Waste from Electrical and Electronic Equipment: A South Australian Perspective

Prepared for

Environment Protection Agency
Department for Environment and Heritage
Government of South Australia

by

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This report has been prepared by the above consultants for the Environment Protection Agency (EPA), Department for Environment and Heritage.

The findings and recommendations in the report are those of the consultants, and are not necessarily endorsed by the EPA. The report has been released to the public for information and discussion.

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Waste from Electrical and Electronic Equipment

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The survey to establish the current practice in dealing with waste from electrical and electronic equipment in South Australia was conducted by the Marketing Science Centre of the University of South Australia. The results of this survey form the basis of section 5 of this report.

Terms and Abbreviations

CFC	Chlorofluorocarbon
CRT	Cathode ray tube
DFD	Design for disassembly
DFE	Design for environment
EEE	Electrical and electronic equipment
EEP	Electrical and electronic product
EOL	End-of-life
EPR	Extended producer responsibility
EU	European Union
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
MITI	Ministry of International Trade and Industry (Japan)
NED	New equipment dealer
Ni-Cd	Nickel-cadmium
OECD	Organisation for Economic Cooperation and Development
OEM	Original equipment manufacturer
PC	Personal computer
PCB	Polychlorinated biphenyl
SEPA	Swedish Environmental Protection Agency
TBBA	Tetrabromobisophenol–A
TCLT	Toxic characteristic leaching test
WEEE	Waste from electrical and electronic equipment

Executive Summary

The issue of waste from electrical and electronic equipment (WEEE) is one of growing concerns at national and international levels. For example, in South Australia alone, it is anticipated that, in 1999, 24 000 computers will have been landfilled and an estimated 68 800 analogue mobile phones will have become obsolete. While much of the focus is on computers and mobile phones, the European Union (EU) Directive specifies a much broader range of electrical and electronic equipment (EEE) to be considered including whitegoods (washing machines, refrigerators, etc), browngoods (video recorders, televisions, etc), computer equipment and peripherals, power tools, toys, and electronic games. Of particular interest in Australia will be the effect on WEEE production of the introduction of digital television and the advent of digital video disk (DVD) technology (now known as digital versatile disk).

The rapid technological advancements being made in the manufacturing of these products and the desire for consumers to have state-of-the-art products mean that ever-increasing numbers of EEE can be expected to become obsolete in the future. The potential environmental hazards that result from the disposal of obsolete EEE, such as the accumulation or leaching of hazardous and toxic substances, and the loss of non-renewable resources such as scarce and precious metals, highlight the need for the increased recycling of WEEE, not only within South Australia, but also on a world-wide scale.

All member states within the European Union, Japan, and some states in the USA (such as Minnesota and California) have embraced the philosophy of extended producer responsibility (EPR). EPR shifts the responsibility for recycling WEEE onto the producer, who is responsible for the initiation of product take-back schemes, advance disposal fees, or product refund schemes to ensure that obsolete equipment is efficiently transferred to a recycling industry. The manufacturer is encouraged to employ design initiatives aimed at improving the efficiency of product recycling, such as design for disassembl*y* (DFD) and the use of environmentally friendly raw materials. Governments in the aforementioned countries have been employing strategies based on a combination of legislation banning the landfill disposal of particular kinds of WEEE accompanied by a range of incentives including tax relief to ensure these schemes are implemented. These strategies, in turn, appear to have provided the stimulus for companies to adopt waste reduction schemes and to promote innovation within the industry towards WEEE recycling, which together create a competitive and self-sustaining WEEE recycling industry.

By comparison, there has been very little activity in Australia dealing with the problem of WEEE. Compaq Australia is reported as currently undertaking a computer take-back and cathode ray tube (CRT) monitor recycling pilot project in cooperation with the New South Wales Government. The aim is to demonstrate a model recycling program that may be implemented on a nation-wide basis. Similarly, the Australian Mobile Telecommunications Association (AMTA), again in collaboration with the New South Wales Government, has undertaken a Nickel-Cadmium (Ni-Cd) battery recycling scheme with participation from retail outlets in Sydney, Newcastle, and Wollongong as collection centres for disposed Ni-Cd batteries. This scheme is reported to have recycled over 100 000 mobile phone batteries in a six-month period and is now being expanded to an Australia-wide scheme, with take-back schemes currently under way in Adelaide.

The main object of the work reported here has been to gain an appreciation of the extent of the problem of waste electrical and electronic equipment (WEEE) in South Australia. To this end, a market survey was conducted, which targeted six main groups, namely (1) corporate bodies, (2) private individuals, (3) original equipment manufacturers, (4) new equipment distributors, (5) second-hand dealers, and (6) recycling companies.

The survey findings reveal that the corporate and private sectors in South Australia suffer from a fundamental lack of knowledge about issues relating to WEEE. Such issues include the environmental impact of dumping WEEE to landfill, which products can be recycled, the recycling avenues available, and where the responsibility for recycling lies. It has been found that much of the obsolete electrical and electronic equipment (EEE) is either stored or given away or simply dumped due to a perceived lack of alternatives. Despite this perception, there appears to be a marked willingness in both sectors to recycle obsolete EEE, provided information is available and mechanisms are in place to enable recycling to be effected. This willingness highlights the need for educational programs to provide the South Australian community at large with the information necessary to promote participation in recycling of WEEE on an informed basis.

According to survey results, original equipment manufacturers (OEMs) and new equipment distributors (NEDs) in South Australia exhibit similar traits in that there exists a distinct core group of companies within each sector that actively engages in environmental initiatives. These companies regard such initiatives either as an essential ingredient of their commitment to the environment or as potential marketing tools. Outside of these core groups are those companies that do not currently participate in environmental initiatives, the majority of which are not committed to environmentally benign practices, now or in the future. This lack of commitment suggests that these companies do not have any policy on environmental issues and do not view themselves as responsible for the environmental impact of the products they manufacture or sell. The introduction of legislation to enforce the implementation of environmental design initiatives by OEMs and NEDs, as has been observed overseas, would thus appear to be the most likely means of facilitating extended producer responsibility in the South Australian EEE manufacturing sector.

The second-hand market for obsolete EEE in South Australia appears to be quite active. It is also apparent, however, that the second-hand market is limited economically and that many second-hand dealers favour financial incentives from government as a means of supporting the industry. It is anticipated that the ongoing rapid advancement in technology will mean that obsolete equipment of higher quality will enter the second-hand market in the ensuing years, which will ensure that the second-hand market maintains a significant role in the life cycle of EEE.

South Australia houses a small, but active, recycling sector with a high level of recovery of precious metals, heavy metals, ferrous and non-ferrous scrap metals and plastics. Many of the recycling companies surveyed, however, pointed to a lack of infrastructure to support WEEE recycling in South Australia, along with a lack of awareness in the community of the need for, and environmental issues related to, WEEE recycling. The need for the development of a network within the recycling sector, which should include landfill operators, is highlighted by the amount of recoverable material being destined to landfill. Many waste products can potentially be recouped by recycling companies; this recoup can be achieved if companies are strategically linked in a network to enable them to trade or exchange obsolete EEE components or materials. Furthermore, the majority of the recycling companies surveyed indicated that they have the potential to expand their current operations, provided sourcing arrangements for WEEE are adequate. Landfill operators interviewed confirmed the high level of WEEE that goes to landfill with an estimated 1500 tonnes to be landfilled in 1999 alone. While some landfill operators undertake sorting and segregation of valuable EEE, most items containing environmentally hazardous components, such as CRTs, appear to end up in landfill.

Throughout the EU, Japan, and the USA, the responsibility for recycling is being increasingly shifted onto manufacturers. It appears that, within the South Australian community, it is generally accepted that both the manufacturers and consumers are responsible for, and should hence bear the cost of, recycling WEEE. The respondents did not consider recycling companies—nor governments at local, State, or Federal level—to be solely responsible for recycling. This perspective appears to suggest that initiatives such as extended producer responsibility (EPR) are appropriate within the South Australian context; the scope exists, however, for extending the responsibility to the consumer also, possibly by means of an up-front environmental levy.

Of the estimated 1500 tonnes of WEEE entering landfill in South Australia in 1999, approximately 458 tonnes are likely to be computers, which represents approximately 24 000 units. This number of computers is projected to increase, however, to 55 500 units—or 1060 tonnes—by the year 2005. In 1999, WEEE disposal to landfill in South Australia is estimated to represent 47 tonnes of lead, 10 kg of mercury, and 46 kg of cadmium, all of which are heavy metals and are detrimental to the brain, kidney, nervous and reproductive systems of both animals and humans. One hundred and fifteen tonnes of plastics will also be landfilled, which places an added drain on non-renewable fossil fuels. Furthermore, toxic substances such as tetrabromobisophenol–A (TBBA) are employed during the manufacture of these plastics.

Chlorofluorocarbons (CFCs), found in older refrigerators, freezers, and air conditioners, also pose an environmental danger as they are highly active ozone depleters, while polychlorinated biphenyls (PCBs) are used in all types of older electrical equipment. PCBs are known to attack the nervous system and to cause kidney and liver damage. In total, it is estimated that the recycling of WEEE could have saved approximately 4750 m^3 of landfill in 1999, which will increase to 11 350 m^3 by the year 2005.

Whilst the recycling of WEEE appears to offer some potential environmental benefits in preference to landfill disposal[1], there are also potential economic benefits: WEEE contains valuable materials as gold, silver, and platinum, along with aluminium, steel, copper, and plastics. All of these materials can generate a return upon recovery and, given their respective estimated quantities and current prices, it is possible that in excess of $300 000 could have been recouped in 1999 as a result of the recovery of these materials. This figure does not account for collection or processing costs.

The foregoing considerations form the basis for the recommendations of this report in dealing with the problem of waste electrical and electronic equipment (WEEE) in South Australia, a summary of which follows.

SUMMARY OF RECOMMENDATIONS

[1] This statement does not account for the environmental impact associated with the transport and processing undertaken during the recycling of WEEE, which is outside the scope of the current study.

- a WEEE advisor`y body be constituted that comprises members from relevant industry, research, and government sectors for the purpose of providing advice and support to the EPA on matters relating to WEEE recycling
- a more detailed study of WEEE in South Australia be undertaken, over an extended period, in which electrical and electronic equipment (EEE) that enters the consumer market and the WEEE that are disposed via the recycling sector are audited to provide meaningful data on which feasibility studies can be based
- a network of recycling companies in South Australia be developed with the aim of minimising the volume of WEEE disposed to landfill and to facilitate the trade of obsolete EEE, components, or materials between recycling companies and landfill operators
- educational programs be initiated to inform the South Australian community at large of the environmental issues related to WEEE, the types of EEE that can be recycled, and mechanisms by which they can access the recycling sector
- research and development of environmental design initiatives be promoted among original equipment manufacturers (OEMs) in South Australia, to embrace the notion of extended producer responsibility (EPR), which may require the introduction of appropriate legislation at a national level as has been experienced in the USA, the EU, and Japan
- a study be undertaken into WEEE collection schemes that currently operate in South Australia for the purpose of providing recommendations to council or community groups about the most appropriate collection schemes
- a detailed feasibility study be undertaken to establish the viability or otherwise of either expanding the current recycling practices in South Australia or developing a single dedicated WEEE recycling facility; the feasibility study will need to consider all aspects of WEEE recycling from collection through to markets for the recovered materials
- a pilot-scale WEEE recycling plant be established, contingent upon the results of the feasibility study, to investigate further the economic and logistical issues in the development of a commercial facility; if the pilot plant trials prove successful, development of a commercial scale facility can commence (note: both of these stages are subject to the availability of funding support)
- draft legislation for the disposal and handling of WEEE in South Australia be developed using the EU Directive as a basis and which takes into consideration factors unique to the South Australian situation
- a donor scheme be established for the purpose of extending the useful life of obsolete EEE, notably computing equipment; such a scheme can link major corporate bodies with disadvantaged schools and communities in South Australia to provide computing hardware and technology support.

1. Introduction

There are growing globally shared concerns that arise from the rate of waste generated from electrical and electronic equipment. The rapid technological advances in the field of electrical engineering are accompanied by accelerated obsolescence and, hence, the potential for waste production at an accelerated pace. This potential applies particularly to products used in information technology such as mobile phones, computers and their peripherals, although almost every other type of electrical and electronic device is also implicated, albeit not at the same rate of obsolescence.

At present, some limited recovery of parts and materials takes place, especially in the case of whitegoods and browngoods. There is also a lively trade in computers and associated devices. The accelerating rate of obsolescence in consumer electronics and information technology equipment, however, is threatening to render such items void of value for users in the foreseeable future. Consequently, without systems and infrastructure in place to capture and recycle these devices, contaminants such as heavy metals will accumulate in landfills and non-renewable resources such as precious metals will continue to be wasted.

Concerns about these issues are almost universally shared. Although there is no common agreement on remedial action, especially from the industry, the seriousness of the problem of WEEE is widely acknowledged. Concerns are shared at all levels ranging from individuals and the community at large to governments. The perceived need for urgent action has been driving initiatives globally. The European Union has already produced a proposal for a directive, which will bind all member states once it is ratified, to deal with the problem of WEEE. Several countries, including Japan and those in Europe, already have measures in place to counter these issues as they arise.

2. Objectives

The objectives of this study arise from the project brief given in Appendix A. They are as follows:

- to undertake a literature review with a view to establishing which measures are being adopted globally and nationally to cope with the problem of waste production from electrical and electronic equipment
- to identify what constitutes electrical and electronic waste beyond information technology (IT) and computer equipment
- to establish benchmarks by ascertaining what constitutes best practice in dealing with WEEE
- to quantify, as far as practicable, the amount of electrical and electronic waste produced in South Australia
- to identify current disposal paths including that of disposal to landfill
- to recommend further courses of action in order to provide advice to the South Australian Government through its agencies so that policy and legislation measures that deal with the WEEE problem can be formulated.

These objectives are to be achieved largely by means of a literature review and market research.

The project targets include finding out the extent of annual electrical and electronic waste production in South Australia and the current recycling and disposal practices with a view to establishing the potential that exists for increased recycling in the future. Findings from the study are to assist with the determination of future waste reduction and recycling activities and potential business opportunities.

The electrical and electronic devices of interest include in the first instance:

- computers and peripheral equipment
- telecommunications equipment (including mobile phones)
- Cathode ray tubes (CRTs) (including TV sets and monitors).

The study also aims to identify any other electrical and electronic equipment that has the potential to become a problem waste in the future and is thus worthy of further investigation.

3. The Problem

The problem of electrical and electronic waste is complex and multifaceted. It involves concerns about diminishing landfill sites, waste of valuable non-renewable resources, and the creation of hazards due to the toxicity of some materials.

The euphoria of mind-boggling advancements in electrical and electronics products appears to have camouflaged the enormous risks these products pose to the environment at the end of their life cycle. The risks are particularly acute if WEEE ends up in a landfill and arise from a cocktail of toxic materials that are routinely used in the manufacture of electrical and electronic products (EEPs). The disposal of WEEE to landfill therefore results in the accumulation of these toxic materials at landfill sites. This accumulation will pose a significant problem for the future remediation and utilisation of these sites, and the leaching of these materials into local groundwater or surrounding soils may be a threat to flora and fauna[2]. Such materials include in particular:

- lead
- cadmium
- mercury
- polychlorinated biphenyls (PCBs)
- halogenated flame retardants
- chlorofluorocarbons (CFCs).

All such substances are hazardous in varying degrees: known ill-effects are summarised in Appendix H. Increasingly, there are concerns that, despite the marginal volume of electrical

[2] While sound engineering practices ensure that the risk of leaching from landfill sites is low, these issues can not be totally discounted

and electronic waste in comparison with total waste production, the environmental threats from this waste are potentially profound.

Products that contribute to the waste problem include office equipment, consumer products such as television sets, VCRs, radio receivers, batteries, telecommunication devices, clocks and watches, games, toys, lighting equipment, medical apparatus, laboratory equipment, whitegoods and other products for household use. The introduction of digital television in Australia over the coming years has the potential to increase markedly the numbers of analog television sets entering the waste stream, and DVD technology may also see substantial numbers of stereo sets, CD players and videos becoming obsolete. The continual changes in the telecommunications industry may render existing telephone handsets outdated. The increased availability of new types of kitchen appliances and power tools with consumer appeal may lead to the disposal of superseded products and, thus, the entry into the waste sector of considerable quantities of superseded products also.

4. Current Recycling and Disposal Practices

Globally, there are growing concerns about waste production in general, and the accelerating pace of waste production from electrical and electronic equipment (EEE) in particular. Governments, environmental interest groups, and industry sectors are proposing measures to arrest the problem and turn it around.

The quickening pace of technological developments in all areas of electrical engineering, and ever-increasing number of new types of EEP, eagerly sought by consumers at large, coupled with shorter lead times to end-of-life (EOL), have contributed to the generation of a rapidly growing stream of waste. Of further concern has been the intrinsically poor recyclability of EEPs, the relatively low yield of reusable materials, and the amount of energy expended in procuring the materials required and in manufacturing EEPs (Bergendahl & Segerberg, 1997: 172–175).

The most advanced and progressive legislation related to handling waste electrical and electronic equipment (WEEE) has been proposed by the European Union. The requirement for producers to set up an end-of-life product return system is specified in the *Proposal for a Directive on Waste from Electrical and Electronic Equipment* (1999) (http://www.icer.org.uk). The purposes of the guidelines are to reduce the amount of hazardous waste from EEPs entering the environment and to increase the recovery of non-renewable resources from EEE. Several European countries have adopted laws and regulations on WEEE with various responsibilities allocated to producers, importers, distributors, retailers, municipalities, government, and consumers. Depending on who bears the responsibility for collection of WEEE, four systems can be identified:

- the use or expansion of existing community household waste collection channels
- the utilisation of retailers and shops as return channels
- separate (branded or non-branded) collection systems, whereby companies establish joint collection schemes or participate in recognised national collection schemes
- any combination of the above.

In Europe, the US, and Japan, policies and regulations to increase environmental protection have provided stimulus for innovation and have prompted companies to identify new business opportunities. Leading companies have invested heavily in reducing the environmental impact of their products. The perceived benefits to these companies have been in positioning themselves as market leaders and innovators, cost savings by using raw materials more efficiently, opportunities to influence the direction of legislation, and the ability to anticipate future regulations. The expected, practical bottom line commercial benefits appear to prove a strong motivation for companies to act responsibly in product design, manufacture, and recycling.

When it comes to cutting-edge practices in waste avoidance and resource recovery, Australian product manufacturers appear to continue to trail behind most OECD countries. Also, unlike in the USA, Europe, and Japan, most Australian industry associations take a passive position on waste minimisation issues relating to electrical and electronic products (EEPs) (Gertsakis, Ryan, & Hoy, 1996).

In a survey of 34 Australian electronic product manufactures, on average 60% of producers believed that most of their end-of-life products were landfilled. While 13% believed that most were recycled, 9% believed that their products were mostly reused. In the same survey, 56% of the companies surveyed had an environmental policy and 41% had implemented an environmental design program. Some 21% had not implemented any environmental measures at all (Gertsakis, Ryan & Hoy, 1996).

Australian companies may not be affected by extended producer responsibility (EPR) in Australia but they are still influenced by overseas policies. Australian companies exporting to countries where EPR policies are in force will have to meet the regulatory requirements of those countries. Australian producers will have to compete against green imports from other companies that have complied with the requirements of various EPR policies. Australian companies that are part of multinational companies can be drawn into EPR because some countries where the company operates are most likely to be subject to EPR regulations, and it is easier not to design different products for different markets. Alternatively, Australian manufacturers may choose to adopt EPR principles voluntarily if they expect national EPR legislation to be introduced in the foreseeable future, particularly before their products reach their end-of-life.

There are examples of innovative Australian initiatives regarding the recycling of WEEE. Compaq Australia is involved in a pilot program (June 1999 to July 2000) supported by a grant from the New South Wales Government to establish a computer take-back and monitor recycling scheme. Cathode ray tubes (CRTs) are the most difficult EEP to recycle as well as being one of the most hazardous. A pilot program has been set up in Sydney for corporate customers to recycle fully computers and associated hardware. The pilot findings are expected to provide a model to expand the program throughout Australia and to other industries. Compaq estimates that 30% of computer equipment collected in the pilot program will eventually be reused in computers, while another 30% will be used in other electronic equipment such as toys. The remaining equipment will be recycled mainly for metals, glass, and plastics recovery (Compaq Australia, 1998).

Ni-Cd batteries are often an important part of many EEPs, including mobile phones and laptop computers, but the disposal of Ni-Cad batteries to landfill is banned in Australia (*Environment Protection Act 1993*, Schedule of Listed Wastes). In November 1999, the Australian Mobile Telecommunications Association (AMTA) launched a nation-wide program for the take-back and recycling of mobile phone handsets, Ni-Cd batteries, and related accessories. This program follows on from a trial program conducted jointly by AMTA and the New South Wales Government, which saw over 100 000 mobile phone batteries recycled in a six-month period. The program is funded via a $1 levy placed on the sale of new mobile phone handsets by participating companies, including Alcatel, Brightpoint, Ericsson, Mitsubishi, Motorola, NEC, Nokia, Panasonic, Philips, RF Industries, and Samsung. The equipment can be returned to over 400 retail stores around Australia, including Telstra T-Shops, Optus World, Orange, Strathfield Car Radios, and Vodafone stores. The batteries are processed by Australian recycler MRI, which works with Ausmelt Ltd to undertake the recycling. The recycling process involves closed-loop bath smelting, which has been developed in Australia by Ausmelt. The process melts the batteries at 1200¦C and produces three saleable products: a nickel-containing product (35% nickel), a cadmium fume (63% cadmium), as well as a low-value slag that is suitable for use in roadfill. It is hoped that more battery manufacturers will join the program as it is implemented nationally; discussions with laptop computer manufacturers and computer suppliers are also underway (Australian Mobile Telecommunications Association, 1999).

5. South Australian Practice

The current status of WEEE recycling in South Australia was assessed by means of a market survey. The survey was conducted by the Marketing Science Centre of the University of South Australia and was developed to target six main focus groups:

- corporate users, which are defined as registered South Australian companies who use EEE in their daily activities; 100 corporate users in total were surveyed
- private users, who are defined as residents of South Australia who have EEE within their households; 100 private users in total were surveyed
- original equipment manufacturers (OEMs), which are defined as those companies whose sole role is in the construction (and subsequent distribution) of EEE, where the production facility is based in South Australia; eight OEMs in total were surveyed
- new equipment distributors (NEDs), which differ from OEMs in that they do not undertake manufacturing within South Australia and are merely distributors of equipment manufactured either interstate or overseas; 84 NEDs in total were surveyed
- second-hand dealers, which are those companies that deal in the resale of used EEE and may undertake some reconditioning of the equipment prior to resale; seven second-hand dealers in total were surveyed
- recycling companies, which are those companies whose major role is in the recycling of components of electrical and electronic products and are likely to undertake partial or complete dismantling of the equipment to obtain specific parts from which material of some resale value may be obtained; four recycling companies in total were surveyed.

The results of the survey are summarised according to the respective focus groups, as follows. Furthermore, individual recycling companies and landfill operators were contacted outside of the main survey to identify more precisely the nature of the current WEEE recycling and landfill activities in South Australia. A more detailed analysis of the survey is available in Appendix B[3].

[3] *Not available – commercial in confidence*

CORPORATE USERS

The number of computers used by the surveyed corporate users varied, with 62% using between 0–10 computers, 27% between 11–50, 5% between 51–100, 4% between 101–500, and 2% with 501 or more computers. Sixty one per cent of these companies reported computer upgrade times of two or more years and 23% reported upgrade intervals of between one and two years (refer to Figure 5.1). Fifty one per cent of companies preferred a complete replacement of obsolete computers, while 35% preferred to replace components as needed with an upgrade rather than a complete replacement.

When computers were finally deemed obsolete, only 5% of companies indicated that their obsolete computers passed directly to a recycling company, while 5% indicated that they sent obsolete units directly to landfill. Fifteen per cent of companies stored their obsolete computers and, in total, 30% of companies indicated that their obsolete computers were either sold, traded in, reused, returned to the dealer or manufacturer, or donated to schools or charities (refer to Figure 5.2). These latter disposal methods serve to increase the lifetime of computers and shift the responsibility for recycling onto a second party. Of those companies that chose to store obsolete computers, 55% indicated a storage period of more than two years. Thus, it is unlikely that computers purchased in 1999 will reach the recycling or landfill sectors prior to 2004.

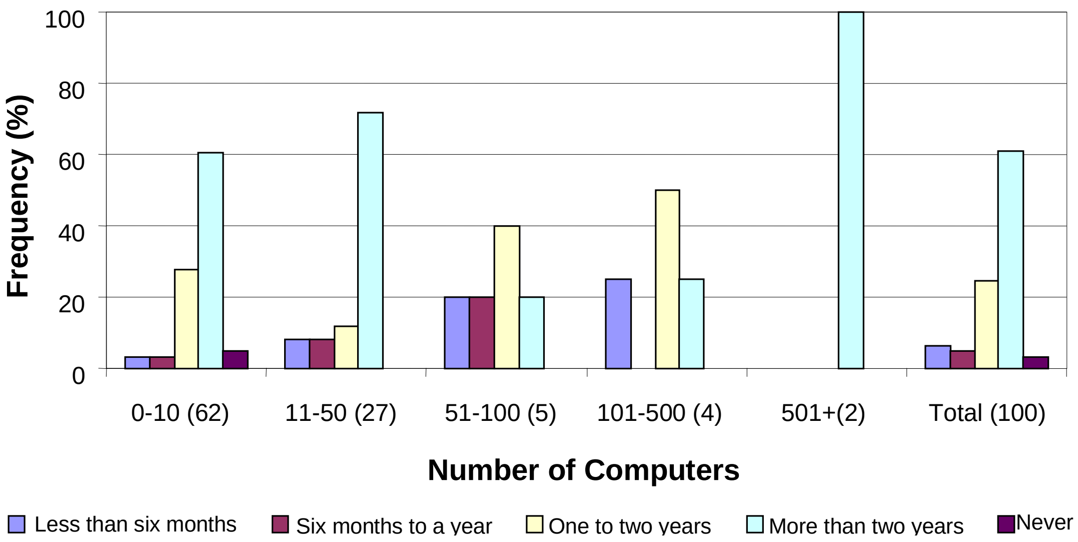

Figure 5.1: Lifetime of computers within corporate bodies in South Australia. (Data are split according to the number of computers used by the company, with the number of companies within each size group shown in brackets.)

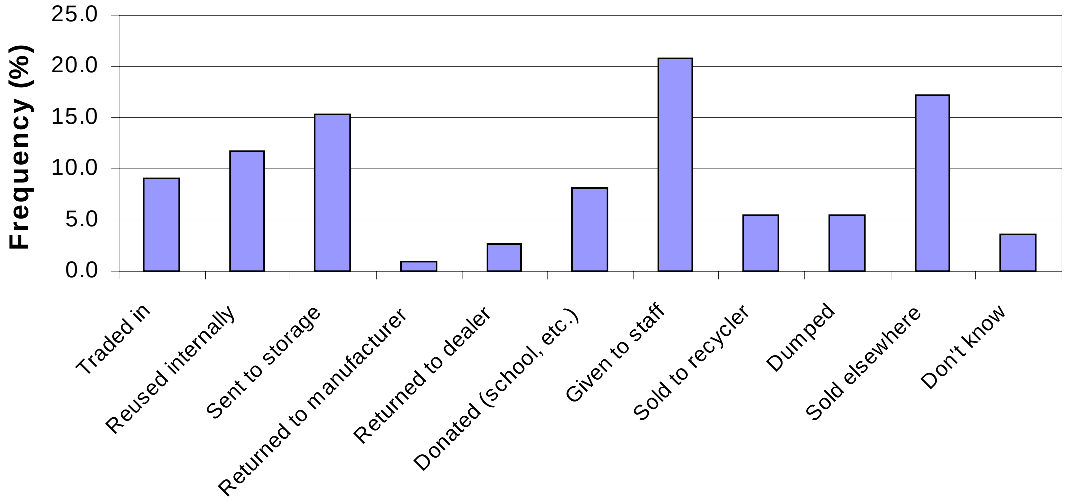

Figure 5.2: Fate of obsolete computers from corporate bodies in South Australia

Mobile phones are the other commonly employed EEE in the corporate sector: 76% of companies have between 0–10 mobile phones, 15% between 11–50, 4% between 51–100, and 1% between 101–500. Forty three per cent of the companies surveyed upgraded their mobile phones every two or more years, while 26% upgraded every one to two years (refer to Figure 5.3). Forty eight per cent of obsolete mobile phones were either sold, traded in, reused, returned to the dealer or manufacturer, or donated to schools or charities with 33% being accounted for by trade-ins. Landfill accounted for 9% of obsolete mobile phones, while 17% remained in storage and were used for parts or as spare units. There was no indication that obsolete mobile phones were being sent directly to the recycling sector (refer to Figure 5.4).

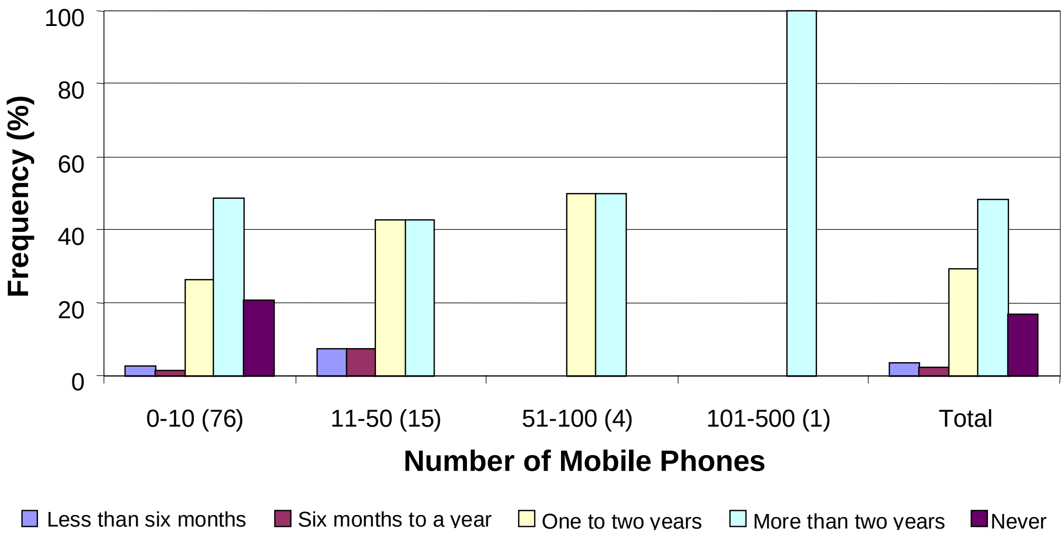

Figure 5.3: Lifetime of mobile phones within corporate bodies in South Australia (Data are split according to the number of mobile phones used by the company, with the number of companies within each size group shown in brackets.)

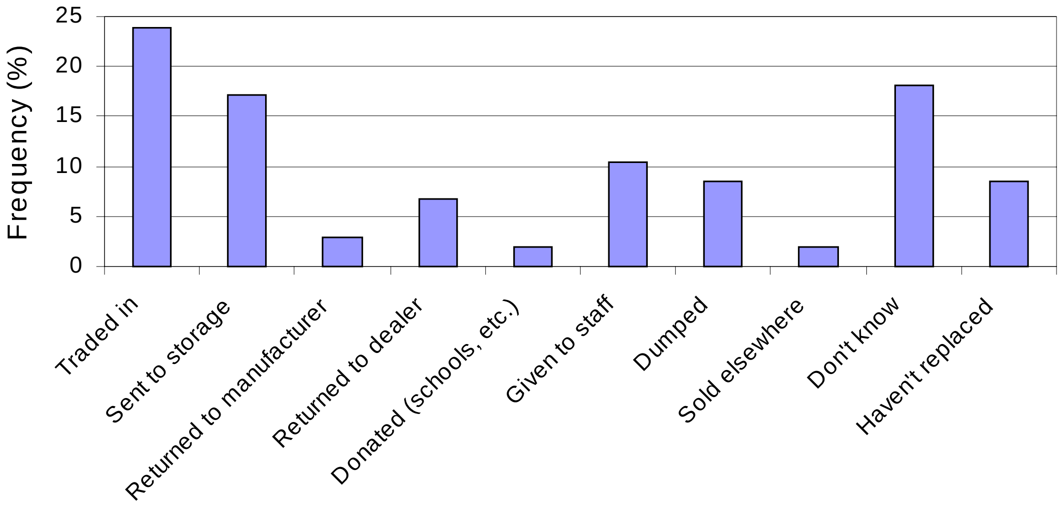

Figure 5.4: Fate of obsolete mobile phones from corporate bodies in South Australia.

The most commonly preferred method for disposal of waste from electrical and electronic equipment (WEEE) by the corporate sector was via recycling (27% of companies surveyed), but other methods included trade-in (16%), resale (15%), giving to staff (14%), and donation to charity (7%) (refer to Figure 5.5). The lack of significant levels of recycling by the corporate sector was explained by companies thus: either they 'didn't think of it' (50% of companies surveyed), or they 'didn't have to' (28%). These explanations highlight a general lack of knowledge of the environmental impacts associated with WEEE disposal across the corporate sector. Furthermore, 26% of the companies surveyed indicated that no incentives were available to increase their recycling activities, which suggests that the companies themselves did not consider WEEE recycling to be of critical importance. Of those companies that gave a positive response, 43% indicated that either higher returns, lower cost, or government incentives would provide the motivation to improve potentially their recycling practices. These companies saw the economics of recycling as a significant factor despite the fact that very few companies indicated that the economics was directly inhibiting their recycling practice.

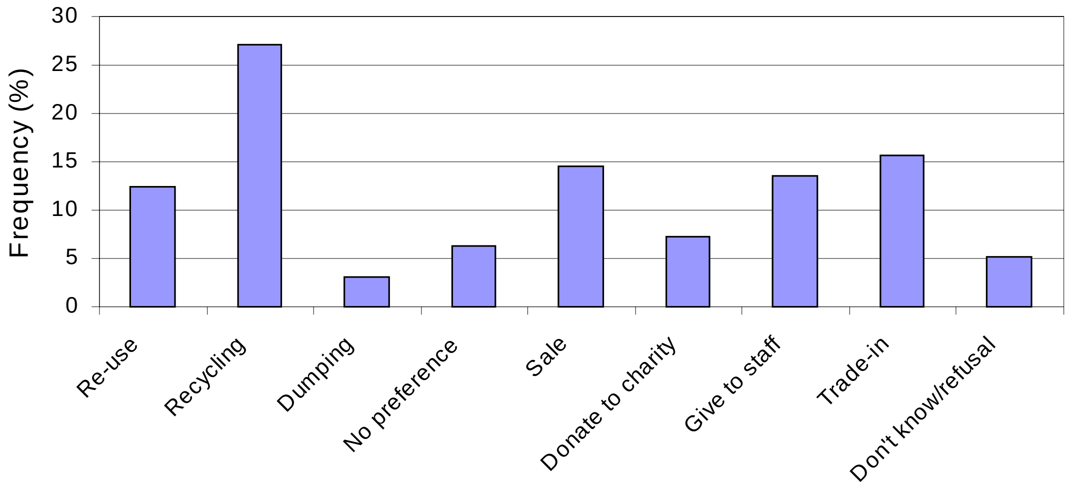

Figure 5.5: Preferred option(s) of corporate bodies in South Australia for the disposal of obsolete EEE.

Generally it was found that the limited recycling activity associated with the corporate sector is a reflection of their ignorance of the need for WEEE recycling rather than being related to any financial constraints or an inability to access the recycling sector. This can be alleviated by means of an appropriately targeted educational program to the corporate sector to provide education on the environmental issues facing WEEE disposal, and mechanisms by which they can freely access the recycling sector.

PRIVATE USERS

As would be expected, the private users in South Australia employ a wide variety of EEE including computers and associated accessories, mobile phones, whitegoods (refrigerators, washing machines, microwaves), browngoods (stereos, videos, TV sets), and power tools. Computers were found to be used by 65% of the households surveyed, while mobile phones were used by 52% of households. Seventy-five per cent of households had computers that were less than five years old, and 71% of households had mobile phones less than two years old. In comparison, browngoods were generally between two and ten years old, while whitegoods were on average greater than five years old (refer to Figure 5.6).

Forty-six per cent of the households surveyed were yet to replace their first computer, and of those which had done so, 80% indicated that they replaced them prior to five years of age. This replacement trend tends to suggest that many of the computers currently in use in South Australian households will become obsolete in the next three to five years. South Australian households saw the lifetime of browngoods as being up to ten years. Given the age profile of this equipment, it is unlikely that the quantities of obsolete browngoods for disposal will be significant over the next five years. Whitegoods also had a life expectancy of up to ten years in South Australian households. Given the older age profile of this equipment, it is more likely that larger volumes of whitegoods will enter the waste sector over the next five years.

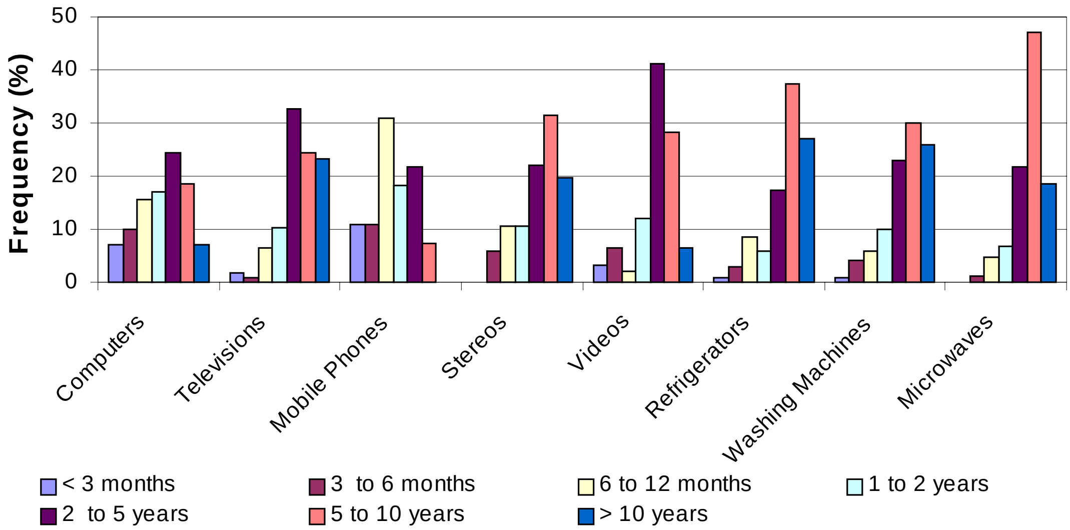

Figure 5.6: Age profile of various types of EEE commonly used in South Australian households.

Disposal trends for obsolete electrical and electronic equipment (EEE) by South Australian households indicated that the equipment was either kept by the original household (27% on average for all EEE), passed on to other households (22%), traded in (17%), or sold (9%). Computers were predominantly kept (34%) or given to other family members (26%), and mobile phones were commonly traded in (37%) or kept (30%). There was very little indication of recycling: only 5% of households took equipment directly to recycling companies and 2% of households indicated that they disposed of WEEE using council collection schemes. Eight per cent of WEEE was taken directly to landfill by South Australian households, and 7% remained in storage (refer to Figure 5.7). Of those that indicated that they stored their WEEE, 41% of households were unaware of how to dispose of the equipment while 37% were keeping the equipment for possible future use.

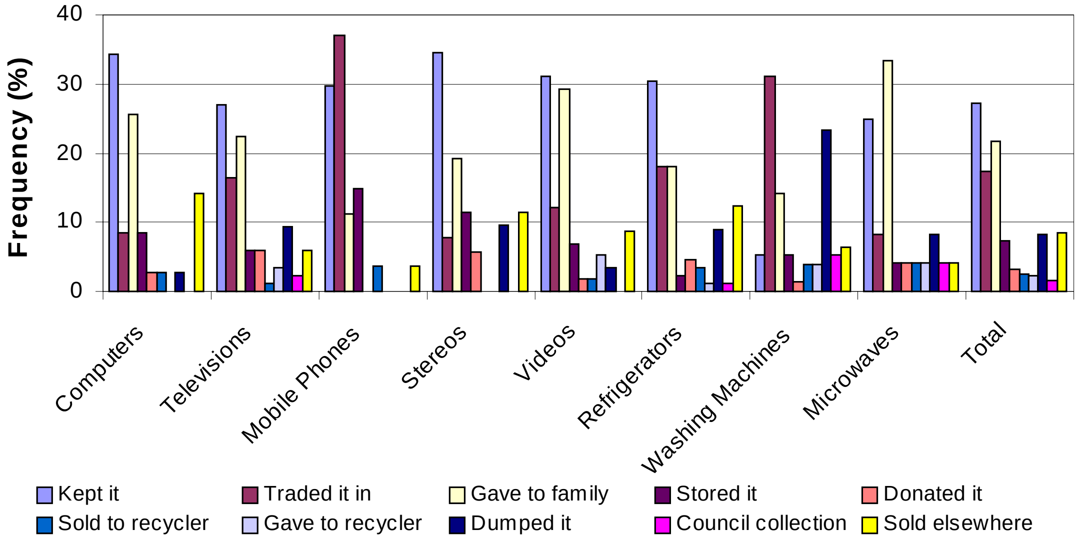

Figure 5.7: Trends for the disposal of obsolete EEE in South Australian households.

The largest portion of households (37%) disposed of WEEE by donating it to schools or charities, while 25% of households preferred to recycle their WEEE. Trade-in (10%) and resale (17%) of obsolete WEEE were other common disposal preferences while 12% of households still dumped WEEE for landfill (refer to Figure 5.8).

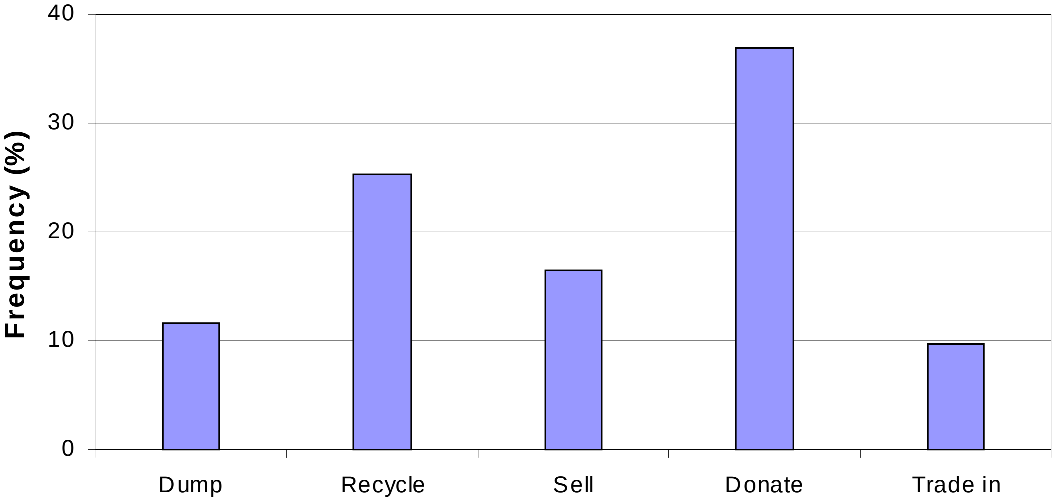

Figure 5.8: Preferred methods for the disposal of obsolete EEE by South Australian households.

The recycling of WEEE by South Australian households was being limited by the fact that households 'didn't know how to do it' (50% of households surveyed), while 26% of households believed it was 'too difficult' and 10% saw it as 'too expensive'. In comparison, 34% of households believed WEEE recycling could be enhanced simply by the provision of more information on the issues relating to the landfill disposal of WEEE and how WEEE recycling can be undertaken. Furthermore, 19% of households required collection schemes to enable them to access the recycling network, while 18% of households expected higher returns from recycling (refer to Figure 5.9).

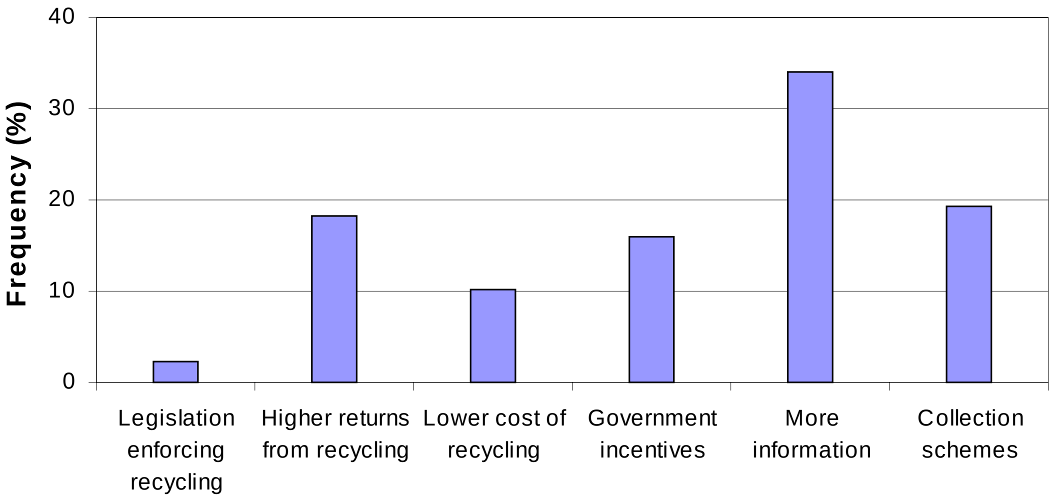

Figure 5.9: Factors which may promote the recycling of EEE by households in South Australia.

The recycling of WEEE by South Australian households is affected by similar factors to those that affect the corporate sector: there is insufficient information regarding the potential environmental impact of WEEE upon disposal, the types of WEEE that can be recycled, and how households can access the recycling network. Provided this information is available and the infrastructure (such as a recycling network and dedicated collection schemes) exists to support the process, there is potential to improve the practice of recycling in South Australian households.

ORIGINAL EQUIPMENT MANUFACTURERS (OEMs)

One way by which OEMs can contribute is by implementing environmental design initiatives aimed at minimising the environmental impact of their products upon disposal. Of the OEMs surveyed, 38% of companies were actively undertaking 'design for increased product life'. This is an indirect method of minimising the environmental impact of EEE since it does not minimise the environmental impact of any single unit but aims to minimise the number of units in circulation at any one time. Twenty-five per cent of the OEMs surveyed were 'reusing used components' and 13% were employing 'design for disassembly', 'environmentally friendly raw materials', or 'design for repair'. Promotion of the use of 'environmentally friendly raw materials' by OEMs is the ideal means of reducing the environmental impact of WEEE upon disposal; these raw materials are generally more expensive, however, and result in modifications to the manufacturing process. Twenty five per cent of the OEMs surveyed did not have any environmental design initiatives in place at present and, of those, 75% did not envisage employing any such initiatives in the future (refer to Figure 5.10).

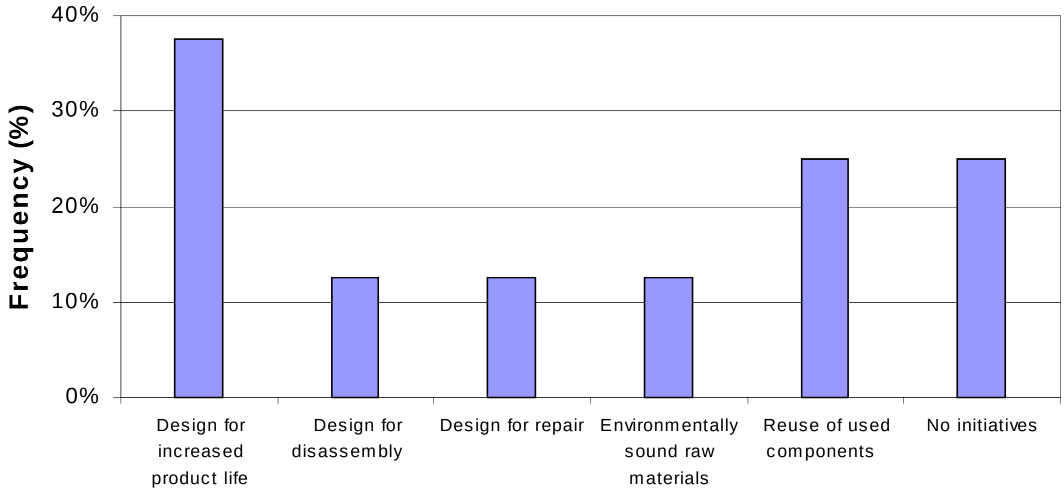

Figure 5.10: Preferred design initiatives for improving the environmental performance of products by OEMs in South Australia.

Those OEMs that currently employ environmental design initiatives indicated that they had done so because they saw a marketing advantage in promoting their design initiatives (83% of companies surveyed), or they viewed themselves as environmentally aware manufacturers (67%). These perspectives indicate that the performance of OEMs is linked to the philosophy of the company and their perception of the role and importance of the company in addressing environmental issues. Those companies that did not employ environmental design initiatives indicated that legislation (75% of companies) and/or the development of standard industry practice (50%) would be necessary to force them to undertake any initiatives. Only 25% of these companies saw improvement in their environmental performance as a contributing factor to developing environmental design initiatives, which suggests that these companies did not have a philosophy that regarded environmental issues highly (refer to Figure 5.11).

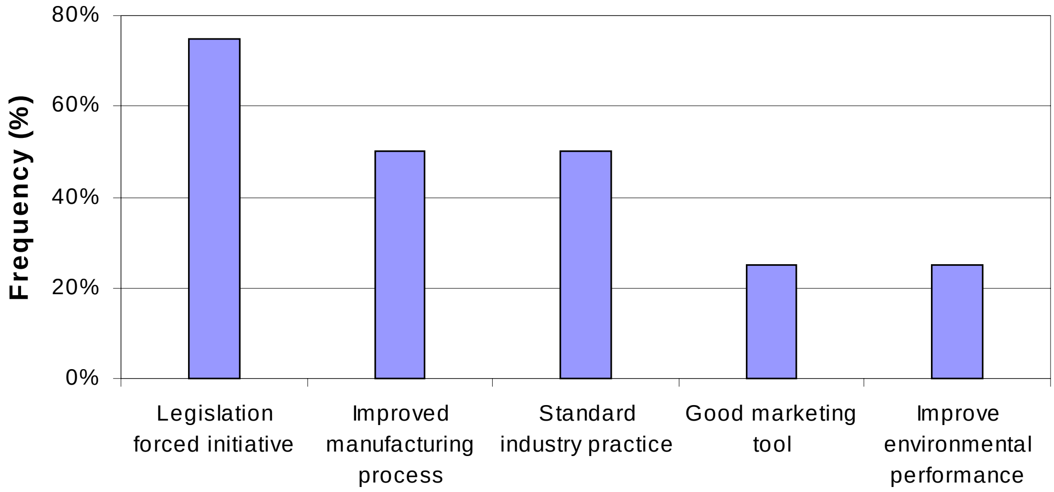

Figure 5.11: Factors required to prompt OEMs in South Australia to initiate environmental design initiatives.

These results indicate that there are two distinct groups of OEMs in South Australia. The first group has actively taken on environmental design initiatives and sees them as being important to the overall operation of the company. By contrast, the second group of OEMs has not done anything in this regard and seems reluctant to do so in the future. The latter group is unlikely to embark on developing environmental policies without compulsion since it does not consider itself as having a responsibility for the impact associated with the disposal of products manufactured. Evidently, a positive change in the philosophy of companies in this group will assist substantially in reducing the impact on the environment of the disposal of WEEE. This change in philosophy constitutes a significant challenge and, as has been seen in overseas markets, legislation may be the only means by which 'extended producer responsibility'-type initiatives may be effectively facilitated. Such legislation may make use of the EU Directive as a model and seek input and close cooperation from major stakeholders, especially from relevant industry sectors.

NEW EQUIPMENT DISTRIBUTORS (NEDs)

New equipment distributors have an opportunity to become actively involved in minimising waste from electrical and electronic equipment (WEEE) via the implementation of product take-back and trade-in schemes for obsolete electrical and electronic equipment (EEE). Of the NEDs surveyed in South Australia, 50% were found to have currently in place either product take-back or trade-in schemes. Of these companies, 54% indicated that they had implemented such a scheme as a result of the perceived marketing advantage in implementing schemes of environmental benefit, and 29% of these companies indicated that they viewed themselves as environmentally aware NEDs. Twenty seven per cent of the companies surveyed indicated that they viewed take-back and trade-in schemes as standard industry practice. Although these data suggest that there is willingness in the NED sector to recover obsolete equipment, the fate of recovered equipment must also be considered.

Of the NEDs that currently operate product trade-in or take-back schemes, 71% resold some of the equipment they recovered, while 37% indicated that they send at least some of the recovered equipment directly to recycling companies. Ten per cent of these NEDs stored some of the recovered equipment for spare parts, while 7% of these NEDs disposed of equipment directly to landfill. While the resale of obsolete EEE merely acts to extend the lifetime of the product, this resale does reduce the total number of units in circulation and it is encouraging to see that recycling of EEE has also been commonly employed (refer to Figure 5.12).

Of those NEDs that did not currently implement product take-back or trade-in schemes, 26% indicated they did not have any incentive to prompt them to implement such schemes in the foreseeable future. Twenty-four per cent of the NEDs surveyed stated that they would require government legislation before they would institute take-back and trade-in schemes. These findings suggest that there is a distinct group of NEDs that are opposed to product take-back and trade-in schemes and do not appear likely to implement them in the near future. These companies, as in the case OEMs, were unlikely to have environmental policies in place and did not consider themselves as having any responsibility to the environment or for the environmental impact of the equipment they distribute. Some NEDs that did not currently undertake these schemes indicated that they would consider implementing the schemes in the future if recycling avenues were readily available (18%), more information was provided (5%), or the process was easier to undertake (3%).

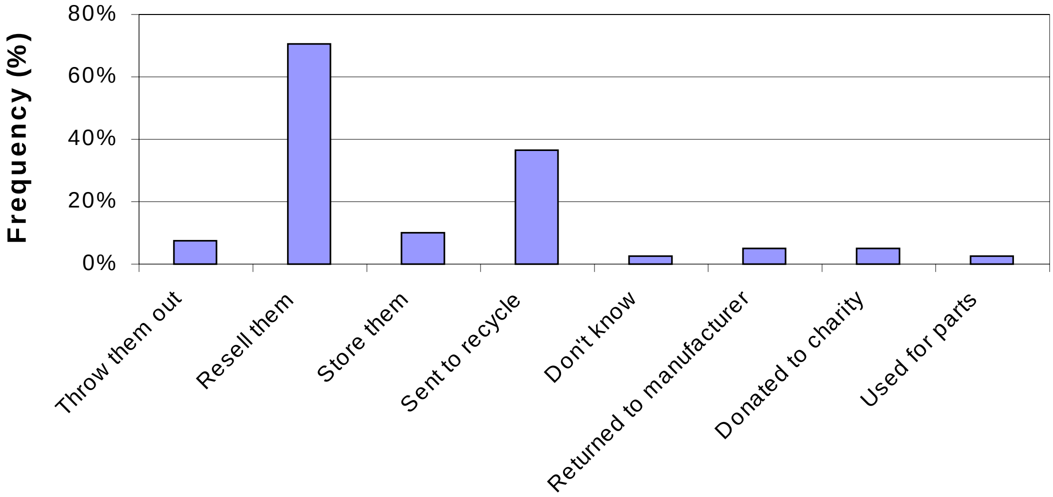

Figure 5.12: Fate of EEE returned to NEDs in South Australia via product take-back and trade-in schemes.

NEDs in South Australia, as with OEMs, can be categorised into two distinct groups: one group actively implements product take-back or trade-in schemes; the other group seemingly opposes such schemes. Generally, however, there is a reasonable amount of activity amongst NEDs in South Australia in recovering used EEE for resale or recycling, which is encouraging. The effective impact of this is to reduce the total amount of EEE in circulation at any given time.

SECOND-HAND DEALERS

Second-hand dealers play an important role in the life cycle of EEE by facilitating redistribution of used EEE with some residual value or operating life. Therefore, the second-hand dealer’s role is to extend the lifetime of the equipment rather than to reduce or eliminate any environmental impacts associated with equipment disposal. It is likely that this equipment is sold to consumers who may otherwise not have bought new equipment. The total amount of equipment in circulation, however, effectively remains unchanged. Second-hand dealers in this survey indicated that they paid some compensation for the equipment that they received if there was a potential profit from its resale. Approximately half the equipment collected by second-hand dealers was at no cost because such equipment was of little or no resale value.

Usually, some work had to be carried out on the second-hand equipment before it could be resold. Sixty seven per cent of the second-hand dealers surveyed indicated that the equipment collected required a simple ‘clean-up’ prior to resale, while 50% of companies indicated that some of this equipment required the replacing of specific components. Complete upgrades of equipment were undertaken by 17% of the second-hand dealers surveyed, and 33% indicated that they dismantled some equipment for spare parts and materials.

‘Financial incentives from government’ were considered by 71% of the second-hand dealers surveyed to be the factor most likely to increase the activity in the second-hand market. Twenty nine per cent of second-hand dealers indicated that creating a ‘greater environmental awareness’ in the community at large would improve the second-hand market, while 14% of second-hand dealers indicated that enforcing ‘government legislation’ on the disposal of WEEE would also assist in expanding the second-hand market (refer to Figure 5.13).

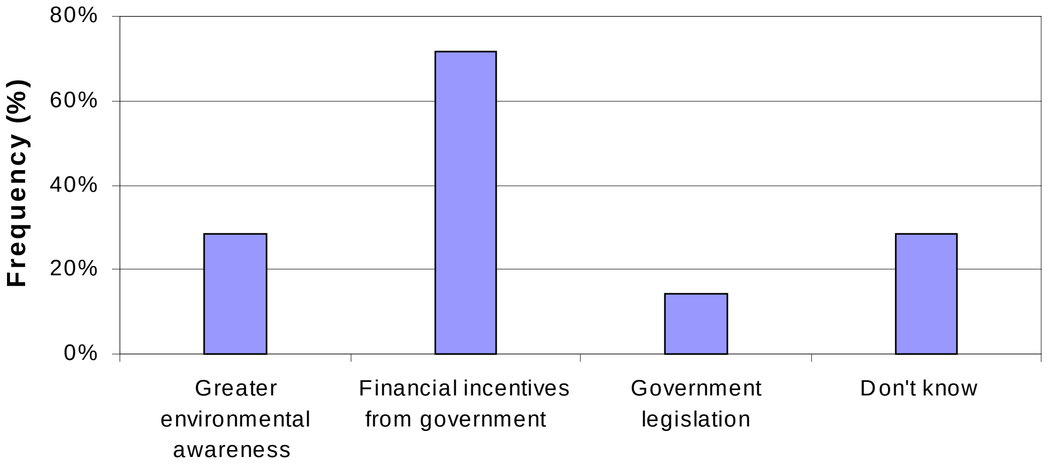

Figure 5.13: Incentives required to promote the resale of used EEE in South Australia.

The responses received from second-hand dealers suggest that the market for used EEE in South Australia is quite active and strong. To some extent, this includes NEDs that also act as second-hand dealers. While the resale of used equipment does not reduce the environmental impact of these products when they finally enter the waste stream, the resale does serve to increase the total lifetime of the equipment and reduces the total volume of equipment in circulation.

The second-hand market is likely to play a crucial role in the future when advancing technological improvements are most likely to mean that consumers will replace EEE on a more frequent basis. Therefore, equipment of higher quality is bound to be available for resale. This provides second-hand dealers with the potential to increase their profits from the resale of EEE, which will further improve the viability of the second-hand sector.

RECYCLING COMPANIES

Recycling companies enter at the end of the life cycle of electrical and electronic equipment (EEE) and represent the final environmental barrier prior to ultimate disposal of equipment to landfill. Recycling companies have the opportunity to recover materials of value from waste electrical and electronic equipment (WEEE) and, as they often undertake dismantling, there is also the opportunity to segregate components that pose a danger to the environment and to discard them via appropriate means.

The recycling companies in the survey indicated that they sourced their EEE from the public sector (100% of companies surveyed), the corporate sector (50%) and the government sector (100%). Fifty per cent of the recycling companies surveyed paid for the EEE they received, which would suggest that there are sufficient returns from recycling. 'Recovery of valuable materials' was being actively undertaken by 75% of the companies surveyed, while 50% of the companies were undertaking either the 'dismantling of products' or the 'recovery of useable parts'. Twenty five per cent of companies also indicated that they acted as a collection centre for WEEE to be transferred to specialised recycling operations (refer to Figure 5.14).

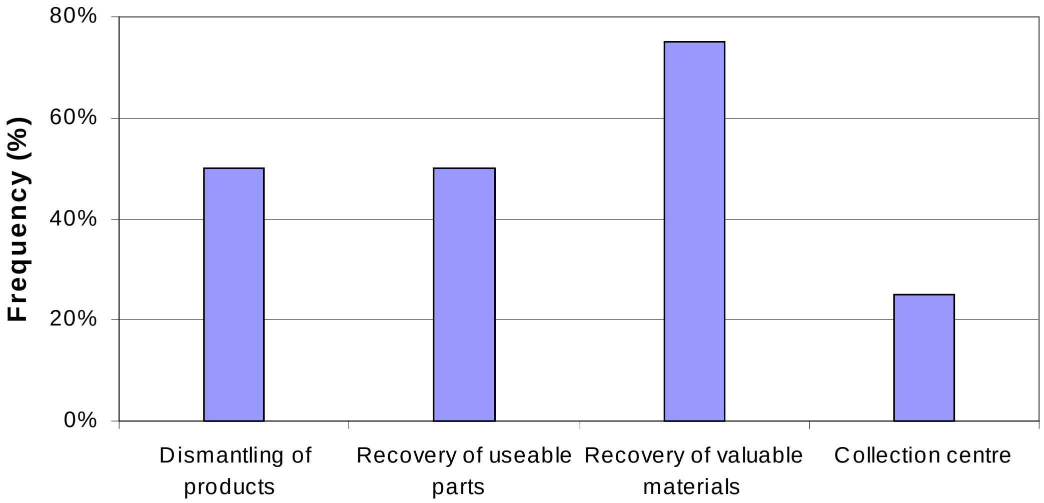

Figure 5.14: Nature of the recycling carried out by recycling companies of EEE in South Australia.

In the case of recycling companies that recover valuable materials from the electrical and electronic waste collected, the major materials recovered were metals such as copper, aluminium and brass, along with other scrap metal like iron, and plastics. To a lesser extent, heavy metals (cadmium, mercury, lead, etc) and precious metals (gold, silver, etc) were also being recovered (refer to Figure 5.15).

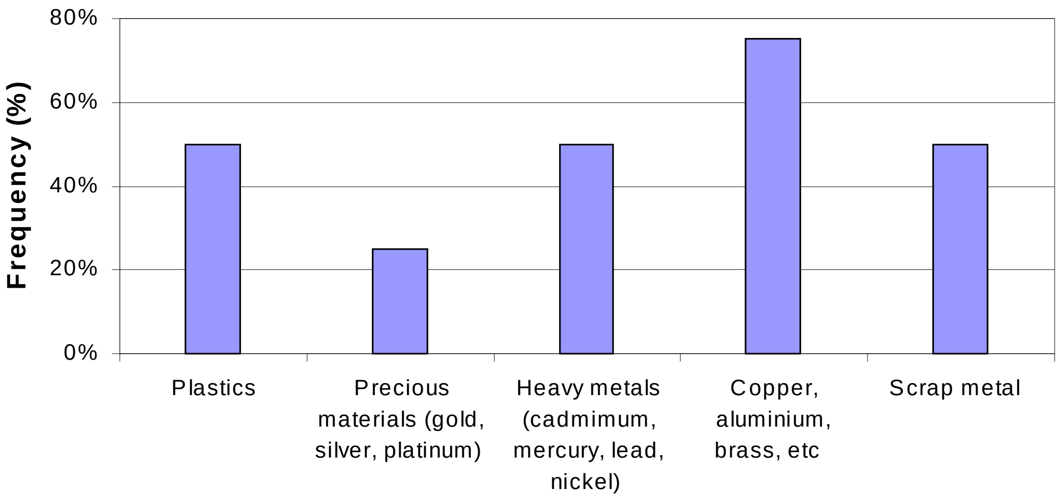

Figure 5.15: Nature of the material recovered from electrical and electronic waste by recycling companies in South Australia.

These survey results tend to indicate that a certain amount of sophisticated recycling of WEEE is being undertaken in South Australia. Recycling companies have again indicated certain factors, however, which limit the amount of recycling that they are capable of undertaking. As can be expected, all of the recycling companies surveyed indicated cost as being the limiting factor in recycling. Seventy five per cent of the companies surveyed indicated that they were limited by difficulties in obtaining sufficient amounts of WEEE to recycle. This lack suggests that the potential exists for an increased rate of recycling, provided recycling companies can increase their intake of WEEE. Fifty per cent of the recycling companies believed that there was a lack of public awareness as to how and what kind of EEE can be recycled. These limitations were further compounded by both apathy on the part of private consumers (25%) and government inactivity (25%) (refer to Figure 5.16). These responses underscore the previous observations in this report that there is a general lack of knowledge of the issues related to WEEE recycling in South Australia along with impeded access to the recycling network.

Fifty per cent of the recycling companies surveyed believed that increasing awareness about WEEE recycling and establishing financial incentives from government were motivational means by which to promote the recycling of WEEE. An increase in the awareness of the recycling value of goods (25% of recycling companies surveyed) as well as information about recycling avenues (25%) were also suggested as possible incentives. The link between price limitation in current rates of recycling and financial incentives from government to increase future rates of recycling indicates that the economics of recycling remains a critical factor in maintaining a stable WEEE recycling network (refer to Figure 5.17).

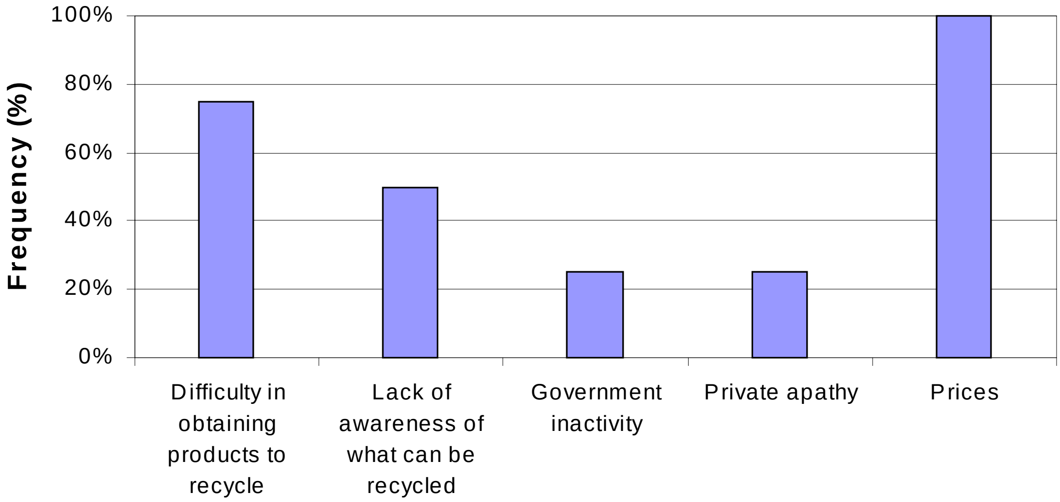

Figure 5.16: Factors that limit the potential of recycling companies in South Australia.

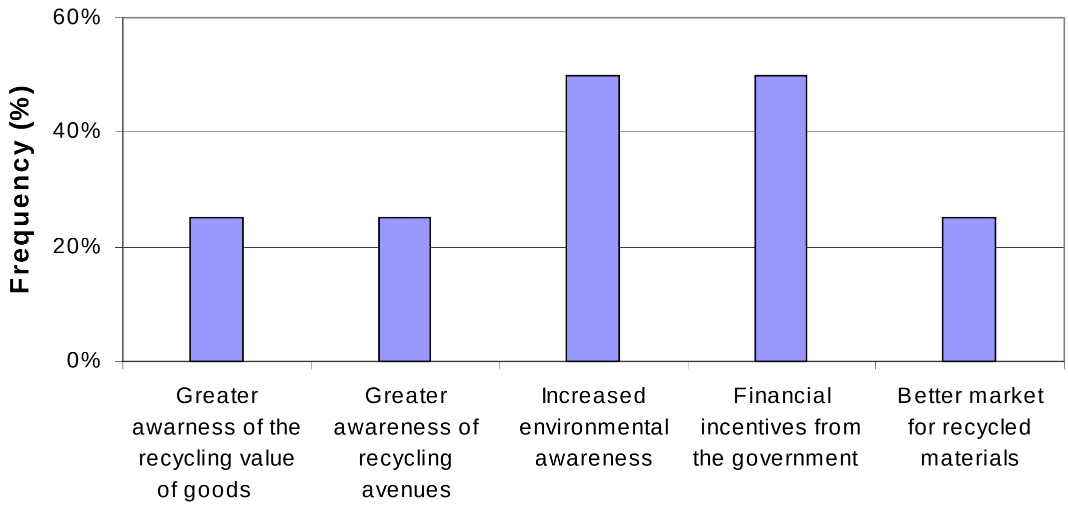

Figure 5.17: Incentives required to promote the recycling of obsolete EEE in South Australia.

A review of the activities undertaken by individual recycling companies highlighted the absence of any network that connects the various recycling companies. For example, several recyclers have indicated that they generated waste streams of mixed plastics which ended up in landfill, while other companies specifically recycled plastics and could potentially have processed these waste streams. This lack of connection highlights the need for recycling companies in South Australia, indeed in Australia, to be strategically linked to improve the efficiency of the recycling sector and to minimise the volumes of waste materials that leave it.

In general, the response from the recycling sector indicates that South Australia presently has a reasonable recycling capability and the capacity to increase the amount of WEEE recycled, provided the right incentives and mechanisms are put in place to promote WEEE recycling. Current limitations seem to arise from the economics of recycling, the lack of suitable mechanisms that enable WEEE to reach recycling centres, as well as a lack of appreciation on the part of the public at large of the importance of WEEE recycling.

LANDFILL OPERATORS

It was seen from the survey results that there is a reasonably large amount of WEEE that ends up in landfill in South Australia: approximately 1500 tonnes per year of WEEE in total is processed in the metropolitan area. While some landfill operators have indicated that they segregated equipment of residual value, the activity in the second-hand sector would tend to indicate that minimal equipment of significant resale value has ended up in the waste sector. Scrap metal and metals such as copper and aluminium are commonly segregated for recycling. Other materials, however, such as plastics and glass, have been predominantly disposed to landfill. A number of landfill operators stated that CRTs were regularly dumped, with no current restrictions on their disposal.

The ideal position would be that no WEEE enters landfill at all. In the interim, there needs to be a concerted effort to reduce the amount of WEEE and to eliminate hazardous materials from WEEE that go into landfill. The linkage of landfill operators into the recycling network and the enforcing of the segregation of environmentally harmful components will increase the effectiveness of WEEE recycling in South Australia.

THE RESPONSIBILITY FOR RECYCLING

It is important when considering the development of strategic recycling to consider also which sectors of the community should bear the responsibility and cost for undertaking waste electrical and electronic equipment (WEEE) recycling. The groups identified by all participants in the survey as most responsible were manufacturers (34% of all sectors surveyed) and consumers (22%). A similar response was obtained when the respective groups were prompted to consider who should bear the cost of these recycling activities. Once again, the most common responses were that manufacturers (27%) and consumers (31%) ought to bear the bulk of the recycling cost (refer to Figures 5.18 and 5.19).

It is interesting to note that, by comparison, recycling companies were not considered to be responsible for recycling (11%), nor that they should bear the cost for recycling (7%). Similarly, governments at all levels (Federal, State, local) were not considered to be responsible (4%, 7%, 7%, respectively), nor were they expected to bear the cost of recycling (7%, 6%, 10%, respectively). These figures are in contrast to a number of other survey responses, which indicated that certain government initiatives were required to enhance recycling activities. Therefore, any schemes developed with the aim of increasing the rate of WEEE recycling in South Australia must be structured to ensure that the bulk of the responsibility and cost of recycling is borne by the manufacturing and consumer sectors.

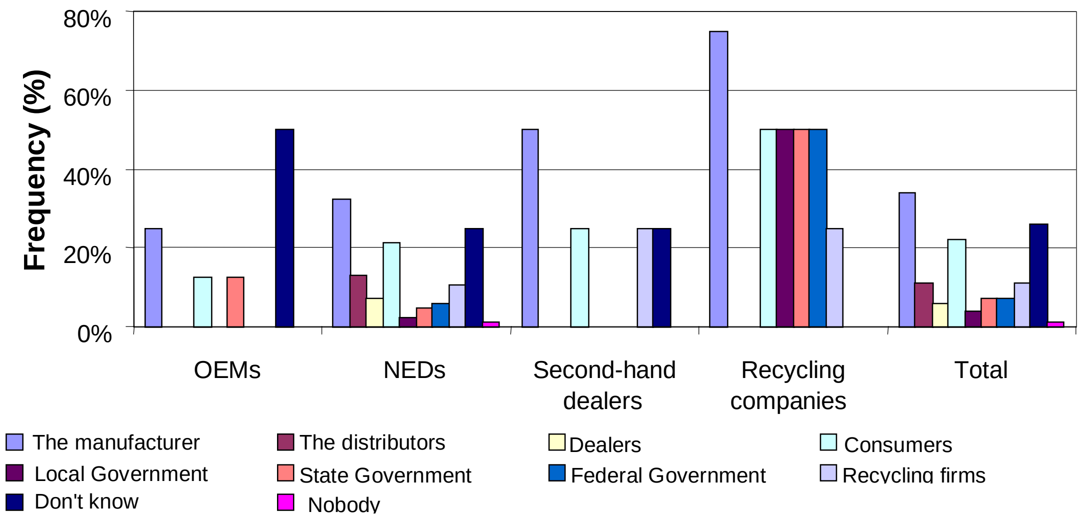

Figure 5.18: Groups considered to be most responsible for the recycling of obsolete EEPs in South Australia.

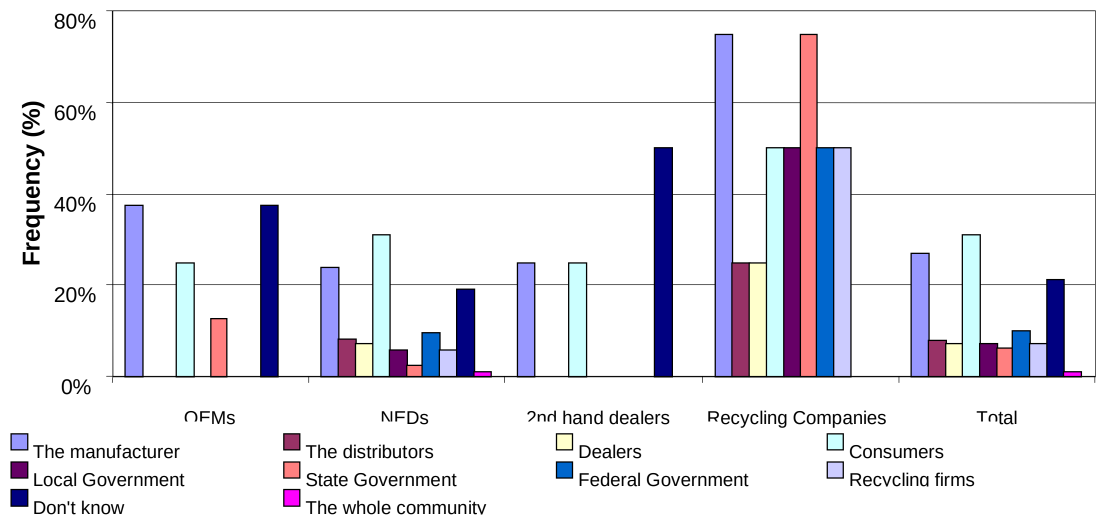

Figure 5.19: Groups considered most responsible for bearing the cost of the recycling of obsolete EEPs in South Australia.

With the information gained from the market survey, it is possible to generate a flow diagram that depicts the life cycle of EEE between various sectors of relevance. This cycle is shown in Figure 5.20.

This figure highlights that there are numerous pathways for used equipment to follow once it is considered obsolete by its original user. Presently, most of this equipment is either returned to NEDs via trade-in or take-back schemes and hence, it remains in the consumer market as second-hand goods or is sent into storage. The equipment sent to storage is generally of insufficient value for resale and has a tendency to remain in storage for some time. It then invariably passes to the landfill sector with the return of a minimal amount to the recycling sector.

In general, it can be seen that once EEE leaves the consumer sector, there are no defined avenues for its ordered disposal. Ideally, in order to minimise the environmental impact of WEEE, it must enter the recycling sector, which is where high-level recycling activities can take place. There are numerous pathways along which used or discarded equipment can travel in order to enter the recycling sector and the total recycling cost is likely to increase depending on the number of pathways followed. Given the general perception that manufacturers and consumers should bear the responsibility and cost of recycling, the pathway that leads directly from the consumer sector to the recycling sector needs to be better developed, which will also minimise handling costs, provided an acceptable collection mechanism can be developed.

By the further development of this pathway, the time lag between the designation of the equipment as obsolete and the same equipment's entry into the recycling sector can be minimised. This reduction will result in a more consistent supply of WEEE that enters the recycling sector, which makes the development of high-level recycling facilities more economically viable due to a regular supply of raw materials. Note that the second-hand sector will not be eliminated while there is the potential for consumers to gain some return for their used equipment. Furthermore, the second-hand sector is crucial since it effectively minimises the total volume of EEE that circulates within the system. An efficient system is needed as the basis of a high-level recycling industry that is capable of transfering obsolete equipment directly from the consumer to the recycling sector and bypassing the storage and waste collection sectors. This system will help to minimise costs and to ensure a more consistent supply of WEEE to the recycling industry.

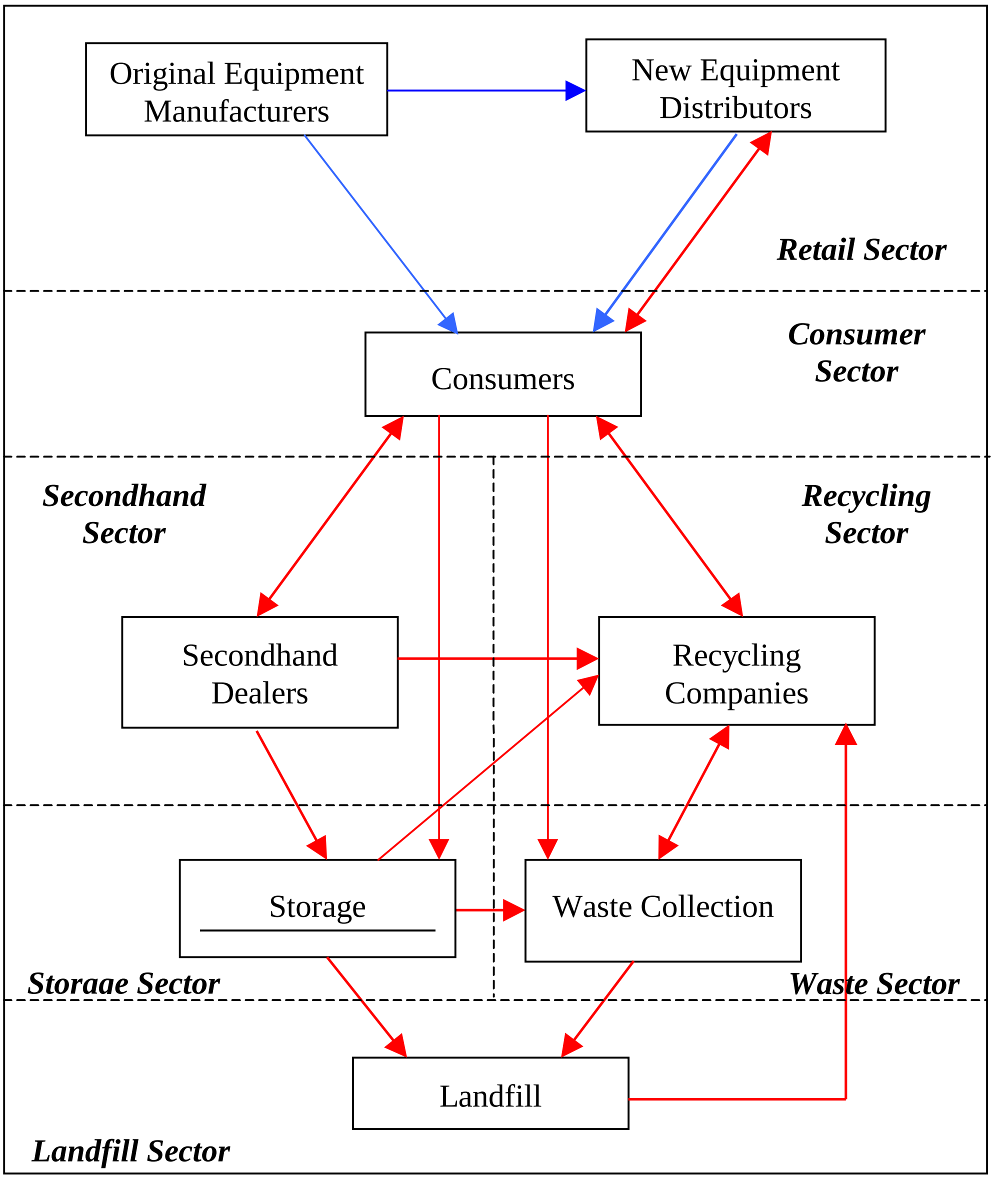

Figure 5.20: Flow diagram representing the life cycle of EEE in South Australia (The arrows in blue denote the flow of new equipment, while the arrows in red denote the flow of used equipment.)

6. Potential Benefits of Recycling for South Australia

ENVIRONMENTAL BENEFITS

In total, it is estimated that 1500 tonnes of WEEE will have ended up in landfill in 1999. Approximately 24 000 computers or 458 tonnes of computers entered landfill in South Australia in 1999 based on the estimation detailed in Appendix D. This figure is anticipated to increase to 55 500 units or 1060 tonnes by the year 2005.

The calculations outlined in Appendix D indicate that approximately 68 800 analogue mobile phone connections remained in South Australia as of June 1999, with approximately 440 000 digital mobile phone connections in place. The total number of mobile phone connections is expected to reach 600 000 by the end of 2000. Given that analogue mobile phones are being phased out, 160 000 digital mobile phone connections are expected prior to the end of 2000. The survey results indicate that obsolete mobile phones generally were not recycled or landfilled: due to their size, they were mostly stored. As a result, it becomes difficult to estimate the numbers of mobile phones that are likely to enter landfill in the near future. With the discontinuation of the analogue network, however, some additional 68 800 mobile phones will become obsolete by the end of 2000, which highlights the need for an environmentally sound disposal or recycling option.

At present, there is little or no information on the actual environmental impact of WEEE. The greatest environmental danger comes from hazardous or toxic components contained in electrical and electronic products (EEPs). At end-of-life, when these products enter landfills, are intentionally or accidentally incinerated or are illegally dumped, the potential for these hazardous and toxic components to leach into the surrounding soil or waterways poses some danger. Due to the advances made in landfilling operations the potential for leaching of toxic substances is minimal, but because of the severity of the potential impact, these issues cannot be ignored (Gertsakis, Ryan & Hoy, 1996).

A major issue for the disposal of computers to landfill is the cathode ray tubes (CRTs) of computer monitors. Since PCs represent around 85% of total computer sales (Sim, 1998), approximately 20 400 CRTs will have entered landfill in South Australia in 1999. The glass components of CRTs contain lead: CRTs have been found to leach lead above the maximum allowable US levels, which equate to 100 mg of lead leaching into the groundwater per kg of solid waste in 20 years of landfill (Chelsea Centre for Recycling and Economic Development, 1998).

The risk of lead leaching from landfilled CRTs is further exacerbated by the fragile nature of CRTs, which leads to damage during landfill operations. Sound engineering practices ensure that the risk of contaminants leaching from landfill sites is low, but as the above data indicate, the possibility remains that lead will leach into groundwater supplies over extended time periods.

The potential impact of lead is more severe if inhaled. The crushing of CRTs during landfilling has the potential to generate airborne lead dust particles, which may be directly inhaled by landfill operators. Such inhalation may potentially cause respiratory problems, lead poisoning or ultimately, lung cancer in operators (http://www.advancerecovery.com /environmentalissues/html/crt_ recycling.html).

CRTs are also an essential component of television sets, and similar concerns apply upon their arrival at the landfill. The results of the survey outlined in section 5 suggest, however, that the number of TV sets that enter landfill is much lower than the number of computers as a source of CRTs.

The average computer contains around 0.0022%, or 0.45 g of mercury. Therefore it is estimated that up to 10 kg of mercury will have entered landfills in South Australia in 1999 as a result of computer disposal. The US EPA has specified a limit of two parts mercury per billion in drinking water. The leaching of mercury from computers, if not handled correctly, has the potential to contaminate large volumes of groundwater (Biddle, 1999). The human nervous system is sensitive to high levels of mercury, as are the kidneys and reproductive system. Mercury can also be converted to methylmercury by water-borne organisms: methylmercury is reported to be a human carcinogen (http:// www.atsdr.cdc.gov/facts46.htm).

A standard computer contains cadmium, which corresponds to approximately 0.01% of the computer's total weight (Biddle, 1999). Consequently, around 46 kg of cadmium will have entered South Australian landfills as a result of computer disposal in 1999. The effect of cadmium is not as dramatic as mercury, but long-term exposure to high levels of cadmium can result in kidney disease, lung damage if inhaled, liver damage, as well as damage to the reproductive, immune and nervous systems (http://www.iet.msu.edu/journal/cadmium/htm).

A typical computer workstation comprises 25% plastics, which translates into a total of 115 tonnes of plastics that entered South Australian landfills in 1999. The plastics used in computer assemblies are non-biodegradable and, as such, will not decompose. Furthermore, these plastics are manufactured from petrochemicals, which places an added drain on already limited non-renewable fossil fuels (http://www. plasticsresource.com).

The plastics found in computer workstations are commonly treated with flame retardant, such as tetrabromobisophenol–A (TBBA). It is estimated that around 30% of all plastics used in computers contain TBBA (http://www.corpwatc.org/trac/ feature/hitech/plastics.htm). TBBA is potentially toxic to humans, and reports of measurable levels of flame retardants in human blood already exist. The continued landfill disposal of plastics associated with WEEE must therefore be carefully assessed (http://www.techrecycle.com).

While the landfilling of computers has a number of potential environmental impacts, computers constitute only 30% of the estimated volume of WEEE going to landfill, based on the feedback obtained from the various landfill operators surveyed. The potential environmental impacts of other WEEE must also be considered.

Chlorofluorocarbons (CFCs), which were previously used as coolant in refrigerators and air conditioners, are highly active ozone depleters (they have since been replaced by HCFCs and HFCs). Despite the phasing out of production of CFCs in 1978, the anticipated lifetime of refrigerators in South Australian households and the fact that they are often given to other family members when obsolete suggest that potentially large numbers of refrigerators and air conditioners with CFCs remain to be disposed of at some future time. If these units are landfilled, the potential exists for damage of the cooling coils, which results in the release of CFCs to the atmosphere with serious consequences (http://www.schwaben.de /home/kepi/ozone6.htm).

Ni-Cd batteries are commonly used in mobile phones and, as was previously discussed, cadmium poses a number of potential hazards. In addition, cordless power tools also employ rechargeable Ni-Cd batteries as a power source. The recently established recycling initiative for mobile phone batteries places greater emphasis on power tools as a source of waste Ni-Cd batteries, which have the potential to end up in landfill without correct disposal.

Polychlorinated biphenyl, or PCB, has been commonly used in all types of electrical and electronic equipment. Due to its high dielectric strength, PCB is used as a dielectric fluid in capacitors and transformers (http://www.tredi.com/atredi/faq/faq1.htm). PCB is generally chemically stable and non-biodegradable: it can therefore lead to persistent problems of bioaccumulation. The leaching of PCBs into groundwater can lead to accumulation in fish and marine mammals and, ultimately, in human tissue. PCB can cause problems in humans associated with the nervous system as well as liver and kidney damage and it is a suspected carcinogen (http://www.atsdr.cdc.gov/tfacts17.html). The incineration of components containing PCB may result in the generation of dioxins or furans, which are highly toxic human carcinogens (http://www.atsdr.cdc.gov/tfacts17.html). The importation of PCB has been banned since 1976, so only older equipment is likely to contain PCB above the maximum allowable level of 50 mg/kg (Environment Australia, 1999), such as components of older mainframe computers, electric motors, and transformers (Gertsakis, Ryan & Hoy, 1996).

As can be seen, a number of environmental benefits arise from increasing the rate of WEEE recycling. It is anticipated that the 458 tonnes of computers alone that were landfilled in 1999 would have required around 1600 m^3 of landfill. This volume will increase to 3800m^3 by the year 2005 (refer to Appendix D for a detailed calculation). Since the discarded computers represent only 30% of the total electrical and electronic waste, it can be estimated that around 5300 m^3 of WEEE would have been landfilled in 1999 This figure will rise to 12 600 m^3 by 2005. Around 10% of WEEE is not recyclable and will ultimately be landfilled, so the recycling of this WEEE could have potentially saved 4750 m^3 of landfill space in 1999 and will potentially save 11350 m^3 in 2005 (Matthews, 1997).

ECONOMIC BENEFITS

Along with these environmental benefits, the recycling of waste electrical and electronic equipment (WEEE) offers certain potential financial benefits. Note that these economic benefits will be offset by costs associated with the collection, demanufacturing, and processing of the equipment, which will also need to be considered in a detailed feasibility study. Precious metals such as gold and silver are commonly used in electrical and electronic equipment (EEE), with prices of such commodities at $15 300/kg and $285/kg, respectively (HighTechnology Metal Recyclers, pers comm). Computers alone are estimated to house approximately 0.02% silver and 0.001% gold (Biddle, 1999), which means that around 92 kg of silver and 4.5 kg of gold could have been recovered from the computers landfilled in 1999 and would have generated $68 850 and $26 200 respectively. WEEE also contains a fraction of platinum, which realises a return of $11 000/kg. If the fraction of platinum is assumed to be 0.0005% for all WEEE, the total potential return for platinum is approximately $82 500.

Aluminium, steel, and copper may also be recovered and sold; it is estimated that approximately 5% of all WEEE is aluminium, 25% is steel, and 4% is copper in the form of wiring (Pepi, 1998). These commodities realise a resale price of $1.30/kg, $5/tonne, and $0.50/kg, respectively (HighTechnology Metal Recyclers, pers comm). The potential returns, based on these figures, are $97 500, $1875, and $30 000 from the estimated recovery of aluminium, steel, and copper respectively for WEEE that was landfilled in 1999.

There is a potential, based on the figures, to return a total of $306 925 from the recovery of the precious, ferrous, and non-ferrous metals from WEEE. These figures do not include the potential returns for the recovered mixed plastics. Mixed plastics comprise approximately

15% of all WEEE (Pepi 1998). If a resale value of $50/tonne were assumed, the recovery of mixed plastics would have returned a further $11 250 in 1999.

7. Recommendations

The following recommendations arise from the results of the current study.

RECOMMENDATION 1: FORMATION OF A WEEE ADVISORY BODY

An advisory body should be established whose role is to assist in the development of strategies and legislation aimed at promoting the recycling of WEEE at a national level. The advisory body should comprise representatives from the manufacturing, distribution, recycling, government, and educational sectors, and other sectors of relevance to WEEE recycling as deemed appropriate. The advisory body should also be responsible for advising on the management and implementation of the recommendations to follow to ensure that they are carried out to the best interest of all relevant sectors concerned. With the representation of all relevant groups, the further development of WEEE can continue by taking into account the interests and difficulties faced by all associated sectors of the community. This recommendation is in line with the recent decision by the Australia New Zealand Environment and Conservation Council (ANZECC) to support the development of a National Strategy on Electrical and Electronic Waste by establishing a working group to provide advice and cooperation.

RECOMMENDATION 2: DETAILED STUDY OF WEEE IN SOUTH AUSTRALIA

Further research should be undertaken that uses cooperating manufacturers, distributors, and recycling companies to carry out an audit of the EEE that enters the consumer market in South Australia as well as that which is currently being disposed through the recycling sector. Such a study should be undertaken for a period of no less than six months in order for the information gathered to be meaningful. This research will alleviate the existing lack of data on the volumes of WEEE that pass through the recycling and landfill sectors in South Australia. The research should focus on the full range of WEEE and should not be limited to computers and mobile phones.

RECOMMENDATION 3: DEVELOPMENT OF A RECYCLING NETWORK IN SOUTH AUSTRALIA

A network of recycling companies and landfill operators should be developed through which cooperating companies can become strategically linked to minimise the amount of waste EEE that reaches landfill. This network may involve the development of an Internet-based web site on which companies can log equipment, components, or materials that are available and cannot be utilised by the company. This network will allow cooperating companies to trade in these commodities with the ultimate aim of minimising the total amount of material that enter landfill. Preliminary scoping studies are also recommended to gauge the acceptance of such a scheme within the industry and to identify potential cooperating companies. This recommendation can be best administered through the SA Waste Management Association.

RECOMMENDATION 4: WEEE EDUCATIONAL PROGRAM FOR THE SOUTH AUSTRALIAN COMMUNITY

An educational program should be initiated to educate the South Australian community at large on issues of importance to WEEE recycling. These issues include the environmental impacts posed by the landfill disposal of WEEE, the types of WEEE that can be recycled, and mechanisms by which WEEE recycling can actively be undertaken. The program may be developed through major retailers of EEE, which can display posters and distribute pamphlets promoting WEEE recycling, and product take-back or trade-in schemes. In addition to providing general information on the need for WEEE recycling, the pamphlets may list cooperating recycling companies and distributors. In this way, the advertising that these companies receive as a result of these pamphlets may be used to cover part or all of the cost of the program. This recommendation can be best facilitated via the SA Waste Management Committee.

RECOMMENDATION 5: RESEARCH AND DEVELOPMENT OF ENVIRONMENTAL DESIGN INITIATIVES FOR OEMs IN SOUTH AUSTRALIA

Manufacturers of EEE in South Australia should be encouraged to introduce environmental design initiatives to reduce the environmental impact of their products upon disposal. Development of these initiatives may be facilitated through the provision of research and development grants for local industries. These grants may be in the form of government- and industry-funded grants with an emphasis on the cooperation of industry partner(s) to support this research. This cooperation may be further encouraged by the drafting of legislation that promotes extended producer responsibility (EPR) in line with similar efforts in the US, European Union, Germany, and Sweden. It is recommended, however, that the drafting of legislation be undertaken in conjunction with the industry bodies through the advisory body.

RECOMMENDATION 6: RESEARCH AND DEVELOPMENT OF WEEE COLLECTION SCHEMES FOR SOUTH AUSTRALIA

Existing collection schemes for WEEE in South Australia should be reviewed, and recommendations made to individual councils and/or community groups as to the most effective schemes for South Australia. These recommended schemes must complement both current and future WEEE recycling activities in South Australia. Facilities must be in place to handle and distribute the WEEE collected as necessary. This process may involve the development of a centralised location for the sorting of WEEE and its distribution to various recycling facilities as appropriate, or such a location may be incorporated into future recycling facilities if appropriate. Ultimately, the collection schemes must minimise the handling associated with WEEE and ensure the efficient transfer of WEEE from the consumer to the recycling sector.

RECOMMENDATION 7: WEEE RECYCLING PLANT FEASIBILITY STUDY

A feasibility study into the development of a dedicated facility for WEEE recycling in South Australia should be undertaken. Using the data collected as part of Recommendation 2, the feasibility study should consider all aspects of WEEE recycling, from collection and handling through to markets for the recovered materials, with a view to determining the economic feasibility and logistical implications of either expanding current recycling activities or developing a dedicated recycling facility in South Australia. The feasibility study will need to consider the range of technologies that are being adopted overseas for WEEE recycling, those currently used within Australia, and the nature and quantities of various types of WEEE that are likely to be available in South Australia and Australia-wide. The SA Department for Industry and Trade is expected to play a major role in carrying out this recommendation.

RECOMMENDATION 8: PILOT- AND COMMERCIAL-SCALE WEEE RECYCLING PLANT DEVELOPMENT

A pilot WEEE recycling facility should be developed through which the potential for the development of a commercial-scale facility can be further investigated, contingent on the results of the feasibility study. The pilot facility will enable operational issues of relevance to be investigated; it should be operated for an extended period (a minimum of one year is recommended) to assess further the viability of a commercial-scale recycling facility. In this way, processing issues that may arise can be examined and alleviated without the cost incurred by a commercial-scale facility. If the pilot plant trials prove successful, development of a full-scale commercial facility can be commenced. Funding may be available for each of these stages through government-based funding schemes provided cooperating industry partners can be identified; these partners may be sought from South Australia, Australia, or internationally. The SA Department for Industry and Trade is expected to play a major role in carrying out this recommendation.

RECOMMENDATION 9: DEVELOPMENT OF DRAFT WEEE DISPOSAL AND HANDLING LEGISLATION

Draft legislation should be drawn up to address the issue of WEEE disposal and handling from a national perspective. It is recommended that the legislation be based on the EU Directive but should take into account any unique factors that may apply to Australia. Development of the legislation will rely on close contact with all relevant sectors through the WEEE Advisory Body. The draft legislation should be developed in line with, and complementary to, the needs of current and future WEEE recycling facilities and collection schemes, so as not to compromise the successful development of the WEEE recycling sector in Australia. Upon acceptance of the draft legislation, development and implementation of full legislation should commence to formalise the development of WEEE recycling in Australia. Ideally, any legislation introduced should be at a Federal level, such as a National Environmental Protection Measure (NEPM).

RECOMMENDATION 10: DEVELOPMENT OF AN EEE DONOR SCHEME IN SOUTH AUSTRALIA

A donor scheme should be established to link corporate users that have obsolete EEE to disadvantaged schools or communities in South Australia. Participating corporate bodies can be subsequently recognised for their efforts through advertising in print media or other selected media on a biannual basis. Such a scheme should target major corporate bodies: it can be established through existing industry associations such as the Electronics Industry Association (EIA), which is primarily funded by industry, educational, and government members. Such a scheme will not only reduce the long-term environmental impact of WEEE but will also promote the electronics industry in South Australia as an environmentally aware and active industry.

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LEGISLATION

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Contents

Terms and Abbreviations

CFC	Chlorofluorocarbon
CRT	Cathode ray tube
DFD	Design for disassembly
DFE	Design for environment
EEE	Electrical and electronic equipment
EEP	Electrical and electronic product
EEW	Electrical and electronic waste
EOL	End-of-life
EPR	Extended producer responsibility
EU	European Union
MITI	Ministry of International Trade and Industry (Japan)
NED	New equipment dealer
Ni-Cad	Nickel-cadmium
OECD	Organisation for Economic Cooperation and Development
OEM	Original equipment manufacturer
PC	Personal computer
PCB	Printed Circuit Board
PCB	Polychlorinated biphenyl
SEPA	Swedish Environmental Protection Agency
TBBA	Tetrabromobisophenol – A
TCLT	Toxic characteristic leaching test
WEEE	Waste from electrical and electronic equipment

Appendix A

Project Brief

The aim of this consultancy study is to provide information to the State of South Australia to ensure the appropriate management of current and future electrical and electronic waste and provide strategic input to the development of reuse and recycling systems to minimise the disposal of these waste products. Data gathered from the planned study will assist with determining future waste reduction and recycling activities and potential business opportunities.

Within this general setting, the specific objectives are to:

- Perform a literature review of current activities and research into electrical and electronic waste.
- Identify current disposal paths including reuse, recycling and disposal activities being carried out in this area in South Australia.
- Determine the quantity and source of electrical/electronic waste produced in South Australia annually.
- Identify what potential exists for increased recycling in the future and any limitations to its implementation.
- Identify and quantify, as far as practicable, the amount of this material disposed to landfill annually.
- Quantify where possible the economic and environmental benefits arising to the State as a result of further recycling in this area.
- Based on the findings of this study recommend what further research needs to be done (if any) to address electrical and electronic waste from the South Australian context.
- Identify any other electrical and electronic equipment that has the potential to become a problem waste in the future and is worthy of further investigation.

Appendix B

Survey Details

B.1 Methodology

Presently, little information exists on the current practice of WEEE disposal and community attitudes regarding it in South Australia. Thus, the Marketing Science Centre at the University of South Australia was commissioned to conduct a survey of representative target groups to find out, as realistically as possible, the position in South Australia. The survey was designed with the aim of identifying factors which may be limiting the recycling of such equipment within South Australia, as well as of projecting any potential improvements to the recycling environment as a means of increasing the rate of WEEE recycling in South Australia.

The survey focussed on six target groups, namely:[1]

- *Corporate Users (100),*
- *Private Users (100),*
- *Original Equipment Manufacturers (OEMs) (8),*
- *New Equipment Distributors (NEDs) (84),*
- *Second-hand Dealers (7)*
- *Recycling Companies (4).*

Corporate Users are defined as registered South Australian companies who use EEE in their daily activities.

Private Users are defined as residents of South Australia who have EEE within their households.

Original Equipment Manufacturers (OEMs) are defined as those companies whose sole role is in the construction (and subsequent distribution) of EEE, where the production facility is based in South Australia.

New Equipment Distributors (NEDs) differ from OEMs in that they do not undertake manufacturing within South Australia and are merely distributors of equipment manufactured either interstate or overseas.

Second-hand Dealers are those companies dealing in the resale of used EEE and may undertake some reconditioning of the equipment prior to resale.

Recycling Companies are those companies whose major role is in the recycling of components of EEE and which are likely to undertake partial or complete dismantling of the equipment to obtain specific parts of resale value and to recover base materials.

[1] Numbers in brackets refer to the sample size for each category.

B.2 Survey Results

CORPORATE USERS

The main focus of the survey of *corporate users* was to identify how the business community deals with WEEE within their system. The survey aimed at drawing comment from corporate users to disclose company attitudes and philosophies with regard to disposal of WEEE, and to indicate both negative and positive factors, which may either inhibit or encourage the adoption of certain recycling practices. In total, 100 corporate users were surveyed. Whilst the range of EEE used in business operations is wide, special attention was paid to computers and mobile phones, since they represented equipment designated in the project brief as arousing particular environmental concerns; thus these have been directly targeted in the survey.

Figure B.1 illustrates the impact of rapid advances in computer technology on the computing stock held by corporate users; it indicates the time after which computers are generally upgraded within a company. The data are further broken down to compare the respective upgrade times against the size of company with respect to the total number of computers used by the company. Ninety per cent of companies surveyed stated they used less than 50 computers and 67% of these companies indicated they upgraded their computers every two or more years. It seems that companies with 51 to 500 computers prefer an upgrade in less than two years (78%) while companies using more than 500 computers all reported an upgrade time of two or more years. Overall, 61% of companies indicated they would upgrade their computers every two or more years.

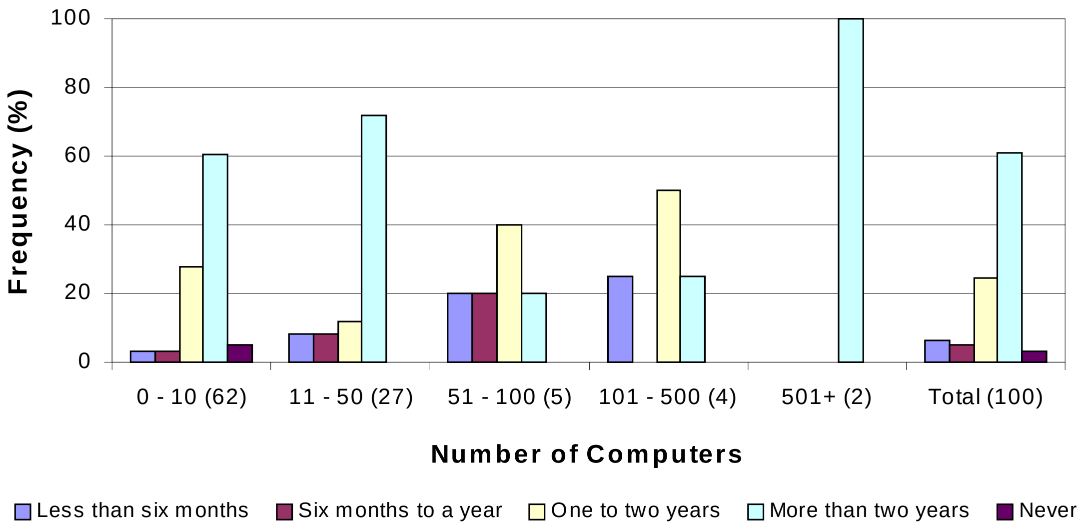

Figure B.1: Lifetime of computers within corporate sector in South Australia. Data are split according to the number of computers used by the company, with the number of companies within each size group shown in brackets.

These results suggest that in general there will be two or more years of turnaround time for computers within the corporate sector. Given this, it is important to understand the nature of the upgrades undertaken by respective companies. Figure B.2 seeks to clarify this. As can be seen, larger companies have a greater tendency towards complete replacement of computers than small businesses; this may be expected given the maintenance cost involved in partially upgrading large numbers of units. As the number of computers in the company gets smaller there is a shift toward component upgrade of computers. However, 51% of companies prefer a complete replacement of obsolete computers.

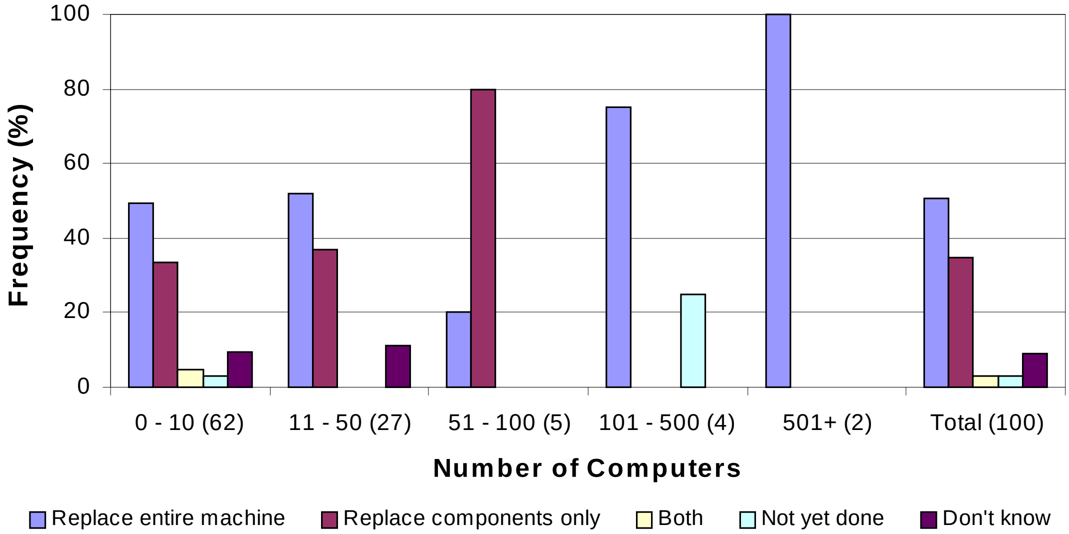

Figure B.2: Nature of upgrades carried out on computers by corporate bodies in South Australia. Data are split according to the number of computers used by the company, with the number of companies within each size group shown in brackets.

The data presented suggest that there is a preference for complete replacement of computers after two years or so within the corporate sector. Due to the large numbers of computers used in the corporate sector it is important to know the fate of computers upon being replaced; Figure B.3 attempts to shed light on this.

The array of options available for the disposal of obsolete computers suggests that there is no one dominant disposal pathway presently existing in South Australia. The most common practice appears to be for companies to release their out-of-date computers to their staff for private use (21%). This has the result of increasing the lifetime of the computers prior to disposal, but effectively shifts the onus of end-of-life disposal to the private sector. In total, 30% of companies indicated their obsolete computers are either sold or traded in, or they are returned to the dealer as well as being donated to schools and charities. This only serves to shift the responsibility for the end-of-life disposal issues onto another party. Only 5% of companies indicated they sold obsolete units to recycling companies, while 15% of companies declared that they store their obsolete computers on site; 5% of companies send their computers directly to landfill.

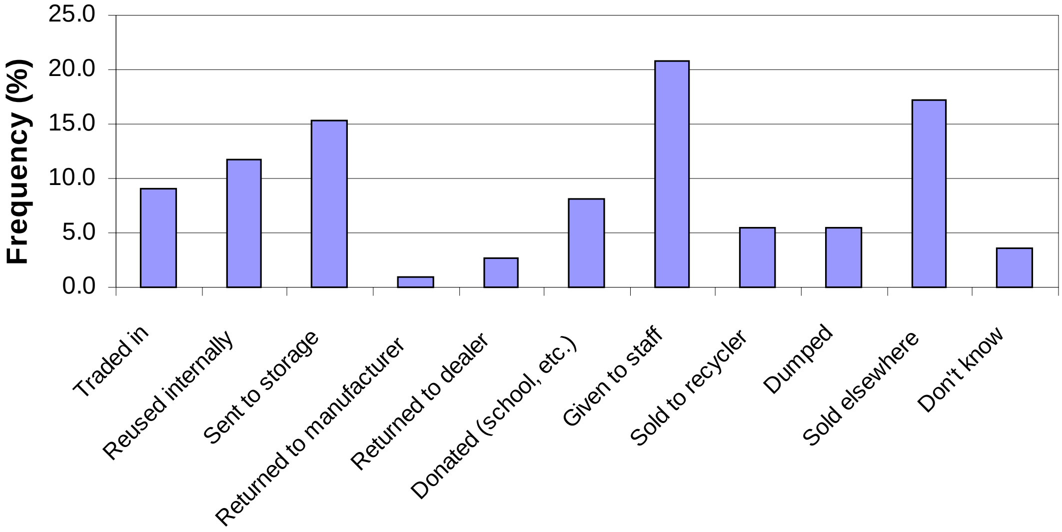

Figure B.3: Fate of obsolete computers from corporate bodies in South Australia.

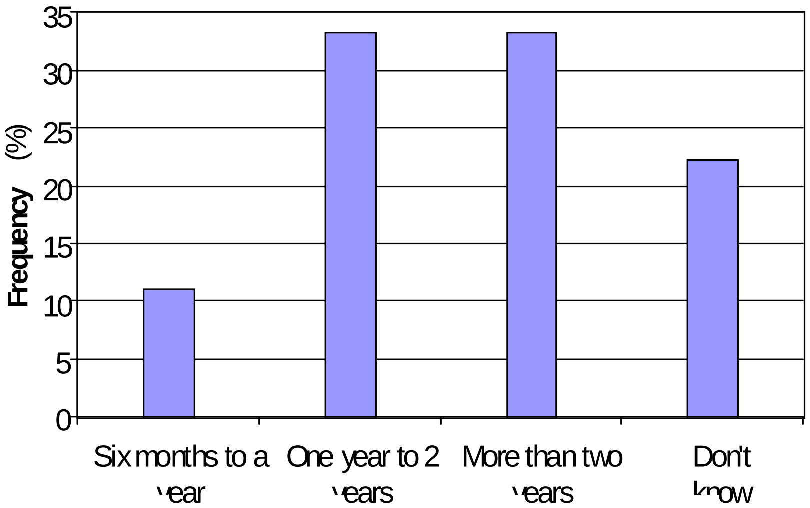

Figure B.4: Storage time for obsolete computers within the corporate sector in South Australia.

It would appear from Figure B.4 that obsolete computers, which are stored by companies, remain in storage for periods of over two years (55%) which, when combined with their average useful life, means that computers purchased during 1999 may only begin to appear in the recycling network by 2004. The data reported in Figures B.3 and B.4 tend to suggest that there is no system available to enable corporate bodies to undertake WEEE recycling efficiently. Therefore, interim methods are employed to either store or dispose of obsolete computers outside of the recycling network.

Mobile telephones represent another major item of EEE used within the corporate sector. Figure B.5 shows the lifetime of mobile phones used by corporate bodies in South Australia, with the data split according to the number of mobile phones used within each group. Once again the data indicate an average lifetime of two or more years with a tendency for smaller companies to upgrade their mobile phones on a more frequent basis. A comparison of Figures B.3 and B.6 shows that companies exhibit a greater willingness to use either trade-in or product take-back schemes than in the case of computers (ie 33% for mobile phones compared with 13% for computers). Of the companies surveyed, 17% indicated their obsolete mobile phones are kept in storage, either for the purpose of using them either in emergency or for spare parts. Eleven per cent of companies give their obsolete mobile phones to staff, 9% send them directly to landfill, and there is no indication of obsolete mobile phones being sent to recycling companies.

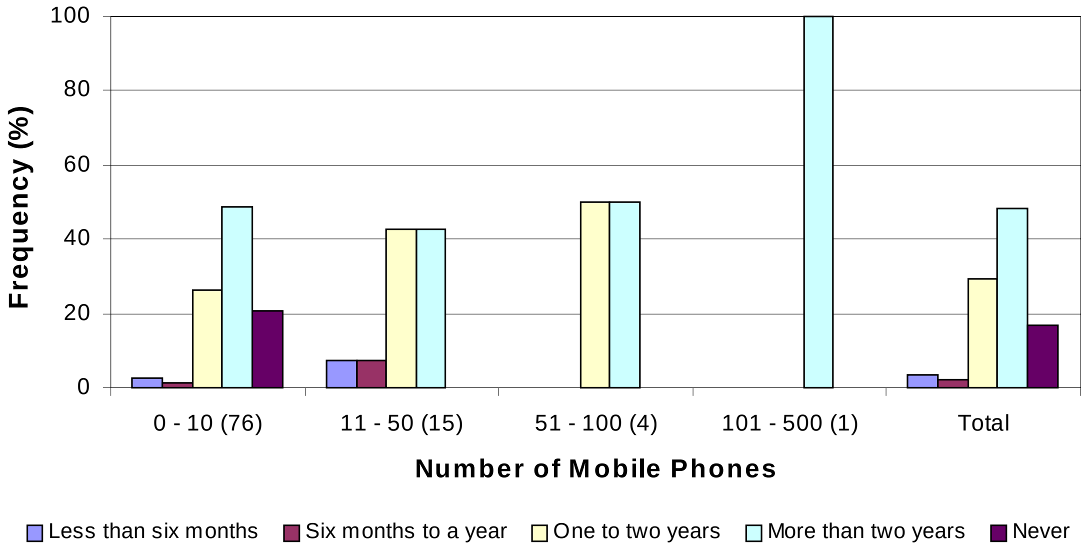

Figure B.5: Lifetime of mobile phones within corporate bodies in South Australia. Data are split according to the number of mobile phones used by the company, with the number of companies within each size group shown in brackets.

Once again there is a broad range of disposal options used for obsolete mobile phone disposal, suggesting there are no clearly identified recycling pathways for corporate bodies to access. Of those companies indicating they stored their obsolete mobile phones, 85% indicated they chose storage as they were unaware of methods of disposal for obsolete mobile phones. This is indicative of lack of information regarding recycling of WEEE in general and of mobile phones in particular.

Figure B.7 shows the optional preferences by corporate bodies in South Australia for the disposal of WEEE. Twenty seven per cent of companies indicated a preference for recycling despite the trend in current practices which suggests that limited recycling is taking place. Others cited resale (15%) or trade-in (16%) as alternative options, which may be mainly based on cost recovery considerations. Companies which have selected donating their obsolete equipment to charity (7%) or giving to staff (14%) seem willing to forfeit the potential for limited cost recovery, and apparently view donation as a satisfactory solution to their WEEE problem. Evidently, this passes the responsibility for final disposal of equipment onto another party, and may in fact be an easier alternative for the company than seeking a recycling avenue.

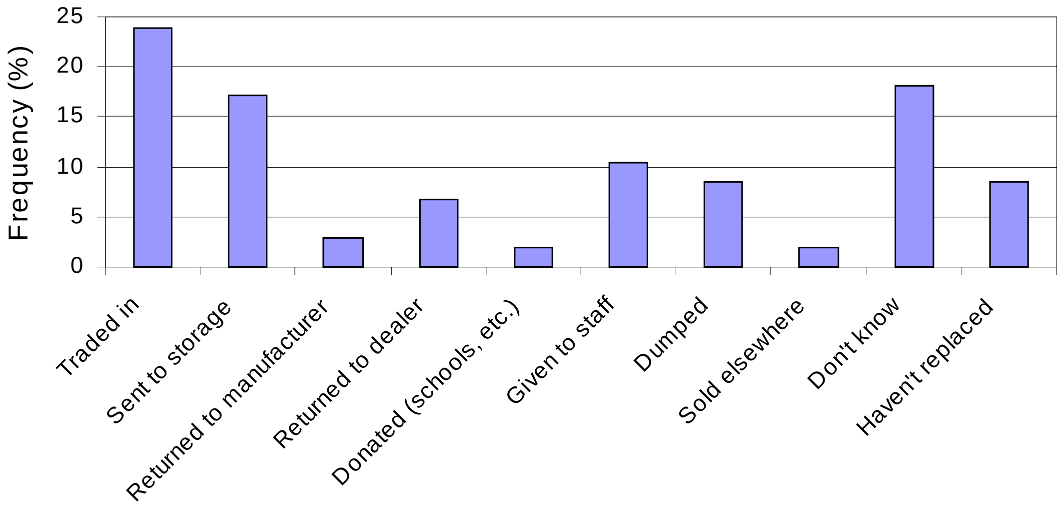

Figure B.6: Fate of obsolete mobile phones from corporate bodies in South Australia.

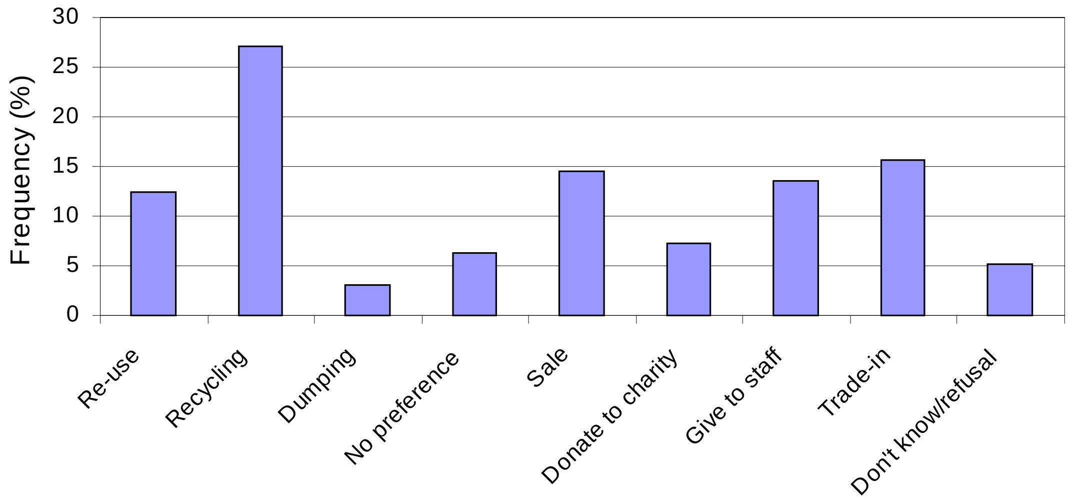

Figure B.7: Preferred option(s) of corporate bodies in South Australia for the disposal of obsolete EEE.

The lack of awareness in the corporate sector of the need for recycling of WEEE is highlighted by Figure B.8, which shows the factors which companies believe limit their recycling practice. As can be seen, 50% of companies had not even considered recycling their WEEE while 28% of the companies simply ignore recycling as they "don't have to" undertake it on a compulsory basis. Nine per cent of companies view recycling EEE as "too difficult" and 6% of companies are "unsure what to do" which suggests the recycling network is difficult to access at this point in time or companies do not have sufficient knowledge of the recycling network itself.

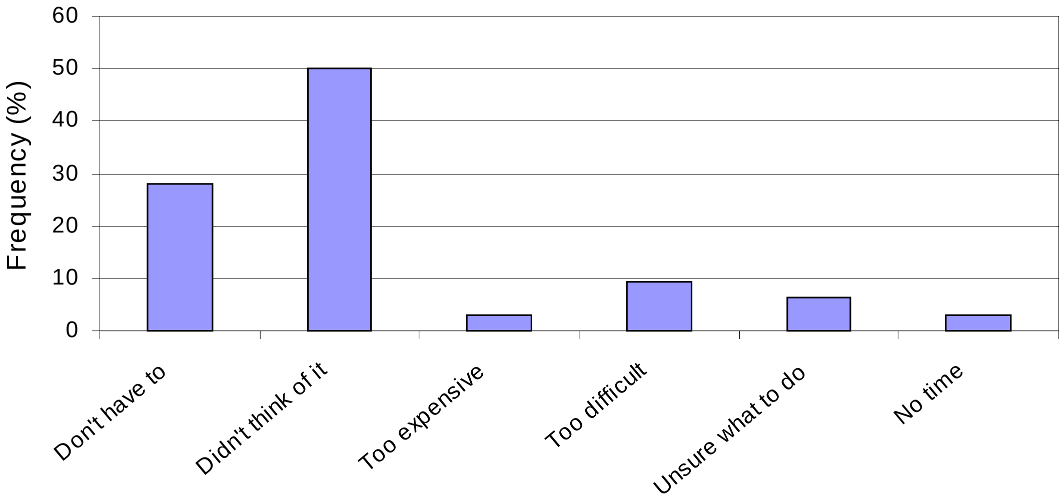

Figure B.8: Factors limiting the recycling of EEE by corporate bodies in South Australia.

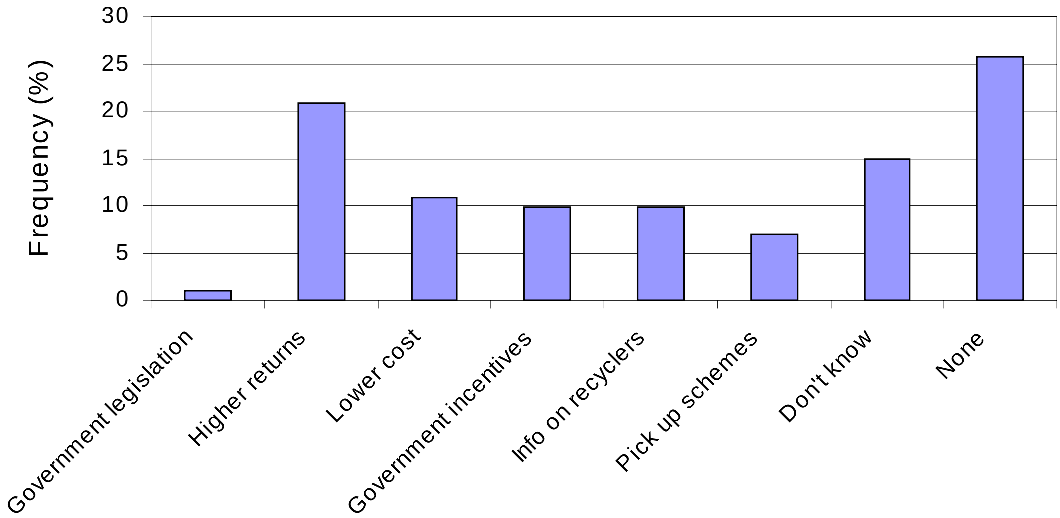

Figure B.9: Factors which may promote the recycling of EEE by corporate bodies in South Australia.

Companies were further asked to indicate factors which may act as incentives to improve their practice of recycling WEEE. Their responses are shown in Figure B.9. It is interesting to note that the largest number of responses received (26%) indicated that no incentive ever was likely to increase the level of recycling carried out by the respondent company. This would imply that there is an underlying problem with the attitude of a sizeable proportion of the companies surveyed, which would seem to be main impediment to recycling rather than the lack of a well ordered recycling process as at present. On the other hand, 43% of survey participants responded positively, suggesting that higher returns, lower cost and government incentives would improve their recycling performance. The indication is that these companies see improving the economic viability of recycling as the best incentive. It is also likely that companies, seemingly not interested in recycling, will participate once the economic viability is established. Ten per cent of the companies surveyed would require further information on recyclers in order to access the recycling network, while 7% of companies wish to have easier access to a recycling network via *equipment pick-up schemes*. Only a small number of companies (1%) was in favour of government legislation and 15% of all companies surveyed offered no response, with the implication that they are yet to consider WEEE recycling.

Companies were also asked to provide any general comments regarding WEEE recycling. Most respondents indicated that there was very little information available in South Australia on recycling of WEEE, including the details of actual recycling companies. These comments support the earlier observations regarding the fundamental lack of knowledge within the South Australian corporate sector regarding the environmental impacts of electrical and electronic waste, as well as potential avenues for the recycling of WEEE. Furthermore, many companies indicated that they would support the constitution of effective collection schemes to facilitate transport of WEEE from companies to recyclers.

In general it can be concluded that companies perceive the recycling of WEEE as an issue of low priority. Thus there is no obvious incentive for taking recycling initiatives. The first step in addressing this problem is to mount an educational program to make companies aware of the environmental issues related to electrical and electronic waste disposal, and of avenues which are available for companies to access the recycling network. Ultimately, any effort to increase recycling in the corporate sector will rely on a change in attitude of companies to consider the future impact of electrical and electronic waste disposal.

PRIVATE USERS

The survey of private users of EEE in South Australia was aimed at identifying the types of EEE currently used in private households, and the practices and attitudes toward the recycling of WEEE. In total 100 private users were surveyed.

Figure B.10 indicates the types of EEE commonly used in South Australian households. Given these data, it was decided to concentrate on the following equipment: computers, televisions, mobile phones, stereos, videos, refrigerators, washing machines, microwave ovens. These represent the most commonly used units, or are those units which present significant disposal problems from an environmental perspective.

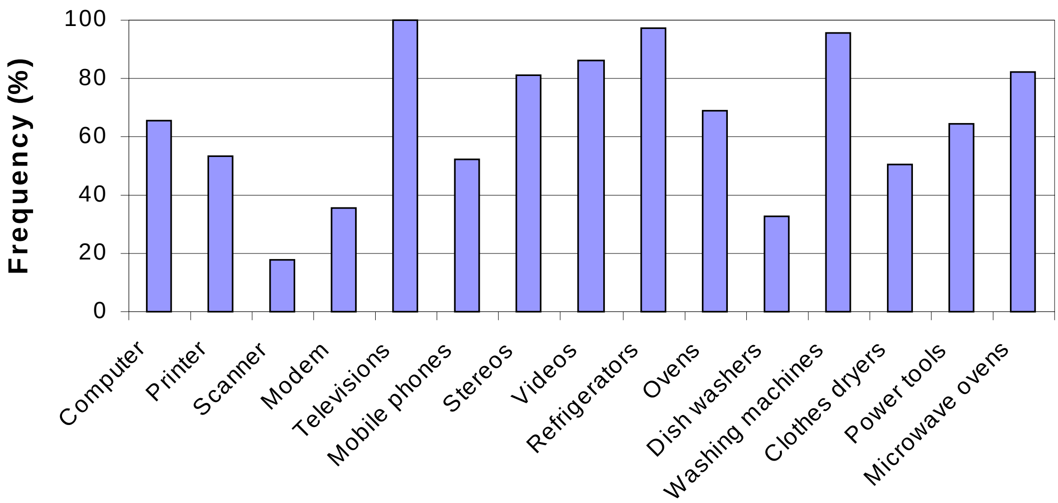

Figure B.10: Occurrence of various types of EEE in South Australian households.

In order to gain an understanding of the disposal rate of EEE by households in South Australia, data were obtained regarding the current age of selected EEE, along with the expected periods after which households are likely to replace them. Results are presented in Figures B.11 and B.12, respectively. Figure B.11 shows that the bulk of computers in households (75%) is less than five years old, and the majority of mobile phones (71%) is less than two years old. The average age of equipment increases for browngoods, increasing up to 10 years in general: (televisions, 80% > 2 years old; stereos, 73% > 2 years old; VCRs, 76% > two years old). Whitegoods have an average age greater than five years (refrigerators, 64% > five years old; washing machines, 56% > five years old; microwaves, 66% > five years old).

These data can then be compared with the times by when households are likely to replace such EEE (Figure B.12). It is of note that a large number of households (46%) had yet to undertake a replacement of their first computer. Of those households that have replaced their computers, 80% indicated the replacement time was up to five years. Sixty two per cent of respondents who had replaced their mobile phones indicated that mobile phones are replaced every three years or sooner and, again, there were numerous households (48%) who were yet to replace their first mobile phone.

The average expected lifetime of browngoods in South Australian households is less than ten years (televisions, 55%; stereos, 62%; videos, 79%). Given the age profile of this equipment in Figure B.10, the rate of disposal of browngoods in South Australia is expected to be reasonably low over the next five to 10 years. The disposal rate will only increase if technology improvements entice households to purchase *state of the art* browngoods, which is possible in the case of televisions given that the conversion from analogue to digital technology will take place in Australia during 2000.

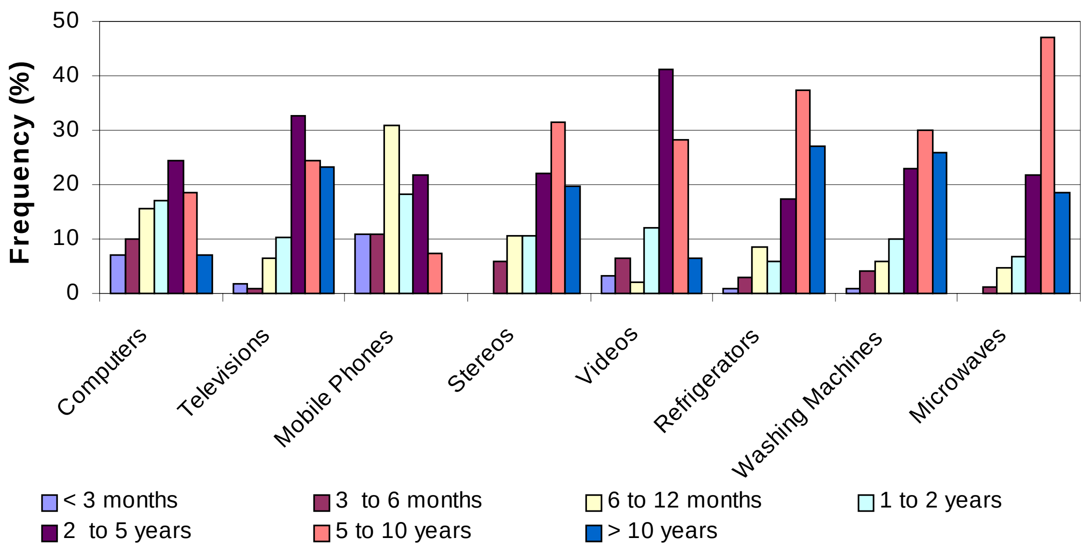

Figure B.11: Age profile of various types of EEE commonly used in South Australian households.

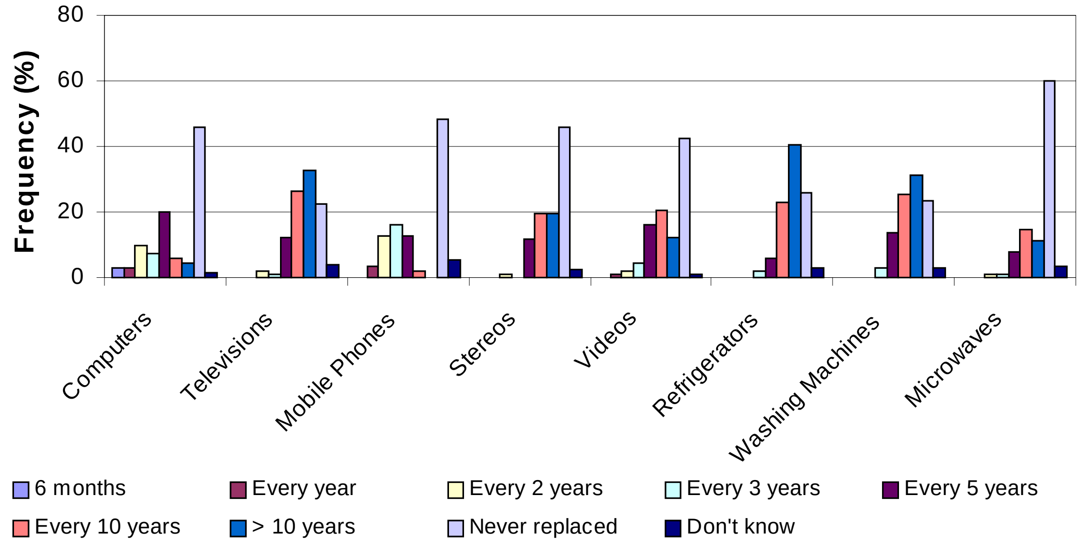

Figure B.12: Estimated replacement times for various types of EEE commonly used in South Australian households.

The lifetime of whitegoods is also shown to be less than ten years (washing machines, 57%; microwaves, 68%) except for refrigerators which have an expected lifetime of greater than ten years (57%). Considering the current average lifetime of greater than five years for whitegoods, there is expected to be a rise in the obsolescence rate of EEE in South Australian households over the next five years. Note that many households indicated they were yet to replace their first units and many of these units are also likely to become obsolete in the near future.

While these data indicate the potential for particular types of EEE entering the waste stream over the next five years, there seems to be potential for the timeline to be extended depending on how the households choose to dispose of these unwanted items. Figure B.13 shows the current trends for the disposal of various types of EEE by South Australian households. The data show that in a majority of cases the equipment is kept by the original household (computers, 34%; mobile phones, 30%; refrigerators, 30%; televisions, 27%), and these are used as second units or are simply retained for no specific reason. Many of the units are also passed on to other family members (computers, 26%; mobile phones, 12%; refrigerators, 20%; televisions, 22%) or sold (computers, 14%; mobile phones, 4%; refrigerators, 12%; televisions, 6%), which effectively extends their lifetime, thus increasing the time before they enter the waste stream.

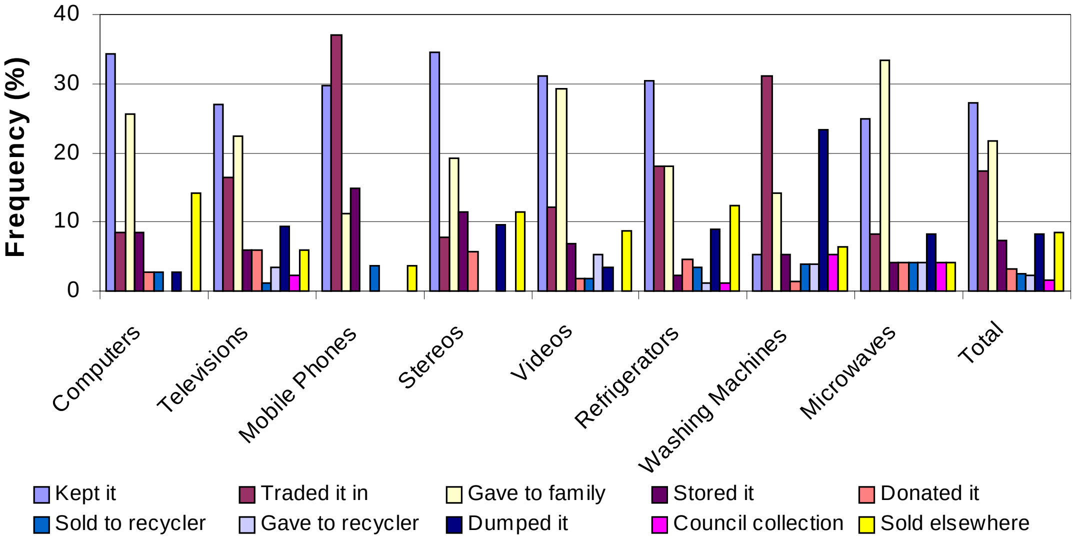

Figure B.13: Trends for the disposal of unwanted EEE in South Australian households.

In the case of mobile phones, 37% of households were able to trade in their obsolete mobile phones, which reverts the responsibility for disposal back to the distributor. There is also an indication of a reasonable level of trade-in occurring for televisions (17%), refrigerators (18%) and washing machines (31%) while computers were traded in by only 9% of the households surveyed. Households indicated no real tendency toward recycling with the most commonly recycled equipment being microwave ovens (8%) and washing machines (8%), with only 3% of households recycling computers and 4% recycling mobile phones. This may be attributable to the fact that collection of obsolete equipment through council collection schemes is minimal and, if available, it generally applies to larger items such as washing machines, microwave ovens and television sets.

Of those households that indicated that they stored unused EEE, 41% responded that they were unaware of how else to dispose of the equipment while 37% said they were keeping the equipment in case it was needed in the future. The remaining respondents either were intending to dump the equipment at a later date or were unsure as to why they had not disposed of them otherwise. Furthermore, these households indicated that this equipment remained within the household for a minimum of 2 years before disposal may be contemplated, which effectively extends the time before such equipment enters the waste stream.

Figure B.14 shows the method South Australian households would choose were they to decide to dispose of their obsolete EEE. Donating equipment to charities and schools is presently the most preferred option by 37% of households, while 25% of households would rather recycle obsolete equipment. The figures for trade in (10%) or resale (17%) of obsolete equipment suggest that many households still see such equipment as valuable, and the resale value is likely to be more attractive than any returns made from recycling. Twelve per cent of households tend to dump obsolete EEE in landfill, which indicates a lack of community knowledge regarding the associated environmental impact.

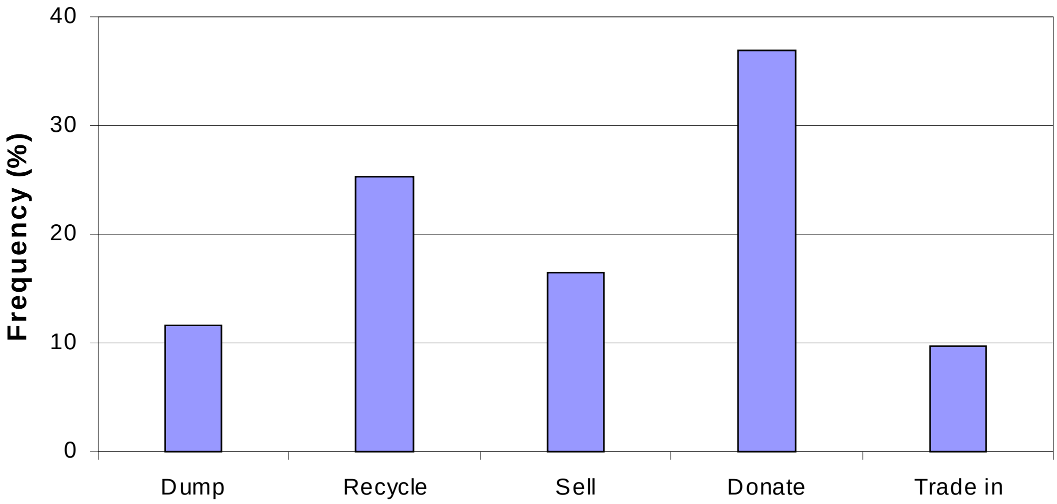

Figure B.14: Preferred methods for the disposal of WEEE by South Australian households.

Figure B.15 indicates factors that households perceive as limiting their ability in recycling WEEE. Three major factors emerge as impediments to effective recycling: 50% of households indicate that they "don't know how to do it"; 26% view it as "too difficult"; and 10% say it is "too expensive". These comments support the observation that the community at large is ill-informed about recycling issues and actions.

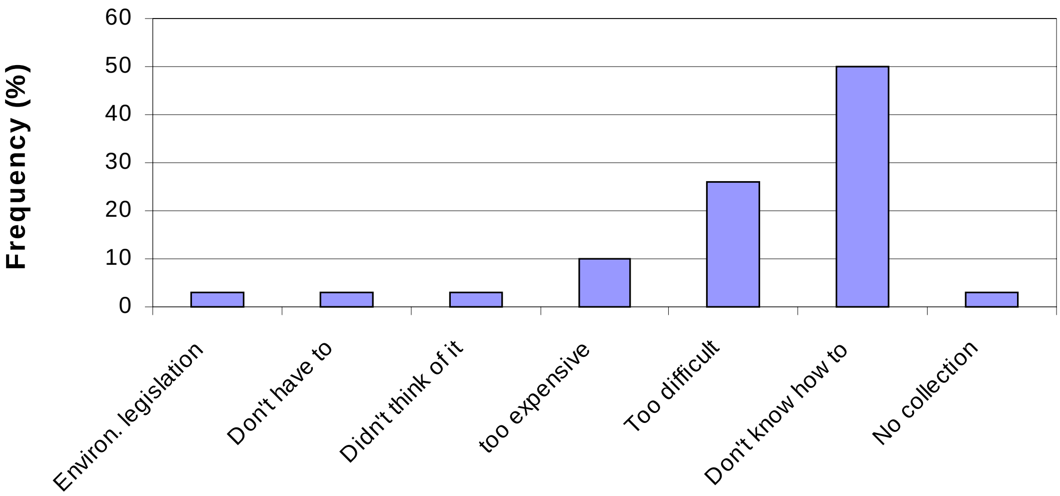

Figure B.15: Factors limiting recycling of WEEE by households in South Australia.

When contemplating what incentives are needed to increase the rate of recycling by households, a number responded that providing more information about recycling of WEEE (34%) and establishing efficient collection schemes (19%) were essential. The data in Figures B.15 and B.16 clearly indicate that a major hurdle to the recycling of WEEE by South Australian households at present is a fundamental lack of information and access to recycling pathways. Higher monetary returns from recycling are also considered as an incentive by 18% of private respondents.

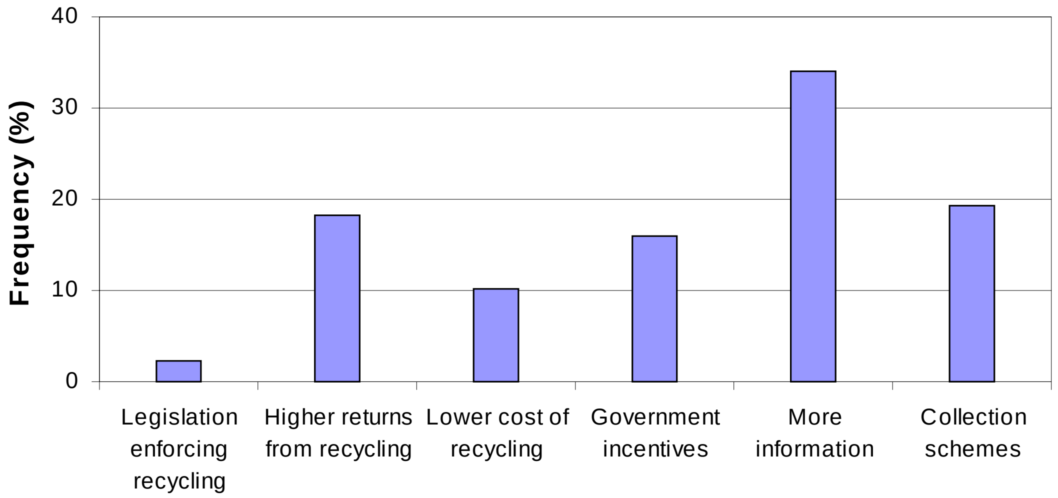

Figure B.16: Factors which may promote the recycling of EEE by households in South Australia

This last point is in agreement with the consensus of survey participants in all categories that currently recycling is too costly.

Households were also asked to provide general comments on recycling of WEEE. The responses highlight the need for more information on the types of EEE, which are potentially hazardous to the environment and health if discarded carelessly, and the mechanisms for recycling. Households at present do not see any effective collection schemes available for them to easily access the recycling network.

ORIGINAL EQUIPMENT MANUFACTURERS

Original equipment manufacturers (OEMs) in South Australia were surveyed in order to gauge the level of awareness of their role in the life-cycle of EEE, and how they may consider to be able to minimise the environmental impact upon disposal of the products they manufacture. In total eight OEMs in South Australia were surveyed.

Evidently, the role of OEMs in reducing the environmental impact of WEEE begins with the product design and development stages, where manufacturers have the opportunity to implement a number of design strategies toward that outcome. Figure B.17 presents the design initiatives, most favoured by OEMs in South Australia. The most commonly employed strategy is “design for increased product life”, actively practised by 38% of companies. This approach ensures an extended functional lifetime of the product; however, it does not directly address any environmental issues, which may arise upon product disposal.

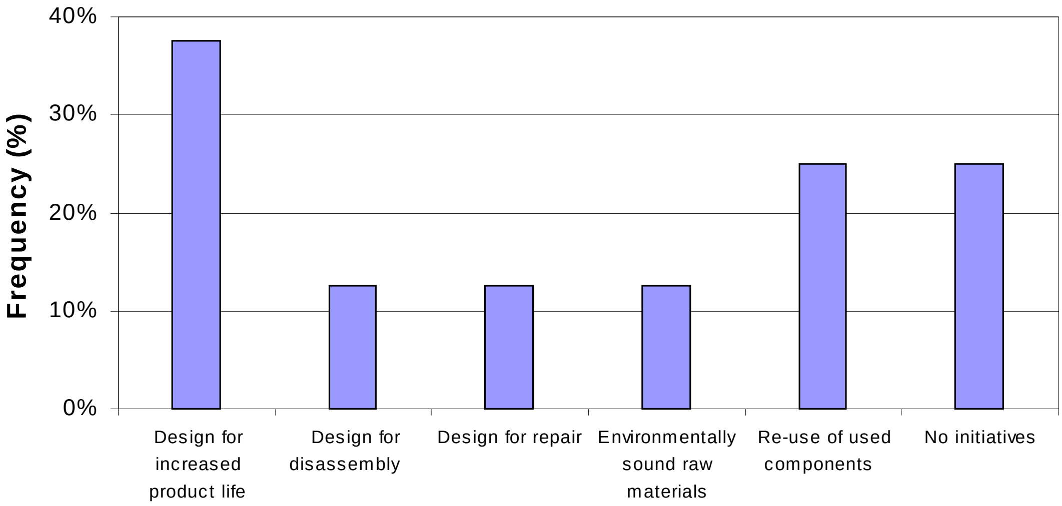

Figure B.17: Preferred design initiatives by OEMs in South Australia[2] for improving the environmental impact upon disposal of their products.

On the other hand, a number of companies (25%) reported no design initiatives in place at present, of which 75% indicated no intention of initiating any such programs in the near future. This group of OEMs see the adoption of environmentally based initiatives as adding to the product cost, either by a more extensive design phase or by the use of environmentally friendly raw materials or both, thus diminishing the price competitiveness of their product in the market place. Twenty five per cent of the companies surveyed stated that they use recovered components and materials in the manufacture of their products. Other initiatives were taken on a less frequent basis.

Figure B.18 shows the factors seen as being instrumental in adopting strategies for good product design. Eighty three per cent of the OEMs indicated that they see a marketing advantage in promoting their design initiatives, while 67% of the OEMs see themselves as environmentally aware companies. These results would indicate that much of the environmental performance of OEMs may in fact be linked to the company management and its perception of the role and importance of the company in addressing environmental issues. These companies appear to see the benefit in undertaking environmental design initiatives despite the potentially increased production costs, and are prepared to offset these costs by strategic marketing of their environmental performance. In contrast, those companies not presently undertaking product design initiatives, showed a distinctly negative attitude in identifying factors which may prompt them to adopt environmentally aware design strategies. Seventy five per cent of the OEMs, not presently undertaking design initiatives, indicated that there had to be legislation before they would adopt environmentally aware design initiatives. Fifty per cent indicated developing a standard industry practice would also coerce them into adopting such. Evidently, the company philosophy has a critical role in determining a company's environmental performance. However, improving the negative impact on the environment of the products designed and manufactured was acknowledged by only 25% of the respondents as a company objective.

[2] Multiple responses were possible from each OEM surveyed.

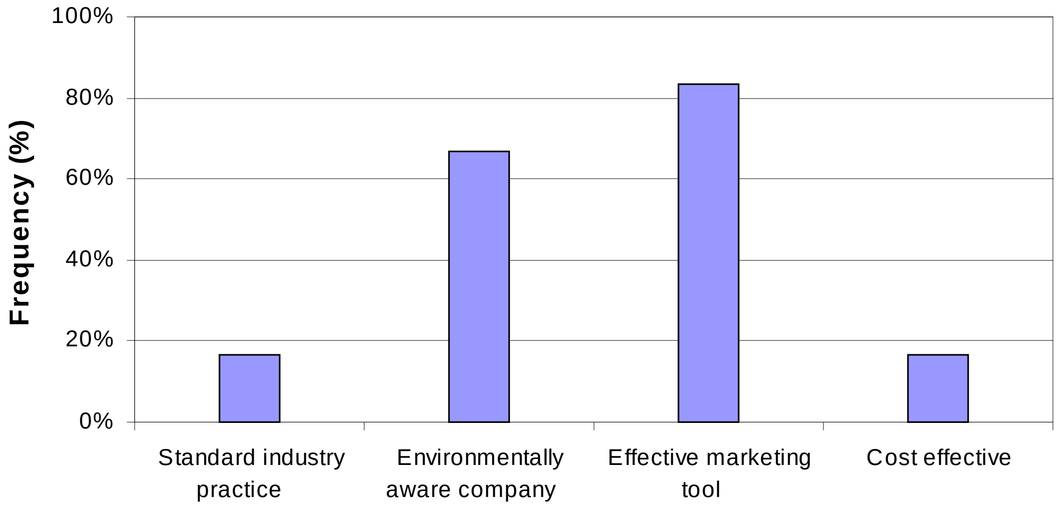

Figure B.18: Factors influencing the implementation of product design initiatives by OEMs in South Australia.

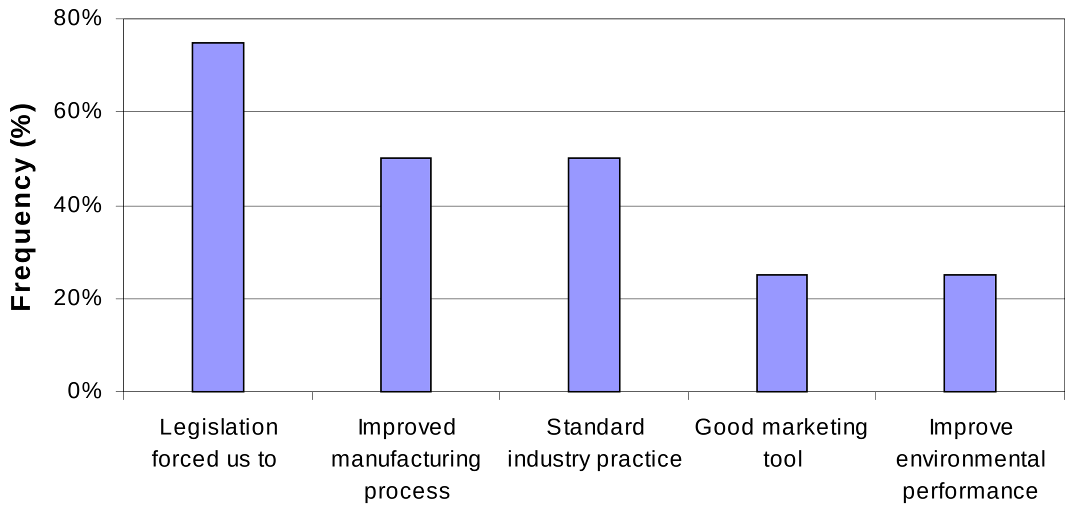

Figure B.19: Factors required to prompt OEMs in South Australia to initiate environmental design initiatives

The data presented above indicate that OEMs in South Australia can be grouped in two distinct categories. The first group is environmentally conscious and has identified a marketing advantage in undertaking environmental design initiatives. However, the strategy favoured by these companies is "design for increased product life", which merely acts to increase the product lifetime, with no effect on the environmental impact of the product upon disposal. The second group of companies, on the other hand, seems to be opposed to the concept of environmental design initiatives. Major initiatives such as relevant legislation or new standard industry practice appear to be needed before this group takes any action. A combination of persuasion and coercion may be required for the entire OEM sector to adopt united measures that go beyond the adoption of "design for increased product life" strategies. This may occur, for instance, through planned achievement of the target of using environmentally friendly raw materials by 2005 for a proportion of manufactured products, with penalties for manufacturers not achieving the targets. This not only improves the performance of companies currently undertaking environmental design initiatives, but also forces the non-compliant companies to take measures to match what is most likely to become standard industry practice in not so distant future.

NEW EQUIPMENT DISTRIBUTORS

The opportunity for new equipment manufacturers (NEDs) to become actively involved in the recycling network is via product take-back and trade-in schemes for obsolete EEE. The survey of NEDs in South Australia indicated that 50% of NEDs have currently in place either product take-back or trade-in schemes. A majority of these companies will accept equipment that is either still of resale value or has no real value, with a slight majority of companies indicating they only accept equipment of resale value. A total of 84 NEDs were surveyed.

Figure B.20 indicates the reasons given for adopting trade-in and take-back schemes by the NEDs. Fifty four per cent of NEDs cited the marketing advantage in undertaking schemes of environmental benefit as the driving force behind adopting these schemes. Twenty nine per cent of companies indicated they view themselves as environmentally aware. Twenty seven per cent of companies consider product “take-back” or “trade-in” schemes as being standard industry practice. This is encouraging and it would appear that there is considerable activity amongst NEDs to relieve consumers of WEEE.

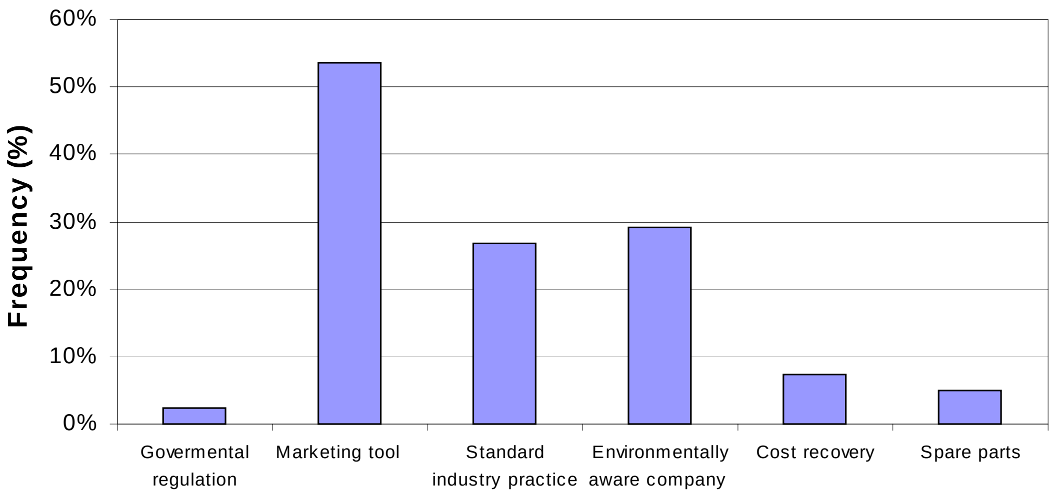

Figure B.20: Factors behind the implementation of trade-in or take-back schemes by NEDs in South Australia.

Figure B.21 indicates the fate of used EEE returned to distributors via product take-back and trade-in schemes. Seventy one per cent of companies resell EEE obtained through these schemes, whereas 37% of companies pass on received EEE directly to recycling. Ten per cent of companies store some or all of this equipment while 7% dump some equipment to landfill. Reselling EEE is another example of extending the lifetime of the unit, which postpones the problem rather than solve it. However, there are encouraging signs in current recycling practice, which is the most common form of disposal method in South Australia after resale.

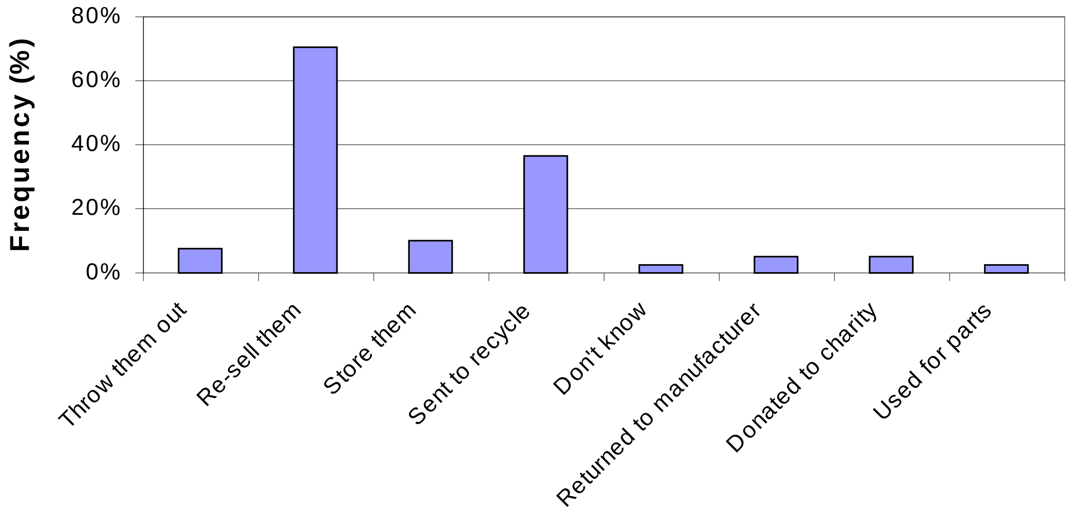

Figure B.21: Fate of EEE returned to NEDs in South Australia via product take-back and trade-in schemes

Figure B.22 shows the factors stated by respondents in response to the question of what would be required for the non-conforming NEDs to implement product take-back or trade-in schemes in the future. Twenty six per cent of NEDs indicated there was nothing which would persuade them to implement similar schemes, while 24% supposed that government legislation would need to be introduced. Eighteen per cent of the companies surveyed indicated they may undertake product take-back or trade-in schemes if recycling avenues were readily available, 5% indicated they may undertake these initiatives if more information could be provided, and 3% required the process of recycling to be easier.

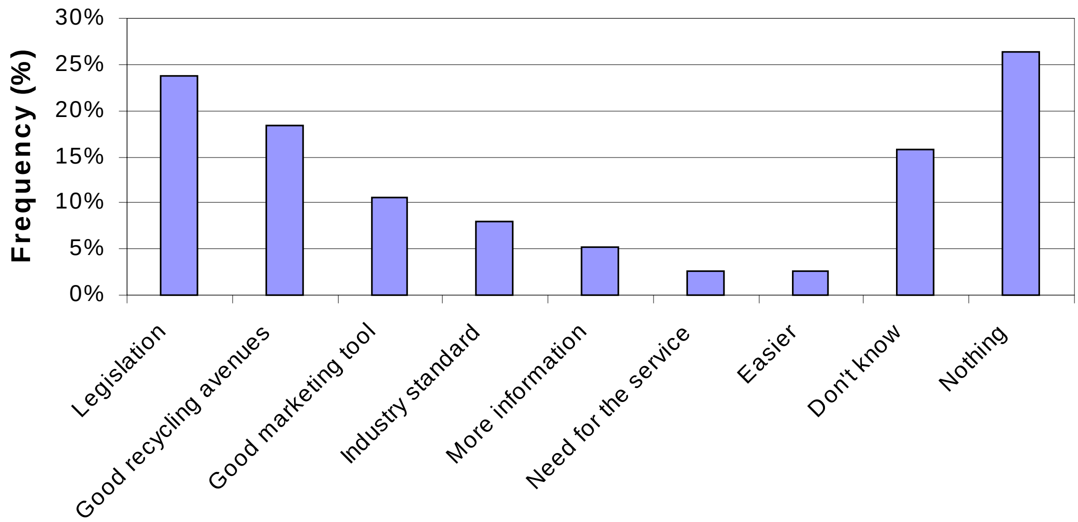

Figure B.22: Factors required to force non-conforming NEDs to implement product take-back or trade-in schemes.

It would seem that approximately half of the companies surveyed are principally opposed to the concept of product take-back or trade-in schemes and attempts to change their philosophy poses a challenge. Generally, there seems to be a great deal of activity in this sector with a considerable flow of computers between distributors and consumers taking place. The amount of recycled WEEE is likely to increase by ensuring that pathways exist for both distributors and consumers to easily access the recycling sector. The participation of all NEDs in product “take-back” or “trade-in” schemes, including those who resist the notion at present, would obviously further increase recovery from WEEE.

SECOND-HAND DEALERS

The second-hand dealers' role in the life cycle of EEE is as to act as a redistribution centre for equipment which has some residual value or operating life remaining once deemed obsolete by a particular user. Therefore, the second-hand dealers help extend the lifetime of equipment rather then reduce or eliminate any environmental impact associated with equipment disposal. Most second-hand dealers do not deal in used EEE exclusively; EEE forms part of their product range. A total of seven second-hand dealers that deal in EEE were surveyed.

Figure B.23 shows the origin of equipment received by second-hand dealers in South Australia. As can be seen, second-hand dealers predominantly pay for the equipment they receive knowing there is a potential profit from the resale of reworked EEE. Approximately half as much equipment is collected by second-hand dealers at no cost.

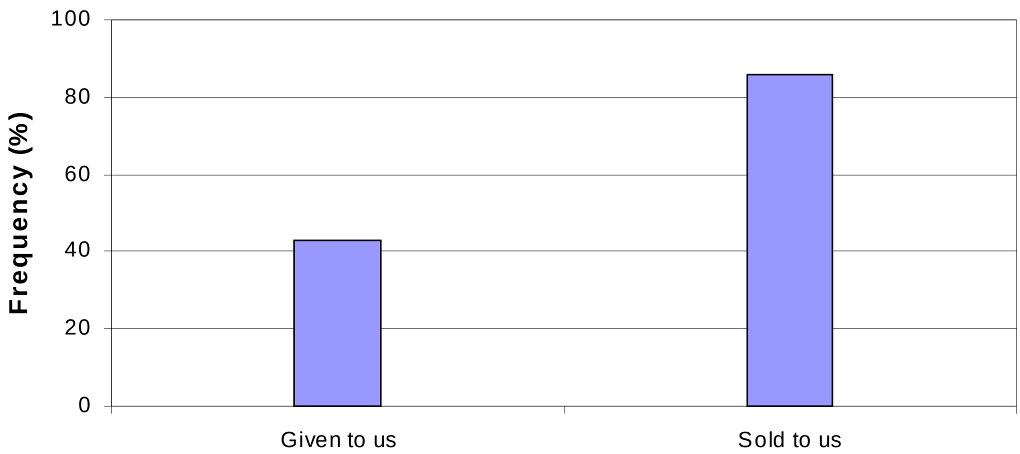

Figure B.23: Origin of second hand equipment obtained by second-hand dealers in South Australia.

Figure B.24 highlights the work carried out on the received products by second-hand dealers, which shows that 67% of dealers undertake some minor “clean up” of equipment prior to resale. Some companies (50%) indicate some component repairs are required, and it is likely that spare parts obtained from the dismantling of units (33%) are used to undertake these repairs. In some cases (17%), major upgrades of equipment are necessary prior to resale.

These data suggest that the market for second-hand EEE within South Australia remains reasonably active. While the resale of used equipment does not reduce the environmental impact of these products when they finally enter the waste stream, it does serve to increase the total lifetime of the equipment, reducing the volume of WEEE at any given time. The continual improvements being made to technology in recent years has resulted in businesses opting to upgrade their equipment on a more frequent basis. If this trend continues in the future, as can be expected, larger volumes of equipment in good working order, disposed by the corporate sector, will be available on the second-hand market. Thus the opportunity to deal in equipment of increasing quality will arise, provided the incentives exist to maintain a second-hand market.

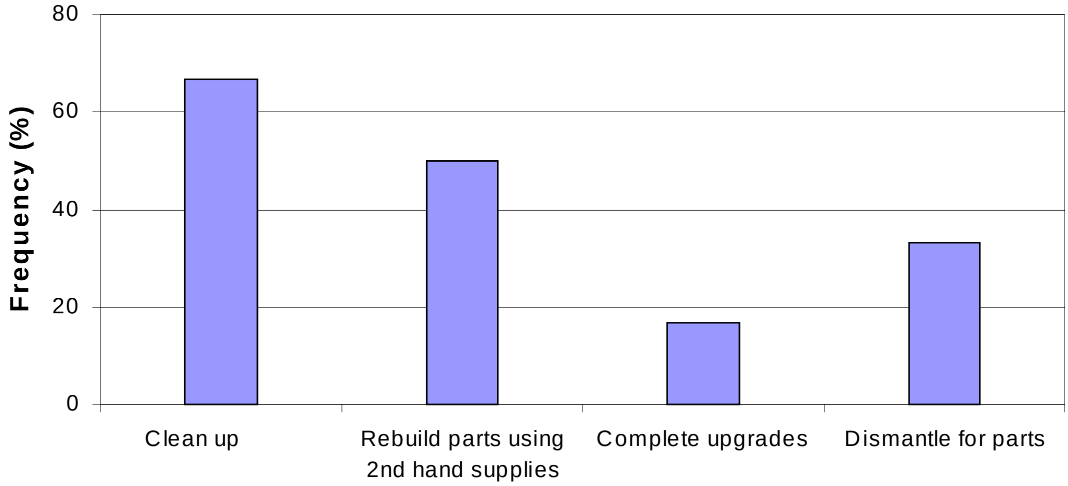

Figure B.24: Work undertaken on second-hand equipment prior to resale by second-hand dealers in South Australia.

Figure B.25 indicates the incentives that second-hand dealers believe should be put in place to promote the second-hand market for EEE in South Australia. By far the most frequently quoted incentive is that of financial awards from government in support of the second-hand market (71% of companies surveyed). Such an incentive may include a government refund for consumers purchasing second-hand equipment from registered dealers of used EEE in South Australia, or a government subsidy for approved second-hand dealers based on the number of units sold. Second-hand dealers do not anticipate any shortage of EEE equipment for the foreseeable future. However, profit margins are considered low, especially if work is to be undertaken on the equipment prior to resale. This is why government subsidy is seen as being important to help maintain a viable second-hand trade.

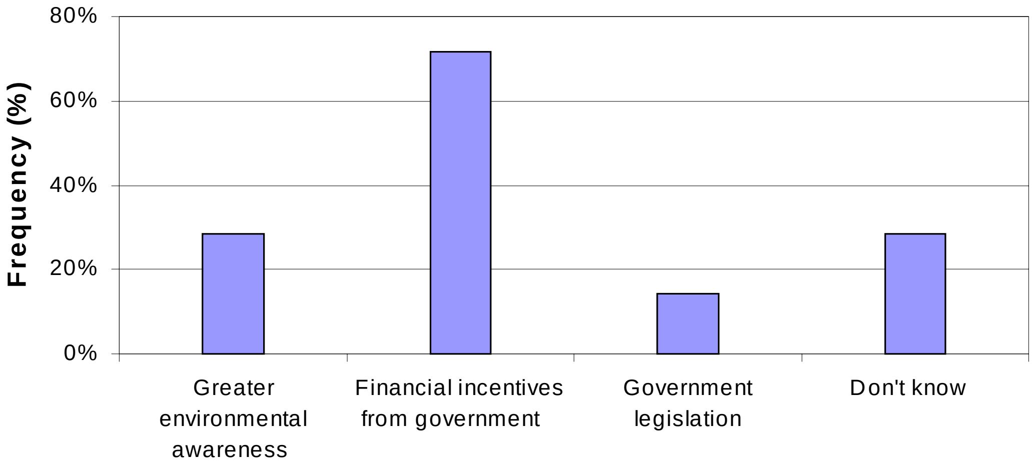

Figure B.25: Incentives required to promote the resale of used EEE in South Australia.

The responses received from the second-hand sector suggest that there is an active market for second-hand EEE in South Australia, given that stocks are available via product trade-in and take-back schemes, and trade is profitable to second-hand dealers if they have to pay for the equipment they receive. The second-hand market may play an important role in the near future when technological advancement is likely to lead to a more frequent replacement of EEE.

RECYCLING COMPANIES

Recycling companies enter at the end of the life cycle of EEE, and represent the final environmental barrier prior to ultimate disposal of the equipment as waste. Recycling companies undertake both dismantling and recovery. A total of four recycling companies dealing with EEE were surveyed.

Figure B.26 shows the origin of the equipment received from recycling companies in South Australia, with all companies indicating they receive some equipment from the public and some from the government (via collection schemes) half the companies indicating they obtain equipment directly from corporate bodies. Of the companies surveyed, 50% indicated they purchased some of the equipment they obtained for recycling which indicates some potential for profit, while a similar number also indicated they charge a premium to collect obsolete equipment.

Figure B.27 shows the nature of recycling carried out on WEEE by recycling companies in South Australia. A majority of companies recover materials of greater or lesser value from the equipment (75% of companies surveyed). Several recycling companies undertake equipment dismantling for recovery of useable parts (50%), while some act as a distribution centre for WEEE to be further transported to dedicated recycling venues (25%). The types of materials recovered are shown in Figure B.28. The major materials recovered are metals such as copper, aluminium and brass, along with other scrap metal (predominantly iron) and plastics. To a lesser extent, heavy metals (cadmium, mercury, lead, etc.) and precious metals (gold, silver, etc.) are also recovered.

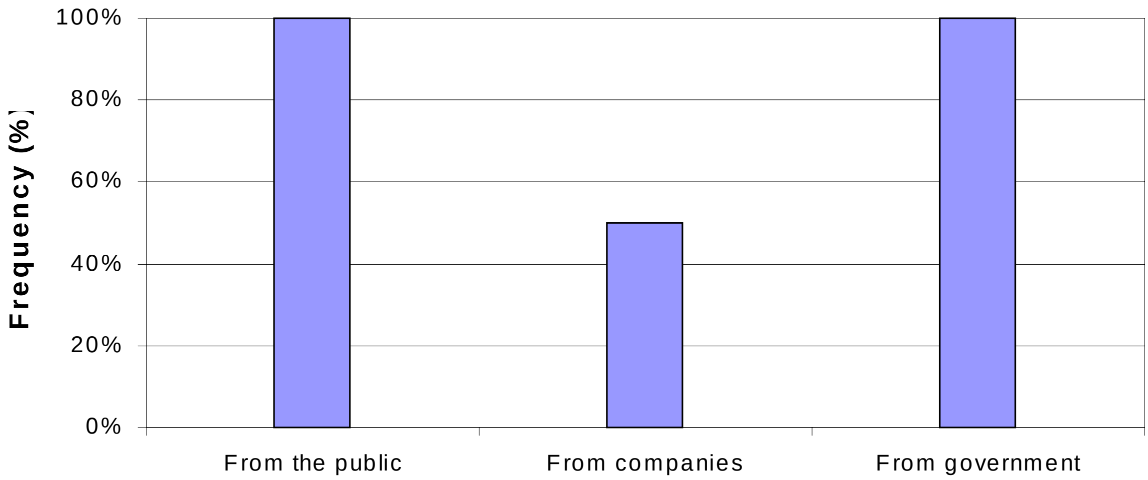

Figure B.26: Source of equipment received by recycling companies in South Australia.

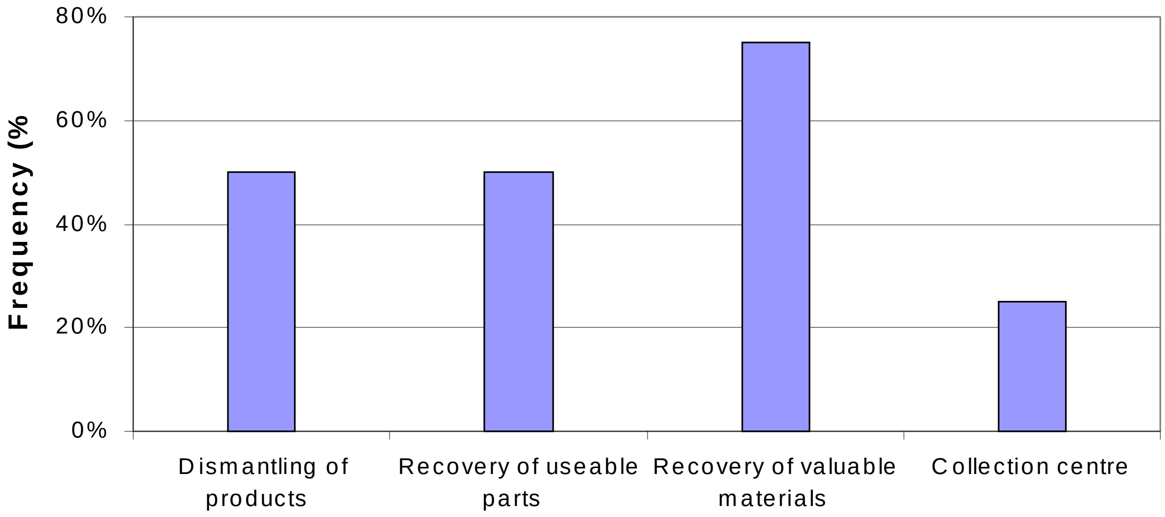

Figure B.27: Nature of operations by recycling companies in South Australia.

Figures B.27 and B.28 tend to indicate that a certain amount of high level recycling of electrical and electronic waste is being undertaken in South Australia. However, the surveyed recycling companies have indicated certain factors which limit the amount of recycling they are capable of undertaking. These limitations are illustrated in Figure B.29, and as expected the major limiting factor is the cost of recycling. Seventy five per cent of the companies surveyed suggested they were limited by the difficulty in obtaining products to recycle, which implies they could increase their rate of recycling provided they could source sufficient amounts of suitable WEEE. Fifty per cent of companies believe that a lack of awareness of what can be recycled is a problem, and these last two responses support the findings of this survey obtained from other categories of survey respondents. These limitations are seen to be further compounded by both private apathy and government inactivity, which again are indicative of the lack of understanding in the South Australian community at large regarding the importance of issues related to WEEE.

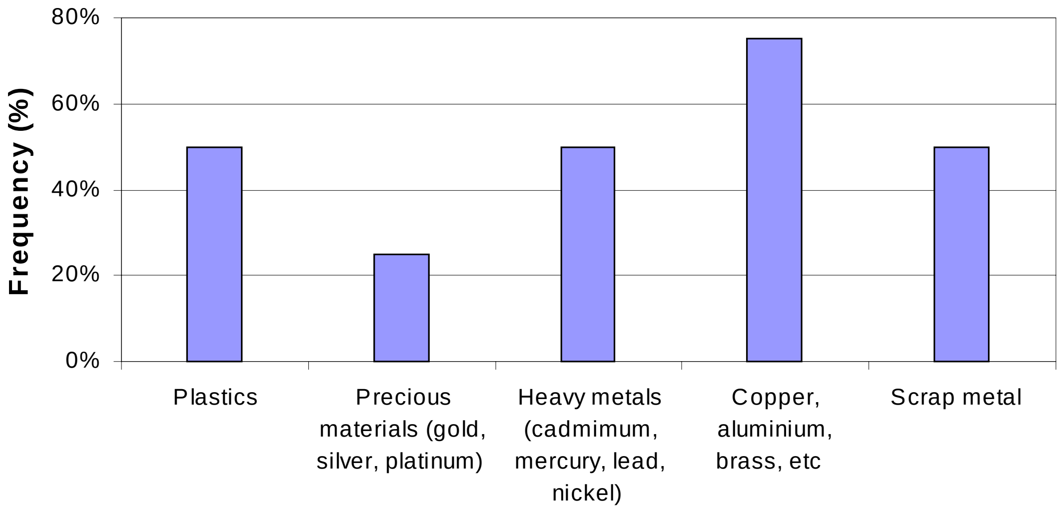

Figure B.28: Types of material recovered from electrical and electronic waste by recycling companies in South Australia.

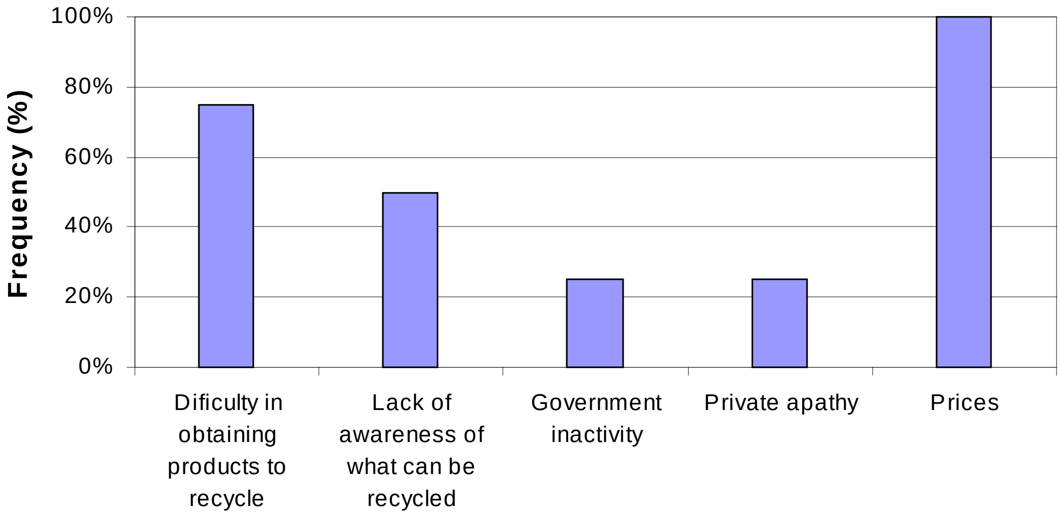

Figure B.29: Factors limiting the volume of recycling done by South Australian recycling companies.

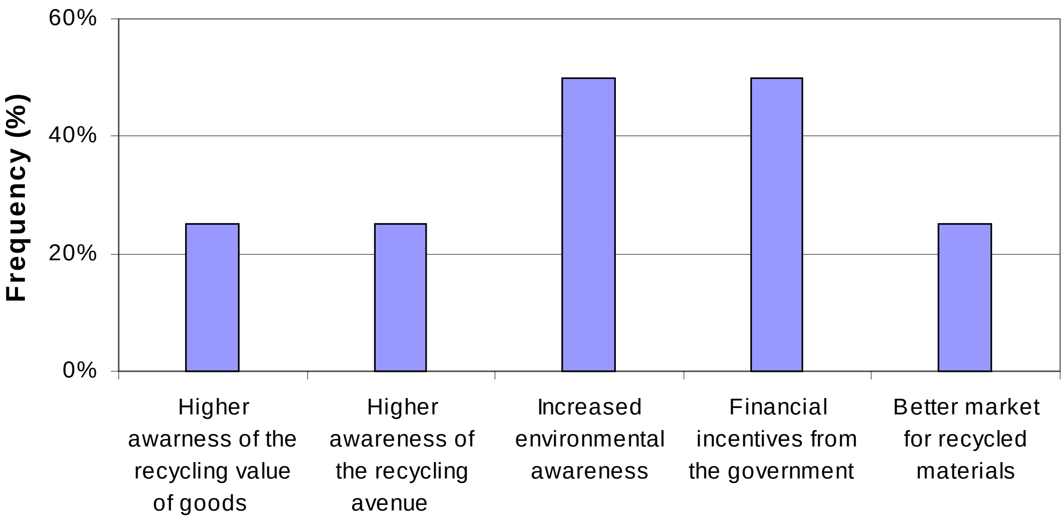

Figure B.30: Incentives required to promote recycling of obsolete EEE in South Australia.

From the responses presented in Figure B.30, it can be seen that recycling companies believe that increasing awareness of recycling and establishing financial incentives from the government are crucial factors in increasing the recycling efficiency of WEEE. The link between prices limiting current rates of recycling and financial incentives from the government to add to the value of future recycling operations suggests that the economics of recycling activity is crucial to maintaining a stable recycling network in South Australia.

In general, the response from the recycling sector has indicated that South Australia presently has a reasonable recycling capability which is limited by a lack of suitable mechanisms enabling WEEE to reach recycling centres, and a lack of knowledge within the general public regarding the importance of recycling WEEE. Recycling companies do not view recycling of WEEE as highly profitable, and it is likely that the recycling of WEEE may constitute only a modest proportion of their total recycling activities. However, it would appear that there is scope within South Australia to increase the volume of recycling of WEEE, provided incentives and mechanisms are in place.

THE RESPONSIBILITY FOR RECYCLING

When considering the development of effective recycling programs, it is important to consider what sectors of the community should bear the responsibility and cost for undertaking electrical and electronic waste recycling. Figure B.31 indicates the sections of the society, considered by the survey respondents as being most responsible for recycling WEEE. The general consensus is that manufacturers and consumers are the groups to shoulder most of the responsibility. Note that the majority of the manufacturers surveyed were unsure as to who should be responsible for recycling; despite this, a substantial proportion of these respondents has unambiguously identified the manufacturer as having a major responsibility.

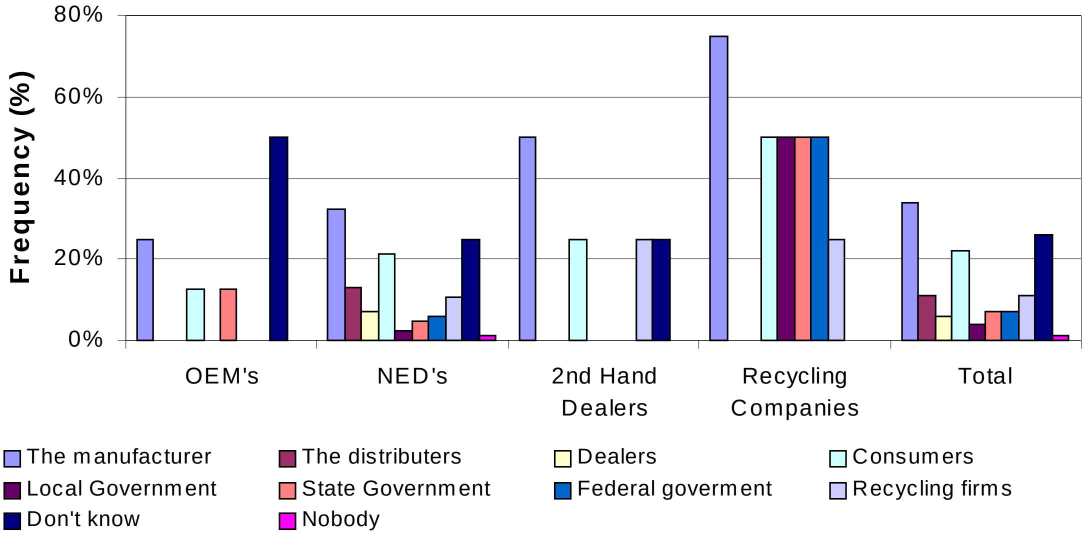

Figure B.31: Groups considered to be most responsible for the recycling of WEEE in South Australia.

A similar response was obtained when the respective groups were prompted to consider who should bear the cost of recycling. Once again the most common responses, as illustrated in Figure B.32, were that manufacturers and consumers ought to bear the bulk of the recycling cost. It is of note that all the groups surveyed indicated that recycling companies were not to be held responsible for recycling nor should they bear the cost of recycling. Similarly, neither local governments nor the State and Federal governments were considered to be responsible in this regard. This is in contrast with the substantial number of responses indicating government initiatives were essential to enhance recycling activities.

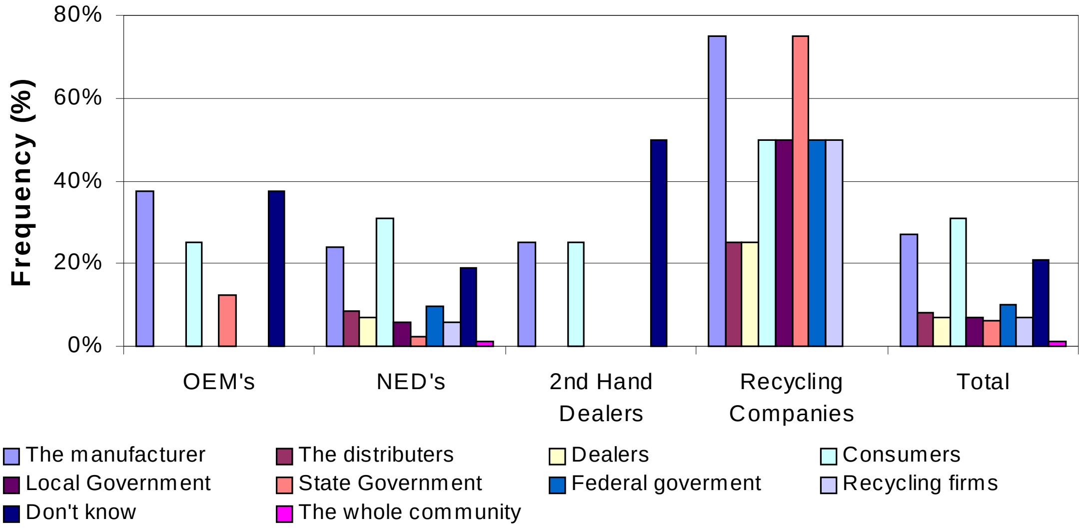

Figure B.32: Groups considered most responsible for bearing the cost of the recycling of obsolete electrical and electronic waste products in South Australia.

Ultimately, most groups appear to be in agreement that the parties who benefit most from the products are to be held to be the most responsible for their use from the start to the end. Those are considered to be the manufacturers who profit from the sale of the EEE, and consumers who benefit from the use of EEE.

WEEE RECYCLING COMPANIES IN SOUTH AUSTRALIA

The survey has established that there is currently a reasonable degree of high level recycling of WEEE in South Australia. However, consumers have indicated they have insufficient information on available recycling avenues for their WEEE. Therefore there is a need to develop a network of recycling companies, information about which can be circulated throughout the South Australian community to make them aware of how and where to dispose of their electrical and electronic waste. With this intention in mind, a number of recycling companies have been directly contacted, that provided information on the nature of recycling activities.

Several recycling companies produce a waste stream of plastics, which is sent to landfill, while one has a plastic recycling plant which can accept mixed plastics and is currently establishing supply markets. These recycling companies need to be strategically linked to increase the efficiency of the recycling sector and to ensure that only the bare minimum amount of potentially recyclable material enters landfill.

HANDLING OF WEEE AT WASTE DISPOSAL FACILITIES IN SOUTH AUSTRALIA

The final checkpoint for WEEE prior to being dumped in landfill in South Australia is the various waste disposal facilities. At these, the potential exists for WEEE to be segregated from general waste. The equipment can then either be transferred to recycling companies, or sent to landfill.

Most waste disposal facilities undertake some segregation of EEE, at least extracting either scrap metal or copper to be sent away for recycling. In general, however, most of the remaining material from WEEE, which enters these facilities, ends up in landfill if it is not suitable for resale. Given the nature of the second-hand market it is unlikely that much EEE in a reasonable working order ends up at waste disposal facilities.

A number of waste disposal facilities have indicated that CRTs are definitely entering landfill from their waste disposal facility, which is of major concern given the potential impact of CRTs on the environment. It is highly likely that other components posing environmental dangers are also entering landfill in view of the fact that there is no impediment to stop CRTs from being dumped. This reaffirms the need for tighter regulation over the disposal of WEEE in South Australia than at present, as well as the necessity of an educational program to inform the South Australian public about the threats and dangers posed by WEEE

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Appendix C

Survey Participants

Following is a complete listing of survey participants in the first five categories.

C.1 Corporate Sector *(100)*

- Australian Submarine Corporation
- Cartridge World
- Energy Power Systems
- Julie Dunn
- Clint
- Motovadio
- S D Tillett Memorials
- Thermal Control Industries
- Business Machine Wholesaling
- Graham
- Greenteam Paper Recycling Services
- CBC Bearing Co (SA)
- Geoservices Overseas S A
- Interior Projects
- South Australian Telecasters Ltd
- Gibson Chemicals Ltd
- National Marine Insurance Agency Ltd
- Reserve Bank Of Aust
- Vogue Furniture (SA)
- National Trust Advisory Service
- Rotec
- Credit Solutions Australia (SA)
- Cope Bookshop
- Count Financial Group
- Professionals In Computer Knowledge
- Mc Ewen D'Arrigo Associates
- P&R Electrical Wholesalers
- Kalleske & Hill
- Wingfield Timber Supplies
- MGM-McKinlay Graphics & Media Productions
- National Australia Bank
- South Australian Telecasters Ltd
- Alchemy Advertising & Design
- Hartley Dialysis Centre
- Western Community Hospital Inc
- Northern Accounting Services
- Ad Design
- Glen Osmond Seymour College Inc
- Festival Tours
- Solutions 2 Property Management
- Mailbox Distributors (SA)
- The Media Alliance
- West Torrens Council Community Information Service
- Able Bookkeeping
- FM Tool & Gauge
- Experimental Art Foundation
- Centennial Park Cemetery Trust Incorporated

- World Marine & General Insurances
- Weg Australia
- Migration Museum Bookshop
- Cashman & Bennett
- Australian Property Projects
- B T O'Callaghan & Associates
- Japan Airlines
- Ansett International Air Freight
- Bankwest
- Health Insurance
- Hutton Lorimer
- Homeloans Plus
- Michael Gee Payroll Services
- Mc Grath Ray
- S A Greyhound Racing Authority
- All Transport Services Ltd
- Professionals Golden Grove
- Personal Publications
- Continuing Education & Locus Staff Development
- Bioethics Institute Southern Cross
- Regency Park Transport & Distribution Centre
- Comm Tech Communications
- Fleet Street Couriers
- Household Business Directories
- Le Messurier Timber Co
- Bakewell Tom Chartered Accountant
- Aacm International
- Steed Press
- Just Training & Development
- Plevin & Associates
- Productive Computer Hire
- Bartercard Adelaide South
- Lincoln Engineers
- Commercial & Industrial Brake Services
- Sedgwick Ltd
- Kombi Couriers & Taxi Trucks
- Elders Real Estate
- Rokset Industries
- CPS Financial Services
- Phoenix Society Inc
- Kent Engineering Co (SA)
- Mc Phee Transport
- The Memorial Hospital Inc
- Main Seacombe Electrical
- Key Homeloan Services
- Typegraphics
- Drogemuller Pudney & Drew
- Players Biscuits Australia
- The Institute Of Chartered Accountants In Drafting Contractors of SA
- De Corso Business Development & Accounting
- Peters Transport Terminal

C.2 Original Equipment Manufacturers (OEMs) *(8)*

- Barsat
- Connect Electronics (SA)
- Email Ltd
- APV Australia

- Leith Electrical
- Nilsen Electric (SA)
- Canon Australia
- Vomax

C.3 New Equipment Distributors (NEDs)*(84)*

- Adelaide Business Software
- AJ Distributors
- Aurora Computers
- Action Computing Services
- A1 Computing
- Aztronics
- Brashs
- Market Plaza Computers
- Lawrence & Hanson
- Light Spot
- Adelaide Computer Centre
- GEC Electrical Wholesale
- Computer Imaging & Business Solutions
- Compuzip
- Powerking Generator
- Pierlite Lighting
- OG Computers
- Npa
- SA Lighting Supplies
- Scientific Devices Australia
- Sumitomo Cyclo
- The Paper Barn Cartridge & Toner Supplies
- In-Tc Computers
- User Friendly Computers
- Advanced Business Machines
- Ace Plot Technology
- Aberfoyle Park Computer Hub
- Bbc Micro Supplies Aztronics
- Talking Heads Cellular Services
- Comstore
- Centari Systems
- Apples Only
- Allphones Morphett Vale
- Computer Net International
- Freedom Digital Communications
- Dick Smith Electronics
- GEC Electrical Wholesale
- Computer & Printer Services P/L
- ESI Electronic Service & Installation P/L
- Yacoub Enterprises
- Jones Bryan Distribution
- Johns Computers
- Laptop World
- Kensington Computer Services
- Litesource P/L
- Man Phone Rentals
- Memec EBV P/L
- Hindley Computer City
- NT Computer World Centre
- Ornare Lighting Australia
- Mm Electrical Merchandising
- Optus World
- Transceiver Services P/L
- Affordable Mobile Phones
- National Communications

- Atco Controls P/L
- Dick Smith Electronics
- Australian Cartridge Co
- Idc Computing
- Challenge Communications
- Mobile Engineering
- Power Mobile P/L
- C&PAa (SA) P/L
- Moonlighting
- Powertech Australia P/L
- Silicon Intelligence
- The Light Factory Megastore
- Retail Solutions
- Taxi Cab Conversions
- Sun Microsystems Australia
- BFT Boom Gates
- Neil Muller
- Group-DSI
- Toner Cartridge Replacements
- Allphones
- Allied Technologies
- Anelco Components
- Allphones Mt Barker
- Applications Systems & Consulting
- Cartridge World
- Fiorentino Exclusive Lighting
- Western Electric
- Charles & Hunting

C.4 Second-hand Dealers *(7)*

- AAA Unley Road Pawnbrokers and Second-hand Dealers
- Computers Reborn
- The Recycled Office Shop
- Power Disposals Pty Ltd
- Cash Converters
- Cash X Change Pty Ltd
- Second Byte Computers

C.5 Recycling Companies *(4)*

- Hitechnology Metal Recyclers
- Simsmetal
- Adelaide Waste and Recycling Centre
- Andy The Battery Bloke

Appendix D

Estimation of Quantity of Computers Entering Landfill in South Australia

This calculation is based on a similar calculation published in *Disposition and End-of-Life Options for Personal Computers* (Matthews, 1997). The calculation uses the following assumptions:

1. New computers purchased become obsolete after five years on average (Matthews, 1997). This correlates with the data obtained from the survey of both corporate and private users.
2. The fate of obsolete equipment has been modified from that used by Matthews (1997) and the new statistics are compared with those of Matthews (1997*)* in Table D.1. The statistics used in the current study are derived from the average values for the private and corporate users obtained through the market survey. Reuse of computers included any computers returned to distributors or manufacturers, computers donated to charities, and computers given to family members or sold elsewhere.

Table D.1: Fate of Obsolete Computers.

Parameter	***Matthews (1997)***	***Current Study***
% Obsolete Reused	45	75
% Obsolete Recycled	5	5
% Obsolete Stored	45	12.5
% Obsolete Landfilled	5	7.5

3. The lifetime of reused computers has been estimated at three years (Matthews, 1997). No comparison was possible from the market survey; hence this value was adopted.
4. The fate of reused equipment has been modified from that used by Matthews (1997), and the two sets of statistics are compared in Table D.2. The statistics used in the current study are derived from the statistics of Table D.1, with the "% Obsolete Reused" omitted and the remaining statistics adjusted accordingly.

Table D.2: Fate of Reused Computers.

Parameter	***Matthews (1997)***	***Current Study***
% Obsolete Recycled	40	20
% Obsolete Stored	50	50
% Obsolete Landfilled	10	30

5. The lifetime of stored computers was estimated at 3 years (Matthews, 1997). This correlates well with the information obtained from the corporate and private sectors.

6. The fate of stored equipment was also modified from that suggested by Matthews (1997) and the relevant statistics are compared in Table D.3. The statistics used in the current study were derived from those in Table D.2 with the "% Obsolete Stored" omitted and the remaining statistics adjusted accordingly.

Table D.3: Fate of Stored Computers.

Parameter	***Matthews (1997)***	***Current Study***
% Obsolete Recycled	75	40
% Obsolete Landfilled	25	60

7. The average weight of a computer is 19.1 kg based on a weighted average for both PCs and laptops (Matthews, 1997).
8. Market statistics for the number of PCs sold in Australia for four quarters between October 1997 and September 1998 show that in total 1.927 million computers were sold in Australia for the 12 month period (Sim, 1998). South Australia has 8% of the total Australian population according to the 1996 Census (http://www.abs.gov.au), and based on this it can be estimated that 154,160 computers were sold in South Australia during 1998. It is then assumed the annual growth rate in computer sales over the last 10 years has been 15% (Sim, 1998). Given these data, and those above, it is possible to estimate the total rate of discarded computers entering the waste stream over an extended period.

Table D.4 summarises the data for the period between 1990 and 2005. The results presented indicate that South Australia can expect approximately 458 tonnes of computers to be landfilled in 1999, and this number may grow to 1060 tonnes by the end of 2005. The survey of landfill operators indicates between 1500 and 2000 tonnes of electrical and electronic equipment is landfilled in South Australia annually. This would tend to suggest that computers make up between 23% and 30% of all electrical and electronic equipment entering the waste stream in South Australia. This does not come as a surprise when their shorter life span in relation to other electrical and electronic equipment is taken into account.

Table D.4: Predicted volumes of Computers entering landfill in South Australia between 1990 and 2005.

			Fate of Obsolete PCs				**Fate of Reused PCs**			**Fate of Stored PCs**		**Annual Totals**	
Year	***New Sales***	***Obsolete PCs***	***Reuse***	***Recycle***	***Store***	***Landfill***	***Recycle***	***Store***	***Landfill***	***Recycle***	***Landfill***	***Landfill Units***	***Landfill Mass (t)***
1990	50395	25055	18791	1253	3132	1879	2471	6178	3707	824	1236	6821	130
1991	57954	28814	21610	1441	3602	2161	2842	7105	4263	947	1421	7845	150
1992	66648	33136	24852	1657	4142	2485	3268	8170	4902	1089	1634	9021	172
1993	76645	38106	28579	1905	4763	2858	3758	9396	5637	1253	1879	10375	198
1994	88141	43822	32866	2191	5478	3287	4322	10805	6483	1441	2161	11931	228
1995	101363	50395	37796	2520	6299	3780	4970	12426	7456	1657	2485	13720	262
1996	116567	57954	43466	2898	7244	4347	5716	14290	8574	1905	2858	15778	301
1997	134052	66648	49986	3332	8331	4999	6573	16433	9860	2191	3287	18145	347
1998	154160	76645	57484	3832	9581	5748	7559	18898	11339	2520	3780	20867	399
1999	177284	88141	66106	4407	11018	6611	8693	21733	13040	2898	4347	23997	458
2000	**203877**	**101363**	**76022**	**5068**	**12670**	**7602**	**9997**	**24993**	**14996**	**3332**	**4999**	**27596**	**527**
2001	234458	116567	87425	5828	14571	8743	11497	28742	17245	3832	5748	31736	606
2002	269627	134052	100539	6703	16757	10054	13221	33053	19832	4407	6611	36496	697
2003	310071	154160	115620	7708	19270	11562	15204	38011	22807	5068	7602	41971	802
2004	356581	177284	132963	8864	22161	13296	17485	43713	26228	5828	8743	48266	922
2005	410069	203877	152907	10194	25485	15291	20108	50270	30162	6703	10054	55506	1060

Appendix E

Estimation of Quantity of Mobile Phones in Use in South Australia

Statistical data on the numbers of mobile phones, both analogue and digital, in circulation Australia-wide was published by the Australian Communications Authority in its Telecommunications performance report (1998-1999). These data are shown in Figure E.1.

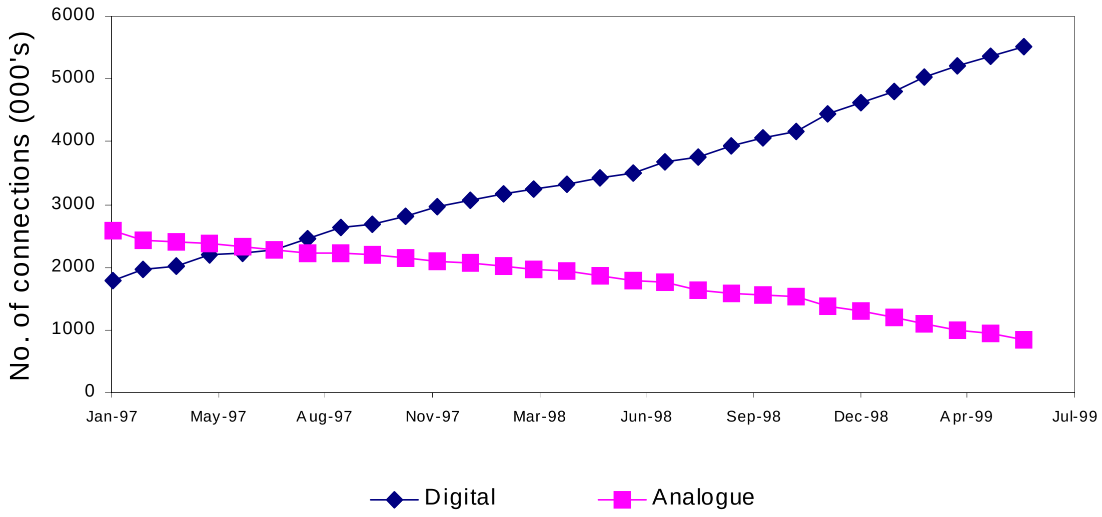

Figure E.1: Number of analogue and digital phone connections in Australia (Reproduced from the Telecommunications Performance Report 1998-1999, Australian Communications Authority).

As of June 1999, approximately 861 000 analogue mobile phone connections had remained in use Australia wide, while in total around 5 500 000 digital mobile phones were connected. This gives a total of approximately 6 361 000 mobile phone connections Australia wide. The number is expected to increase to 7 500 000 by the end of 2000 (*Telecommunications performance report 1998-1999*, Australian Communications Authority).

Given that South Australia comprises 8% of the total Australian population (http://www.abs.gov.au), it can be estimated that 68 880 analogue mobile phone connections had remained in South Australia, as of June 1999. At the same time 440 000 digital mobile phone connections were in place, with this projected to grow by 160 000 to 600 000 by the end of 2000.

Appendix F

Overseas Practice

F.1 Global Concerns

There are growing concerns globally about waste production in general, and the accelerating pace of waste production from electrical and electronic equipment in particular. Governments, environmental interest groups and industry sectors are proposing measures to arrest the problem and to turn the tide around.

Of particular concern is the toxic nature of many of the base materials used in the manufacture of electrical and electronic devices. It is feared that, despite the marginal volume of electrical and electronic waste in comparison with total waste production, the environmental effects are profound, and the associated risks are substantial.

Shorter service life, the accelerating pace of technological developments and a rapid increase of new applications give rise to an ever-growing stream of electrical and electronic waste. Typical hazardous and critical materials used in EEE are lead, mercury, halogenated flame retardants and volatile organic compounds. The manufacture of electronic components also involves the use of rare metals such as thallium, bismuth and molybdenum with implications of irretrievable loss of non-renewable resources (Bergendahl & Segerberg, 1997).

For instance, it is estimated that in 1995 some 6 million items of EEW entered the waste stream in the UK. The scrap value of these items would have been some 50 million pounds but would have cost approximately 120 million pounds to process (Dettmer, 1994).

Concerns of another kind are raised, mainly by the manufacturers through their representative industry associations who fear that the proposed measures may have a negative impact on the viability of their commercial activities. For instance, the influential industry body FV IT[3] has raised major concerns that the proposed EU Directive on Waste from Electrical and Electronic Equipment can potentially lead to the creation of cartels handling small material streams with high cost. FV IT further argues that any regulation applying to IT products must be applicable globally, and not be self-imposed by EU to apply just within EU, since this would be tantamount to unfair practice (http://www.fvit-eurobit.de/FVIT/POSITION/Pos003.htm). Organisations representing the electrical and electronics industries in the USA express similar concerns. Again, the potential disadvantage of being unevenly constrained by a looming WEEE regulation, driven by the EU, is perceived as a threat to the viability of the US industry on a global basis (http://www.svtc.org/svtc/cleancc/weeeaea.htm).

The above observations must be seen as the main causes of the furor that has been created over the potentially disastrous consequences of the continued use of such materials and their unchecked disposal at the end of the useful product life. Many initiatives are emerging

[3] Fachverband Informationstechnik, Germany

globally to curb the problem. The following sections will discuss some of initiatives from mainly the industrially developed nations.

F.2 Emerging Strategies

Several companies around the world have begun implementing a program known as the *Natural Step*, which is a guide to developing sustainable business that re-evaluates natural resource dependent manufacturing practices. It maps out a series of steps for operation of the organisation to become fully sustainable. One of the key principles of *Natural Step* is the recycling of resources. Companies implement the *Natural Step* because it provides both short-term benefits through increased efficiency as well as longer-term environmental gains (*Electronic Product Recovery, and Recycling Conference Summary Report*, Environmental Health Center, 1998)

The notion of the *environmental procurement* has been proposed to form the basis for a flow of data, physical parts and products along the supply chain, from the suppliers to the recyclers. Sixteen international manufacturers (including ABB Industrial Systems, Ericsson Telecom, Nokia Research Centre, Philips and Siemens Elema), a distributor (ELFA) and suppliers (such as National Semiconductor, 3M and VARTA) together with the Swedish Institute for Production Engineering Research, have developed tools for environmental procurement. The objective of the tool is to enable component engineers, designers and purchasers in the electrical and electronic supply chain to acquire basic and general environmental data about products, facilitate the choice of products from an environmental point of view by purchasers and support marketing and recycling of the end products. The procurement tool data comprise information about the company (environmental certification, ie ISO 14001, environmental education, disposal plans, environmental results in the annual report) and its products (company marking, relevant substances, recycled material, CFC Class I and II, and packaging). It is suggested that the environmental procurement has the potential of making a substantial contribution to the environmental performance (Bergendahl & Segerberg, 1997).

F.3 Extended Producer Responsibility (EPR)

A number of developed countries have either implemented or are in the process of implementing the so-called *extended producer responsibility* (EPR), also known as *product stewardship* or *product take-back*. EPR aims to keep products out of the waste stream by ensuring that manufacturers play a significant role in waste management. EPR encourages producers to design products that are conducive to reuse and easy to recycle by forcing the producer to assume a greater responsibility than at present for the product manufactured.

EPR defines greater producer responsibility in waste management. By compelling producers of electrical and electrical equipment to assume a greater responsibility for the EOL treatment of their products, EPR forces producers to design products that are easier to reuse and recycle. Countries at the forefront of WEEE recycling, including ten OECD countries, already have legislation in place providing for such mechanisms as regulations, covenants and ordinances to impose EPR on certain EEP categories.

There are several policy tools available to governments wishing to impose EPR.

- Deposit-refund schemes—where makers/suppliers of the product levy a refundable deposit.
- Advance disposal fees—where a fee is set to a level estimated to cover the disposal/recovery costs at the end of the products. The fee is paid by the producer into a government fund. A variation on this is when consumers who handle the product in a specified way receive a refund of the fee.
- Voluntary agreements/covenants—where the government and producers negotiate waste reduction strategies and long-term goals with regulatory implications if the voluntary goals are not met.
- Product take-back systems—where the producer is required to take back end-of-life products for reuse and recycling.

The concept of EPR was conceived in Northern Europe but other nations are implementing similar strategies including the US, Canada, Taiwan and Japan. Ten OECD countries have legislation in place that provides for regulations, covenants, ordinances, or other mechanisms to impose EPR on certain product categories. An example of legislated EPR is that of the proposed Ordinance on Waste Collection and Disposal that gives the Swedish Environmental Protection Agency (SEPA) the possibility to impose regulations to ensure an environmentally sound treatment of WEEE. The Swedish Government is set to legislate EPR with the following obligations:

- Take back free of charge old equipment when the customer buys a new one.
- Inform households and others about the take-back obligation.
- Present the scheme and participate in discussion, if municipality wishes to discuss the take-back scheme of a producer.
- Treat waste from electric and electronic products (WEEE) in an environmentally sound manner.
- Inform the recyclers of the content of products to facilitate recycling.
- Provide SEPA with facts that are needed to ensure compliance with the ordinance.

The scheme has a wide scope, and covers EEPs including household appliances, IT and office equipment, TV, audio and video equipment, games and toys and lighting equipment. Refrigerators and freezers are to be excluded since municipalities are held responsible for handling these products (SEPA, 1995).

The best known case of EPR is embodied in the German Packing Ordinance (1991) which includes an industry-wide take-back and recycling/reuse scheme for packaging waste. Despite implementation problems initially, the system was able to reduce plastic waste in Germany by 10% in just four years, and create some 18 000 jobs (Gertsakis, Morelli & Ryan, 1998).

In Europe, North America and Japan, regulations and policies to increase environmental protection have provided stimulus for innovation, prompting companies to identify new business opportunities. Leading companies have invested heavily in reducing the environmental impact of their products. They do this because they want to position themselves as market leaders/innovators, anticipate future regulations, desire to act responsibly and desire to influence the direction of legislation/regulations. They also want to improve the market image of the company, to save money by using raw materials more efficiently and to provide better customer service which they ultimately see translated into practical commercial *bottom line* benefits. One company, actively embracing EPR, is Bosch in Germany. Bosch is a leading manufacturer of power tools. The company takes back discarded power tools free of charge, and processes them to minimise their environmental impact. Bosch has applied *design for environment* principles to its products to make them easier to de-manufacture and recycle at the end of their life. Bosch in Australia offers to take back NiCd batteries from its power tools, but currently has no product take-back scheme in place (Gertsakis, Morelli & Ryan, 1998).

F.4 Europe

Europe has been seen as taking the lead in dealing with the problem of WEEE, virtually driving environmentally focussed initiatives around the globe. The most visible action is the proposed *Directive on Waste from Electrical and Electronic Equipment* by the European Union (refer Appendix I). The proposal is still under discussion, but has attracted much attention throughout the world because of its far-reaching ramifications. It sets guidelines and targets for all areas of recycling and reuse of WEEE for the member countries within EU. These include:

- measures to improve recycling such as encouraging producers to reduce the use of hazardous substances and to use a common coding for materials and components
- design for upgradability, reuse, disassembly and recycling
- a target of collecting and average of four kg of WEEE per inhabitant by the year 2004 by ensuring producers institute free take-back schemes
- a target of 90% by weight recycling/reuse, to be achieved by 2004, for WEEE containing CFCs, HCFCs, and HFCs, large household appliances and gas discharge lamps
- a target of 70% by weight recycling/reuse to be achieved by 2004 for all other WEEE, including CRTs
- a target of 5% of the total plastics content in new EEPs to be recycled plastics
- costs of collection, recycling and reuse to be borne by the producer.

The purpose of these guidelines is to reduce the amount of hazardous waste from WEEE entering the environment, and increase the recovery of non-renewable resources from WEEE (http://www.icer.org.uk/).

Europe is often seen as promoting commercial and governmental activities with environmental consciousness. Examples range from the proposed German law for electrical and electronic waste take-back to cooperation between national governments or the European Union (EU) and companies for enhanced development of environment-related infrastructures and technologies.

One particular factor for the pressure to combat the WEEE problem in Europe arises from severe limitations of landfill space. The environmental issues are vast, ranging from eroding statues due to air pollution to contaminated beaches and dying forests. As a result, awareness of environmental issues is on the rise. Inhabitants of such countries as Germany, The Netherlands, and Denmark are increasingly sensitive to environmental damage.

Considering that tourism contributes over 5% of the gross domestic product (GDP) within the EU, the issues related to environment have become of critical importance and are taken very seriously. As a result, many companies, industry trade groups, government entities and universities across Europe are launching studies of business and trade issues related to the EEPs and the environment.

The efforts made by European companies to create a *green* company image range from establishing corporate environmental policies and programs to carrying out environmental audits. A 1994 survey of German companies indicated that almost two- thirds have conducted, or plan to conduct, an environmental audit. Several European countries are establishing codes of practice and tools for environmental auditing related to EEE in cooperation with industry.

Germany has relatively stringent environmental laws, yet a poll of German electronics companies indicated that the industry views such requirements in a positive light. A large majority believe that such laws create a solid legal framework, forcing companies to establish environmental procedures ahead of foreign competitors, thereby helping them recoup profits sooner and be more competitive. Some companies find business advantages resulting from anticipated markets for environmental technology[4].

An initiative dubbed *Vision 2000* was launched in early 1994 to resolve technical and infrastructure issues in CRT recycling. The project allows companies from across Europe to cooperatively establish an infrastructure that will help to:

- ensure a high quality of recycling
- support markets for recycled materials and products
- guarantee a system for equipment recovery and disassembly
- set take-back prices.

Several other European projects also deal with the environmental impact of CRTs, although no two countries in Europe seem to approach the problem of electrical and electronics waste at the same pace or in the same manner. Germany and The Netherlands, for example, drafted legislation on electronics waste in 1994 to improve recycling and to implement extended producer responsibility. Other countries such as France generally contend that market forces should drive waste reduction activities. In many EU countries industry trade groups have an active voice in the process of drafting environmental legislation (http://www.mec.com/env/).

A new Environmental Code came into force in Sweden 1 January 1999. The act that had been in force for 30 years was replaced by the new code. Recyclers must have a permit from the County Administrative Board if they treat more than 10 000 tonnes per year of scrap or WEEE. If they treat less they have to notify the municipality. The Ordinance on Waste Collection and Disposal gives the Swedish Environmental Protection Agency (SEPA) the possibility to write regulation to ensure an environmentally sound treatment of WEEE. In the future WEEE will have to be treated by certified recyclers. The Ordinance on Waste

[4] Estimates published by the OECD and the US EPA put the worldwide environmental technology industry at $200 billion a year (1994), and expect the amount to reach between $300 and $600 billion by 2000

Collection and Disposal will have a ban for landfilling, shredding and incineration of WEEE unless it has been treated by a certified recycler. This ban is planned to come into force at the same time as the producer responsibility. A system for certification of the pre-treatment companies will have to be established in Sweden before the ban can come into force (http://www.enviro.se:8084).

In the UK, a national campaign has been launched to collect and recycle old mobile phones. Called *Takeback*, the scheme is being run by ECTEL (the European Telecommunications and Professional Electronics Industries Association), with 10 phone manufacturers participating. Estimates suggest that there are more than two million old, disused or broken phones in circulation in the UK at the moment, a figure that is expected to rise. Customers will be able to return their phones, batteries, holsters and chargers to recycling points around the country, or by post. ECTEL believes that this scheme will be the forerunner of others that will proliferate across the industry in the next few years (http://www.tecweb.com/wlibrary/elect99.htm 1999).

F.5 North America

WEEE problems are not seen as threatening in the US as in Europe, mainly due to the lower population density and more open-ended free market management economy in the US. However, there is at least one very successful example of an effective legislative initiative: in 1996 the US Government passed a law to implement the Universal Waste Rule for Nickel-Cadmium (Ni-Cd) batteries. As a result of this law Ni-Cd batteries were banned from landfill. The battery industry funded recycling through an up-front disposal fee on new batteries. There are several parallels that can be drawn between the recycling of Ni-Cd batteries and other EEPs, in particular CRTs. In both cases the product is potentially hazardous to the environment if sent to landfill and recycling is unprofitable. In the case of Ni-Cd batteries, reducing or eliminating the barriers to recycling did not increase recycling. Imposing a landfill ban on Ni-Cd batteries was the most effective way to create a collection system, recycling system, and a means of paying for it. (*Electronic Product Recovery and Recycling Conference Summary Report*, Environmental Health Center, 1998)

Another state-based scheme was introduced in July 1999 by the Massachusetts Government, which imposed a solids waste ban on CRTs for landfill and combustion facilities. Other items that have been banned include whitegoods, tires and car batteries. The banned items are sorted by disposal facility operators. Regular inspections of waste loads are made to ensure there are no banned items present. CRTs and other banned items delivered to landfills and incinerators must by law be removed and set aside for recycling. To prevent CRTs and other electronics from being put into the municipal waste steam in the first place a series of 'front-end' collection schemes are being funded including, one-day drop-off programs, seasonal curbside collections, and retailer collections. It is believed that collecting the CRTs at the *front end* will result in a larger number of reusable machines. The cost to consumers of this system is minimal, with a typical charge for collection of bulky items of up to $10. The Massachusetts Government estimates that some 25 000 tonnes of CRT waste is generated every year in the state, about half of which comes from residential sources. It is expected that the cost of CRT recycling will be lowered by establishing a volume based scrap recycling infrastructure. (Massachusetts Department of Environmental Protection, 1998)

While defining a waste as hazardous can reduce the amount sent to landfill and thus polluting the environment, associated regulations for handling the waste can prohibit recycling. The Massachusetts Department of Environmental Protection sees the benefits of recycling CRTs in environmental and social terms as very significant and has implemented a hazardous waste exemption for CRTs to facilitate recycling and imposed a solids waste ban on CRT disposal. A similar solids waste ban is in place to encourage the recycling of white goods. (Department of Environmental Protection, *CRT/Electronics Recycling Strategy Cost/Benefit Analysis*, Commonwealth of Massachusetts Executive Office of Environmental Affairs, Department of Environmental Protection, 1998)

One of the primary concerns with the disposal of WEEE to landfill and incineration is the potentially adverse environmental effects of toxic compounds entering the groundwater. To combat this United States EPA has a hazardous waste rule which prevents waste deemed hazardous from being disposed of to municipal landfill or incineration and requires it to be correctly treated. The EPA uses a *toxic characteristic leaching test* (TCLT) to determine the relative hazardousness of waste products. The test simulates 20 years in a landfill. Regulations are set for the amount of toxic compounds that can be leached from the waste before it is deemed hazardous. EEPs such as batteries, CRTs and fluorescent lights are regarded as hazardous (Department of Environmental Protection, *CRT/Electronics Recycling Strategy Cost/Benefit Analysis*, Commonwealth of Massachusetts Executive Office of Environmental Affairs, Department of Environmental Protection, 1998).

The US Conference of Mayors has conducted a survey of municipal waste programs in cities with populations above 30 000. According to the survey 79% of the cities donated some of the electronic products to schools, which would normally enter the waste stream. Nearly half of the cities send electronic equipment to landfills or *waste-to-energy* facilities. Almost half of the respondents recycled some or all of the computer components entering the waste stream. Only 15% had engaged in municipal collection of computers. Only 4% of the respondents removed hazardous constituents before disposal, yet 85% recognised that there were heavy metals present in the electronic waste. Of the cities not engaged in municipal collection of computers, some 90% were not planning to initiate a program due to a lack of funding and information (*1998 Electronic Product Recovery and Recycling Conference Summary Report*, Environmental Health Center, 1998).

South Carolina is in the process of evaluating a bill that would establish a State-wide electronic equipment recycling program. It would impose a $5.00 fee on each piece of electronic equipment containing a cathode ray tube (CRT) sold and require the state treasurer to deposit the fees into an electronic equipment recycling fund. This fund would be used, among other things, to determine the most efficient means of collecting, transporting, and processing scrap electronic equipment and to award grants, contracts, and loans to further the process and technology for recycling electronic equipment (http://www.nsc.org/ech/epr2.htm, 1999).

In contrast with the European policy emphasis on industry take-back schemes and EPR, in the US the Institute for Scrap Recycling Industries sees the principle of Design-for-Environment (DfE) as an alternative to the take-back model. However, DfE obviously cannot solve the problem of dealing with old EEPs as they become obsolete.

WEEE is the major source of heavy metals (lead, mercury, cadmium) in fly ash leachate from municipal solid waste incineration. For this reason, many areas in the US have electronics waste collections, aimed not at recycling but at storing WEEE as hazardous waste. In some places recycling is not an option. Governments recognise that the current environmental laws are not adequate for dealing with WEEE. Particularly since treating WEEE as hazardous waste can be prohibitive to recycling. As the law stands currently in the US there is some contention over the hazardous nature of some WEEE, with some states opting to pass their own laws to deal with the issue (Biddle, 1999).

On the manufacturing front, there are some successful schemes in operation. For instance, Hewlett-Packard is one of the leading electronics manufacturers in America. It is concerned about what happens to its products at the end of their life. In 1987 Hewlett- Packard established an end-of-life management program. Through this Hewlett-Packard refurbishes and recycles its end-of-life EEPs. This is done at an 18-hectare processing facility in conjunction with Micro Metalics Corporation. Recovered electronics are firstly inspected and working parts are removed for maintenance contracts if required. Previously the waste electronics were separated manually for recycling, which made the recovery process unprofitable. In 1998 the company installed a highly automated shredding and separation system. The first step in the process is to reduce the size of electronics to a uniform size in a shredder. The shredded material is then separated into clean steel, clean aluminium, copper rich fines, mixed metals and mixed plastics with some metals. The separation process is a dry system which incorporates vibrating screens for fines removal, magnets for recovery of ferrous metals, eddy current separators to remove plastics from lighter metals, and sand flow separators to separate materials based on their density. The process has a capacity of approximately three tonnes/hr and, due to it being capital intensive, needs a steady near-capacity throughput to be cost effective. Recovered steel and aluminium are sold locally to scrap dealers. The plastics are used as a fuel source while the other metals are sent to a copper smelter for recovery of precious metals and copper (*Electronic Product Recovery and Recycling Conference Summary Report*, Environmental Health Center, 1998).

Another example is that of Philips Electronics. The company practises environmentally conscious product design (*ecodesign*) through all its operations in the USA. It employs life cycle assessment tools to evaluate their products' environmental impact in all stages of life cycle including use, production and disposal. As a result, by the year 2000 Philips expects to have reduced its energy consumption by 25%, use 15% less packaging, implement *ecodesign* in all products and impose environmental standards on its suppliers. Philips actively promotes environmental awareness within its work force, by having annual awards for environmental achievement (*Electronic Product Recovery and Recycling Conference Summary Report*, Environmental Health Center, 1998).

A further example is Noranda Inc. Noranda operates the largest metals recycling process in North America at its home smelter in Quebec, recovering precious metals from all sorts of electronics as well as lead from CRTs. The company processes some 150 000 tonnes of recycled material a year of which a third is electronics. The process involves shredding the material to be recycled, then cremating it in large reactors. Plastics in the electronics provide an additional fuel source, with fumes recovered as sulphuric acid. The molten metal from the reactors is mostly copper. This copper is separated and then purified for sale. In this process, precious metals such as gold, palladium and silver are also recovered from the electronics. There can be as much as US$2000 worth of precious metals in a tonne of electronics. However the amount of precious metals in electronic waste has been decreasing, since less precious metal is used in newer electronic equipment. There are two similar operations located in Europe (Nadeau, 1999; Dillon, 1998).

F.6 Japan

Japan is at the forefront of electrical and electronics manufacturing. Japanese companies are fiercely competitive and are responsive to consumer demands, and the relationship between the Ministry of International Trade and Industry (MITI) and Japanese industry creates a different situation for environmental activities from that in the US or Europe. Environmental activities in Japan are mostly driven by company initiatives.

The primary regulatory avenues in Japan are the Recycling Law and strong encouragement from MITI to conserve energy. The Recycling Law includes most EEPs such as PCs, videos, phones, mobile phones, refrigerators, washers, air conditioners, and televisions. The Japanese government has also developed strong incentives in its tax system to encourage environmental consciousness, including tax reductions, exemptions, and special depreciation systems. MITI is encouraging corporations to invest in energy-efficient, labour-saving, and environmentally friendly equipment. MITI is also involved improving the structural design of products so that disassembly, material separation, and recycling processes are less costly (http://www.mec.com/env/). In May 1997, the Committee on Solid Waste Disposal and Recycling, which is established under the Industrial Structure Council of the Ministry of International Trade and Industry (MITI), published a report concerning the future treatment of waste from electrical and electronic equipment (WEEE). The report lists some critical issues concerning the role of municipalities, recycling rate, landfill shortage, how to finance the system, product range and control of hazardous substances. In summary, the following recommendations are made:

- the proposed WEEE handling procedures be business-driven, with possible exclusion of municipalities
- recycling rate targets be set for efficient and viable recycling
- landfill sites be secured by manufacturers, but possibly run in cooperation with municipalities
- costs be basically born by consumers
- only a specified range of EEE be targeted
- particular attention be paid to controlling hazardous substances such Ni-Cd batteries and CFCs (http://www.cpijp.com/cpi/reports-sano01.html).

In 1991, a law in Japan was passed setting standards for companies to make products easier to recycle. Hitachi, along with other Japanese appliance builders, began making its products with fewer components and easier to disassemble. This also reduced the assembly time and lowered the production cost (Gertsakis, Ryan & Hoy, 1996). Meanwhile, Japan has developed a highly automated recycling facility for refrigerators, washing machines, air-conditioners, television sets and computer monitors. These items make up 1% of Japanese household waste, or some 14 million items. The processing facility cost over five billion yen (over AU$70m). The plant separates different metals, plastic, leaded glass, and CFCs for recycling. Construction of the plant began in 1992 and it was in operation in 1995. The plant was constructed the introduction of legislation to facilitate recycling. Anticipating more severe legislation, Hitachi developed a plan to build the Home Appliances Recycling Pilot Plant with support from the New Energy and Industrial Technology Development Organisation (NEDO) and the Engineering Advancement Association of Japan (ENAA) and the Association for Electric Home Appliances (AEHA), 1998).

Appendix G

Australian Perspective

Generally, Australia has been lagging behind other industrialised countries in dealing with the problem of WEEE. There seems to be a general lack of awareness concerning the important issues arising from WEEE. However, initiatives have been emerging both nationally and on a state-by-state basis. For instance there is a *draft guidance on the hazardous status of WEEE* (http://www.environment.gov.au/epg/hwa/scrap.pdf, 1999).

The New South Wales Government through its EPA requires industry to adopt the principles of EPR in the formulation and implementation of waste reduction plans (Gertsakis, Morelli & Ryan, 1998).

Australian companies exporting to countries where EPR regulations are in force will have to meet the EPR requirements regardless of whether national legislation for EPR exists or not in Australia. Furthermore, Australian manufacturers producing EEE for the home market will have to compete against *green* imports from overseas, notably the EU.

A survey of 34 Australian electronics producers discovered the following (Gertsakis, Ryan & Hoy, 1996):

- Followed by legislation and regulations, consumer demand was seen as the most compelling reason to produce *green* products. Only 6% thought that company concern for the environment was a strong reason to produce *green* products.
- Manufacturers of whitegoods mainly focus on design for durability to keep their products out of the waste stream, whereas manufacturers of office equipment view recycling as being important.
- In order to keep their products out of the waste stream in future, most companies were focused on recycling. They also hoped for support from recyclers and government in this area. The preferred strategy to keep products out of the waste stream is designing for durability and disassembly.
- Most companies surveyed believe that the disposal cost for their products are borne by the consumer and local government.
- Among the top responses for who should be responsible for the recycling of products once obsolete were waste management companies, consumers, and the producer.
- The producers were divided on the question of whether or not consumers should pay extra to ensure recycling. It was believed that if consumers were going to pay extra for recycling then they should pay at the time of purchase.
- Eighteen per cent believed that environmentally benign products were an important future market in Australia.
- Only 21% of respondents thought that consumers would be willing to pay more for products that they thought would be recovered and recycled in an environmentally sound manner.

As part of its waste reduction grants program the NSW EPA has awarded two separate grants aimed at the reuse and reduction of waste from printer consumables (http://www.epa.nsw.gov.au).

In the US, Europe and Japan industry associations have played a major role in the EEW debate. A 1995 survey of Australian industry associations revealed that the same is not true in Australia. Of the associations interviewed, none had any policies in place concerning WEEE or EPR. The Australian Electrical and Electronics Manufacturers' Association was the most active industry association on the issue of WEEE. It monitored waste minimisation developments with a view to implementing world's best practice. Most Australian industry associations were passive on waste minimisation issues in the case of EEPs (Gertsakis, Ryan & Hoy, 1996).

An example of fruitful cooperation between governments and industry is that of New South Wales Government and Compaq Australia. The company was awarded a grant from the government to establish a computer take-back and monitor recycling scheme for corporate customers. A pilot program has been set up to fully recycle computers and associated hardware in Sydney. The pilot findings will provide a model to expand the program to other industries throughout Australia. The program is scheduled to run from June 1999 to July 2000. MRI will be used as the scrap recycler for the pilot. In addition to computer recycling, Compaq with MRI will develop a process for the recycling of computer monitors. Compaq estimates that 30% of computer equipment collected in the pilot will eventually be re-used in computers, while another 30% will be used in other electronic equipment such as toys. The remaining equipment will be recycled mainly for metals, glass and plastics recovery. Compaq hopes the pilot will pave the way for further computer recycling in Australia (Compaq Australia, 1998).

Around 5% of the annual gold production is used in the electronics industry. In Australia there is little to no recovery of this gold and other high value metals. The labour costs make the disassembly of old electronics unprofitable. However, there is a market for export of old electrical equipment to Asia. This can fetch up to $500/tonne when exported. Exporting to Asia takes advantage of low labour costs and existing infrastructure to process electronics for reuse and recycling. Under *The Hazardous Waste (Regulation of Exports) Act* a permit is required to export electronics waste that contain hazardous components. This permit is required to ensure that the importer of the electronics handles them in an environmentally sound way and realises the hazardous nature of the material (http://www.environment.gov.au/epg/hwa/scrap.pdf).

Recycling of Nickel Cadmium (Ni-Cd) batteries is becoming compulsory in a number of countries including the US. They are often an important part of many EEPs including mobile phones and laptop computers. The Australian Mobile Telecommunications Association (AMTA) in conjunction with the NSW Government is working to set up a Ni-Cd battery recycling program. The program is currently in the trial stages and is collecting mobile phone batteries from participating manufacturers in 140 retail outlets in Sydney, Newcastle and Wollongong. Participating retailers and suppliers include Alcatel, Brightpoint, Ericsson, Motorola, NEC, Nokia, Panasonic, Philips and RF Industries. The program was announced in November 1998 and was intended to run for six months before being implemented nationally. The batteries for the trial will be collected by Australian recycler MRI, who will work with Ausmelt Ltd to undertake the recycling. The recycling process involves closed loop bath smelting, which has been developed in Australia by Ausmelt. The process melts the batteries at 1200°C producing three saleable products: a nickel-containing product (35% nickel), a cadmium fume (63% cadmium) and a low value slag that is suitable for use in roadfill. To date the program has collected over 100 000 mobile phone batteries. The initiative is funded by a voluntary levy paid by manufacturers, as well as a NSW Government grant. It is hoped that more battery manufacturers will join the program as it is implemented nationally. AMTA is assessing the feasibility of extending its take-back program to mobile handsets as well as just the batteries (http://www.amta.org.au/, 1999).

Appendix H

Harmful Effects of Hazardous Materials in WEEE

The concerns in dealing with WEEE mainly arise from the toxic nature of some substances, routinely used in the manufacture of electrical and electronic equipment. The following is a brief dot point summary of some of the harmful effects of common materials employed in electrotechnology. Relevant references are grouped at the end of the section.

H.1 Lead

- Main sources of lead in EEE are solder, especially in printed circuit boards, capacitors and CRTs. [1]
- Lead contamination in the environment is also caused from smelting, leaded petrol old house paints, and discarded car batteries.[2]
- The US regulatory limit for lead in non-hazardous solid wastes is 5 mg/l in a TCLP test, which corresponds to 100 mg of lead leached into the ground water per kg of solid waste in 20 years of landfill.[3]
- Lead is leached from CRTs in landfills. This exceeds the regulatory limit for a hazardous waste.[21]
- When CRT glass is crushed in a trash-compacting facility, the lead-bearing particles can also become an airborne hazard.[12]

There are several health hazards to humans arising from an exposure to lead. Some of these are:

- Lead is toxic to virtually every biological system in humans, especially the brain, kidney and reproductive system.[2]
- Lead harms body systems by disrupting enzyme systems mediated by other metals important to the body such as iron, calcium and zinc.[2]
- Lead is absorbed through ingestion, inhalation or other exposures.[2]
- The effects are the same whether it is breathed or swallowed.[11]
- Studies have shown links between childhood lead exposure and learning disabilities, impaired growth, reduced hearing acuity, hyperactivity, aggressiveness and attention deficit disorder. [2]
- Lead affects the formation of haem, a complex iron-containing organic compound important to organs with haem proteins, namely liver, kidneys, blood-forming tissues and the brain.[2]
- Lead accumulates in bones and has a half-life of 20 years.[2]

- Recent findings indicate that lead stored in women's bones from exposures throughout lifetime can recirculate with osteoporosis or during pregnancy, potentially exposing the foetus to lead while in utero.[2]
- Lead can affect childbirth, increasing miscarriages, and causing underweight babies and premature births. It can also cause mental development of the foetus to be impaired.[2]
- In adults, lead may decrease reaction time, cause weakness in fingers, wrists, or ankles, and possibly affect the memory. Lead may cause anemia, a disorder of the blood. It can cause abortion in pregnancy and also damage the male reproductive system. It is not certain whether exposure to low levels of lead can also cause same ill effects.[11]

There are several harmful effects on the environment. The following observations highlight the concerns:

- The full impact of lead on an ecosystem and its biota is not well understood, although its toxic effects to all organisms are widely recognised.[2]
- Some areas requiring more detailed investigation of lead's effects on individuals, species and the ecosystem as a whole include how lead is transferred in the ecosystem, its bioaccumulation in the environment, and the implications for biodiversity.[2]
- Different species react differently to lead exposure. For instance, crustaceans are extremely sensitive aquatic animals, and molluscs and polychaetes are known to have an extremely high uptake of lead.[2]
- Some plants are known to hyperaccumulate a specific metal in their roots and leaves, without significant ill effects, although plants may be poisoned if planted in a site contaminated with several metals.[2]

H.2 Mercury

- The US regulatory limit for mercury in solid wastes for landfill is 0.2 mg/l in a TCLP test which corresponds to 4 mg of mercury leached into the ground water per kg of solid waste in 20 years of landfill.[3]
- Mercury is found in WEEE from mercury switches, relays, batteries, and fluorescent lights.[14]
- Mercury combines with other elements, such as chlorine, sulphur or oxygen, to form inorganic mercury compounds or 'salts', which are usually white powders or crystals. Mercury also combines with carbon to make organic mercury compounds. The most common one, methylmercury, is produced mainly by small organisms in the water and soil. [8]
- More mercury in the environment can increase the levels of methylmercury that these small organisms make.[8]
- Inorganic mercury (metallic mercury and inorganic mercury compounds) enter the air from mining ore deposits, burning coal and waste, and from manufacturing plants. It enters the water or soil from natural deposits, disposal of wastes including WEEE and volcanic activity.[8]

- Methylmercury builds up in the tissues of fish. Larger and older fish tend to have the highest levels of mercury.[8]
- Exposure to mercury can occur from eating fish or shellfish contaminated with methylmercury, breathing vapours in air from spills, incinerators, and industries that burn mercury-containing fuels.[8]

There is a number of ill effects of mercury on human health, namely:

- The nervous system is very sensitive to all forms of mercury. Methylmercury and metal vapours are more harmful than other forms, because more mercury in these forms reaches the brain.[8]
- Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidney and developing foetus.[8]
- Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing and memory problems.[8]
- Short-term exposure to high levels of metallic mercury vapours may cause effects including lung damage, nausea, vomiting, diarrhoea, increases in blood pressure or heart rate, skin rashes and eye irritation.[8]
- There are inadequate human cancer data available for all forms of mercury; however, mercuric chloride has caused increases in several types of tumours in rats and mice, while methylmercury increased kidney tumours in male mice.[8]
- The USA EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.[8]
- Very young children are more sensitive to mercury than adults.[8]
- Mercury in the mother's body passes to the foetus and can pass to a nursing infant through breast milk.[8]
- Harmful effects of mercury that may be passed from the mother to the developing foetus include brain damage, mental retardation, incoordination, blindness, seizures and an inability to speak.[8]
- Children poisoned by mercury may develop problems of their nervous and digestive systems and kidney damage.[8]
- In some poisoning incidents, consumers of fish with high levels of methylmercury, developed permanent damage to the brain and kidneys.[9]
- In the USA, EPA has set a limit of two parts of mercury per billion parts of drinking water (two ppb).[8]
- The USA Food and Drug Administration (FDA) has set a maximum permissible level of one part of methylmercury in a million parts of seafood (one ppm).[8]
- The USA Occupational Safety and Health Administration (OSHA) has set limits of 0.1 milligram of organic mercury per cubic metre of workplace air (0.1 mg/m3) and 0.05 mg/m3 of metallic mercury vapor for eight-hour shifts and 40-hour work weeks.[8]
- Dietary intake is the most important source of non-occupational human exposure, with fish and fish products being the dominant sources.[9]

H.3 Cadmium

– The USA regulatory limit for cadmium in solid wastes for landfill is one mg/l in a TCLP test which corresponds to 20 mg of cadmium leached into the ground water per kg of solid waste in 20 years of landfill.[3]

– Cadmium is used extensively in EEPs for Nickel-Cadmium batteries, and can be found in the phosphorous coatings of some old TV screens and monitors.[13,14]

– Sources of cadmium pollution are burning of coal and household waste, metal mining and refining processes, disposal of waste from households or industries, fertiliser application to the soil, spills and leaks from hazardous waste sites.[6,7]

– Cadmium can enter the air from mining, industry and burning coal and household wastes. Cadmium particles in air can travel long distances before falling to the ground or water.[7]

– Plants take up cadmium from the soil and fish take up cadmium from water. Cadmium can build up in the food chain (bioaccumulation).[7]

– Average cadmium levels in foods range from two to 40 parts of cadmium per billion parts of food (ppb).[6]

– The level of Cadmium in most drinking water supplies in USA is less than 1 ppb, with the average person consuming about 30 micrograms of cadmium each day.[6]

– The Occupational Safety and Health Administration (OSHA) limits workplace air to five micrograms cadmium per cubic metere.[6]

Cadmium is known to have adverse effects on health. Following is a summary of observations about cadmium:

– Cadmium has no known beneficial effects on human health.[6]

– Breathing air with very high levels of cadmium severely damages the lungs and can cause death. [6]

– Inhaling or consuming low concentrations of cadmium over a long time can cause kidney disease, lung damage and increase the chance of getting lung cancer. Other tissues that could sustain damage include the liver, the male productive organs, the immune and nervous systems and the blood.[7,6]

– Eating food or drinking water with high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea. [6]

– Research findings are inconclusive on the effect of cadmium on the developing foetus or the potential for cadmium ingestion to cause cancer.[6]

– Animals given cadmium in food or water show high blood pressure, anemia, liver disease and nerve or brain damage. It is not known if humans get any of these diseases from eating or drinking cadmium.[6]

– Skin contact with cadmium is not known to cause health effects in humans or animals.[6]

H.4 Plastics

- Plastics make up some 25% of a typical computer workstation.[5]
- Electronics manufacturing accounts for 3% of USA plastics sales or one million tonnes per year.[5]
- Plastics are made from petrochemicals putting a drain on limited non-renewable fossil fuels.[4]
- The use of plastics in EEPs is necessary for lightweight, insulation, cost reduction, etc.[4]
- Recycling of plastics is growing. In the early 90s this was limited to bottles. Today more than 500 tonnes of non-bottle post-consumer plastics are recycled every year, as well as about 750 tonnes of plastic bottles in the USA.[4]
- In recent years, both the market demand and reclamation capacity have outstripped the supply of recovered plastic containers.[4]
- Plastic waste can be recycled in the form of PEF (Process Engineered Fuel), which contains approximately 30% plastic and 70% paper with similar combustion properties to coal. Using PEF as a supplement for coal can also reduce some types of environmental emissions, particularly sulfur dioxide. Studies have also shown that PEF can reduce the yield of carbon dioxide compared with conventional coal and biomass fuels.[4]
- Plastics constitute 9.4% by weight or 16% by volume of all waste generated in the United States.[4]
- The electronics industry uses tetrabromobisophenol-A (TBBA) as a flame retardant in its plastics. Methyl bromide is a by product of TBBA and is a category 1 acute toxin and potent ozone depleter.[5]
- Up to 30% of plastic in computers contain TBBA.[14]
- Flame retardants have been found in human blood and it is believed that they can disturb foetal development.[14]

H.5 PCBs

- Polychlorinated biphenyls (PCBs) are a group of manufactured organic chemicals that contain 209 individual chlorinated chemicals (known as congeners). PCBs are either oily liquids or solids and are colourless to light yellow in appearance. They have no distinguishable smell or taste.[10]
- PCBs are widely used in EEE due to their excellent insulating and cooling properties and are extensively used in transformers, capacitors and other electrical equipment. PCBs do not burn easily, which makes their disposal difficult.[10]
- The manufacture of PCBs ceased in the USA in 1977 because of evidence of hazardous build-up in the environment, causing harmful effects.[10]
- PCBs may be carried long distances in the air; they remain in the air for approximately 10 days.[10]

- In water, a small amount of the PCBs may remain dissolved, but most sticks to organic particles and sediments.[10]
- PCBs in water can lead to bioaccumulation in fish and marine mammals, and can reach levels thousands of times higher than the levels in water.[10]
- Direct exposure to PCBs can occur by using old appliances such as television sets and refrigerators; these may leak small amounts of PCBs into the air when the equipment is at operating temperature. Indirect exposure may occur by eating food, including fish, meat and dairy products containing PCBs, breathing air near hazardous waste sites that contain PCBs, drinking PCB-contaminated well water, repairing or maintaining PCB transformers and capacitors.[10]

There is a range of serious health effects. These include:

- People exposed to PCB in air for a long time have experienced irritation of the nose and lungs as well as skin irritations, such as acne and rashes.[10]
- It is not known whether PCBs cause birth defects or reproductive problems in people. Some studies have shown that babies born to women who consumed PCB-contaminated fish had problems with their nervous systems at birth. However, it is not known whether these problems were definitely due to PCB or other chemicals.[10]
- Animals that breathed very high levels of PCB had liver and kidney damage, while animals that ate food with large amounts of PCB had mild liver damage.[10]
- Animals that ate food with smaller amounts of PCB had liver, stomach and thyroid gland injuries, anemia, acne and problems with reproductive systems.[10]
- Skin exposure to PCB in animals resulted in liver, kidney and skin damage.[10]
- As yet, it is not known if PCBs cause cancer in humans. In a long-term (365 days or longer) study, PCB caused cancer of the liver in rats that ate certain PCB mixtures.[10]
- The USA Department of Health and Human Services (DHHS) has declared that PCBs may be assumed to be carcinogens.[10]
- The EPA in the US has set a maximum contaminant level of 0.0005 milligrams of PCB per litre of drinking water (0.0005 mg/l).[10]
- The USA Food and Drug Administration (FDA) requires that milk, eggs, other dairy products, poultry fat, fish, shellfish and infant foods contain not more that 0.2–3 parts of PCBs per million parts (0.2–3 ppm) of food.[10]

H.6 Phosphors

- Phosphors are found in all CRT screens as well as fluorescent lights.[13]
- Phosphors used in CRTs are materials that radiate visible light of various wavelengths when stimulated with an electron beam.[13]
- Old TV phosphor for green contained cadmium as did old black and white TV sets.[13]

- Computer monitors contain phosphors which most commonly contain yttrium oxysulphide, europium, aluminium-activated zinc sulphide, and silver-activated zinc sulphide.[14]
- Many phosphors used in CRTs contain zinc. Zinc can be harmful in large amounts, but is an essential trace element in human diet. Zinc can accumulate in fish, but not in plants. The small quantities of phosphors in used in EEPs mean that zinc contamination of groundwater from landfilled phosphors is of little concern.[15]
- Some phosphors used in monitors can contain terbium. Little is known of the toxicity of terbium. It should be handled with care as with all other lanthanide elements.[16]
- Some old monitors contain phosphors that contain arsenic. Arsenic is a human poison in its inorganic form. Arsenic can accumulate in fish, but only in the non-toxic organic form. As little as 60 ppm of arsenic in water or food is fatal. Care should be taken when dealing with old monitors that contain arsenic. However, the small quantities of phosphors in used in EEPs mean that arsenic contamination of groundwater from landfilled phosphors is of little concern.[17]
- Phosphors from fluorescent lamps are contaminated with mercury.[18]

H.7 CFCs, HCFCs and HFCs

- CFCs (freons) are sometimes used for washing printed circuit boards and in the manufacture of expanded foam for packaging.[14]
- The main use of CFCs is as a refrigerant, and can be found in many old refrigerators (both the coils and the polystyrene cabinets) and air conditioners.[14]
- Due to adverse environmental effects, the production of CFCs was phased out in the USA in 1978.[19]
- CFCs break down ozone and, thereby, damage the ozone layer, ultimately leading to increased ultraviolet light reaching the earth and contributing to skin cancer.[14]
- CFCs are not directly harmful to humans.[14]
- Other refrigerants found in air conditioners and refrigerators are HCFCs and HFCs.[20]
- HCFCs also deplete the ozone layer but their ozone depleting potential is greatly reduced.[20]
- HFCs do not deplete the ozone layer.[20]

H.8 Other Substances

There are several other substances which cause concerns when discarded to landfill. Some of these concerns relate to the following:

- Because of the small quantities of lead and silver, monitors and CPUs rarely fail the Toxicity Characteristic Leaching Procedure (TCLP) test and are routinely disposed of as solid wastes.[14]

– Computer batteries are considered hazardous waste because of the acids, lithium and metals contained within them and need to be removed and treated separately.[14]

H.9 References

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Appendix I

EU Proposal for a Directive on Waste from Electrical and Electronic Equipment (July 1999)

The following text is taken from the Industry Council for Electronic Equipment Recycling website (http://www.icer.org.uk). References made in the text are part of the original document and are therefore not included.

EUROPEAN PARLIAMENT AND COUNCIL DIRECTIVE

on Waste Electrical and Electronic Equipment amending Directive 76/769/EEC

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 95 and 175 thereof,

Having regard to the proposal from the Commission

Having regard to the opinion of the Economic and Social Committee

Having regard to the opinion of the Committee of Regions

Acting in accordance with the procedure laid down in Article 251 of the Treaty

Whereas

(1) The objectives of the Community's environment policy, as set out in Article 174 (1) and (2) of the EC Treaty, aim in particular at preserving, protecting and improving the quality of the environment, protecting human health and utilising prudently and rationally natural resources. Whereas this policy shall be based on the precautionary principle, on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.

(2) The Community program of policy and action in relation to the environment and sustainable development ("Fifth Environmental Action Program") [83] states that the achievement of sustainable development calls for significant changes in current patterns of development, production, consumption and behaviour and advocates, in order inter alia, to reduce wasteful consumption of natural resources and to prevent pollution; whereas this program mentions Waste Electrical and Electronic Equipment (WEEE) as one of the normative target areas, in view of the application of the principles of prevention, recovery and safe disposal of waste.

(3) The Council, in its Resolution of 24 February 1997 [84] on a Community strategy for waste management, invited the Commission to develop, as soon as possible, an appropriate follow-up to the projects of the priority waste streams program, including WEEE.

(4) Article 2(2) of Council Directive 75/442/EEC of 15 July 1975 on waste[85], as last amended by Commission Decision 96/350/EC[86], provides that specific rules for particular instances or supplementing those of the said directive on the management of particular categories of waste may be laid down by means of individual Directives.

(5) The amount of WEEE generated in the European Union is rapidly growing, the content of hazardous components in electrical and electronic equipment constitutes a major concern during the waste management phase and recycling of WEEE is not undertaken to a sufficient extent.

(6) In accordance with the principle of subsidiarity and the principle of proportionality, the objective of improving the waste management of WEEE cannot be achieved effectively by Member States acting individually; whereas in particular diverging national approaches as to standards for "design for recycling", including the phase-out of specific substances, constitute technical barriers to the trade of electrical and electronic equipment; whereas different national applications of the producer responsibility principle lead to substantial disparities of the financial burden for economic operators; whereas the presence of different national policies concerning the management of WEEE hampers the effectiveness of national recycling policies.

(7) Disparities between the laws or administrative measures adopted by the Member States as regards the management of WEEE could create barriers to trade, distort competition in the Community and may thereby have a direct impact on the establishment and functioning of the internal market; whereas it therefore appears necessary to approximate the laws in this field.

(8) The scope of the legislation should comprise all electrical and electronic equipment used by consumers and those electrical and electronic equipment destined for professional use, which risk to end in the municipal waste stream.

(9) While Community waste management policy attaches priority to the prevention of waste, it is necessary to design electrical and electronic equipment in a way which facilitates their repair, possibility to be upgraded, re-use, disassembly and recycling; whereas the reduction of hazardous waste implies the ban of using certain hazardous substances in new equipment.

(10) Member States have to take into account international standards on the design for recycling, in particular the marking of plastic products.

(11) Only separate collection renders specific treatment and recycling of WEEE feasible; whereas consumers have to actively contribute to the success of this collection and should be encouraged to return WEEE. To this purpose convenient facilities for the return of WEEE, including public collection points and retailers where private households should be able to return their waste free of charge, have to be set up.

(12) A collection target for WEEE used by private households should be aimed at, in order to attain harmonised environmental objectives in the European Union and more specifically to ensure that Member States, in particular producers strive to set up efficient collection schemes.

(13) A specific treatment for WEEE is indispensable in order to avoid the dispersion of pollutants into the recycled material or into the waste stream; whereas the recycling

facilities have to comply with certain minimum standards to prevent negative environmental impacts linked to the treatment of WEEE.

(14) A high level of recovery, in particular re-use or recycling expressed in targets should be achieved and producers encouraged to integrate recycled material in new equipment.

(15) Basic principles with regard to a financing of the WEEE management have to be set at Community level and financing schemes have to contribute to high collection rates as well as to the implementation of the principle of producer responsibility;

(16) Users of electrical and electronic equipment from private households should have the possibility to return WEEE free of charge; whereas producers setting up WEEE management schemes individually should not be discriminated compared to producers setting up collective management schemes (pools); whereas financing has to be also ensured for waste from products which have been put on the market before the entry into force of the present legislation.

(17) Information of the users about the collection systems and their role in the management of WEEE is indispensable for the success of WEEE collection; whereas this information implies the proper marking of those electrical and electronic equipment, which could end up in rubbish bins or similar means of municipal waste collection.

(18) Information for treatment facilities provided by producers is important to facilitate the management, in particular the treatment, of WEEE.

(19) Information on the number and weight of electrical and electronic equipment put on the market in the European Union and the rates of collection of WEEE is necessary to monitor the success of collection schemes.

(20) The format for information on the collection success and the adaptation to scientific and technical progress of the phase-out of certain hazardous substances, the requirements for treatment facilities and the treatment of WEEE as well as of the targets for re-use and recycling should be effected by the Commission under a Committee procedure.

Article 1

Objectives

This Directive sets out measures that aim, firstly, at the prevention of waste electrical and electronic equipment, secondly at the re-use, recycling and other forms of recovery of such wastes, and thirdly at minimising the risks and impacts to the environment associated with the treatment and disposal of waste electrical and electronic equipment. It is also the aim of this Directive to harmonise national measures concerning waste electrical and electronic equipment in order to ensure the functioning of the internal market and to avoid obstacles to trade and distortion of competition within the Community.

Article 2

Definitions

For the purposes of this Directive:

1. "Electrical and Electronic Equipment" means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in

Annex I A and designed for use with a voltage rating not exceeding 1000 Volt for alternating current and 1500 Volt for direct current.

Electrical and Electronic Equipment includes all components, sub-assemblies and consumables, which are part of the product.

2. "Waste electrical and electronic equipment" means electrical or electronic equipment which is a waste within the meaning of Article 1(a) of Directive 75/442/EEC.

3. "Prevention" means measures aiming at the reduction of the quantity and the harmfulness for the environment of waste electrical and electronic equipment, their materials and substances.

4. "Re-use" means any operation by which waste electrical and electronic equipment or its components are used for the same purpose for which they were conceived. "Re-use" includes the continued use of waste electrical and electronic equipment, which is returned to collection points, distributors, recyclers or manufacturers.

5. "Recycling" means the reprocessing in a production process of the waste materials for the original purpose or for other purposes but excluding energy recovery. Energy recovery means the use of combustible waste as a means to generate energy through direct incineration with or without other waste but with recovery of the heat.

6. "Recovery" means any of the applicable operations provided for in Annex II B to Directive 75/442/EEC.

7. "Disposal" means any of the applicable operations provided for in Annex II A to Directive 75/442/EEC.

9. "Treatment" means any activity after the waste electrical and electronic equipment has been handed over to a facility for depollution, disassembling, shredding, recovery or disposal and any other operation carried out for the recovery and/or the disposal of the waste electrical or electronic equipment and its components.

9. "Producer" means manufacturer of electrical and electronic equipment or professional importer of electrical and electronic equipment into a Member State.

10."Distributor" means anyone who provides a product on a commercial basis to the party who is going to use that product.

11."Waste electrical and electronic equipment from private households" means waste from private households, as well as commercial, industrial, institutional and other waste which, because of its nature and quantity, is similar to waste from private households.

12."Dangerous substance or preparation" means any substance or preparation which has to be considered dangerous under Directive 67/548/EEC or Directive 88/379/EEC.

Article 3

Scope

1. This Directive shall cover the categories of electrical and electronic equipment falling under the categories set out in Annex I A.

2. This Directive shall apply without prejudice to other Community legislation in particular as regards safety and health standards.

Article 4

Prevention

1. Member States shall encourage producers to minimise the use of dangerous substances and preparations in electrical and electronic equipment. The number of different types of plastics in the individual items shall be reduced with a view to facilitating recycling.

2. Member States shall ensure that measures aimed at prevention and to improve recycling are implemented.

In particular, Member States shall:

a) Encourage the design and production of electrical and electronic equipment which takes into full account and facilitates their repair, possibility to be upgraded, re-use, disassembly and recycling. In particular, Member States shall encourage the producers to increase the use of materials which can be easily recycled.

b) Ensure that producers use common component and material coding standards, in particular to facilitate the identification of those components and materials which are suitable for re-use and recycling. Member States shall ensure that ISO 1043-1, 1043-2 and ISO 11469 on the generic identification and marking of plastic products is applied to plastic parts weighing more than 50 grams.

3. The Commission shall promote, as appropriate, the preparation of European standards relating to the design of electrical and electronic equipment according to paragraph 1, 2 a), b) and Article 7 paragraph 6. With regard to the implementation of these paragraphs Member States shall take into account existing international standards.

4. a) Member States shall ensure that the use of lead, mercury, cadmium, hexavalent chromium, PBB and PBDEs are phased out by 1 January 2004.

The applications of lead, mercury, cadmium and hexavalent chromium listed in Annex II are exempted from this provision.

b) In accordance with the procedure laid down in Article 14 the Commission shall on a regular basis, according to technical and scientific progress, amend Annex II, in order to:

(i) as necessary, establish maximum concentration values up to which the existence of the substances referred to in subparagraph (a) in specific materials and components of electrical and electronic equipment shall he tolerated;

(ii) exempt materials and components of electrical and electronic equipment from the provisions of subparagraph (a) if the use of the substances referred to in subparagraph (a) in these materials and components is unavoidable;

(iii) delete materials and components of electrical and electronic equipment from Annex II if the use of the substances referred to in subparagraph (a) in these materials and components is avoidable.

Article 5

Separate Collection

1. Member States shall ensure that systems are set up so that last holders and distributors can return waste electrical and electronic equipment from private households. To meet this obligation Member States shall ensure the availability and distribution, taking into account the population density, of the necessary collection facilities.

2. Member States shall ensure that distributors, when supplying a new product, offer to take back free of charge similar waste electrical and electronic equipment from private households provided that the equipment is contaminant free (including radioactive and biological).

3. Member States shall ensure that producers provide for the collection of waste electrical and electronic equipment from holders other than private households. They shall be allowed and encouraged to set up take-back systems for waste electrical and electronic equipment from private households.

4. Member States shall ensure that collection and transport of waste electrical and electronic equipment is carried out in a way which ensures the suitability for re-use and recycling of those components or whole appliances which might be re-used and/or recycled. For this purpose wastes containing discharge lamps, cathode ray tubes, liquid crystal displays, amongst others, have to be protected to avoid breakage.

5. Member States shall aim at achieving a minimum rate of separate collection of four kilograms on average per inhabitant per year of waste electrical and electronic equipment from private households. Member States shall provide information on the achieved rates of collection from private households to the Commission by 1 January 2004 and on a three-yearly basis thereafter. The information shall be provided in a format which shall be adopted by the Commission within one year from the entry into force of this Directive in accordance with the procedure laid down in Article 18 of Directive 75/442/EEC.

6. On the basis of the information gathered under Article 5.5 and taking into account information gathered under Article 11, the Commission will propose that the Council and the Parliament shall establish compulsory targets for collection of waste electrical and electronic equipment from private households from 1 January 2006 onwards.

Article 6

Treatment

1 Member States shall ensure that producers set up systems to provide for the treatment of waste electrical and electronic equipment that is separately collected in accordance with Articles 5.1 and 5.3. For the purposes of Article 4 of Directive 75/442/EEC this treatment shall, as a minimum, include the removal of all fluids and a selective treatment according to Annex III provided that this treatment does not hinder the re-use and recycling of components or whole appliances.

2. Member States shall ensure that any establishment or undertaking carrying out treatment operations shall obtain a permit from the competent authorities, in compliance with Articles 9 and 10 of Directive 75/442/EEC. The derogation from the permit requirement referred to in Article 11, paragraph 1, of Directive 75/442/EEC shall not apply to operations concerning waste electrical and electronic equipment covered by this Directive.

3. Member States shall ensure that any establishment or undertaking carrying out treatment operations shall store and treat waste electrical and electronic equipment in compliance with the technical requirements set out in Annex IV.

4. Member States shall take the necessary measures to ensure that the permit referred to in paragraph 2 includes all conditions necessary for compliance with the requirements of paragraph 1 and 3 as well as Article 7 paragraph 2 and 3.

5. The treatment operation may also be undertaken outside the respective Member State or the EU provided that the shipment of waste electrical and electronic equipment is in compliance with Regulation (EEC) 259/93. In all cases, Member States shall ensure that producers deliver the waste electrical and electronic equipment to establishments or undertakings, which are certified under equivalent conditions as those set out in this Article.

Article 7

Recovery

1. Member States shall ensure that producers set up systems to provide for the recovery of separately collected waste electrical and electronic equipment in order to meet the objectives laid down in this Directive.

2. Member States shall take the necessary measures to ensure that no later than 1 January 2004 the following targets are attained by producers:

a) For all separately collected waste electrical and electronic equipment falling under category I (large household appliances) of Annex I A the rate of component, material and substance re-use and recycling shall reach a minimum of 90% by weight of the appliances.

b) For all separately collected waste electrical and electronic equipment falling under the category 2, 5, 9 and 10 of Annex I A, with the exception of equipment that contain Cathode Ray Tubes, the rate of component, material and substance re-use and recycling shall reach a minimum of 70% by weight of the appliances.

c) For all separately collected waste gas discharge lamps the rate of component, material and substance re-use and recycling shall reach a minimum of 90% by weight of the appliances.

d) For all separately collected waste electrical and electronic equipment containing a cathode ray tube the rate of component, material and substance re-use and recycling shall reach a minimum of 70% by weight of the appliances.

3. For the measurement of the re-use and recycling rates the denominator is constituted by the weight of the respective group of waste electrical and electronic equipment (paragraph 2 a), b), c) or d)) sent to the recycler. The numerator is constituted by the weight of the materials from the respective group not sent to a disposal or incineration operation.

4. 2006 at the latest the Council and the Parliament shall re-examine the targets referred to in paragraph 2 a), b), c) and d) on the basis of a report of the Commission, accompanied by a proposal.

5. Without prejudice to paragraph 2 Member States shall also promote the recovery of energy from waste electrical and electronic equipment.

6. Member States shall encourage producers to integrate an increasing quantity of recycled or used material in electrical and electronic equipment. Member States shall take this requirement into account with regard to national legislation on public procurement.

Article 8

Financing

1. Member States shall ensure that holders of waste electrical and electronic equipment from private households can in accordance with Articles 5.1 and 5.2 return this waste free of charge.

2. Member States shall ensure that the costs for collection, treatment, recovery and environmentally sound disposal of waste electrical and electronic equipment from private households are borne by producers.

3. Member States shall ensure that producers provide for the financing in accordance with this article either by collective systems with other producers or by individual systems for the products of their own brand only. No discrimination should occur between producers, who comply with this Article by means of collective systems or by individual systems.

4. For all categories listed in Annex I A, except categories 2, 5, 6 and 9 this Article enters into force two years after the entry into force of this directive.

Article 9

Information for users

1. Member States shall ensure that users of electrical and electronic equipment in private households obtain the necessary information about:

- the return and collection systems available to them,

- their role in contributing to re-use, recycling and other forms of recovery of waste electrical and electronic equipment,

- the meaning of the symbol shown in Annex V.

2. With a view to achieving a high rate of collection Member States shall ensure that producers appropriately mark with the symbol shown in Annex V electrical and electronic equipment which could, due to their size, be disposed of in rubbish bins or similar means of municipal waste collection.

Article 10

Information for treatment facilities

Member States shall ensure that producers provide, as far as it is needed by treatment facilities, appropriate information which identify the different electrical and electronic equipment components and materials, and the location of dangerous substances and preparations in the electrical and electronic equipment.

Article 11

Information for authorities

1. Member States shall ensure that producers provide information yearly on the quantities of electrical and electronic equipment put on the market within the Member States, both by numbers and by weight. It has to be indicated under which of the categories of Annex I A the equipment falls.

2. Member States shall ensure that the information required in paragraph 1 is transmitted to the Commission by 1 January 2004 and every three years from that date in accordance with Article 5.5.

Article 12

Obligation to report

Member States shall report to the Commission on the application of this Directive in accordance with Article 5 of Council Directive 91/692/EEC. The first report shall cover the period 2002-2004.

Article 13

Implementation in national law

1. Member States shall bring into force the law, regulations and administrative provisions necessary to comply with this directive within 18 months from the adoption of this directive. They shall immediately inform the Commission thereof.

2. When Member States adopt these provisions, these shall contain a reference to this directive or shall be accompanied by such reference at the time of their official publication. The procedure for such reference shall be adopted by Member States.

3. Member States shall communicate to the Commission all existing laws, regulations and administrative provisions adopted within the scope of this directive.

Article 14

Committee procedure

The Commission shall be assisted by the committee established by Article 18 of Directive 75/442/EEC, and according to the procedure laid down therein, in order to adapt the Annexes III and IV to this Directive to scientific and technical progress.

Article 15

Existing Community legislation on dangerous substances and preparations

The provision of Article 4.4 shall be inserted in Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations.

Article 16

Entry into force

This Directive shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Communities.*

Article 17

Addressees

This Directive is addressed to the Member States.

Done at Brussels,

For the European Parliament	*For the Council*
The President	*The President*

ANNEX I A

CATEGORIES OF ELECTRICAL AND ELECTRONIC EQUIPMENT

COVERED BY THIS DIRECTIVE

1. Large Household appliances
2. Small Household appliances
3. IT-Equipment
4. Telecommunication
5. Radio, Television, Electroacoustic, Musical instruments
6. Lighting equipment
7. Medical equipment systems

8. Monitoring and control instruments

9. Toys

10. Electrical and Electronic tools

11. Automatic Dispensers

ANNEX I B

EXAMPLES FOR THOSE PRODUCTS WHICH ARE FALLING UNDER THE CATEGORIES OF ANNEX I A

1. Large Household appliances

Large cooling appliances for professional use

Refrigerators

Freezers

Washing machines

Clothes dryers

Dish-washing machines

Cooking
Electric stoves

Electric hot plates

Microwaves
Heating appliances

Electric heaters

Electric fans

Air conditioners

2. Small Household appliances

Vacuum cleaners

Carpet sweepers Irons

Toasters

Fryers

Coffee grinders

Electrical knives

Coffee machines

Hair dryers

Tooth brushes

Shavers

3. IT-Equipment

Centralised Data processing:

Main frames

Minicomputers

Printer units

Personal Computing:

Personal Computers (CPU, mouse, screen and keyboard included)

Lap-top computers (CPU, mouse, screen and keyboard included)

Note-book computers

Note-pad computers

Printers

Copying equipment

Electrical and electronic typewriters

Pocket and desk calculators

4. Telecommunication

User Terminals and systems

Facsimile

Telex

Telephones

Pay telephones

Cordless telephones

Cellular telephones

Answering systems

5. Radio, Television, Electroacoustic, Musical instruments

Radio sets (Clock radios, radio-recorders)

Television sets

Videocameras

Video recorders

Hifi recorders

Audio amplifiers

6. Lighting equipment
Luminaries
Straight fluorescent lamps
Compact fluorescent lamps
High intensity discharge lamps, including high pressure sodium lamps and metalhalide lamps
Low pressure sodium lamps
Other lighting equipment

7. Medical equipment systems (with the exception of all implanted and infected products)
Radiotherapy equipment
Cardiology
Dialysis
Pulmonary ventilators
Nuclear Medicine
Laboratory equipment for in-vitro diagnostic
Analysers
Freezers

8. Monitoring and control instruments
Smoke detector
Heating regulators
Thermostat
Clocks
Scales

9. Toys
Game boys
Other electrical or electronic toys

10. Electrical and Electronic tools
Drills

Saws

Sewing machines

11. Automatic Dispensers

Automatic dispensers for hot drinks

Automatic dispensers for hot/cold, bottles/cans

Automatic dispensers for solid products

ANNEX II

APPLICATIONS OF LEAD, MERCURY, CADMIUM AND HEXAVALENT CHROMIUM, WHICH ARE EXEMPTED FROM ARTICLE 4 PARAGRAPH 4

Mercury in compact fluorescent lamps not exceeding 5 mg per lamp

Mercury in straight fluorescent lamps not exceeding 10 mg per lamp

Mercury in lamps not specifically mentioned in this Annex

Mercury in laboratory equipment

Lead as radiation protection

Lead in glass of cathode ray tubes, light bulbs and fluorescent tubes

Lead as an alloying element in steel containing up to 0.3% lead by weight, aluminium containing up to 0.4% lead by weight and as a copper alloy containing up to 4% lead by weight

Lead in electronic ceramic parts

Cadmium oxide on the surface of selenium photocells

Cadmium passivation as an anti-corrosion in specific applications

Cadmium, mercury and lead in hollow cathode lamps for atomic absorption spectroscopy and other instruments to measure heavy metals

Hexavalent chromium as an anti-corrosion of the carbon steel cooling system in absorption refrigerators

ANNEX III

SELECTIVE TREATMENT FOR MATERIALS AND COMPONENTS OF WASTE FROM ELECTRICAL AND ELECTRONIC EQUIPMENT IN ACCORDANCE WITH ARTICLE 6.1

1) Components containing substances or preparations listed below have to be removed from any waste electrical and electronic equipment that is separately collected:

Lead (except Lead in Cathode Ray Tubes)

Mercury

Hexavalent Chromium

Cadmium

Polychlorinated Biphenyls

Halogenated flame retardants

Radioactive substances

Asbestos

Beryllium (except alloys where the Beryllium content does not exceed 2% of the overall weight of the alloy)

These Substances or preparations mentioned above shall be disposed of or recovered in compliance with Article 4 of Council Directive 75/442/EEC.

2) The following waste electrical and electronic equipment that is separately collected has to be treated as indicated:

Cathode Ray Tubes: The fluorescent coating has to be removed

Equipment containing CFC, HCFC or HFCs: The CFC present in the foam and the refrigerating circuit shall be properly extracted and destroyed. HCFC or HFCs present in the foam and the refrigerating circuit shall be properly extracted and destroyed or recycled.

Gas discharge lamps: the mercury shall be removed

Liquid crystal displays shall be removed and treated separately

Electrolyte capacitors of a height of more than two cm and a diameter of more than one cm or of a comparable volume shall be removed and treated separately

The substances or preparations mentioned above shall be disposed of or recovered in compliance with Article 4 of Council Directive 75/442/EEC.

ANNEX IV

TECHNICAL REQUIREMENTS IN ACCORDANCE WITH ARTICLE 6.3

1) Sites for storage of waste electrical and electronic equipment:

Impermeable surfaces

Weatherproof covering

2) Sites for treatment of waste electrical and electronic equipment:

Balances to measure the weight of the treated waste

Impermeable surfaces and waterproof covering for appropriate areas

Appropriate storage for disassembled spare parts

Appropriate containers for storage of batteries, PCB/PCT containing condensators and other hazardous waste

Equipment for the treatment of water, including rainwater

ANNEX V

SYMBOL FOR THE MARKING OF ELECTRICAL AND ELECTRONIC EQUIPMENT

The symbol indicating separate collection for electrical and electronic equipment consists of the crossed-out wheeled bin, as shown below: the symbol shall be printed visibly, legibly and indelibly.

Appendix J

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