have argued that mineral prices follow U-shaped paths and that the decline in mineral prices will be eventually reversed. For example, according to Hartwick and Olewiler (1986), mineral prices tend to increase as declining ore grades increase the costs of extraction. This tendency to higher costs (and prices) can be initially offset by technological change. But eventually technological change becomes unable to offset the cost increases due to declining ore grades and costs and mineral prices rise. Hartwick and Olewiler (1986) cite an analysis by Slade (1982) which, based on prices for the 1870-1978 period, suggests that mineral prices have in fact followed U-shaped paths. In particular, Slade found that for every mineral analyzed, price had passed the minimum point on the U-shaped curve by 1978.

The evidence cited by Hartwick and Olewiler (1986) suggesting that mineral prices have increased during recent years is consistent with Myers and Barnett's warning that:

> By 1970, however, a number of developments had appeared that raised questions regarding the validity of price trends as indicators of changes in relative scarcity, and in the continuation of the price patterns themselves. These developments include an increasing awareness of the impact of mineral extraction and use, and an increase in the strength of cartels among suppliers of imported minerals (Myers and Barnett 1985, p.10).

Myers and Barnett (1985) argue that the production of basic materials was among those most strongly affected by the increasingly stringent environmental and occupational regulations. According to them, another strong influence capable of producing higher materials prices was the sharp rise in oil prices, brought about by the actions of OPEC in 1973. Increased oil prices spread through the economy, affecting the prices of other fuels and electricity and the production costs of most materials.

The issue then arises of whether the relative decline in minerals prices shown in Tables G.4 and G.5 was reversed during the 1970s and 1980s. In other words, the question is whether there has been a distinct break from the 100 years evidence mentioned above. The following section examines this issue.

Economic scarcity: recent evidence

The previous discussion provides a rationale for formulating the following hypothesis: the trend in the (real) price of materials during the pre-1973 years (ie previous to the first oil shock) changed after the 1973 oil shock.

A test of this hypothesis was carried out with a simple trend analysis.[2] The test was applied to selected minerals and fuels, forest-based materials, and materials used as inputs in agriculture.

[2] A regression estimate of the model $Log_e(P_t)=a+bD_t+cTime_t+dD_tTime_t$ (eq 1) was used in the analysis. In this equation $Log_e(P_t)$ is the natural logarithm of the real price of a material in year t, D_t is a dummy variable with value of zero up to 1972 and value of one thereafter, and $Time_t$ is the year minus 1954. a, b, c, and d are constant coefficients to be estimated. An estimate of the trend before 1973 is given by the value of c. If the estimate of d is significantly different from zero, it indicates that the trend changed after 1973 from the pre-1973 period. If the estimates of both c and d are statistically significant, then their sum measures the trend during the post-1973 period.

The time periods considered varied according to data availability. The relevant intervals and trends are included in Table G.6. The real or deflated price series for each material considered are plotted in Figure 1 together with the trends obtained from equation 1.

Table G.5: **Changes in relative prices and consumption**

Mineral Category						
Average Annual Rates of Change (%)[a]						
	1870 -1890	*1890 -1910*	*1910 -1930*	*1930 -1950*	*1950 -1970*	*1870 -1970*
Fuels	-5.4	-0.5	1.2	0.6	-1.0	-0.4
Metals	-1.9	0.5	-3.3	1.1	-0.5	-0.7
Non-fuel,non-metal	-4.9	-1.3	-3.1	-2.1	-1.3	-1.5
All Minerals	-5.0	-0.6	-0.3	0.1	-1.0	-0.7
US Mineral Consumption, Value (Millions of 1967 US dollars)[b]						
	1870	*1890*	*1910*	*1930*	*1950*	*1970*
Fuels	258	995	3 104	5 426	9 748	19 651
Metals	64	349	1 143	1 450	3 021	3 691
Non-fuel,non-metal	134	535	689	985	1 650	3 984
All Minerals	456	1 878	4 936	7 860	14 419	27 326
US Mineral Consumption, Annual Average Rate of Change (%)						
	1870-1970					
Fuels	+4.4					
Metals	+4.1					
Non-fuel,non-metal	+3.5					
All Minerals	+4.2					

a) Minerals prices divided by GNP deflator. b) Physical quantities valued at 1967 prices.
Source: Myers and Barnett (1985), Tables 1.1.1 and 1.1.2.

In the case of fuels, Figure G.1 and the results in Table G.6 indicate that no trend was discernible before 1973. While it is clear that the 1973 oil-shock resulted in a significant increase in petroleum prices, this increase took the form of a discrete jump rather than a sustained trend towards higher prices. This feature is important in explaining the price trends of other materials because while it is true that the world has had to adjust to substantially higher energy prices, there has not been a clear upward trend in those prices after the 1973 oil shock. Note that neither the slightly positive post-1973 trend for petroleum nor the negative one for coal included in Table G.6 and plotted in Figure G.1 are statistically different from zero at the customary 95 per cent confidence level.

The 1973 oil shock coincided with major changes in the price trends of forest-based product. Figure 1 suggests that this is especially true in the case of pulp and newsprint although changes are also apparent for logs, sawnwood and rubber. Table G.6 shows that the upward trends in the price of logs both before and after 1973 are not significantly different from zero. The post-1973 upward trend in the price of newsprint is, however, statistically significant and represents a dramatic break with the statistically significant negative pre-1973 trend.[3] The negative price trends associated with all other forest-based products before 1973 continued during latter years. In particular, the considerable downward trend in rubber prices persisted.

Figure G.1 indicates that the 1973 oil shock was associated with a substantial jolt on the price trends of materials used as inputs in agriculture. The effect was brief to the extent that in all cases the pre-1973 downward trends resumed during the post-1973 period. Table G.6 shows that those downward trends were statistically significant except for superphosphate which, nevertheless, appears to be closely related to the phosphate rock price as expected.

If the test results are valid, the meaning is that various materials (eg petroleum, coal, bauxite, logs, sawnwood, plywood and newsprint) have become relatively more scarce since 1973 which is a reversal of the trend found for the preceding 100 years by Myers and Barnett (1985). Those results would also confirm the U-shape price paths suggested by Hartwick

3 Note that of all the materials studied, only petroleum, logs, and newsprint were associated with upward prices during the post-1973 period and only the latter was statistically significant.

Table G.6: **Comparison of relative price changes of materials**

(Average Annual Rates of Change, %)

Group	*Material*	*Pre-1973 Trend*[a]	*Post-1973 Trend*[b]	*Period Analyzed*
Fuels:				
	Petroleum	+0.0	+1.13	1955-89
	Coal	+1.1	-3.6	1965-89
Metals:				
	Aluminium	-1.7	-0.7	1957-89
	Bauxite	+1.3	-0.1	1965-87
	Copper	+1.6	-4.2**	1955-89
	Lead	-1.8	-5.8**	1955-89
	Tin	+1.3	-5.2**	1955-89
	Iron Ore	-5.2*	-4.6	1955-89
Forest-Based Products:				
	Logs	+0.3	+1.2	1958-89
	Sawnwood	-0.8	-0.6	1958-89
	Pulp	-3.3*	-1.4	1955-88
	Plywood	-0.5	-0.5	1963-89
	Newsprint	-1.7*	+0.2**	1955-89
	Rubber	-7.0*	-4.5**	1955-89
Agricultural Inputs				
	Potash	-3.5*	-2.9	1955-89
	Urea	-7.3*	-7.2	1957-89
	Phosphate Rock	-4.3*	-5.3	1955-89
	Superphosphate	-2.5	-6.2	1963-89

a) c in equation 1. b) c plus d in equation 1. The statistical test refers to the significance of d being different from zero.

*Significantly different from zero at the 5 per cent probability level. **Significantly different from the pre-1973 trend at the 5 per cent probability level.

Source: Commission estimates based on prices from International Financial Statistics, IMF, Washington. The original prices (all in nominal US dollars) were deflated using the US GDP price deflator (1985=100).

and Olewiler (1986). However, to the extent that the non-competitive market behaviour of OPEC played a major role in the observed price rises, depletion of resources does not seem to be the main explanation for the observed post-1973 patterns.

This interpretation is consistent with the downward price trends identified for most of the materials analyzed which suggest that prices have fallen as the OPEC's market power has weakened. In summary, the conclusion reached by Myers and Barnett (1985, p.17) in 1983 is still accurate in 1991:

> It appears to be too early to conclude that declining historical price trends in minerals have been reversed. The durability and strength of OPEC or similar cartels, the full but as yet unknown cost of environmental protection, and exchange rate developments will all affect the outcome. As of 1983, however, there is not convincing evidence that minerals are truly becoming relatively more scarce.

The role of technology

A critical consideration for sustainability is whether the overall cost of supplying materials increases with cumulative production. The price evidence included above shows that for most materials this has not been the case in the past. At the centre of that process are changes, mostly in technology, that have allowed society to produce more final goods and services with lower quality materials. Those changes can (and have) effectively expanded society's production frontiers in various directions.

For example, in the case of iron ore the decreasing availability of high grade iron ores can be offset by new mining techniques which make available increasing quantities of lower-quality ore or by new steel-making technology which allows the same quantity of steel to be made with less raw materials. If those mechanisms fail to offset cost increases brought about by lower grade iron ores, materials substitution permits replacing steel with such products as concrete, wood or aluminium. And of course increased steel recycling may make possible replacing increasingly expensive iron ore with steel scrap as an input in steel-making. However, whether increased recycling will actually take place depends on the interaction of supply and demand factors in various steel-related markets. In summary, numerous forms of scarcity-offsetting technological changes can (and usually do) take place at every stage in the production chain.

Figure G.1: **Real prices and trends for selected materials**

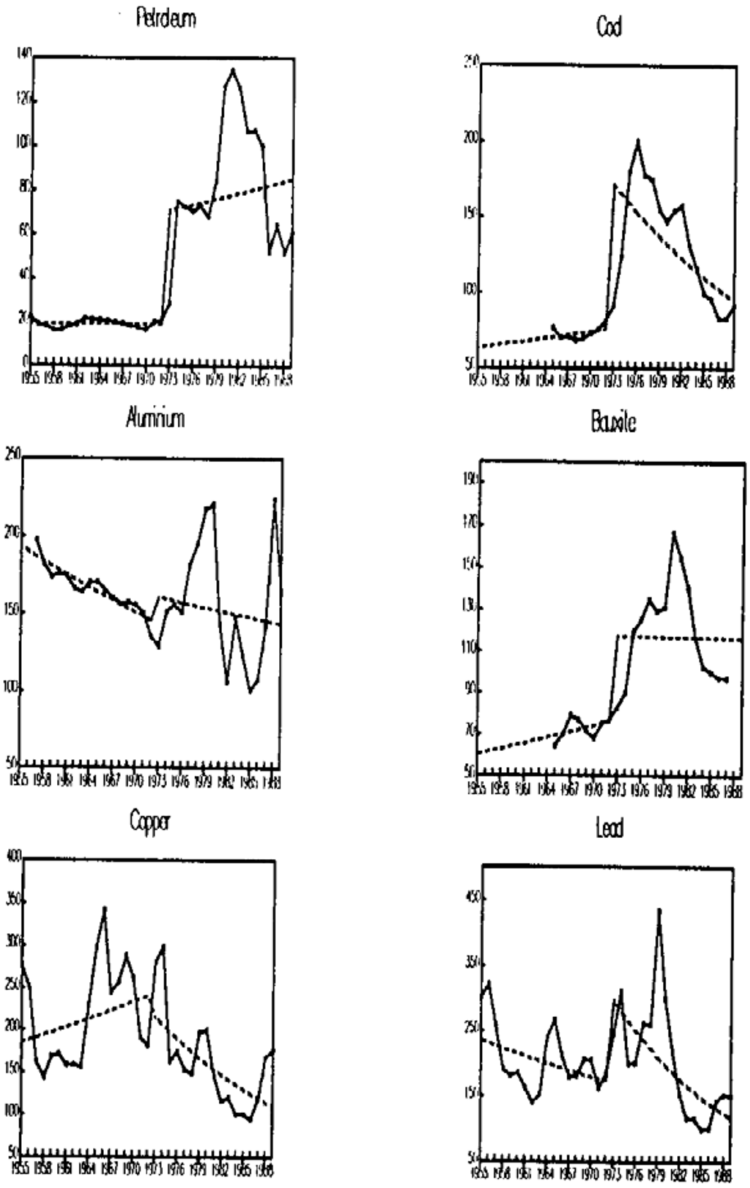


Figure G.1 (cont): **Real prices and trends for selected materials**

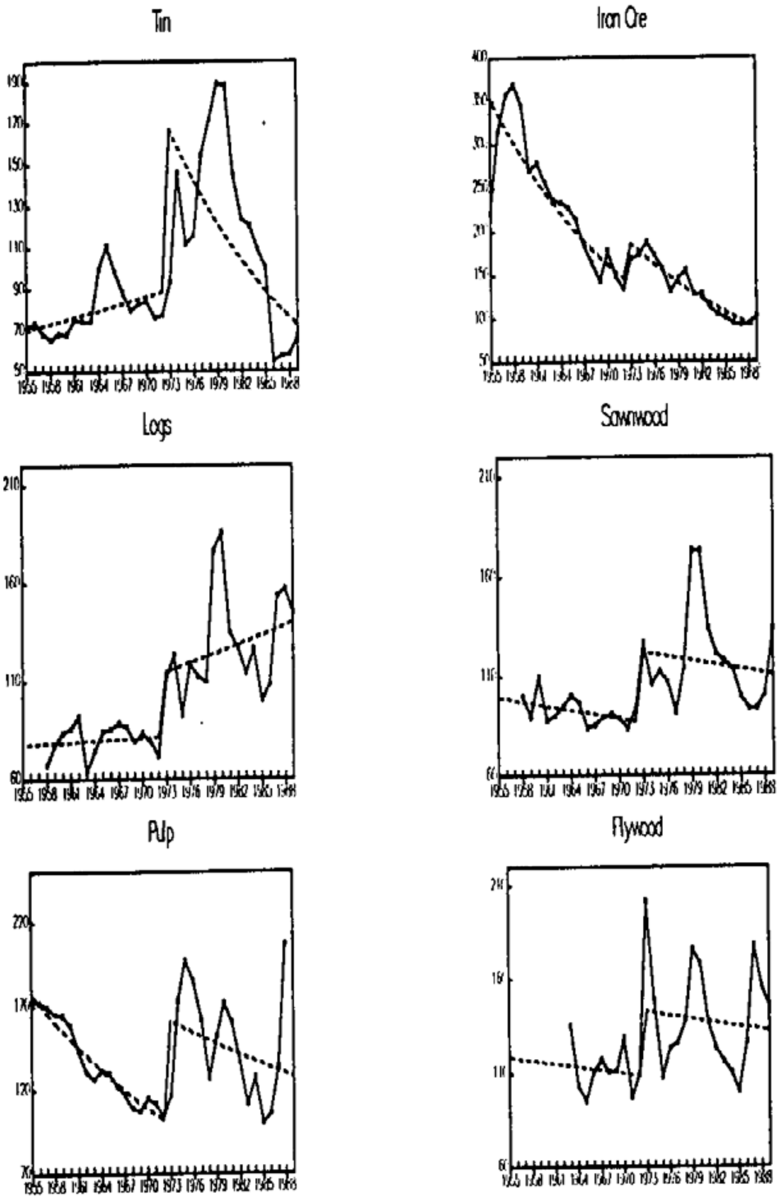
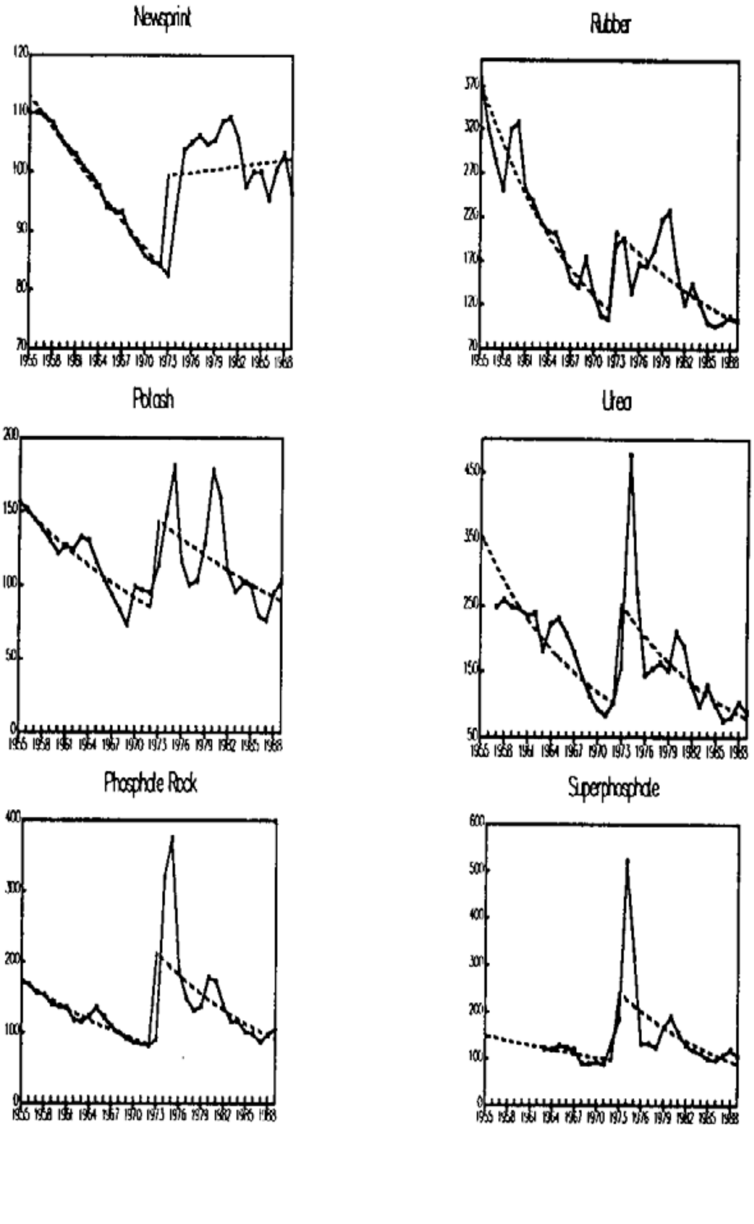


Figure G.1 (cont): **Real prices and trends for selected materials**



Given that society's resources - including the natural environment, labour, capital and technological know-how - are limited, choices must invariably be made in relation to how to offset the effect of lower quality materials sources. Choosing a set of solutions necessarily entails forgoing, at least in part, some other alternatives. Thus, a crucial problem is to determine how best to search for the most efficient combination of solutions. In view of the complexity of the interrelation between markets and the many forms in which technological progress can affect and be affected by costs at various stages of production, determining that combination is probably best left to the market system. That system has succeeded for at least one century in preventing the price of most materials from substantially rising despite great upheavals in the energy markets and more stringent environmental regulations.

Conclusions

The analysis of price trends reveals that, over the century to the 1970s, the real price of the various materials examined declined. This indicates that while some materials sources were depleted, there was declining economic scarcity as new sources were discovered and technological progress affecting the supply and demand for materials more than offset the physical depletion effect on prices. Since then, a sharp break with past trends occurred for most materials at around 1973. The upward shift that occurred seems to have been associated with the sharp increase in petroleum prices that resulted from the non-competitive market behaviour of OPEC rather than from increased economic scarcity.

A final key point that can be made from this analysis is that whether the costs of materials production will rise in the future is an open question. The answer depends on whether technological progress will offset the declining quality of materials sources and the more stringent environmental regulations likely to be imposed in the future. The analysis of what has been happening to materials prices over the long term suggests that - because the same forces that have been at work in the past, in some cases for centuries, will probably play a significant role in the future - the physical scarcity of materials is unlikely to become a significant problem in the foreseeable future.

APPENDIX H: FORESTRY

Chapter 6 discussed the possible effects of higher sawlog royalties and shorter forestry rotations on the incentives to recycle paper.

The first section of this Appendix discusses whether sawlog royalties and non-wood charges could be higher than they currently are. Subsequent sections give a general discussion of some broad forest management issues and the variety of ways in which timber and environmental values interact; the effects on harvest rates and log supplies of requiring higher rates of return; the effects of raising royalties and non-wood charges on harvest ages; and the effects of withdrawing forests from production for conservation reasons.

Forest values

Over the last two hundred years, 50 per cent of Australia's forests and 75 per cent of its rainforests have been cleared (CSIRO 1989). Today, native forests cover only 5 per cent of Australia's land area.

Most native forest is dominated by various species of eucalypts, with the balance consisting of cypress pine and rainforest timbers. Native forests provide valuable sources of timber for the sawn-timber industries and pulp and paper manufacture, as well as a variety of environmental or non-wood services.

Around 75 per cent of native forests are publicly owned. Consequently, the ways in which governments allocate forest resources to wood and non-wood uses are crucial in determining the mix of 'wood' and 'environment' which is supplied.

Some forests are set aside for their conservation values. Most other forests are managed under multiple-use management regimes, supplying both wood and non-wood outputs. The method of harvesting, and the ages at which trees are harvested, will largely determine the mix of wood and non-wood outputs that is available from multiple-use forests.

The royalties that forest managers receive should reflect the market value of trees either as a source of logs or as a source of non-wood values, as well as the value of the land itself and the costs of providing infrastructure such as roads. In general, the wood values of trees for sawlogs increase with tree size, as larger logs can be used to produce higher-valued products. Also, the larger the tree, the lower the costs of sawing per unit of sawntimber produced. However, the sawlog values of very mature trees decline because of the increasing number of defects in the wood.

In the case of pulplogs, log size is less important and, in fact, younger trees are preferred for most kinds of pulp because they produce a lighter pulp and hence require less treatment.

Forests’ environmental values depend upon the kinds of trees and the age structure of a forest (Australian Biological Research Group 1989). Mature eucalypt forests with a range of tree species support a greater number and diversity of native animals than do younger or less diverse forests. Stream flows may be low while young regrowth forests are growing quickly, but increase as the forest reaches maturity. They may be substantially reduced if eucalypt forests are converted to pine plantations, because of the closer canopy. Native shrubs and plants may be abundant in young pine plantations, but become suppressed as the plantation matures and the canopy closes. Thus some non-wood values may be higher in younger forests, while others will be higher in more mature forests.

For some environmental values, the mix of ages of trees in a forest is even more important than the forest’s maturity. Mixed age forests provide a range of habitats for wildlife, for example in clearings left by natural mortality or harvesting, in shrubs encouraged by young regrowth forest, in the canopies of mature trees, and in the hollows of `over mature' trees. Recreational and aesthetic values are also probably higher for older and more diverse native forests than for pine plantations.

Either setting forests aside for a particular use, or managing them for multiple uses, is an appropriate management practice, depending upon the quality of the forest, its age and age-mix, etc (Bowes and Krutilla 1985). However, the ways in which rights to use forests are allocated will strongly influence the prices that forest managers receive through royalties and non-wood charges.

In multiple-use forests, these prices also provide the incentives for forest managers to choose a particular management regime, thereby choosing a particular balance of ‘wood’ and ‘environment’.

Harvesting rights for pulp and sawlogs are often allocated to mills under long-term concessions which guarantee log supplies to particular mills. While long-term concessions confer security of tenure which can be important where large scale investments are required, the apparently close relationship between forest services and mills in royalty negotiations has lead to the belief that royalties are lower than they should be.

Security of tenure itself does not require particular mills to have guaranteed log supplies. Security could be facilitated by forest services guaranteeing to supply a particular volume of logs to the market, but with competition between mills for a share of this volume through periodic tenders or auctions for concessions. This would not require forest services to guarantee to supply any particular mill as at present (ABARE 1990b).

One method of determining whether royalties are lower than they might be in a more competitive market is to examine the prices at which harvesting licences are sold. In most States, licences cannot be traded directly, but can only be transferred through the sale of a mill. If royalties are below the market value of logs, the rents conferred will be capitalized into mill sale prices.

There is evidence that mills sell for significantly more than the value of their capital assets (Byron and Douglas 1981). In Victoria, licences recently became transferable. Again, if royalties are below their market value, the rents will be capitalized into licence values. ABARE has found that the prices at which these licences are traded were equivalent to roughly 40 per cent of the sawlog royalty in 1989-90 (ABARE 1990b). That is, wood processors were willing to pay 40 per cent more than the royalty for their sawlogs.

Many forests’ environmental services are provided for very low, or even zero, prices in the market. Recreational users pay only nominal entry charges, if any, to national parks and State recreational areas. Water authorities do not pay forest services for maintaining their water catchments.

It may be relatively easy to charge entry fees for recreational users, particularly in forests where recreational use is heavy and revenues would more than cover the costs of administration.

Similarly, water authorities could enter into supply agreements with forest services to provide a return to the forest service from protecting water catchments.

Other environmental services are difficult to price in a market. Preservation and wilderness values may provide benefits which are spread across both current and future generations of Australians. Maintaining the genetic diversity supported by forests may benefit people around the world.

However, some, though not all, preservation and wilderness values can be priced in a market. For example, conservation easements would allow environmental groups, recreational clubs, tourist resorts or other groups to lease the rights to a particular forest area. Conservation easements, as well as outright purchases of land by conservation and recreational groups, are used in some parts of the United States to ensure the continued supply of wildlife habitat, recreational and other environmental values (Tasman Economic Research Centre 1990). They provide evidence that people are prepared to pay for at least some non-wood uses of forests.

If forests are to be used to provide the most valuable mix of wood and environmental values, forest managers need to ensure that they are informed about the value of forests' outputs. This means that royalties should reflect the market value of logs, and that, where possible, environmental services should be priced in markets, or at least have some value attached to them.

Thus there may be scope for improving the institutional environment in which forest use is decided, for example through the introduction of greater competition between different wood users for the rights to harvest forests, and the use of non-wood charges where feasible (Tasman Economic Research Centre 1990). However, as discussed in a later section of this Appendix, the inclusion of environmental values can complicate the decision as to when to harvest.

Choosing harvest rates

For wood production

The previous section suggested that lack of competition in the allocation of harvesting concessions could lead to log royalties being lower than they should be.

There is some evidence that this is in fact the case. In addition it would seem that non-wood charges could also be higher. This section further examines the question of whether forest uses are under-priced by looking at harvest rates given the rates of return forest services are required to earn. The assumption in this section is that forests are being managed solely for wood production. Environmental considerations are introduced in the next section.

Most forest services are now required to earn a 3 or 4 per cent rate of return. The Commission was unable to establish whether this applies to the stock of trees, the land and the infrastructure, or or only to one or two components of investment. If confined to the stock of trees, the rate of return to a forest is a function of the trees' growth rates and the ages at which trees are harvested.

A young forest may have low timber values because of the low volume of timber, but these values would in general rise quite quickly as the trees mature and the market value per cubic meter increases. In contrast, the wood values of mature forests grow more slowly as growth rates slow down and the number of defects start to rise. Ultimately the wood values in a mature forest can start falling as the trees stop growing but the number of defects keep increasing.

The trees in a forest may thus be treated as a capital investment. The growth in revenues achievable as the trees grow represents a rate of return to the standing forest. As the trees can always be harvested and the revenues invested elsewhere in the economy, the trees should be left to grow as long as the rate of increase in their value, net of management costs, is greater than the rates of return obtainable on other investments.

In the case of a young forest with timber values rising quickly, the standing forest is likely to generate high timber returns. As long as these returns are higher than could be earned elsewhere, a forest manager would not choose to harvest. Once the returns fall below the market rate of return, either because interest rates rise or the trees' growth rates slow down, the forest manager can better serve his shareholders by harvesting and investing the proceeds in a younger more productive forest or another asset. The key choice facing the forest manager is thus the age at which the trees should be harvested in order to maximize returns to the shareholders. In the case of publicly owned forests, the 'shareholders' are the public in whose name the forests are owned and managed.

The rate of harvest can thus be more accurately described by the ‘age’ (or maturity) at which trees are harvested. The harvest age has significant implications for the rates of return currently being earned by forest services, as well as for the volume of timber that can be supplied, and the supply of environmental services.

Modelling forestry

A simple net present value model of forest production is used to calculate optimal harvest ages. The objective is to maximize the present value of royalty revenues received from both sawlog and pulplog sales. Since trees grow over time, there will be a particular harvest age, which, given an interest rate at which future revenues are discounted, will maximize the net present value of royalty revenues. The assumption is that forests are managed solely to supply wood; environmental values are introduced later.

Data on the costs incurred in the management of native forests have not been included. Since higher management costs have the effect of increasing optimal harvest ages, their exclusion means that the optimal harvest ages shown below may be under-estimated, and the value per hectare over-estimated.

Optimal harvest ages will also depend significantly on local topographic, soil and climatic conditions, as well as market conditions. In other words, optimal harvest ages are partly a function of biological growth rates, and partly a function of market prices for wood and interest rates. As a consequence of the dynamic nature of the market, there is no unique optimal harvest age determined by biological conditions alone.

Keeping in mind these simplifications, the problem can be modelled in the following way, where λ represents the net present value of royalty revenues (Nguyen 1979):

$$\lambda = \max PV(t)\exp^{-rt} + PV(x)\exp^{-rt'} / (1 - \exp^{-r(t'-t)}) \quad \text{eq. 1}$$

P is the (current) royalty per cubic meter of wood harvested, V(t) is the volume per hectare of timber available at thinning age(s) t, V(x) is the volume of merchantable sawlog timber per hectare available at harvest age x, (t’-t) represents the rotation period, or years, between harvests, and r is the real market interest rate.

The thinning age(s) T and final harvest age X which maximize λ must satisfy the conditions:

$$dV/dt = r \{V(t + V(x)exp^{-r(t'-t)} / (1 - exp^{-r(t'-t)})\} \qquad \text{eq. 2}$$

$$dV/dx = r\, V(x)/(1 - exp^{-r(t'-t)}) \qquad \text{eq. 3}$$

The interpretation of these conditions is that the growth in royalty revenues which is possible as the trees grow larger, shown as dV/dt and dV/dx, must at least compensate for the interest income forgone by delaying harvesting. This income forgone is the interest which could have been earned by harvesting the trees and investing the money in an alternative asset, shown by the terms on the right hand sides of equations 2 and 3.[1]

Forest yields, corresponding to the volumes of wood per hectare at different ages V(x), are shown in Table H.1 (Borough, Incoll, May and Bird 1984). The yields shown for alpine and mountain ash are for unthinned stands, while that for blackbutt was based on a thinning at 8 years (Borough et al 1984). However, since thinning can improve future yields, data available from other alpine ash trials, showing the effects of thinning, have been used to scale up the yield from the unthinned alpine ash stand prior to calculating the net present value and optimal harvest age for alpine ash.

The results presented in Table H.2 for alpine ash are thus based on a light thinning at 7 years. These thinnings were assumed to raise the volume of wood per hectare by 17 per cent, in comparison with an unthinned stand, by the time the trees reached the age of 15. It was not possible to calculate the effects of thinning on future yields for the other species.

The optimal harvest ages are the ages at which the net present value of the harvest is greatest, given the royalties which are received and the rate at which future revenues are discounted. Net present values and optimal harvest ages were derived under the assumption that only 30 per cent of the sawlog harvest can be sold at the sawlog royalty rate. The other 70 per cent of the harvest was assumed to be logging waste which must be sold at the lower pulplog royalty rate.

[1] The denominators on the right hand sides are the periods over which revenues from the next harvest must be discounted. If a forest is being selectively harvested, (t'-t) is the period between one selective harvest and the next. If a forest is being clearfelled, (t'-t) collapses to t, the rotation (harvest) age.

This is an average sawlog/pulplog yield from a reasonably productive forest - less productive and old growth forests may only yield 10 per cent sawlogs.

Table H.1: **Yields of selected hardwood species**

				Volume of Timber (m^3) per Hectare	
Age (years)	*Alpine Ash (Bago,NSW)*	*Blackbutt (southern QLD)*	*Mountain Ash (Toolangi, VIC)*	*Silvertop Ash[a] (eastern VIC)*	*Wet Regrowth (Tasmania)*
-	-	-	-	-	-
8	-	0	-	-	-
10	92	-	-	-	-
15	168	-	-	-	-
19	-	160	-	-	-
20	252	-	-	221	-
23	-	229	-	-	-
25	337	-	382	-	-
27	-	288	-	-	-
30	430	-	485	342	251
35	508	-	579	-	-
37	-	365	-	-	-
40	574	-	638	453	311
43	-	427	-	-	-
45	631	-	716	-	-
49	-	468	-	-	-
50	682	-	787	534	337
55	725	-	814	-	-
60	763	-	839	592	359
70	822	-	-	-	380
80	861	-	-	-	401
90	892	-	-	-	419
100	915	-	-	-	430
110	934	-	-	-	434
120	949	-	-	-	436
130	960	-	-	-	-

a) Average yield from three sites.

Source: Tasmanian yield data supplied by Margules and Partners. Alpine ash data from Forestry Commission of NSW (1986), *Management Plan for Bago-Maragle Area*. Other eucalypt yield data from Borough et al, 1984.

In addition, sawmills cannot cut logs into sawntimber if the log's mid diameter is much below 40 centimeters (Page 1984). It was thus assumed that only the pulplog royalty was available from trees harvested at a diameter of less than 40 centimeters.

Most forest services are currently required to earn a 3 or 4 per cent rate of return. Optimal harvest ages are presented which give a 4 per cent real rate of return to the standing forest under existing royalties. They range from 10 years for alpine ash to 40 years for mountain ash (Table H.2).

The most striking implication of the results is that under current royalties, the optimal harvest ages are so low - and the trees so small - that very little of the harvest would be suitable for sawlogs. Under current royalties and a requirement to earn a 4 per cent return to the forest, only the trees harvested from mountain ash and Tasmanian regrowth would be large enough to be used for sawlogs.

Table H.2: **Optimal harvest rates under 1988-89 royalties**

	Alpine Ash (Bago, NSW)	*Blackbutt (southern. QLD)*	*Mountain Ash (Toolangi, VIC)*	*Silvertop Ash[a] (eastern VIC)*	*Wet Regrowth (Tasmania)*
Pulplog royalty($/t)	11.32	6.83	9.00	9.00	13.54
Sawlog royalty($/m^3)	25.06	13.52	20.75	20.75	14.76
				For 4% ROR to forest:	
NPV ($/ha)	3800	1000	2000	1600	1500
Optimal harvest age(years)	10	23	40	20	30
				For 8% ROR to forest:	
NPV ($/ha)	1600	300	540	500350	
Optimal harvest age (years)	10	19	25	20	30

Sources: Royalties from State Forest Services' Annual Reports (1988-89). Harvest ages and land values are Commission estimates based on Table H.1 and equation 1.

While these calculations have not taken into account any silvicultural constraints which might prevent a rotation as short as 10 years, it is nevertheless fairly clear that, were these native forests to be managed so as to maximize the returns from wood production, from a financial point of view it may only be worthwhile managing these forests on short rotations. As noted earlier, the exclusion of management costs means that the optimal harvest ages may be somewhat higher than calculated here.

Optimal harvest ages which would yield an 8 per cent real rate of return were also calculated, in order to illustrate the effects of higher interest rates. The real rate of return on 10 and 20 year Treasury bonds has averaged 5 per cent over the last 10 years (Reserve Bank of Australia various years, Treasury 1990). It has also been reported that required rates of return after tax in the manufacturing sector have averaged 10 to 13 per cent (Australian Manufacturing Council 1990). Thus market rates of return may be higher than the 4 per cent rate required of State forest services.

A higher market interest rate means that the returns that can be earned on alternative investments have increased. Since young trees have higher growth rates, reducing the age at which they are harvested will increase the rate of return earned by growing trees. Thus, requiring a forest service to earn an 8 per cent return rather than 4 per cent, would reduce the optimal harvest age for mountain ash from 40 years to 25 years, and of blackbutt from 23 to 19 years.

Another important influence on the optimal harvest age is the availability of a pulpmill. The alpine ash forest at Bago, for example, is not close enough to a pulpmill to be able to sell the pulpwood produced with the sawlog harvest. Thus the pulplog royalty is effectively zero for the alpine ash.

The optimal harvest ages in the absence of pulplog royalties are shown in Table H.3. Without the sale of pulplogs, the optimal harvest age for alpine ash is 50 years rather than 10, and for blackbutt it is 43 rather than 23 years under a 4 per cent discount rate. The data did not extend far enough to be able to calculate the optimal harvest age for silvertop ash as the trees are not large enough for sawlogs until sometime after 60 years.

Table H.3: **Optimal harvest ages under sawlog royalties only**

	Alpine Ash	*Blackbutt*	*Mountain Ash*	*Silvertop Ash*	*Wet Regrowth*
				Optimal Harvest Ages (years)	
4% Return to Forest	50	43	40	>60	30
8% Return to Forest	50	43	40	>60	30

The availability of a pulpmill can thus significantly change the economics of forest management. Revenues from pulplogs, which can be earned much earlier than revenues from sawlogs, mean that the financial returns to a forest manager from a shorter pulplog rotation can be significantly higher than the returns from a longer rotation, despite the fact that longer rotations produce more sawlogs which attract a higher royalty. This conclusion does not necessarily hold if sawlog royalties increased with log size. This is discussed next.

The effects of higher royalties for larger trees

Optimal harvest ages for various forests under existing royalties were shown to range from 10 years to 40 years, although these were somewhat higher where there were no pulplog sales.

In practice, of course, most forest services adopt considerably older harvest ages than those derived above. Ash forests in Tasmania and Victoria are currently harvested at around 80 years. Alpine ash in NSW is harvested between 50 and 90 years, while blackbutt in Queensland is harvested at around 110 years with a minimum age of 40.

The evidence is not sufficiently strong to allow the conclusion to be drawn that harvest ages are inappropriate in the alpine ash and blackbutt forests. Nevertheless, it would seem that forests in Victoria and Tasmania are being left to grow for too long from a wood production point of view. Rates of return on these forests could be increased either by reducing harvest ages, ie managing the forests for pulplogs rather than sawlogs, or by raising sawlog royalties.

Given that larger trees are more valuable for sawlogs, it would be appropriate for sawlog royalties to increase with log size. If royalties did increase with log size, optimal final harvest ages could be higher than those derived in Tables H.2 and H.3.

While most forest services do not explicitly charge higher royalties for larger sawlogs taken from native forests, many do include a ‘quality’ component of which log size is one aspect. However, the Commission was unable to obtain details on the relationship between average log size and average royalties. Thus the optimal final harvest ages were derived under the assumption that sawlog royalties do not depend on log size (or quality), based on published information on royalties from forest services’ Annual Reports.

Table H.4 shows the sawlog royalties required to earn the same net present value of royalty revenues from longer rotations ie, the royalties required to financially justify, for example, an 80 year rotation rather than a 30 year one for Tasmanian regrwoth, or a 10 year rotation for alpine ash. It is important to note that the pulplog royalty for alpine ash has not been assumed to be zero. This is because the alternative to raising sawlog royalties would be to shorten rotations as a way of maximizing the rate of return (assuming that a pulp mill could be constructed). It is important therefore that estimates of sawlog royalties required to extend optimal harvest ages take into account the fact that the alternative is to harvest earlier.

Table H.4: **Increases in sawlog royalties needed to justify long rotations**

	Current optimal harvest age	*Sawlog royalty needed to extend optimal harvest age to:*					
		40	*50*	*60*	*70*	*80*	*90 years*
	years				*$/m3*		
Alpine ash	10	35	58	93	145	224	339
Tasmanian regrowth	30	32	64	109	173	263	395

Source: Commission estimates based on Table H.1.

For example, the optimal harvest age for alpine ash under existing royalties (including the pulplog royalty) is 10 years. Table H.4 shows that the sawlog royalty would need to rise to $58/m3 in order to earn the same return from a

50 year rotation as from a 10 year rotation.[2] In other words, if the forest owner could receive \$25.06/m^3 for sawlogs from 10 year old trees, or \$58/m^3 for sawlogs from 50 year old trees, he would wait 50 years before harvesting under a 4 per cent interest rate. The sawlog royalty for Tasmanian regrowth would need to increase from \$14.76 to \$238/m^3 to financially justify an 80 year rather than a 30 year rotation.

Charging higher royalties for sawlogs taken from larger, more mature trees, can thus delay the optimal age at which trees are harvested. As the royalty increases required may be substantial, this suggests that forest services are not currently meeting the requirement to earn a 4 per cent rate of return. It also suggests that a more feasible way of raising rates of return might be to shorten the rotation ages rather than raising sawlog royalties. This would mean, for example, that Tasmanian regrowth would be harvested at 30 years rather than 80.

Table H.5 **Changes in log supplies from shorter rotations**

	Alpine Ash	*Blackbutt*	*Mountain Ash*	*Silvertop Ash*	*Wet Regrowth*
Current harvest age (years)	50-90	40-110	80	80	80
Optimal harvest age with sawlog and pulplog royalties (years)	10	23	40	20	30
Change in log supplies (%)	-32	0	14[a]	12[a]	68
Optimal harvest age with sawlog royalties only (years)	50	43	40	>60	30
Change in log supplies (%) 68				14[a]	-

a) As yield data do not extend to 80 years for these species, these are the changes in log supplies from reducing harvest ages from 60 years rather than 80.

Source: Commission estimates based on Table H.1

2 In chapter 6 (Table 6.1) the pulplog royalty for alpine ash was assumed to be zero. Thus the percentage increase in the sawlog royalty required to justify a 90 year rather than a 50 year rotation was considerably lower than that shown in Table H.4.

Given the more frequent harvests and greater growth rates of younger forests, shorter rotations would increase the allowable cut of Tasmanian regrowth by around 68 per cent, and of mountain ash by around 14 per cent. The results are shown in Table H.5.

The effects of environmental values

The previous section derived optimal harvest rates under the assumption that forests are managed solely to provide wood. Thus the values of environmental services were ignored.

It was shown that actual harvest ages are often higher than the optimal harvest ages which would maximize the returns to forestry. The long rotations currently used may, however, reflect a concern to protect the non-wood values of forests.

The acknowledgement of environmental values can complicate the decision as to when best to harvest. Environmental values generally increase with the age of the trees, as do wood values. Environmental values also increase with the age diversity of a forest, whereas the reverse is true for wood values. In addition, environmental values may depend upon the characteristics of neighbouring forests; an 'over-mature' forest next to a very young forest may be less valuable as a wildlife habitat or recreation area than a single mixed age forest.

Inclusion of environmental values thus mean that harvest ages should be greater in forests managed for multiple uses compared with forests managed solely for wood production. How much higher will depend upon the current age of the forest and the rate at which environmental values are expected to grow relative to the wood values. In a young regrowth forest, for example after a major bushfire, some environmental values may not become significant for many years. During this time it may not be worthwhile forgoing commercial harvests, since both future harvest revenues and future environmental returns will be heavily discounted.

In a mature forest, the environmental values could be sufficiently high to warrant leaving the forest unharvested, since harvesting means forgoing high and rapidly increasing environmental returns.

In contrast, mature forests being managed solely to provide wood should be harvested as soon as possible since their wood values are growing slowly, or even declining.

Between these two extremes, it will generally be the case that harvest ages in medium aged and mixed aged forests managed for multiple uses should be greater than those in forests managed solely for wood production (Bowes et al 1985). Under multiple use management, the revenues from a harvest must be compared with the loss of a steady stream of environmental returns. Where these environmental returns are high and growing rapidly, it will pay to postpone the receipt of harvest revenues since environmental returns can be earned in the meantime. Under single use management for wood production there would be no reason to delay harvesting.

In order to illustrate the possible effects of higher non-wood charges, it is assumed here that environmental values are higher the more mature the forest, and therefore that non-wood users would be prepared to pay more to prevent the harvesting of mature trees than they would younger trees. This may reflect, for example, the recreational and aesthetic values of mature forests, and hence recreational users' willingness to pay for entry to the forest.

Table H.6: **Hypothetical non-wood charges**

	Age of trees (years)										
	30	*40*	*50*	*60*	*70*	*80*	*90*	*100*	*110*	*120*	*130*
Non-wood charge($/ha/yr)	100	225	400	575	650	650	650	650	650	650	650

	Alpine ash	Tasmanian regrowth
Sawlog royalty	$25.06	$14.76
Pulplog royalty	$11.32	$13.54
Actual harvest age	50-90	80
Optimal harvest age	>120	>130

Note: royalties are $\$/m^3$ or $/t, while non-wood charges are in $/ha per year. It is assumed that the non-wood charges can be received each year up to the year of harvest. Thus the optimal harvest ages are the ages at which the cumulative net present value of the non-wood charges, plus the net present value of the royalty revenue (at existing royalty rates) received in the year of harvest, is maximized.

Table H.6 shows a schedule of hypothetical non-wood charges, to illustrate the effects on optimal harvest ages of charging recreational and other fees whilst maintaining existing royalty rates.

The ability to earn revenues from non-wood users could improve the financial rewards for forest managers to delay harvesting until forests are mature. In fact, the non-wood charges schedule in Table H.6 illustrates the potential for the returns from non-wood uses to outweigh any returns from harvesting. For example, under existing royalties, these hypothetical returns from non-wood users would be sufficiently high to warrant leaving the Tasmanian regrowth and alpine ash forests unharvested, while still providing a 4 per cent real rate of return to the forest.

Either charging sawlog royalties which increase with log size, or charging non-wood users, can thus lead to higher optimal harvest ages. Raising the returns available to forest managers from larger trees can provide strong financial incentives to let forests reach a reasonably mature age. Thus charging higher royalties for larger sawlogs and, where possible charging non-wood users, could help to reconcile the currently inconsistent objectives of earning reasonable rates of return while using long rotations for environmental reasons.

Selective harvesting

While some forests require clear felling to encourage regeneration (National Association of Forest Industries 1990), other forests can be managed for multiple uses through the use of selective logging techniques. In many forests, selective harvesting is preferable from a silvicultural point of view, and is widely used in Australian forests. Selective harvesting can be modelled as follows (Nguyen 1979):

$$\lambda = \max\ P\{V(t) - V'\}\exp{-rt} + P\{V(x) - V'\}\exp^{-rt'} / (1 - \exp^{-rt}(t'-t)) \qquad \text{eq.4}$$

$$dV/dt = r[\{V(t) - V'\} + \{V(x) - V'\}\exp^{-r(t'-t)} / (1 - \exp^{-r(t'-t)})] \qquad \text{eq.5}$$

$$dV/dx = r[V(x) - V']/1 - \exp^{-r(t'-t)}) \qquad \text{eq.6}$$

where V’ is the volume of timber per hectare that must be left standing. The results were calculated for two such constraints, one a requirement to leave 200 m3/ha unharvested in order to support wildlife habitats and supply other environmental services, and the second to leave 400 m^3/ha standing.

These constraints correspond roughly to a requirement to leave, for example, a quarter or a half, respectively, of a 60 year old alpine ash forest unharvested. For silvertop ash the constraints would correspond to a requirement to leave a third or two thirds, respectively, of a 60 year old forest unharvested. This is because silvertop grows more slowly than alpine ash, and takes longer to reach the stocking required by the constraints.

The constraints are completely arbitrary; the Commission has been unsuccessful in its attempts to find estimates of the level of forest cover required to ensure the supply of different levels of environmental services. Nevertheless, the constraints are useful as a means of illustrating the nature of the trade-off between wood and (unpriced) environmental values. The results are shown in Tables H.7.

Table H.7: **Optimal harvest rates under 1988-89 royalties and (unpriced) environmental constraints**

	Alpine Ash (Bago, NSW)	*Blackbutt (southern. QLD)*	*Mountain Ash (Toolangi, VIC)*	*Silvertop Ash (eastern VIC)*	*Wet Regrowth (Tasmania)*
Required to leave 200 m^3/ha unharvested	**For 4% ROR to forest:**				
NPV ($/ha)	3300	1200	1700	1200	980
Optimal harvest age(years)	14	23	40	20	30
Years between harvests	1	2	27	2	6
Change in log supplies[a] (%)	-13	35	2	-5	1
Change in NPV[a] (%)	-13	20	-15	-25	35
Required to leave 400m^3/ha unharvested					
NPV ($/ha)	2600	430	1500	550	30
Optimal harvest age(years)	25	43	30	40	80
Years between harvests	1	3	4	5	1
Change in log supplies[a](%)	84	-10	33	-4.5	-88
Change in NPV[a] (%)	-32	-58	-25	-66	-98

a) Shows how log supplies (net present value of harvest revenues) per hectare change in comparison with log supplies (net present value) at the optimal harvest age under no environmental constraint (Table H.2).

Sources: Commission estimates based on Table H.1 and equation 4.

As can be seen by comparison with Table H.2, the requirement to leave 200 m^3/ha unharvested does not significantly change the optimal harvest age. However, it does reduce the volume of timber which can be harvested at the end of each rotation period. As this reduces the flow of timber revenues which can be earned from future, smaller, harvests, the general effect of a requirement to harvest selectively in order to protect environmental values is to significantly shorten the rotation period between harvests. The fact that harvests become more frequent means that annual log supplies available to mills will not necessarily fall - for blackbutt they would increase by 35 per cent.

With the exception of blackbutt, however, the net present value of royalty revenues is reduced by the introduction of the constraint. That is, although harvest volumes may rise, they are generally worth less, either because they are smaller, or they are received further in the future.[3] The change in the harvests' value can be thought of as the implicit cost of leaving some of the forest unharvested for environmental reasons.

The requirement to leave 400m^3/ha unharvested significantly lengthens optimal harvest ages, mainly because the forests take many years to reach the required stocking rate. After this stocking rate has been reached, the requirement to leave it unharvested, only harvesting stocks in excess of 400m^3/ha, again reduces the volume of timber which can be harvested at the end of each rotation period. This reduces the incentive to postpone harvesting much beyond the year in which the forest reaches 400m^3/ha. Thus the rotation period is significantly shorter than it was in the absence of an environmental constraint. For some forests this would increase the log supplies available to mills.

National parks

Old growth forests are considered to have high environmental values, but not necessarily high wood values because of the high number of defects in the wood and the slow or negative growth rates.

3 The effect of discounting is that a dollar received in the future is worth less than a dollar received today.

The results of a hypothetical schedule of non-wood charges were presented in Table H.6. They showed that where non-wood values are rising with forest maturity, but wood values (royalties) are not, environmental values can outweigh the returns from harvesting, thereby providing a financial incentive not to harvest.

Currently there would appear to be little financial incentive not to harvest old growth forests. Under current royalties and non-wood charges, it would be more profitable to harvest these forests and replace them with younger regrowth forests which have better growth rates, with the objective of leaving old growth forests unharvested being met through the creation of national parks.

The withdrawal of forests from wood production through the creation of national parks would not necessarily reduce the total supply of logs available to pulp and saw mills.

For example, Tasmanian regrowth forests are currently harvested at around 80 years or older. The total allowable cut from 80 year old forests is smaller than if the planned harvest age was 30 years. If the harvest age was reduced to 30 years, the allowable cut in non-conservation forests could be increased by around 68 per cent.[4]

If half of the Tasmanian wet regrowth non-conservation forests were removed from wood production through the creation of national parks, the total harvest volume in Tasmania would decline by about 16 per cent. If a quarter of these forests were removed from production and harvest ages reduced in remaining forests, the total harvest volume in Tasmania would rise by about 26 per cent.

Similarly, the allowable cut from mountain ash forests harvested at 80 is lower than if they were harvested at 40. If half the mountain ash forests were removed from wood production, and harvest ages reduced from 80 to 40, the total harvest volume would fall by around 43 per cent. If a quarter of these forests were removed from production and the allowable cuts increased, total harvest volumes would fall by around 15 per cent.

4 In an 80 year rotation the average annual harvest volume would be 401m^3 per hectare, or 5m^3/ha per year. On a 30 year rotation, the average annual harvest volume would be 8.4 m^3/ha/pa.

There is thus scope for harvest ages to be reduced and for the total allowable cut in forests still open to logging to increase. By shortening rotations, some of the log supplies lost to national parks can be made up with an increase in allowable cuts.

While the implications for total harvest volumes from the creation of national parks may still be significant, they are not necessarily quite as dramatic as they appear at first, given the apparent potential for also increasing allowable cuts. The loss of 50 per cent, or 25 per cent, of native forests from wood production would also mean a considerable loss of royalty revenues received by State governments. However, if the creation of national parks were in conjunction with the introduction of higher sawlog royalties and non-wood charges, the effects on government revenues could be reduced.

Economic effects of creating national parks

This appendix has so far looked at the effects on harvest rates and log supplies of various forestry scenarios, ranging from requiring forest services to earn higher rates of return, to withdrawing large forest areas from wood production.

Given that detailed information on forest yields, harvest rates, royalties and management costs is not publicly available, these scenarios were based on a very limited data set. Since growth rates vary widely between forests, the results presented must be treated as illustrative only.

Despite this qualification, the results (Table H.8) are useful for showing, in a stylized fashion, the effects of each scenario on the forestry sector itself. However, another important issue in the debate over forest use, is the effect on the economy of changing the balance of ‘wood’ and ‘environment’. As this is currently the subject of wide community debate, this section presents - again as in an illustration - the economy-wide effects of putting half, or a quarter, of the remaining multiple-use native forests into national parks. The assumption is that national park users are not charged for their visits. In particular the results show the importance of being able to offset lost wood production in native forests with an increase in the allowable cut in remaining forests.

Table H.8: **Economic effects of free national parks**[a]

	(change in per cent)	
	50% of native forests removed from production	*25% of native forests removed from production*
Macroeconomic effects		
Real GDP	-2.0	-0.3
Real household expenditure	-0.5	-0.1
Real private investment	-3.2	-0.7
Exports (volume)	-1.2	-0.9
Imports (volume)	5.4	1.1
Trade balance/GDP	-0.7	-0.2
CPI	1.5	0.5
Industry output		
Hardwood forestry	-35.0	-5.2
Softwood forestry	-16.4	-11.5
Agriculture	0.5	-0.4
Mining	-3.7	-1.2
Manufacturing	-1.0	-1.6
Sawmilling	-67.8	-25.0
Utilities	-1.0	-0.1
Construction	-2.9	-0.6
Services	-0.7	2.6
Imports		
Pulp	172.2	12.4
Sawntimber	632.5	69.1
Industry land usage		
Waste Disposal	0.3	0.3
Hardwood forestry	-50.0	-25.0
Softwood forestry	-16.2	-11.4

a. The assumption is that there are no user-fees for national parks.

Source: ORANI projections.

If 50 per cent of native hardwood forests in all States were removed from wood production, in conjunction with an increase in the allowable cut as harvest ages are reduced toward the optimal harvest ages shown in Table H.3, total sawlog supplies would fall by around 44 per cent, while pulplog supplies would fall by some 30 per cent.

The increase in the allowable cut would thus offset to some extent the loss of half the hardwood forests from production, although more so for the pulp and paper industries than for sawmills. Despite the increase in imported pulp, the loss of domestic hardwood pulplogs was projected to lead to a considerable contraction in the domestic pulp and paper industries.

The effect on the sawmill industry would be even more severe, with a projected loss of output of almost 70 per cent. Sawntimber imports were projected to rise by over 600 per cent, but were not enough to prevent a drop in the construction activity or real investment.

Higher imports would also lead to a projected decline in the trade balance of $2.6 billion, and GDP was projected to drop by 2 per cent, or $7.3 billion, in 1989/90. The removal of half of all native forests from wood production, without any increase in royalties or non-wood charges, could thus have significant economic costs.

The costs of removing forests from production have in fact been over-estimated. Because of the structure of ORANI, there is no substitution between hardwood and softwood sawlogs used in sawmilling. If sawmills could offset the loss of native forests by using more softwood, their output would not fall by as much as in Table H.8, and there would not be such a decline in softwood forestry.

The removal of 25 per cent of native forests would also have considerable effects, although less pronounced. Here, total sawlog supplies were projected to fall by 16 per cent, although pulplog supplies would still increase slightly, by about 6 per cent.

Again the sawmilling industry would suffer the most, with a projected decline in output of 25 per cent. GDP was projected to fall by 0.3 per cent, or $1.1 billion in 1989/90.

Conclusion

Forest services are facing increasingly stringent requirements from State governments to improve financial performance. They are also facing growing demands to protect the environmental values of forests, while at the same time to maintain wood supplies and jobs.

These demands do not necessarily conflict with each other. The current debate on forest use appears to be ignoring the question of how much people should pay for the right to use or harvest native forests. In the absence of discussion of pricing policies, the debate quickly polarizes into one of wood versus environment.

This either/or conflict is unecessary. Better pricing policies could increase supplies of both wood and environment. Many native forests may be well managed silviculturally, but this does not imply that they are well managed economically. The long rotations currently used do not appear to be justified under current sawlog royalties and non-wood charges.

The public's investment in native forests could earn a considerably higher return if explicit non-wood charges were raised, if native forests were managed on shorter rotations, or if sawlog royalties were raised for larger logs.

For example, some non-wood charges may provide forest services with good economic reasons not to harvest mature forests.

Alternatively, shorter rotations would significantly increase allowable cuts, thereby increasing log yields per hectare, particularly of pulpwood. Managing native forests on shorter rotations could worsen the perceived tradeoff with environmental values, as well as impose costs on the sawmilling sector from the loss of high quality sawlogs.

Shorter rotations would, however, allow the wood-based industries to maintain existing levels of output while considerably reducing demands on native forests. By allowing more forests to remain unharvested, the increase in allowable cuts in remaining forests would make it possible to have 'more' conservation without it being at the expense of the wood based industries.

The option of raising sawlog royalties, would not lead to such a reduction in the use of native forests for wood production, but would continue the current emphasis on long rotations, consistent with multiple-use management. The domestic sawmill industry, particularly in Tasmania, would, however, suffer.

The use of shorter rotations would represent a move away from the current objective of multiple-use forest management, in which the majority of forests are managed under long rotations in order to provide wood while protecting some environmental values.

Because of the current emphasis on long rotations, demands for forests to be protected from logging are necessarily at the expense of the wood based industries, as lost wood supplies cannot be made up through increased cuts in remaining forests. It would seem, however, that the severity of the current trade-off between ‘wood’ and ‘environment’ could be reduced.

There would seem to be a choice, therefore, between using forests for both wood and environment through the use of long rotations, or of setting aside some forests entirely for conservation and managing other forests more intensively for wood production. It is not obvious which one is `better' from an environmental point of view. What is clear is that current pricing policies considerably reduce the incentives to conserve native forests and exacerbate the trade-off between wood and environment.

APPENDIX 1: TECHNICAL DETAILS RELATING TO CHAPTER 6

To analyse the combined effects of improved pricing policies governing the provision of forestry products and waste disposal services on the incentives to recycle paper, the Commission used a modified version of the ORANI model of the Australian economy known as ORANI-Recycling. This Appendix provides some details of the modifications made to ORANI to enable it to be used to model recycling and forestry. Further details are available from the Commission on request.

The ORANI model has been widely used for quantifying the economy-wide effects of various policy changes (Dee 1989, IAC 1987, Dixon, Parmenter, Sutton and Vincent 1982). It has the ability to pick up indirect as well as the direct effects of such changes. Changes in log royalties, for example, would affect the costs of other industries, not just those of paper manufacturers, through changes in prices for sawntimber and paper. Thus such reforms could also have significant indirect effects on the paper industry and the level of paper recycling as other industries expand or contract in response to changes in their costs.

These indirect effects can have significant implications for recycling that would not be picked up in a model which only looked at the direct effects of price changes on the incentives of paper manufacturers to recycle.

Several changes have been made to the ORANI model in order to use it to examine recycling and forestry. The essential features are that pulp and paper manufacturers are allowed to substitute between hardwood and softwood pulplogs, and between pulplogs, waste paper, and imported pulp. Also, waste paper which is collected from households and industry can either be disposed of as waste, or can be recycled by the pulp and paper industries.

Data base

The data base for the ORANI model is based on the input-output tables prepared by ABS. Commodities are sold to other industries as intermediate inputs, as well as to households, governments and the export market. The changes made to the structure of the data base for this Inquiry are described below, and are shown schematically in Figure I.1.

Pulp and paper

In the standard version of ORANI, pulp and paper are treated as a single industry producing an aggregate commodity 'pulp and paper'. In reality, different kinds of paper use different pulps, each pulp using different combinations of hardwood and softwood pulplogs. Different pulps also have different electricity requirements, and different technological limits to the amount of waste paper they can use as a feedstock.

In order to examine the effects of changing royalties or log supplies, it was necessary to disaggregate pulp and paper into separate industries. Each industry uses different combinations of hardwood, softwood, and other inputs such as electricity.[1]

The Recycling version of ORANI thus has 5 pulp commodities (mechanical hardwood, mechanical softwood, semi-chemical hardwood, chemical hardwood and chemical softwood) and 6 paper industries (newsprint, printing and writing papers, packaging papers, tissues, bags and fibreboard containers, and paper nec).

Waste disposal

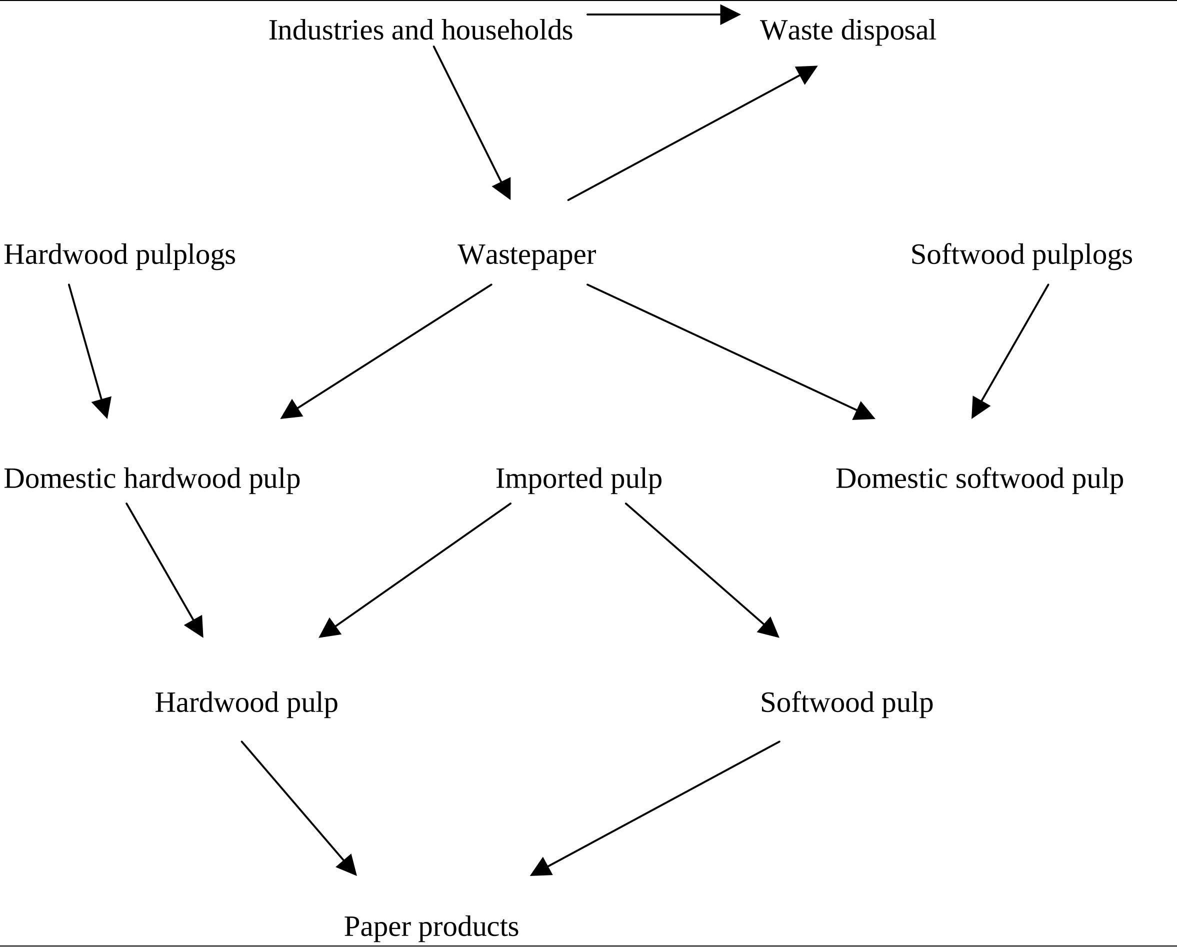
In the standard version of ORANI, waste disposal services are included in the 'Community Services nec' industry. In the Recycling version, waste collection and disposal were disaggregated to form a separate waste disposal industry comprising all non paper waste. It was assumed that all non paper waste must be disposed of in landfill.

1 These combinations were based on confidential information supplied to the Commission.

Paper waste was then separated from the waste disposal industry to form a separate ‘waste paper’ industry. This industry uses waste disposal as an input (representing waste paper that is dumped), and was assumed to be able to sell its waste paper output to the pulp and paper sector for recycling.

Finally, waste disposal was made a land-using industry in order to capture the possible effects on land-use of increasing the level of recycling. Part of the revenues earned by the waste disposal industry was treated as returns to the land invested in landfill.

Figure I.1: **Schematic structure of ORANI-Recycling**



Forestry and logging

In the standard version of ORANI, forestry and logging are a single industry producing a single ‘wood’ output. The output is sold both to pulp and paper and sawmills.

In order to capture the effects of charging higher royalties on the wood based industries, forestry and logging was split into 2 industries, hardwood forestry and logging, and softwood forestry and logging. Hardwood corresponds roughly to native eucalypt forests, while softwood corresponds to softwood plantations. In addition, each forestry industry was treated as producing 2 commodities, sawlogs and pulplogs.

Both forestry industries were assumed to use land as a primary factor of production. Sawlog and pulplog royalties were treated as the returns to forested land.

Substitutability

Because of the above changes to the data base, several assumptions had to be made regarding the ease with which manufacturers can switch between using pulpwood and waste paper, and the ease with which the supply of logs can be increased.

Pulp and paper

Confidential information supplied to the Commission suggested that the substitution possibilities between waste paper and virgin pulp are very low, while the ease with which pulp and paper manufacturers can switch between using domestic and imported virgin pulp is relatively high.

The Commission assumed in the model that it is twice as easy to switch from domestic to imported pulp as it is to switch between virgin fibre and waste paper.

Log supplies

It can take over 20 years to grow trees suitable for pulplogs, and over 40 years for sawlogs. Thus within those time periods there may be little scope for increasing the supplies of logs by growing more trees; supplies can only be increased by harvesting existing forests earlier.

Since the age at which trees are harvested is not modelled in ORANI, and the usual assumption is that the long run is a period of between 2 and 10 years, the supply of forested land was made almost fixed. This reduces the ability of the forestry sectors to expand output dramatically in response to a reduction in their costs of production simply by planting more land with trees. As a result, log supplies are fairly unresponsive to log prices. It was assumed that a 10 per cent increase in both pulplog and sawlog royalties would only lead to a 4 per cent increase in the joint supply of sawlogs and pulplogs (Johansson and Lofgren 1983).

APPENDIX J: SUGGESTED NEWSPRINT SURCHARGE

Below is reproduced a letter from the Ministry for Planning and Environment, Victoria to Mr Greg Taylor of David Syme & Co Ltd:

Ministry for
Planning and
Environment
Victoria

Olderfleet Buildings
477 Collins Street
Melbourne
Victoria 3000
PO Box 2240T
Melbourne 3001

Telephone (03) 628 5111

6 March 1990

Mr Greg Taylor
Managing Director
David Syme & Co Ltd
GPO Box 257C
MELBOURNE VIC 3001

Dear Mr Taylor

I am writing to advise you of my serious concern over the continuing deterioration in the market for waste newsprint and the collapse of several collections in both country and metropolitan areas.

Rather than stabilising, the demand for old newspapers seems to be declining further; only last week collections were abandoned in the greater Ballarat area.

Although I am confident that this situation will be resolved in the long term by the establishment of one or more de-inking plants, industry must also recognise that it has an immediate responsibility to ensure that the present situation is redressed.

As you are probably aware, the glass and aluminum beverage container and paperboard industries have co-operated with the State Government in various ways to ensure the success of recycling schemes which target wastes generated by their industries.

It is my view that the only effective and equitable solution to the present problem of waste newspaper oversupply is for the industry to establish an export facilitation fund. I propose that the moneys for this fund come from a three dollar per tonne surcharge on the price of virgin newsprint sold in this State (about 0.4 per cent on the current purchase price).

I am advised that this very modest impost would be sufficient (at $20 per tonne) to stimulate an increase in exports from the current level of around 1 200 tonnes per month to 2 200 tonnes per month, thereby overcoming the present over supply problem.

Much of this support would flow back to newspaper companies already exporting, with the balance being available for assistance to other independent export companies.

I am confident that the levy will only be needed as a short term measure pending the build up in demand which will precede the commencement of operation of a de-inking plant.

As you no doubt appreciate, the Government is coming under increasing pressure from local government, conservation groups, voluntary agencies and the public at large to take legislative action to address the current problems. However, I believe that a tangible, direct contribution by the industry, such as I am proposing, would render such action unnecessary.

My proposal will form the principal item for discussion at the meeting of the Government-industry Working Group representative will be in a position to convey your reaction to that meeting.

Yours sincerely,

TOM ROPER
MINISTER FOR PLANNING AND ENVIRONMENT

ABBREVIATIONS

ABARE - Australian Bureau of Agricultural and Resource Economics

ABS - Australian Bureau of Statistics

ACI - Australian Consolidated Industries

ACS - Australian Customs Service

AEC - Australian Environment Council

AFCAM - Association of Fluorocarbon Consumers and Manufacturers

AGM - Australian Glass Manufacturers

AGPS - Australian Government Publishing Service

AIP - Australian Institute of Petroleum

ALCOA - Alcoa of Australia Limited

ANM - Australian Newsprint Mills Ltd

ANZEC - Australian & New Zealand Environment Council

APM - Australian Paper Manufacturers

APPM - Associated Pulp and Paper Mills

ARA - Australian Refined Alloys Pty Ltd

ARC - ACT Recycling Campaign

ASDA - Australian Soft Drink Association

ATDA - Australian Tyre Dealers Association

AVCAA - Agricultural and Veterinary Chemicals Association of Australia

BFCs - Bromofluorocarbons

BHAS - Broken Hill Associated Smelters Pty Ltd

BHP - Broken Hill Proprietary Limited

BRRU - Business Regulation Review Unit

CDL - Container Deposit Legislation

CFCs - Chlorofluorocarbons

COMALCO - Comalco Limited

COMPOL - Commercial Polymers

COMSTEEL - Commonwealth Steel Company Limited

CPI - Consumer Price Index

CROWN - ACI Crown Glassware

CSAES - Centre for South Australian Economic Studies

CSIRO - Commonwealth Scientific and Industrial Research Organisation

CTDRA - California Tire Dealers and Retreaders Association

CTV - Contingent Valuation Method

DARA - Department of Agriculture and Rural Affairs

DAS - Department of Administrative Services

DASETT - Department of the Arts, Sport, the Environment, Tourism and Territories

DIY - Do-it-yourself

DPIE - Department of Primary Industries and Energy

ECU - European Currency Unit

EPA - Environment Protection Authority

ER&S - Electrolytic Refining & Smelting Co of Australia Pty Ltd

FOE - Friends of the Earth

GDP - Gross Domestic Product

GHG - Greenhouse gas

GJ - Gigajoules (10^9 Joules)

GPIA - Glass Packaging Institute of Australia

HDPE - High Density Polyethylene

HFA - Hydrofluoroalkanes

HFCs - Hydrofluorocarbons

IAC - Industries Assistance Commission

KESAB - Keep South Australia Beautiful

LDPE - Low Density Polyethylene

LLDPE - Linear Low Density Polyethylene

LRA - Litter Research Association

MIM - Mount Isa Mines Ltd

MJ - Megajoules (10^6 Joules)

ML - Megalitres

MMBW - Melbourne Metropolitan Board of Works

MRI - MRI Pty Limited

MTAA - Motor Traders Association of Australia

MWDA - Metropolitan Waste Disposal Authority

NIMBY - Not In My Backyard

NORSTAR - Norstar Steel Recyclers

PASMINCO - Pasminco Metals BHAS Pty Ltd

PCA - Packaging Council of Australia

PCBs - Polychlorinated biphenyls

PE - Polyethylene

PET - Polyethylene terephthalate

PJ - Petajoule (10^{15} Joules)

PIA - Plastics Industry Association Inc

PILKINGTON - Pilkington (Australia) Limited

PVA - Polyvinyl acetate

PVC - Polyvinyl chloride

RALAC - Recycling and Litter Advisory Committee

RDF - Refuse derived fuel

RMIT - Royal Melbourne Institute of Technology

SAA - Standards Association of Australia

SADEP - South Australian Department of Environment and Planning

SAN - Styrene-acrylonitrile

SAWMC - South Australian Waste Management Commission

SEP - Special Environment Program

SFT - Super critical fluid technology

SIMSMETAL - Simsmetal Ltd

SPCC - State Pollution Control Commission

TCE - Trichloroethane

TFES - Tasmanian Freight Equalisation Scheme

UBC - used beverage can

WMA - Waste Management Association

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