THE EMPLOYMENT CREATION POTENTIAL OF RECYCLING IN SOUTH AFRICA

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1. Introduction

The original intent of this research paper was to determine the potential job creation capacity of the recycling industry in South Africa and to test whether levers existed within government which could harness additional employment prospects in this area. As with previous studies conducted by the sectoral unit of the Economic Growth and Development Initiative (EDGI) it was envisioned that a demand analysis of secondary materials and goods would provide an indication of whether these activities were likely to grow in the future or not, and that this determination, together with an understanding of the supply constraints, would inform a view of whether increased employment was likely to be derived from the recycling sector. In addition, it was hoped that by mapping the backward and forward linkages between the secondary materials and goods markets and the rest of the economy, a cross-economy view could be established, quantifying the total impact of increased recycling activity across the entire economy.

It became evident almost immediately that these expectations could not be met within the existing scope of the study. The four key reasons for this were (1) an almost complete absence of official data, (2) an inability to rely on industry data to fill the official data gaps due to substantial issues of self interest and political positioning, (3) systemic classification and boundary issues which diminish the transparency and identification of secondary materials and goods production and trade, and finally (4) the failure of government to place its recycling intentions within an economic context or to provide a strong indication to the market of where recycling is heading in South Africa in the future.

Since the commissioning of this research, additional funding has been secured to start to address these data constraints. As such the focus of this research has shifted to concentrate on raising the correct set of issues and questions to be answered by the forthcoming quantitative study and survey process. Secondly, the paper aims to make some contribution towards placing recycling activity in an economic context so that the government can adopt a view of the sector as an economic contributor and communicate and interact with the market in a mutually beneficial manner.

The role of government in recycling activities cannot be overestimated. Most economic and environmental commentators agree that waste management and recycling in its various forms will be the next global sectoral revolution, similar to the ICT revolution which created a host of new professions, occupations, enterprises and products in the 20th century. The crucial difference, however, is that whereas the ICT revolution was generated from within the economy and driven by market forces, the environmental redirection of the economy in the 21st century will be driven *initially* by politics and government because it deals with costs external to the market.

As such, the first section of this paper will review the debate concerning the role of recycling in modern industrial production processes and the options available to governments regarding the strategic positioning of such activities in the short and long run. This review is based on international writings and case studies, as the debate has not appeared in South Africa in any formal or informal manner that we have been able to identify. While it would be premature and presumptuous to suggest how these debates could translate to the South African experience, the paper will raise certain key issues which could be considered as part of a process to assist authorities in placing recycling initiatives in South Africa on a firmer economic footing so that a sectoral support policy could be designed and implemented and/or a clear message is sent to the market in terms of long-term goals related to recycling.

The second section of the paper focuses on the current status of South African recycling and the employment created within these activities. As quantitative data is not available, the section focuses on understanding the supply chains that apply to various waste streams and to try to identify where market growth could occur and where potential job creation might arise. This section will also raise important questions regarding net job creation, as international experience has shown that increased job creation in recycling activities often arises at the expense of existing jobs in waste collection, disposal and virgin material production.

2. Understanding recycling as an economic activity

Historically, waste has always been the shadow side of the economy. In an economic and industrialised system focused on production and consumption, waste is what is rejected as useless and barren. Until as recently as the 1970s, waste was never considered an industry. It was seen as "a low technology, labour intensive service, marginalised by the nature of its trade and traditions, working at the margins of health regulations and below the radar screen of the stock market" (Murray, 1999). Jobs in waste management were seen as low status occupations and waste only hit the headlines when things went horribly wrong. Since the 1970s, three drivers have influenced this status quo.

First, concern increased regarding the hazards of waste disposal and its long-term effects on the earth – most notably in terms of global warming and changes to global weather patterns. Second, the change in perceptions regarding waste was driven by resource depletion and a growing awareness that if production and consumption patterns continue as they have in the past, the planet will run out of resources to support this process of production and consumption. For example, in 1900, the US consumed 200-million tonnes of raw materials. This grew to 600-million tonnes by 1945 and a staggering 2 600-million tons in 1989 (Demos, 1999:6). With emerging markets such as China and India growing rapidly and consuming ever-greater quantities of raw materials, it is merely a matter of time before resource depletion becomes a constraint to further growth[1]. The third driver of change has been the economic opportunities created by new waste regulations and technological innovation. Stricter waste regulations and waste minimisation legislation, particularly in the EU and South East Asia, have forced enterprises to internalise costs associated with pollution, waste and disposal, resulting in waves of innovations and technology aimed at reducing these costs. For example, in Japan, Toyota has been able to reduce the kilograms of waste generated in the production of a motor vehicle from 16 kilograms a unit to just two kilograms a unit in the last 10 years. In addition, the percentage of materials in a motor vehicle which are recyclable have increased from 65% to 85% in the last decade, and motor vehicle design has been re-engineered to assist in disassembly once the car is to be scrapped. These innovations arose as a result of producer responsibility programmes which transferred waste and disposal costs to the motor vehicle manufacturers.

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[1] A Report by the Asian Development Bank in 2004 suggests that rapidly growing countries such as China are already facing some growth constraints due to limited resource availability. As such the Chinese government proactively adopted policies to utilise secondary materials and in 2003 imported US$4.9-billion worth of recycled materials.

These three drivers have now changed world perceptions regarding waste as a shadow, marginalised activity which needed to be undertaken by necessity, to a view of waste and waste management as a dynamic, fast changing, mainstream international economic sector. Some researchers believe that "the global imperative to use materials more efficiently is likely to create as many new professions, companies and industries as did the communications revolution of the last centaury" (Ernest Lowe, 2000). Others go further and believe that we are entering a new post-industrial landscape akin to a Schumpeterian paradigm shift which occurs every 50 or 60 years and lays the foundation for a new long-wave economic growth cycle such as those described by Kontrachiev (Perez, 1996). It is uncontested that the old waste order is dying, but it is not yet clear what will replace it.

Reviewing a substantial body of research, it appears as though there are two broad paths forward. The first has been labelled the "chemico-energy modernisation" (Murray, 1999), which seeks to control the hazards of waste disposal by applying modern technology to the old waste system and recover chemical materials and energy through the disposal process and hence decreasing hazardous emissions. Essentially this path is more of the same but better. It maintains the linear industrial production pattern of resource use, production, consumption and disposal, but merely improves on the treatment and final disposal of waste. Essentially this type of modernisation is encapsulated in the evolution from landfill disposal to waste minimisations and incineration where waste is burnt and chemicals and energy release from the process are captured and re-used. While incineration technology has improved substantially over the past 15 years, reducing the pollution released into the atmosphere, and is an improvement on the status quo, it addresses only the first driver of environmental change and not the other two drivers.

The second path forward has been labelled "eco-modernisation" and is essentially a far-reaching path that constitutes the beginning of a new 'post-industrial' era (Murray, 1999). This path stresses the economy of resource use rather than the prioritisations of reducing pollution and environmental degradation. The path is premised on two concepts. The first is waste minimisation, which is achieved by using fewer materials to produce a final good and by using raw materials in the production process, which can be recycled and re-used, thus decreasing the final amount of waste which needs to be disposed of. The second concept is that of a closed production loop where the materials that remain after all waste minimisation activities have occurred can be turned into secondary materials and re-used elsewhere in the economy. As such in this paradigm, the demand for virgin resources decreases substantially. This fundamental shift away from a linear basis of industrialisation to a cyclical basis of industrial production requires systemic change in every area of the economy; it is a fundamental paradigm shift which is the true embodiment of the much-abused term of sustainable development.

At the heart of this paradigm is the concept of de-materialisation or increased resource productivity, leading to the growth of a secondary materials economy to replace the current virgin materials economy. The idea here is that by changing product design and altering production processes, waste and products at the end of their lifecycles can be disassembled and recycled so that countries create their own stock of resources, resulting in material self-reliance, a reduction in the demand and importation of raw materials, and importantly, a decrease in the cost of production, as secondary materials should be less expensive that virgin materials which are limited (hence their scarcity is reflected in their price). In addition, less energy is consumed in producing secondary materials than virgin materials.

On this basis the 'factor four' hypothesis is gaining momentum. The factor four concept, which was first posited by the German Wuppertal Institute for Climate, Environment and Energy in 1998, hypothesises that resource productivity can be increased fourfold by simultaneously doubling wealth and halving resource consumption. The hypothesis, which was expanded into a book, uses 50 case studies to show that four-fold increases in resource productivity have already been achieved on a profitable basis in many countries and sectors across the globe. Indeed, by 2000, this concept has gained sufficient support that a host of governments published targets related to improved resource productivity. Leading this charge was the Organisation for Economic Co-operation and Development (OECD), which has begun establishing targets to decrease resource usage by half by 2050, the French government, which committed itself to halving virgin resources used in energy generation by half by 2040 and the Swedish Eco Cycle Commission, which aims to increase material efficiency tenfold during the first half of the 21st centaury. The push towards this new paradigm, however, is strongly led by Japan and China. Both countries have committed themselves to an eco-modernisation post-industrial paradigm and have begun putting in place policies to ensure that targets are reached. Over and above the local economic aspects of this paradigm shift, Murray (1999) argues that the paradigm shift creates a new competition between nations. He argues that the changed perception of waste and waste management and particularly the factor four hypothesis offer a new basis for competition in the global economy. Rather than seeing resource constraints and tighter environmental regulations as a brake on economic growth, governments are beginning to recognise that the emergence of secondary materials economies and eco-efficiency offer opportunities to stimulate innovation, investment, new sources of wealth, new markets (local and abroad) and new employment creation opportunities.

This hypothesis has been taken further by Van Beukering (1998) who traced trade volumes of secondary materials between industrialised and developing nations, finding that developing countries were net importers of secondary materials, whereas industrialised countries were net exporters. He further found that developing countries appear to exhibit a comparative advantage in the utilisation of secondary materials compared to the production of virgin materials, and that the growth benefits to developing countries of increased trade in secondary materials could be substantial.

As such, for the first time in our history, "waste and the economy are now bound together as in a double helix" (Murray, 1999), with waste no longer being viewed as a cost and an economic drain on productive resources and its activities as marginal to mainstream economic activity. Rather, waste and waste management, and specifically recycling, are now seen as a motor for new trade links, new processes, new products and a new path of industrialisation.

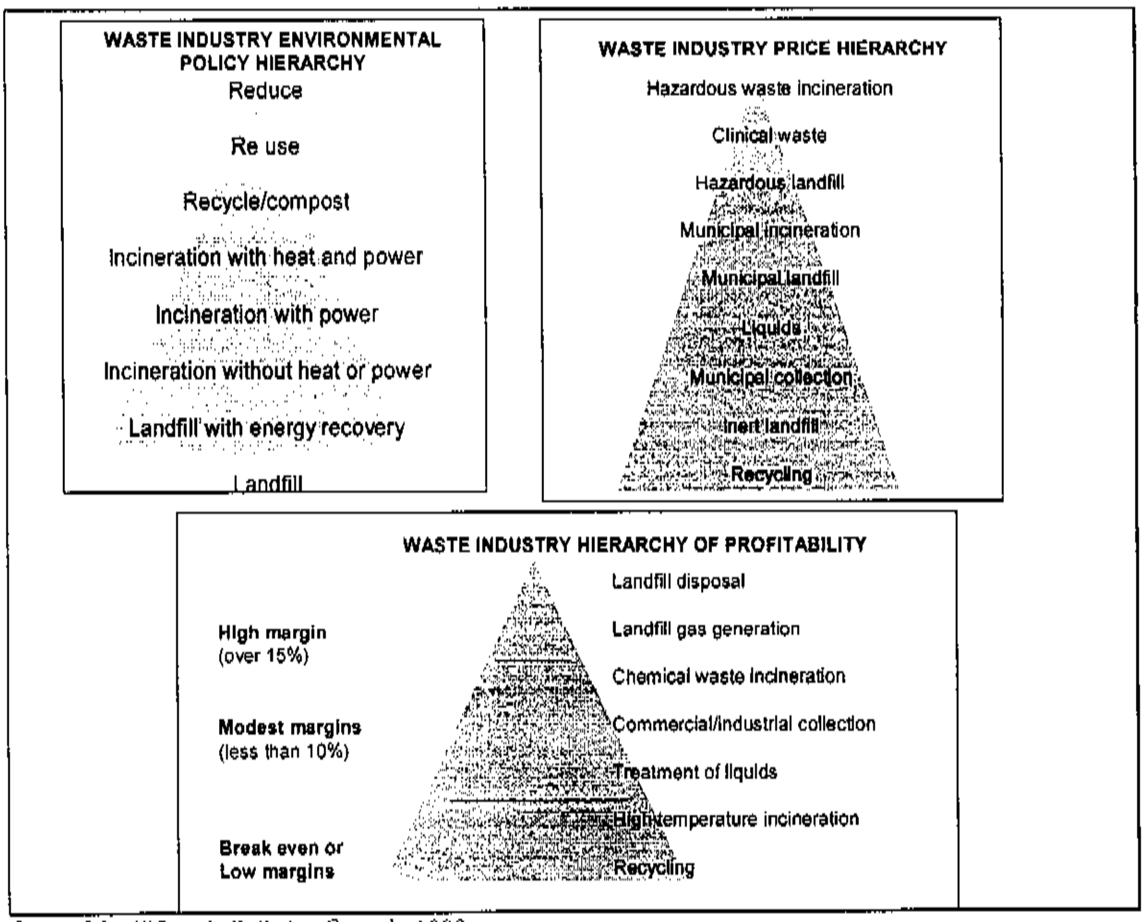
The challenge, however, is to manage the transition from linear to cyclical production patterns. Crucial in understanding this is that at present, while virgin resources remain relatively plentiful, available and cheap, transitioning industrialisation from a linear to a cyclical mode of production will be driven by politics and governments not markets. This is a fundamentally crucial point. While most environmentalists are quick to argue that eco-production will be the next revolution following the ICT revolution, governments and economists are quick to point out that the key difference is that the information revolution was market driven. Resource depletion, however, is not sufficiently advanced to ensure that an eco-production revolution is market driven, leaving it to policy-makers to kick-start the revolution. The reason why governments, particularly in the developed world, are taking this transition on board prior to a market-driven transition is twofold. First, it is driven by public sentiment and the massive rise in green politics. The second reason is strategic – an attempt to achieve first-mover advantage in a process that is guaranteed to become a reality sometime in the future. Nowhere was this strategic intent made clearer than in the US when then-Secretary of State, Warren Christopher, said that the "US must develop a strategy to use environmental initiatives to promote the larger strategic and economic goals of America". He went on to argue that the US government would support environmental initiatives specifically aimed at helping the US environmental sector to capture a larger share of a $400bn global market and to position the sector for future global changes. Murray (1999) reads this and other cited examples as showing that, whereas governments have traditionally sought to promote individual sectors, technologies and firms, it is now whole systems of production and regulation which matter most.

The above suggests three key issues which are important with respect to this paper:

- First, continued resource consumption at current rates is unsustainable in the long run and hence a post-industrialisation era is inevitable. A move from linear industrialisation to closed-loop industrialisation has begun and it will gather momentum until it becomes the new form of production globally. At the heart of this paradigm shift is increasing resource productivity, which means waste minimisation and recycling. As such, recycling is possibly ***the*** growth sector of the future global economy.
- Government will play the crucial role in managing the transition from the current paradigm to the new paradigm. A government's choices will strongly impact on whether a country becomes a pioneer or a follower, and hence determine the ultimate size and structure of the recycling sector in the future of the country's economic structure. In addition, governments' attitude towards this transition will be crucial in managing the decline of virgin material economic activity, especially in countries which are strongly mineral-based economies.
- Finally, growing and supporting this sector is a long-term undertaking. As will be argued below, short-term gains do exist but it is the long-term gains which present the most compelling arguments for supporting recycling and eco-modernisation.

From the above it becomes apparent that a government's view on eco-modernisation will be crucial to the short-run recycling activities supported over the next 10 to 20 years. In a transition period, where market conditions are insufficiently compelling to support fundamental change, the rate at which recycling activity occurs will be determined by the view and hence policies of a country's national government. As such we now turn our attention to understanding the current market forces at play at a macro-economic level regarding recycling, so as to develop a picture of the scale of potential recycling activity and the current constraints to increased activity levels. The analysis below pertains to what is generally termed post-consumption consumer waste and applies to household refuse such as plastic bottles, glass, packaging materials, paper, organic waste and discarded white goods and electronic equipment. The analysis does not apply to post-production waste which is generated by producers. This type of waste will be dealt with separately later in the paper.

Figure 1 – Waste hierarchies



Source: Merrill Lynch, Pollution Controls, 1998

The above three hierarchies exemplify the perversity of general waste recycling markets in the current industrial paradigm. In the blue hierarchy we see that from a policy perspective, all governments that have adopted the UN's Section 21 Agenda on Sustainable Development have as their priority policy goals for waste reduction, followed by re-use and recycling, in line with objectives related to minimising negative environmental impacts and maximising resource utilisation in the face of imminent resource depletion. 148 countries, including all the world's developed countries and a large percentage of developing countries, are signatories to Section 21 and thus formally adopt this policy hierarchy. However, re-use and recycling have tended not to occur in a meaningful manner, resulting in many commentators describing their governments' commitment to Section 21 and the waste policy hierarchy as mere lip service. However, the reasons for the general worldwide slow adoption of policies to achieve these goals are complex and understandable from an economic perspective. The reasons for this are explained by economic realities, the first of which is shown in the green hierarchy, which lists the prices at which disposal options are sold to potential clients, and the second the yellow hierarchy, which exhibits the profitability of various waste disposal options. Essentially recycling, which is high in the hierarchy of policy goals, is at the bottom of the hierarchy of profitability, showing that policy goals and market realities are in no way aligned. This led Merrill Lynch to conclude in its 1998 study that "recycling remains a commercial leper. Prices for recovered materials, in particular, are very depressed. Thus it can often cost more to collect the waste and sort it than can be realised, always assuming there is some demand in the first instance" (Merrill Lynch, 1998:8). This conclusion has set environmental economists to questioning how things could be different so as to increase the commercial viability of recycling. Their arguments focus on three main factors which could influence the economic viability of recycling.

The first argument considers market prices. The argument here is that current market prices do not reflect external environmental costs and benefits, and that this can only be addressed by government policies which subsidise beneficial activities and tax non-beneficial activities so as to reflect the true market price once environmental externalities have been taken into account. A series of international studies have been undertaken to correctly price the environmental effects of different forms of waste management. In a Coopers and Lybrand study undertaken in the UK, for example, it was found that recycling produced the greatest benefit at a positive value of £114/per tonne, whereas landfill produced a net negative value of £6/per tonne (cited in Demos 1999:81). Incorporating these findings in policy development, the UK has introduced a £15/per tonne tax on landfill disposal and recycling credits to increase the viability of recycling, but these credits are still sufficiently low that a recycling gap (between cost and income) ranges from £50/tonne to £70/tonne. Thus, while the UK policy operates in the correct direction in terms of shifting market forces towards recycling and away from landfill, the magnitude of the directional shift has been insufficient to elicit any meaningful change at the market level. The US's approach to this issue is slightly different. Being less supportive of government intervention and particularly the use of taxes and subsidies, the Environmental Protection Agency (EPA) in the US argues that in order to increase the commercial viability of recycling, the most important variable to influence is the demand for secondary materials. They argue that by supporting the demand for recyclables, prices for secondary materials will rise, resulting in increased and improved supply so that recycling activities will grow based on market forces. As such their approach is less interventionist and based more on the principle of "market development" (EPA, 1995:4).

The second argument, which attracts substantial attention from environmental economists seeking to understand how to increase the commercial viability of recycling, is market structure and its impact on waste hierarchy profitability. It appears to be a universal phenomenon that recycling markets in most countries are dominated by monopoly recyclers, or at least a highly concentrated recycling market, where only two or three firms operate for any given waste stream. This may be due to the fact that there is insufficient market demand to support a competitive market environment, or may be due to the high set-up costs and barriers to entry which characterise the industry. Irrespective of the source of monopoly or oligopolistic power, the result is the same in terms of market outcomes. As waste collectors increase the supply of materials available for recycling, this increased supply drives prices down when there is no competition for these materials. As such the recycling monopoly firms capture the economic rents which should be captured by the collectors and sorters of recyclable waste if the system is to be maintained. In the UK, where market concentration appears very similar to that in South Africa, it has been documented that the decrease in price at which recyclable waste could be sold from the municipalities to the recyclers dropped so much when the government's recycling credit scheme increased supply that the net situation for the municipalities was worse than when no recycling credit programme existed. As we will discuss later in this paper, this phenomenon is also rife in South Africa. For example, when the two large paper companies in South Africa – SAPPI and Mondi – embarked on an aggressive recycling campaign, the supply of waste paper increased to such an extent that the price paid for waste paper decreased to a level where it was no longer economically viable for paper collectors to collect, sort and deliver waste paper to the reprocessers. On the other hand, Collect-a-Can, which recycles aluminium cans, maintained a steady price paid for waste cans and has as a result maintained the supply of waste materials available for recycling.

The above two arguments related to the commercial viability of recycling are both demand phenomena. The third obstacle in the commercial viability of recycling is, however, a supply problem. The supply constraint facing recycling does not in fact exist in the recycling process itself, but rather with respect to the collection and sorting of recyclables, i.e. the cost-effective collection, transport and sorting/quality of the recycling processes inputs. Not all recycling is profitable, and profitability is highly influenced by the starting value of the product to be recycled, the cost of transportation (which is dependant on volume and weight) and the quality of the final recycled output (which depends on the intrinsic qualities of the material). The majority of literature available on this issue is based on developed country experiences where collection systems are based on curbside collection and the debate revolves around curbside recycling where households separate out different waste streams at source. In this scenario, the supply-side constraint depends on the cost of collection, capture rates and economies of scale. However, in South Africa the issue is more complex and hence will be covered in a separate collection section later in the paper. For now it is sufficient to argue that it appears that the adoption of intensive recycling, as opposed to ad hoc add-on recycling, would be necessary to ensure that input costs are decreased, exploiting the characteristics of collection and sorting activities as declining cost activities where economies of scale do exist.

Summarising the above, the problem appears to exhibit the characteristic of various sectoral constraints which policy-makers have seen in the past when considering how to grow a particular sector of the economy – getting prices right, increasing market competition, growing demand and improving supply by harnessing economies of scale. As such the challenges of growing the recycling sector do not seem insurmountable. For most environmental economists, the insurmountable challenge appears to be institutional and a matter of attitude. Essentially the argument here is that the traditional waste industry is structured around disposal, with its interests lying in "holes in the ground and chimneys in the air" (Murray 1999:91). If the disposal industry were to embrace intensive recycling, it would be required to re-invent itself and embrace new activities, such as social marketing, household interactions, materials quality control and orientation towards the needs of recyclers as their ultimate clients. All of this would require new skills, new types of labour and management and improved information management system. At present no one is attempting to re-invent themselves because there is no incentive to do so. This is an issue of economic transition and will be dealt with later in the paper. For now the point which needs to be stressed in the context of this paper is the role of job creation within recycling.

As mentioned above, the challenges facing the growth of recycling as an economic activity are not insurmountable, although they are significant given the current availability of virgin resources and linear-based economic production paradigms. Institutional inertia and the lack of government vision and commitment to embrace meaningful sustainable development and/or government's unwillingness to fund a transition to eco-modernisation have left environmental economists with few additional cards to play to elicit government and industry support for intensive recycling at present. It appears that one of the tactics adopted by policy-makers and environmental economists alike to push governments towards rethinking their stance on recycling has been to push the job creation button. Jobless growth is a phenomenon which most developed countries are trying to come to terms with. Increasing employment is a concern of virtually all modern economies and governments, hence to approach intensive recycling as a substantial potential job creator has allowed environmental economists to place their agenda more firmly front and centre than would have been the case if recycling was not potentially highly labour absorbing. On the other hand, for environmental policy-makers who face opposition towards new environmental regulations by industries and consumers who fear increased costs and higher prices, respectively, wielding the job creation card has assisted in diminishing national resistance to such measures. While this may appear somewhat cynical, it does appear to the author to be the best interpretation of the disproportionate preponderance of employment-related research in recycling and environmental policy-related literature, which cannot be explained by any other hypothesis.

3. A review of employment and recycling research

In 2001, the European Commission on Building a Sustainable Europe established a number of working hypotheses which they sought to test regarding environmental policy and employment. These included:

1) "Well designed environmental policies can offer opportunities to create positive effects on employment
2) In the field of waste management, employment benefits may be particularly significant due to the high labour intensity of processes for collection, sorting and recycling wastes
3) Employment in waste management is often unskilled and low paid, with poorer quality jobs in waste replacing higher quality jobs elsewhere
4) Such jobs, though, may provide an initial route back into employment for the socially excluded
5) There are significantly higher risks associated with certain waste-related occupations, such as hand-sorting, and such activities should not be encouraged
6) Waste management measures can give rise to a range of costs and related impacts, including impacts on the competitive position of the industry, which can affect employment levels in turn
7) Advanced technologies and waste minimisation measures may be encouraged through the implementation of high standards for waste treatment; these can have significant business benefits" (EU, 2001:2)

These hypotheses cover many of the working hypotheses that initiated the EDGI's interest in the link between recycling and employment, hence the OECD study is a useful starting point for this review, not only in terms of its findings, but importantly its contribution to the methodological debate of how to enumerate employment changes caused by changes in employment policy. This latter aspect is particularly relevant as it may influence the approach undertaken in the follow-up work to this paper. As such we begin this review by considering methodological and technical issues, followed by a section on reported findings related to job creation and recycling in international literature.

3.1 Technical and methodological issues

Most striking about the seven hypotheses is the strong dichotomy which exists. On the one hand environmental policies and activities such as recycling potentially offer not only increased job creation possibilities, but significantly, for a country like South Africa, they offer potential employment creation for socially excluded and unskilled labour. On the other hand, the hypotheses strongly point to a concern regarding potential job replacement. As such it is impossible to debate the employment potential of recycling and other environmental policies without considering the ***net*** effect of such interventions. While considering ad hoc policies and add-on recycling initiatives, one would be considering relatively low levels of job replacement, essentially with jobs being lost in waste disposal and new jobs created in recycling, and some potential labour-shedding in industries where new policies increase costs and decrease output and hence labour demand. If, however, one escalates the scenario to intensive recycling and a shift towards an eco-modernisation paradigm, then the magnitude of the problem escalates and must incorporate not only job replacement between disposal and recycling but a fundamental shift in labour demand patterns related to virgin material recovery and production. In the majority of the literature reviewed, only the first scenario is considered. As mentioned earlier, few national governments are thinking at present about a fundamental shift away from a linear-based production economy towards a cyclical economic production structure.

Quantifying the employment effects of environmental policy in general and recycling in particular appears to be undertaken in two ways. The first and most pervasive technique is the undertaking of studies on a very small, local scale where new effects can be directly observed and measured. These approaches are often classified as non-monetary assessment approaches and tend to be more qualitative, describing impacts of environmental policy changes in terms of number of full-time job equivalents, number of jobs by occupational skill category, changes in employment relative to regional averages, average wages, etc. Such studies are usually undertaken by local authorities and NGOs and tend to be project-orientated within a regional development scheme. The reasons for this approach are largely pragmatic and revolve around data constraints for larger studies, as well as the origin and character of the majority of recycling and environmental policy initiatives currently being undertaken. The outcome of the approach is that much of the data and findings published using this technique are locale specific and highly anecdotal, so that generalising these findings into a general view may be misleading. As will be shown below, highly divergent estimates of the job creation potential of recycling projects result.

The alternative approach is far more economically rigorous but difficult to reproduce due to data constraints and methodological challenges. The OECD in 1992 began to discuss these methodological and data difficulties when it was originally suggested that the employment effects of environmental policy be tested using a conventional cost-benefit analysis (CBA). We are covering this methodological debate in some detail, as it will be a basis for a decision regarding the methodological way forward to be used in the follow-up study to be undertaken in South Africa, which was mentioned in the introduction to this paper.

The problem with using a conventional CBA in assessing the impact of environmental policy on employment is that traditional, neo-classical CBA assumes that there are no social costs or benefits associated with changes in employment because such changes only represent transfers of activity within the economy. In reality this assumption does not hold in the majority of economies where structural unemployment exists and labour is not perfectly mobile. As a result, new environmental policy measures may create new employment opportunities and not simply result in individuals transferring from one job to another. When a net gain in jobs occurs across the economy, real social benefits will arise. Such gains are only likely to arise, however, when a policy is "likely to affect either the supply of, or demand for, the goods and services produced by one or more sectors. (OECD, 2001:5). As such the OECD decided to move forward from a traditional CBA and suggested three categories of alternate approaches.

The first category incorporates supply-side approaches and relies on current employment data to estimate the number of jobs which could be created if policies change. For example, if one knows the tonnage of waste treated per full-time employee, the effects on employment of changing this tonnage could be calculated. This information would be collected using a survey of firms to determine micro-economic data and job levels over time. The OECD found three particular problems with this approach. The first difficulty is the lack of reliable data on the level of employment generated per unit of waste for many of the activities. Employment levels per unit of waste vary depending on the nature of the technology utilised and the size and scale of the enterprise and its operations, as well as on labour productivity variations. The second problem with the supply-side approach is that it fails to capture indirect employment effects and other induced effects. The final shortcoming of this approach is that new policies may be implemented in a different manner than previous policies so that data levels for existing employment – which would be used as a benchmark – are actually invalid. In summary, the OECD researchers found that "the use of supply-side data may be useful in providing order of magnitude estimates of the direct employment effects arising from a change in waste management policies, where the use of more sophisticated methods is constrained, but indirect and induced employment effects will not be enumerated, leading to a partial overall view of the employment effects of a policy change" (OECD, 1999:9).

The second category of options relates to demand-side studies which predict the number of jobs that will be created (or lost) as a result of new investment or an increase (or decrease) in demand for the goods and services provided by a particular sector (for example, the waste management sector). Two major demand-side options exist. First it is possible to use input-output (IO) models for predicting total net direct and indirect output and employment effects. Because IO models map the inter-relationships between sectors in the economy, they can be used to examine how changes in the total output of one sector is likely to impact on the demand for inputs from other sectors. In addition, the basic set of IO tables that provides the core for such models can be expanded to include both labour and the production of waste by products, to enable the impacts of policies on these two aspects to be examined. In this approach one would definitely be able to compare two distinct states of the economy – pre- and post-policy implementation. The difference between the two states represents the net economic effect of implementing the policy in question, expressed in terms of a change in output. These net economic effects could be added to a determination of compliance costs so that the wider economic effects of the policy could be enumerated. Frankhauser and McCoy (1995) argue that this is crucial to understand the total effect of such policy changes in terms of macro-economic performance and the performance of related markets; however, the OECD researchers remain cautious about this approach. Their key concern is that the IO approach "ignores any changes in demand that may occur as a result of price effects and may not be flexible enough to take into account changes in production relationships. The result is that they may miscalculate the net employment and economic effects stemming from a policy change" (OECD, 2001:10).

The second potential demand-side approach is based on measuring multiplier effects. The advantage of this approach over the IO approach is that it can measure both indirect and induced effects of changes in environmental policy. The challenge in using a multiplier approach, however, is that multipliers assume that all additional spending is new spending rather than transfers from one set of goods and services to another, and therefore acts as a net addition to real output. Where expenditure is not new but simply a transfer, using a multiplier approach will over-estimate effects on both output and employment. Furthermore, the OECD researchers note that multipliers will change in value as a result of technological shifts, which will inevitably be substantial in this area of endeavour. For example, a waste management policy which encourages end-of-life recovery might result in changes to products so that they require fewer inputs during production and less processing prior to re-use. In this case, the application of old technology-based multipliers will lead to incorrect estimates of total output and employment effects.

The third methodological set of options is to adopt macro-economic modelling approaches – either using an econometric model or a general equilibrium model. Macro-economic modelling approaches are the only methodological options which recognise "that the implementation of waste policies by individual companies affects their behaviour as both buyers and sellers, in turn affecting interactions at inter- and intra-sectoral levels" (OECD, 2001:12). As a result they are the only approaches that are able to predict the full net effects generated by a change in waste policy and is the methodological option favoured by the OECD researchers. In the econometric model used by the OECD (called E3ME), the model is generally based on an IO-based accounting framework to which behavioural data is then added. As with IO models, changes in final demand are taken as the starting point, but they are linked to production or input demand functions that incorporate capital, energy, labour and intermediate goods. Through these functions and the associated impacts on demand, prices and real wages, new supply and demand relationships are reached for the various sectors. Once these new relationships have been calculated, changes in employment and output can be determined at a sectoral and macro-economic level. The key advantage of this approach is that it maps actual behaviour; however, its main drawbacks are that it has a limited forecasting capability of probably five to seven years, it relies on changes in GDP as a proxy for economic costs and the use of fixed production relationships may not take into account the all-important role of technological change.

While some of these drawbacks can be eliminated by using a general equilibrium model instead of an econometric model, the time, effort and data required to run a Computable General Equilibrium (CGE) model which explains the effects of environmental policy change on employment and output is often "prohibitive" (OECD, 2001:14). In addition, the OECD lists a number of methodological cautions related to GCE modelling for this purpose and "advise that the results of these studies should be considered with reservations" (OECD, 2001:14). These cautions include the fact that flexibility in production is usually only described in terms of a substitution between capital and labour, that the aggregation of markets necessary to make the model useable will lose certain key effects, and of course that changes in employment are viewed as voluntary given that the labour market is in equilibrium.

Irrespective of the methodological approach adopted, a key feature of all enumeration attempts in this field is problems associated with data. The first difficulty related to data collection regarding environmental economic activity in general or even recycling in particular is the issue related to definitions and boundaries. The first definitional problem relates to the highly heterogeneous nature of the industry. The industry not only includes a vast array of different activities, ranging from the production of goods such as refuse removal trucks and re-processing plants to a wide range of services such as waste management, waste reutilisation and waste disposal, but within each of these categories of services substantial heterogeneity also exists. For example, recycling is not a uniform activity and differs substantially across waste streams, with recycling plastics being a fundamentally different activity from recycling metals. The second data difficulty arises from the transparency and identification of recycling and re-use activities and processes within broader economic activity. For example, where an enterprise purchases waste scrap metal from producers and re-processes this scrap into new inputs or outputs, this activity is easy to identify. However, when an enterprise reclaims metals from an old mine dump as part of its normal course of mining business, using in-house resources, it is difficult to separate out this activity and capture it as recycling or reclamation as a separate activity within the firm's broader economic activity. As only enterprises that specialise in recycling and re-use are easy to identify, the majority of recycling and reprocessing remains hidden within the economic data of enterprises that undertake recycling as part of their core functions. In South Africa, for example, no Standard Industrial Classification (SIC) code exists for glass recycling. Whatever recycling Consol Glass undertakes is captured in SIC code 341 "the manufacture of glass and glass products", which fails to differentiate glass production using virgin materials and glass production using reprocessed glass cullet.

In official datasets using the SIC system, only four SIC codes relate to recycling directly. These are SIC 940 "sewage and refuse disposal, sanitation and similar activities", SIC 3951 which enumerates activities related to the "recycling of metal waste and scrap", SIC 3952 which includes the "recycling of non-metal waste and scrap n.e.c", and SIC 6149 which measures activity related to "wholesale trade in other intermediate products, waste and scrap" (SIC Manual, version 5, 2005). All other recycling and re-use activity is amalgamated into core SIC activity codes such as the production of paper or the manufacture of glass.

These difficulties, which exist across the globe, have resulted in methodological choices of how to enumerate the total effects of changes in environmental policy on output and employment being tailored according the resources available to researchers to produce non-official datasets. Even the OECD with its substantial resources was only able to run its E3ME model for three sectors, based on complete surveys undertaken specifically to gather the appropriate data to run the model. As such, economic analysis on the job-creation potential of recycling and re-use is internationally highly constrained, and until internationally accepted definitions are adopted and reflected in official data collection systems, our understanding of these activities will remain severely constrained and disproportionately influenced by smaller, less rigorous non-monetary assessment approaches. As such we now turn our attention to the findings of several of these studies in order to develop a feel for the scope and scale of potential job creation related to recycling and re-use internationally, before turning our attention to opportunities within South Africa.

3.2 Empirical case studies

We begin by looking at studies which enumerate the size of the waste sector at various levels of disaggregation. The purpose of this is to indicate the size of the current industry so as to place it in some perspective vis à vis other sectors and industries. After we have established a view regarding the relative size of the industry, we will move on to explore changes in employment arising from policy changes and project implementation, especially those related to recycling and re-use. What is immediately obvious in reviewing the status quo data is that employment figures are usually reported as a range rather than a specific number, and remarkably, these ranges are usually substantial, with upper estimates often being 100% larger than lower estimate values. This illustrates once again the fundamental data issues related to environmental economic activity.

Table 1 – Statistical employment data in the EU

	Europe	AU 1993	BE	DK 1990	FI 1990	FR 1992	DE 1994	GE	IR	IT 1990	LU	NL 1997	PO 1997	SW 1998	UK 1992
Employment in the environment industry	1.7m – 3.5m[1]	20,000[2]		22,900[2]	15,000[2]	249,000[2]	421,600[2]			9,680[2]		92,000[3]	3,600[4]	95,000[5]	141,700[2]
% of total employment		0.57[2]		0.86[2]	0.6[2]	1.12[2]	1.2[2]			0.5[2]		1.3[3]		2.5[5]	0.55[2]
Employment in core industries[6]		9,000[2]		3,700[2]	-	139,000[2]	165,600[2]			-		24,000[3]	3,000[4]	9,228[5]	103,200[2]
Employment in NACE classes[7]	79,028	11,990 (1995)	4,841 (1997)	5,377 (1995)	1,062 (1997)	22,761 (1997)		145 (1997)	10,947 (1996)	256 (1996)	5,048 (1995)	3,909 (1997)	13,410 (1995)	9,318 (1997)	
Employees in waste management	3m – 3.5m[8]		12,770[8] (1996)	35,033[8]		102,000[10]	45,000[10] (1990)					39,000[3]	2,600[4]	17,321[5]	65,000[11] (1996)
Employees in recycling	300,000[8] (1998)					26,000[10] (1990)						5,700[3]	680[4]	4,707[5]	
Employment in social enterprises (1998)[12]	35,000	80	2,100	2,318[13]	2,318[13]	4,000	8,130	50	500	2,500	100	4,000	400	3,864[13]	3000 - 5000

Sources: [1] ECOTEC 1997 [2] OECD 1997 [3] Statistics Netherlands 2000 [4] Instituto Nacional de Estatistica do Portugal [5] Statistics Sweden 1999 [6] The core industries are considered to contain 100% environmental industry, mainly waste treatment, wastewater and recycling. The core industries are the NACE code headings 25, 12, 37, 51, 57 and 90. [7] Eurostat Structural Business Statistics [8] Association of Cities for Recycling 1999 [9] Statistics Denmark 1999 [10] Profeta 1996 [11] **the dti** 1997 [12] CWESAR 1999 [13] Data in source is given as 8,500 for Scandinavia, so figure has been divided by Denmark, Finland, Sweden relative to total population

Source: EU, 2001: A3-8

Considering the first row of Table 1, we see that the EU estimates that the environmental industry (which is defined as including waste and wastewater treatment and recycling) employs somewhere between 1.7-million and 3.5-million people, which amounts to between 0.4% and 1.2% of overall employment in the EU. If these figures are correct then the environmental industry in the EU is larger than either the pharmaceutical industry or the IT industry in that union. In the fourth row, the employment figures in the main NACE categories relate to employment in SIC codes 94 and 395 as explained above[2], and identify employment related to environmental activity which is officially collected in national datasets. These figures should include all those employed in the recycling of metal and non-metal scrap (3951 and 3952), as well as employment in waste collection and disposal (9400). In row 6 column 1, a figure of 300 000 employees in recycling in the EU is estimated, but this figure is derived from a study completed by The Association of Cities for recycling, and is possibly viewed as an under-estimation of jobs in this field. The EU researchers query the 300 000 figure, which amounts to 11% of total waste management employment,

[2] NACE is the European equivalent of the SIC code and stands for 'nomenclature generale des activites economique dans les communautes europeennes'. We have reviewed the classifications and NACE 37 is identical to SIC 351/2 and NACE 90 is equivalent to SIC 94.

due to the higher statistics of recycling jobs as a percentage of waste management jobs reported by statistical offices in countries such as Sweden, Holland and France. They report 25% to 30% of waste management jobs being accounted for by recycling activity. One of the reasons for this perceived undercounting of recycling employment appears to be the large number of recycling jobs which occur in the community sector, or what is known in Europe as social enterprises. What is abundantly clear from the table, however, is that the majority of employment in the current status quo is located in waste management activities. This finding is crucially important for the purposes of our study, as it shows that collection and sorting of waste is highly labour intensive and important in overall employment opportunities in this area. In addition, as will be shown later, collection and sorting are crucially important in determining the commercial viability of recycling and re-use activities, as they determine the quality of recycling inputs and the price of these inputs to reprocessers.

In stressing this point, the EU researchers report on the Swedish case study, which, as shown in Table 2, indicates that 59% of employment in waste management in Sweden is attributable to the collection, sorting and reloading of general waste.

Table 2 – Swedish waste management employees by activity

Activity	Number of employees	% of total for waste management
Recycling of metal waste and scrap	468	4.7
Recycling of non-metal waste and scrap	116	1.2
Wholesale of waste and scrap	2,853	28.4
Collection, sorting and reloading of non-hazardous waste	5,922	59.0
Composting and digestion of non-hazardous wastes	4	0.04
Deposit on landfills of non-hazardous wastes	107	1.1
Receiving, reloading and intermediate storage of hazardous waste	268	2.7
Treatment and permanent storage of hazardous waste	127	1.3
Other waste management	173	1.7
Total	**10,038**	**100**

Source: Statistics Sweden, 1998

In the UK, Waste Watch (1999) compared these Swedish statistics to its own employment breakdown and found that only 41% of waste management employment arose from collection, sorting and reloading, while 56% of employment related to reprocessing.

In South Africa, an equivalent picture is hard to frame. The Council for Scientific and Industrial Research (CSIR), while conducting a study on behalf of the Department of Trade and Industry (**the dti**), estimated in 2000 that the Environmental Goods and

Services (EGS) sector (which is broader than the environmental industry definition used by the EU in compiling the table above) employed between 100 000 and 500 000 employees. This figure was arrived at by extrapolation based on a sample survey of 70 enterprises in the EGS industry[3]. No other figure has been found pertaining to the size of the South African environmental industry. At a low estimate of 100 000 employees, the environmental sector in South Africa is relatively small but still important, being greater than the motor vehicle industry which employed 83 000 in 2003 and the communications sector which employed 86 000 in 2003 (HSRC, Presidential Review on Employment Trends, 2005). If, on the other hand, the industry is as large as 500 000, then it is roughly equivalent in size to the mining and quarrying sector which employs 552 000, and is bigger than the clothing, construction or agro-processing sectors. If the top estimate is correct then bar retail and wholesale trade and financial services, the environmental industry is the third-largest employer in the country.

What little official data exists, however, suggests that the upper employment estimation in the CSIR study may be a substantial over-estimation. According to official SIC datasets, SIC94, which includes waste and wastewater services, employed 7 000 people in 2005. This figure seems indefensible given that one company operating in Johannesburg, which has the contract to remove municipal waste in the metropolitan area (Pick-it-Up), employs 3 200 people alone. Considering the other major metropolitan areas in South Africa, as well as refuse removal services in non-urban areas and private sector waste removal companies, a figure of only 7000 appears a massive under-estimation[4]. Industry interviews place a figure of closer to 25 000 as a reasonable estimate of collection jobs in the public sector alone. With respect to SIC 3951 and 3952, no four-digit employment data is available. In 2005, 60 000 people were employed in SIC 391-395 (Quantec, 2005) but this includes employment in the jewellery industry, non-wood furniture production and other assorted industries, so that it is impossible to determine what percentage of this three-digit employment figure is attributable to recycling. On the basis of this scant information it is impossible to assert what the size of the environmental sector in South Africa is. What we can ascertain is that in countries where better research has been undertaken, it appears as though the waste management sector is indeed sizable in relation to other established industries.

Moving from a status quo view of the sector to studies of impacts on employment by changes in environmental policy and specific projects and programmes, we see a mixture of data, which suggests very unclear conclusions.

[3] Bizarrely this report could not be found in its entirety. Neither the dti nor the CSIR were able to find copies of the complete study. Only the executive summary is available.

[4] Statistics South Africa (StatsSA) was contacted regarding this concern. They agreed that in light of the Pick-it-Up employment data, the total figure appears incorrect but they have been unable to identify any potential problems which would account for this and have chosen not to take the issue further.

In the EU study, which considered the chemical, waste electrical and electronic equipment and metals recycling sectors, the net employment effect of policy changes was estimated using a supply-side approach, a demand-side approach and the Cambridge E3ME econometric model. The results are shown in table 3 below.

Table 3 – Results of EU modelling exercise: comparison of predicted employment and GDP effects in EU 15

Case study	Supply-side	Demand-side	Macroeconomic	
	Direct employment only	Direct and first-round indirect employment	Total employment	GDP (€-million)
Chemicals industry	5,700-11,300	18,774	-18,000	-660
WEEE Directive	1,500-2,000	14,150	5,600	145
Metals recycling industry	6,250	5,020	-1,700	-368

Source: EU, 2001

The first noticeable point is that the difference in magnitude and direction between the various predictions is considerable. The supply-side and demand-side figures reflect only direct and first-order indirect employment creation. They do not take into account the negative macro-economic effects that arise from reduced investment and expenditure on other goods and services. These changes are, however, incorporated in the macro-economic analysis. What appears disturbing in the findings is that while partial analyses suggest positive impacts for employment, once total macro-economic impacts have been taken into account, the overall employment benefit may be negative. The conclusion of the EU paper states that "a key finding of the study is that the relationship between waste management policies and employment is more complex than the ongoing debate might indicate. Although waste management policies may increase demand for waste management services, this does not necessarily result in additional jobs. Instead, technology substitution for labour, increased productivity and consolidation in the waste management sector may severely constrain job creation. Overall the study demonstrates that waste management measures are likely to have only a small effect, either positive or negative, on employment" (EU, 2001:vi). These findings are not supported by the data emerging from the US. Although no official data on recycling and waste employment is issued by the EPA, the Institute for Local Self Reliance, which is an NGO with good credentials and a long history, shows that the recycling industry is growing strongly in terms of sales and employment and also indicates that in several states where net job creation has been calculated, new recycling jobs exceed those lost in disposal and virgin production.

For example, in 1967, the recycling industry in the US employed 79 000 people, which has grown to 1.1-million in 2000 – an annual growth rate of 8.3%. By comparison the health care industry in the US grew employment at a mere 4.4% per annum over the same period. (ILSR, 2002). In a study by North Carolina, new environmental legislation which required increased usage of recycled paper in the production of paper and paper products created new employment for 8 700 people. In an assessment of the overall impact on the state employment level, it was found that for every 100 jobs created in recycling, 10 jobs were lost in waste hauling and disposal and three jobs were lost in the timber harvesting industry, resulting in a net job gain of 7 569. Similar studies have been found yielding similar results in 23 additional case studies, all using non-monetary assessment approaches. Rather than expand on these numerous case studies, all of which have strong local dimensions which undermine the deduction of any general view on the dynamics of employment creation in recycling, we have chosen to conclude this section with a series of data collected in various countries, indicating the different job content of various waste activities. This approach, which compares and contrasts the number of full-time jobs created per number of tonnes of waste according to various activities, is far more useful for the purposes of this paper. What these measures show is that irrespective of the differing local circumstances, there does exist general agreement that certain waste activities are more labour intensive than others.

It is probably unnecessary to mention that the table below shows highly variable findings. In addition, our interpretation of the table is limited by the fact that the table is cited in the EU study, but the original document could not be located. As such we do not have explanations or definitions for some of the cells. The table includes estimates from a US study undertaken by Murray (1998) and a European study undertaken by Corticca and Kaurlard (1995).

Table 4 – Job content of waste management activities

Activity	Jobs per 100,000 tonnes	Tonnes per job	Source
Mixed collection – UK	86-157	637-1,165	Cortica and Kaurlard, 1995
Mixed collection – FR	140-157	637-713	Cortica and Kaurlard, 1995
Mixed collection – DE	102-157	637-982	Cortica and Kaurlard, 1995
Mixed collection – IT	44-60	1,664-2,253	Cortica and Kaurlard, 1995
Collecting and sorting	79	1,266	Murray, 1998
Separate collection – glass	36-53	1,892-2,746	Cortica and Kaurlard, 1995
Separate collection – paper	26-42	2,337-2,613	Cortica and Kaurlard, 1995
Separate collection – packaging	466	214	Cortica and Kaurlard, 1995
Separate collection – organic	472	212	Cortica and Kaurlard, 1995
Sorting facility	261	383	Cortica and Kaurlard, 1995
Compost plant	34	2,917	Cortica and Kaurlard, 1995
Central composting	20-30	5,000-3,333	Murray, 1998
Reprocessing	162	617	Murray, 1998
Recycling	241	415	Murray, 1998
Recycling	40-50	2,500-2,000	Murray, 1998
Landfill	4-6	25,000-16,667	Murray, 1998
Landfill	8-12	7,885-15,246	Cortica and Kaurlard, 1995
Incineration	10-29	10,000-3,448	Murray, 1998
Incineration	19-37	2,692-5,397	Cortica and Kaurlard, 1995

Source: EU, 2001:A3-14

Certain trends appear from this data, which reinforce the trends identified in various local recycling and re-use case studies. The first trend appears to be that separate collection of waste streams cumulatively delivers more jobs than mixed waste collection. The separate collection of packaging materials and organic waste appears to be particularly labour intensive. Sorting facilities also appear to be labour intensive, although it is important to remember that sorting facilities are only used if mixed collection occurs, thus the job creation potential of sorting facilities occurs at the expense of jobs which could be gained using separate waste stream collection systems. Jobs arising from composting, reprocessing and recycling range from a low of 20 jobs per tonne to 241 jobs per tonne, and this range is discussed in more detail in the table below. Certainly what is clear is that recycling and reprocessing are more labour intensive than the pure disposal options of landfill and incineration.

The job content of recycling and reprocessing differs substantially due to the heterogeneous nature of recycling and re-use activities attached to different types of waste streams. These waste streams differ in terms of how homogenous they are, how easily identifiable different categories of the same type of material are and the levels of contamination they experience during mixed collection, as well as various intrinsic qualities related to the material to be recycled or re-used. For example, glass which is collected for recycling must be separated into clear glass, brown glass and green glass. Identification and sorting are easy on this basis. On the other hand, plastic packaging has various levels of recyclability, which is usually embossed in the form of a number ranging from 1 to 4 on the bottom of a container. To sort out plastic containers, each item must be examined, the number noted and allocated to the correct bin – a more time-consuming process than the sorting of glass. Another example related to contamination also impacts the labour content of recycling. In mixed collection, one of the problems relating to recycling is the contamination of potential recyclates with wet waste or organic waste found in mixed collection. Wet waste is not a problem when it makes contact with glass as glass in impervious; however, wet waste when it comes into contact with paper which could potentially be recycled, has a large impact on the use of that paper, as paper will absorb wet and organic waste, rendering it useless for recycling. Despite an understanding of these issues, the table below indicates the job content of different materials as collected by five separate agencies in the UK. Again it becomes clear that the data differs substantially, suggesting that "the job content of recycling different materials is poorly characterised at present" (EU, 2001:A3-14). Even for materials where recycling is well established, for example ferrous metals where data is available through the SIC/NACE official collection system, there appears to be little consensus about levels of jobs.

Table 5 – Job content for recycling of specific materials from different sources (tonnes per job per annum)

Material	ACR 1999	NRF 1998	OLSR 1999	LPWAP 1997	COM (463) 1998
Paper/card	500	530	296	486	228
Plastics	583	149	26	214	35
Aluminium	44	933			28
Ferrous metals	700	2,102	162	1,667	290
Glass	493	3,207	138	500	253
Textiles	210		83	100	39
Wood			317		
Asphalt/concrete			2,400		
Vehicle batteries			24		
Rubber			69		
Composting			3,000		

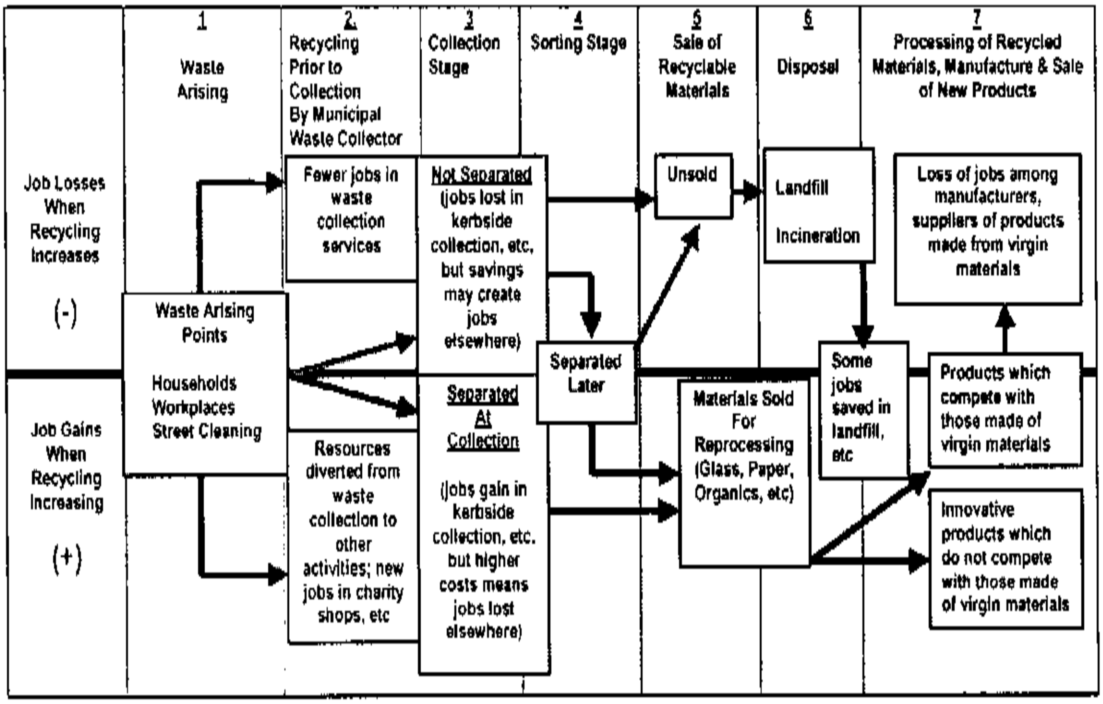
Source: EU, 2001:A3-14

Given that most forecasting and policy studies estimate the potential of job creation through recycling by calculating changes in waste stream tonnage arisings and collection and then multiplying this figure by the appropriate ratio of jobs per tonnes, it is no wonder that the benefits of increased recycling on employment are usually given in terms of an estimate, with a large spread between high-end and low-end estimates.

We conclude this section of the paper by considering one case study in detail, the case of London Remade. The reason for focusing on this particular case study is the appeal of its simple supply chain analysis, which shows at a theoretical and quantitative level how and where jobs can be created and lost as recycling is undertaken. The approach appears to be a pragmatic mix of the non-monetary assessment approaches and econometric, macro modelling, supply- and demand -side approaches reviewed by the EU study. Moreover, it presents the clearest flow of activities and their associated employment impacts, which are helpful in defining the scope of questions we will need to ask in the next section of this paper.

London Remade is a flagship programme within the Greater London Authority, which aims to increase the marketability of recyclates through expansion of existing forms of industrial activity which re-use materials, and through the promotion of new enterprises and technologies to recycle waste. The programme's interventions are intended to directly and indirectly create jobs. As such a core part of the programme's design in 2001 was the inclusion of the Local Economic Policy Unit of the London South Bank University to track and model the employment outcomes of the programme. In 2001 the University published its Stage 1 report, which illustrated the approach it would adopt. By 2004 the University published its Stage 2 report, which quantified progress to date. While we will examine the quantitative findings at the end of this section, our main interest relates to the Stage 1 model developed.

Figure 2 – Employment creation and loss flow chart



Source: London Remade, LEPU, 2004

The London Remade flow chart considers nine elements identified in the calculation of job impact, relating to the various stages of waste processing. We will consider each in turn.

1) **Jobs associated with waste minimisation or consumer re-use initiatives which take waste out of the waste stream.** In this first element the model considers the impact of activities which reduce the tonnage of waste which is collected by the local authority. Being a developed country, the options contemplated here include charity clothing collections, community furniture, white goods recycling initiatives and the like. They argue that if such initiatives were scaled up, jobs would be created in these community enterprises. These activities are not part of the South African culture, but the underlying behaviour and impact of that behaviour are synonymous with the local activity of itinerant waste collectors who are an established part of the South African waste process, i.e. individuals who pick through curbside waste prior to it being collected by the local authority and who either personally consume or use the waste collected for

personal use. This is an important aspect of the recycling picture in South Africa and will be considered in detail in the next section.

2) **Jobs associated with recycling of packaging before it reaches the municipal waste stream.** This second element refers to pre-collection recycling and includes either households who separate out their tin cans, glass and paper and deliver it to recycling centres such as bottle banks and paper banks, or once again, for the local context, itinerant waste pickers who remove recyclable materials from curbside waste containers and then deliver it to recycling centers as a means of earning an income. This is not a uniquely developing world activity. Even in the US where reverse vending machines for tin cans and bottles are placed in supermarkets, numerous homeless people collect cans and place them into the vending machines to earn an income. This is discussed in detail further on. The point being made in the London Remade study is that such activities increase employment, although this is often marginal employment in the informal sector.

3) **Jobs lost in local authority waste collection as a result of more activity under 1 and 2 above.** The model argues that if the local authority saves money due to waste being diverted in manner 1 or 2 above, hence decreasing the volume of waste the authority has to deal with, this saving can be translated into a positive impact on employment in a variety of ways. First, the savings may be applied to new activities such as separate collection of curbside waste; alternatively the savings could be diverted to create employment in a totally different portion of the local authority by being subsumed back into the general budget and reassigned. Finally the model argues that the savings could be passed on to consumers in the form of reduced services charges, in which case it assumes that households will spend this saving on other goods and services, thereby creating indirect employment benefits. Conversely, in element three, if local authorities invest in separate collection to assist recycling goals, this will typically increase the cost of collection, which suggests that in the absence of centrally supplied subsidies, this increased cost will need to be covered by the authority, most likely via cutting spending on other activities, thereby reducing employment.

4) **Jobs gained in local authority waste collection as a result of introducing separate collection of recyclables.**

5) **Jobs gained in material recycling facilities (MRFs) due to increased separation of waste.**

6) **Jobs gained in sale and transport of recyclables.**

These three elements relate to employment that can be created in companies and enterprises which buy waste from the local authority with the aim of adding value to the waste and selling it on at a profit. These activities include sorting waste into separate streams using either manual systems of more technologically developed material recycling facilities, activities which clean these separated waste streams, activities involved in baling or crushing these separated waste streams and activities related to transporting these separated waste stream to the ultimate reprocesser. The number of jobs created in the separating, cleaning and baling will depend on the level of technology developed and utilised. The number of jobs created in the transport activity will be dependant on the cost of transport when compared to value of the product being transported. The value of the material to be transported differs substantially per tonne. Mixed glass cullet, for example, has a very low value, hence it is not commercially viable to transport it great distances and so this type of waste stream will not generate a lot of jobs in the transport sector. High-value waste streams such as aluminium, however, have sufficient value to make it feasible to transport this recyclable waste hundreds of kilometres, which means this waste stream would create substantial jobs in the transport sector.

7) **Jobs are lost in landfill and incineration.** In all of the first six elements, jobs gained will need to be netted off against jobs that will be lost in landfill and incineration, which will occur due to decreased demand for these services.

8) **Increased recycling may create additional jobs.** The model here makes a distinction between job creation in firms that substitute recyclates for virgin materials and enterprises that find new uses for recyclates. The model argues that the job creation effects for increased recycling within firms that choose to substitute recyclates from traditional virgin materials is probably small, as the substitution is induced by price effects and will not necessarily increase output. This effect could, however, be fundamentally altered if demand for recycled products and inputs increased. The model argues, however, that there will definitely be substantial positive employment effects if enterprises developed new uses for recyclates. For example, if glass cullet is used as a construction aggregate instead of being reprocessed into glass bottles again, this endeavour will positively impact on job creation.

9) **Job gains in 8 will be offset by job losses in virgin material suppliers.** In this final element, the model takes into account the potential of job losses in virgin industries due to increased supply or alternative supply based on recycled materials. For example, if glass cullet is used as a construction aggregate, as suggested in 8 above, these new jobs will be created at the expense of jobs in the quarries which produce construction aggregate from virgin quarry material.

Table 6 – Results of London Remade project (Phase 1)

ITEM (refers to notes)	Method of calculation	Source of information	Assumptions	Jobs (per extra 1,000 tonnes recycled)
1. Recycling prior to collection …abandoned cars …furniture …white goods …computers/WEEE	Tottenham 'Create" as example	Mayor's Strategy p.147	1 trainee per 84 machines p.a.; each machine weighs 40kg Assume displacement of 33%	199.40
2. Pre-collection recycling of aluminium packaging	Based on ALUPRO case studies	ALUPRO brochure	Assume one job per 35 tonnes of aluminium	28.57
3. Jobs lost in LA waste collection because of 'pre-collection' recycling		EU report, p.18	One job per 1,000 tonnes collected and landfilled/incinerated	1.00
3a. Jobs gained in other LA functions when money is saved on waste collection	Cost per tonne of London's waste disposal = £75	Mayor's Strategy p.iii	One job in other LA functions per £30,000 saved	2.50
3b. Jobs lost in other LA functions if funds are diverted to additional spending on collection of recyclables	Additional cost of waste collection per tonne, leaving the household when there is separate collection of recyclables and these are sold, divided by cost per job in LAs	ECOTEC Report for Friends of the Earth ad Waste Watch	As for 3a and assuming waste collection and treatment costs as in Sheet 2, i.e. recycling costs £42/tonnemmore than non-recycling	1.40
4. Jobs gained in waste collection when kerbside recycling introduced	Camden model scheme as an example has 18 jobs per 40,000 households	John Enright Camden Council (Mayor's Strategy p.102)	This model scheme yields 2.393 tonnes, from the 43% of households which co-operate (Mayor's Strategy p.vi-vii and see Sheet 3)	7.52
5. Jobs gained in MRFs	Tonnes per employee	Waste Watch report	351 tonnes/employee p.a.	2.85
6. Jobs gained in sale and transport of recyclables	Admin and transport in Bluewater example	Waste Watch report p.14	27 people in transport/admin for 12,000 tonnes p.a.	2.25
7. Jobs lost in landfill and incineration as a result of waste recycled therefore not sent to landfill, etc.	Tonnes per job in landfill (78% of total) and tonnes per job in incineration (21% of tonnage) Assume 80% of landfill sites are out of London	EU report p.34	Mid-range figures of 1,156,5 tonnes/job for landfill and 4,055.5 in incineration	0.19
8. Jobs gained in reprocessing industries – assume 90% of those not assisted by London Remade are outside of London		Waste Watch report p.15	Composition of reprocessing activities by tonnage the same as on page cited Count only 10% in London	0.17
9. Jobs lost by displacement of production of virgin materials	Assume all are outside of London			0.00
Total jobs gained (net) from each extra 1,000 tonnes recycled from municipal waste stream	**Items 4-3b+5+6-7+8-9**			**11.20**
Total jobs gained (net) from each extra 1,000 tonnes of white good recycled prior to collection	**Items 1-3+3a**			**200.90**
Total jobs gained (net) from each extra 1,000 tonnes of aluminium recycled prior to collection	**Items 2-3+3a**			**30.07**

Source: LEPU, London South Bank University, 2004:12-14

The table illustrates some interesting findings. First, at an overall level, taking all effects into account, the model shows that a total of 11.2 net jobs were gained in

London per 1 000 tonnes of waste recycled. With 2004 household tonnage for the UK being 18-million tonnes, potentially net jobs in the order of 201 600 could be created if the model parameters applied across the country. The second interesting finding in the study is the figure of 200.9 jobs being created per tonne of white goods recycled prior to collection. This covers the collection of electronic equipment, computing equipment, fridges, washing machines, etc. While this estimate must be viewed with caution given that is based on only one project, it does suggest that electronic and white good recycling has very high potential job-creating opportunities, which far exceed options related to traditional materials recycling such as paper, glass and plastic. We will consider this in the South African context in detail in the next section. The final cumulative figure in the table is that of 30 net jobs created for each additional 1 000 tonnes of aluminium collected and recycled. Aluminium is often the one general recyclable waste stream that is measured in detail versus paper or glass, for example, due to the high level of industry support for this type of recycling because of the high value of the raw material. The job yield for this material is likely to be higher than for less valuable recyclates.

3.3 Summary of case studies and literature review

The above section will undoubtedly leave the reader highly confused. This confusion is not a function of the presentation of the paper, but a hard to accept reality that environmental economics is an extraordinarily complex subject about which very little is known at an economic level at present. While the general subject matter is not well understood, the particular area of environmental policy and recycling effects on job creation is even less well understood. This is due to the scarcity of data, the inherent complexity of an activity which has substantial forward and backward linkages and the fact that even homogenous activities such as recycling are fundamentally heterogeneous when considered at the level of commercial viability.

When these inherent difficulties are placed in context and read in conjunction with government's policy goals, aims and aspirations and the financial cost and institutional re-engineering which would be required to make them a reality, the magnitude of complexity increases exponentially. So what can we say we have learnt so far:

- Resource depletion and the negative environmental impacts of the old waste system suggest that at some time in the future, economies will need to re-orientate themselves away from virgin production, consumption and disposal towards a more closed-loop industrial process where recycled material are substituted for virgin materials.
- A recycling, re-use revolution will occur but market availability and prices of virgin resources do not as yet make recycling and re-use a commercial necessity. Rather, recycling and re-use are at present ad hoc activities in the current industrial process. To change this course of events prematurely (from a market perspective) will require government intervention.
- Government intervention in this area to date ranges from substantial commitment to very low levels of commitment. Governments such as Japan

and China are firmly committed to moving towards a closed-loop production paradigm. Other developed countries have not committed to a closed-loop paradigm but are committed to waste minimisation, environmental protection and increased recycling and re-use. These latter schemes are sometimes supported for strategic reasons so as to gain first-mover advantage and sometimes for environmental reasons where costs to the government of dealing with disposal are high and methods are sought to pass these costs back to producers and consumers. Finally some developing countries have no formal environmental agenda but undertake recycling and re-use as commercial exercises based on necessity.

- With respect to the job creation potential of recycling and re-use, we see that quantifying this impact is a complex issue which is hampered by a lack of data. The balance of probabilities suggest that, even accounting for jobs lost in waste collection and virgin material production, the net employment effect of increased recycling is positive. The only instances where increased environmental policy changes have negative effects on overall employment seem to occur in industries where increased compliance costs decrease profitability so that output and labour demand decrease. These examples tend to relate to pollution control measures rather than recycling measures.
- While the data is murky concerning where within recycling and re-use job creation occurs, two points emerge with some clarity. First there is substantial employment potential related to the collection and sorting of waste. Second, recycling processing itself will only create jobs of a substantial magnitude if new markets and new products are developed for recyclables. Increasing employment based purely on substituting recyclable inputs for virgin inputs is unlikely to be successful in the short run, although this may change as relative input prices change.
- Within recycling and re-use, activities related to white goods, electronic and computer goods, composting and high-value waste streams such as aluminium and precious and ferrous metals appear to have the highest potential to create mass employment.
- Finally, while the recycling and re-use debate is often viewed in terms of demand, the supply side of the industry has substantial challenges, including the pricing of inputs, the supply of inputs and a lack of market competition and mature markets.

From a long-term strategic perspective, as well as from a short-term job-creation perspective, it appears that the above review supports a position that it is worthwhile further investigating the potential of recycling and re-use in South Africa. Our focus in the next section will be to try to tease out the employment potential of recycling and re-use in South Africa and to test whether the magnitude of the potential of the sector is substantial enough that it should become a priority area of focus for government officials aiming to halve unemployment by 2014. While the insights and findings of the international literature review and case studies will inform our analysis, we will also need to introduce the realities of recycling and re-use for a developing country. As will be shown, recycling and re-use in the developing world differ substantially from their equivalent activities in the developed world. Three key differences emerge – the large role played by the informal sector in waste collection, the reality that many developing countries (and specifically South Africa) are resource-based economies where raw materials are generally abundant and cheap, and finally that recycling and re-use in the developing world are driven more by necessity than by environmental conscience.

4. Recycling and re-use in South Africa at present

4.1 Policy and context

In South Africa the debate regarding sustainable development, environmental policy and the impacts of environmental activities such as recycling and re-use is nascent[5]. Debates such as shifting from linear production paradigms to closed-loop economic processes do not as yet appear on the radar screen. Emissions and global warming debates, the need for alternative energy resources, resource depletion and intensive recycling debates similarly do not appear on the national policy agenda as they do in developed countries. This is not unique among the world's poorer nations where problems such as basic sanitation, education, housing and unemployment tend to dominate policy agendas. In these terms, environmental policy issues appear to fall into the non-priority agenda basket and are viewed as discretionary or luxury policy issues. Few developing nations have adopted national environmental policies such as those found in developed nations; however, numerous developing nation governments do exhibit some interest in these activities in so far as they relate to local job-creation schemes. While local, endogenous forces may be weak, a rising exogenous force is gaining momentum. The globalisation of environmental policy and activity is already emerging and soon developing countries will be required to take these issues to heart, simply due to the trade relations they have with their developed counterparts. For example, academics and policy-makers are already starting to note the increased trade flows of recyclable materials from developed countries to developing countries, steps are being taken to codify waste to stop developed countries dumping hazardous waste in developing countries where environmental controls are weaker, and many national governments are considering introducing environmentally friendly production processes as part of the requirements for the future international standard which will update the ISO 14 000 standard. Increasing policy changes like these, as well as international consumer demand increases for eco-labelling and environmentally friendly goods will force developing nations to improve their compliance with environmentally friendly practices if they wish to continue exporting products and services to countries with highly developed environmental approaches. As such the environmental agenda and debate may be thrust upon the developing world as a result of trade links with more developed nations, forcing countries like South Africa to re-evaluate their policy stance and the role of government.

[5] This is true as a general statement but obscures three areas in which debate and institutional capacity and technology are well developed and indeed world class – these are the areas of water treatment, mining rehabilitation and conservation and nature conservation.

As with many areas of South African policy-making and institutional delivery, a discernable chasm exists between the development of world-class policy and strategy and incomplete, piece-meal and ad hoc implementation and delivery. We begin by looking at South Africa's current policy and strategy.

The White Paper on Integrated Pollution and Waste Management (IP&WP, 2000) is the starting point for this analysis and it is interesting in three respects. First it takes cognisance of external forces which will impact local producers and exporters. Secondly, the White paper takes on board at a general level the paradigm shift which underlies the adoption of Agenda 21 to which South Africa was a signatory at the Rio summit. Finally the White Paper notes the economic potential of the recycling and re-use sector, especially in terms of opportunities to increase employment and to create SMMEs; however, this portion is particularly weak and stops well short of a meaningful view of intensive recycling and the ideas of eco-modernisation. The Paper sets its context by arguing that South Africa's reintegration into the global economy and the international and southern African political arena necessitate an improved pollution and waste management system. It also notes that the country's economic and industrial policy has turned towards export promotion as a pillar of future economic development. On the basis of these two identified changes, the IP&WP argues that South Africa therefore has growing obligations to meet international commitments and to be a globally responsible country. To achieve this the White Paper commits the government to ensuring that:

- "South Africa meets all its international environmental obligations as rapidly as possible
- Exporters are assisted in meeting internationally expected standards of environmental management
- International pollution control efforts are not used as unfair trade barriers against South Africa's exports and
- South Africa's pollution and waste management interests are adequately represented in international forums" (IP&WP, 2000:13)

At a more specific level the IP&WP embraces what has been termed a "paradigm shift" by moving away from end-of-pipe solutions which are focused on waste disposal to a new hierarchy of waste which focuses on waste minimisation and recycling and re-use. This so-called paradigm shift should not be viewed as a substantive shift such as those contemplated in the first section of this Paper but is rather an adoption of "better waste practices", which brings South Africa's policy in this area up to those standards already employed in the developed world. Historically, pollution and waste management in South Africa focused primarily on impact management and remediation. By embracing sustainable development goals, the White Paper shifted "away from impact and remediation policy towards waste and pollution avoidance, prevention and minimisation instead. As such emphasis shifted from 'end-of-pipe' solutions to policies focused on the sources of waste and how to manage waste from cradle to grave" (DEAT, 2001:3). The IP&WP thus suggests that at a strategy and policy level, the South African government has moved away from the old antiquated waste order which focused on disposal and is embracing, at a notional level at least, the more current thinking which has been adopted in Europe and the US for the past 20 years, which is to minimise the need for disposal. The IP&WP is about catching up with the rest of the world and managing the negative fall-out from the differing levels of environmental consciousness, which are beginning to find expression in the markets between South Africa and its more developed trading partners. The White Paper, while a step in the right direction, is certainly not a wholehearted embrace of the forthcoming environmental revolution, nor is it an enthusiastic champion of the environmental industry as a new growth engine for the economy.

While it is perhaps disappointing that the White Paper is more of a catch-up, get-in-line type policy rather than an excited crusader of a potential brave new world, it must nevertheless be viewed as a step in the right direction and an important foundation upon which a more sophisticated and economic argument can be developed. Since the passing of the White Paper, however, progress has been severely hampered by an unwieldy process of transforming the strategy and vision into policies, projects, regulations and programmes. Indeed, the process appears to have failed to use the White Paper as a foundation for deepening the debate and improving our understanding of the economics of recycling and re-use and has instead fallen into the trap, mentioned in Murray (1998), of "doing more of the same only better".

The responsibility of converting the vision and goals of the White Paper into changes on the ground was placed in the hands of a newly established National Waste Management Strategy (NWMS), which is a process rather than an institution or a document. The NWMS is overseen by the Department of Environmental Affairs and Tourism (DEAT) and is difficult as an outsider to come to terms with. It appears to have intrinsic complexities and difficulties which arose during the design phase and which now hamper it playing a stronger role in providing insight, guidance and clear signals to the market regarding recycling and re-use.

The first problem of the NWMS is that it is under-resourced given the scope of its activities. The strategy is responsible for hazardous waste, general waste, medical waste, refuse collection, recycling and work related to specific industries' waste streams. Not only is this a large array of fundamentally different activities for any initiative to oversee, but the human and financial resources necessary to deal with these functions also appear to be limited. This is not a unique predicament and many commentators note that one of the reasons developed nations have more sophisticated environmental approaches is that they have better funds and better human resources to apply to their key national environmental institutions. The second constraining factor facing the NWMS is its chosen modus operandi. The strategy is conducted on a consultative basis with all stakeholders represented at every level of decision-making. Not only is this a cumbersome approach which leads to continual reviews and re-issuing of positions, but it is hamstrung by the strongly self-serving agendas of the major players. This is characterised in two key ways. First there exists enormous monopoly power within the re-use and recycling industry in South Africa at present. Secondly, industrial generators of waste, such as the glass companies, tin manufacturers, paper manufacturers and packaging companies are not only highly concentrated but they operate on the basis of 'enlightened self-interest', whereby they participate in processes such as the NWMS so as to ensure that they show support for such measures but minimise the negative impacts on their operations and profitability. The third difficulty facing the NWMS is that MOUs between industry and DEAT related to recycling, environmental parameters and waste options for specific sectors and companies are negotiated through DEAT-industry negotiations and not through the NWMS process. The final constraint is once again the lack of data, which makes the development of more detailed policy, legislative and programme development difficult. The NWMS is aware of this lack of data and yet, while is states in its 1999 and 2001 draft documentation that this will be addressed and economic data collected, it has not yet occurred, even in the narrowly defined area of recycling.

Over and above the intrinsic difficulties and complexities related to the NWMS and its functioning, the most disturbing feature of the process as it relates to recycling is its approach and attitude towards recycling and re-use. While the introductory portions of the Starter Document on Recycling (DEAT, 2000) make all the right noises about the benefits of recycling, which include "job creation, reduction in the waste stream itself, conservation of natural resources and potential reduced costs to manufacturing" (DEAT, 2000:ii), none of these arguments are developed even at a qualitative level or a level of theoretical debate. Instead the document perpetuates ad hoc recycling rather than considering intensive recycling. It further considers the success and failures of individual recycling projects in South Africa and abroad on a piece-meal basis instead of drawing out arguments regarding the fundamental economic commercial viability arguments and causal chain elements which affect these processes. It also totally ignores arguments of increased resource productivity and the potential to increase the competitiveness of industries by reducing input costs, and finally very obviously fails to recognise recycling and re-use as a potential industrial sector which could be poised for growth. As such, irrespective of what opportunities may exist for recycling based on the strategy set out in the IP&WP, the development of these opportunities into policies and programmes on the ground has not been harnessed. Based on the most recent NWMS documentation, it appears that a mindset change has not occurred at the level of officials and that thinking about the potential of recycling and re-use as a growth sector has not been assimilated. Until the official institutions and departments of state change their view from recycling as an ad hoc activity to one where recycling and re-use are seen as fundamental contributors to the industrial fabric of the local production process, the possibility of these activities contributing their full potential to the economy in terms of employment and growth remains constrained.

The remainder of this document is geared towards understanding how waste is collected, sorted, recycled and re-used in South Africa, and to suggest where additional job creation opportunities may lie within these activities. As mentioned in the introduction, limited data and certain concerns regarding data received from industry mean that much of the analysis will be qualitative and is focused on raising the correct questions, which, if answered in future research initiatives, will arm analysts and policy-makers alike with a deeper understanding of the opportunities of these activities and the required interventions necessary to convert opportunities into real, quantifiable jobs and growth.

We begin our analysis by considering the recycling and re-use of post-consumer and post-producer waste. This category is often termed external recycling, as it excludes the recycling and re-use of waste generated in the production process by companies. This latter form of recycling and re-use is termed internal recycling, which we will consider briefly in the next section under the heading of 'Industrial recycling and re-use'. To make this distinction clear, consider the example of a white good such as a washing machine. The packaging of the washing machine, which must be discarded once the machine is installed, and the discarding of the washing machine itself once it no longer works, would fall into the category of external recycling or post-producer, post-consumer recycling. Metal and plastic off-cuts, shavings and other waste generated on the assembly line during the actual production of the washing machine would fall into the category of internal recycling or industrial recycling. A second clarification is that this paper will only consider non-hazardous post-consumer and post-producer waste. This is because the recyclability of hazardous materials is generally low, as well as the fact that the policies, legislation and economics of hazardous waste are fundamentally different from those attached to non-hazardous or general waste.

Figure 3 – Waste categorisation in South Africa

Source	Domestic	Commercial	Industrial
General:			
Paper	General Domestic Waste	General Commercial Waste	General Industrial Waste
Metals			
Glass			
Plastic			
Organic			
Inerts and Builders Rubble			
Hazardous:			
Class 1 Explosives	Hazardous Domestic Waste	Hazardous Commercial Waste	Hazardous Industrial Waste
Class 2 Gases			
Class 3 Flammable liquids			
Class 4 Flammable solids/substances			
Class 5 Oxidising substances			
Class 6 Poisonous & Infectious Substances			
Class 7 Radioactive Substances			
Class 8 Corrosive Substances			
Class 9 Miscellaneous Substances			

Source: NWMS 1999:10

4.2 Collection, sorting and transportation

We begin by considering the collection, sorting and transportation of general post-consumer and post-producer waste. This waste includes paper, plastics, packaging materials, glass, metals, organic waste and inert waste. We have also included a seventh category of waste not included in the NWMS, but which international literature has highlighted as a crucially important waste stream and on which DEAT is currently undertaking research, namely e-waste which includes "old, end of life electronic appliances, including information technology equipment, office machines, telecommunications equipment, consumer electronics, household equipment and accessories" (EMPA, 2005:1).

The international literature and case studies reviewed in section three of this paper show strongly that a large percentage of job gains due to increased recycling occur at the collection and sorting stage of the recycling supply chain. Over and above the job creation potential of these activities, the quality and efficiency of such collection, sorting and transportation, are also shown to have a substantial impact on the commercial feasibility of the final recycling undertaken by reprocessers. The majority of the literature reviewed showed that separation at source – that is, separate collection of different waste streams, which is then sent to some form of materials recovery facility – is the preferred option to support intensive recycling. The literature also notes, however, that despite this being a declining cost industry, the set-up costs and short-term running costs of such a set of activities (prior to economies of scale being reached) are high. Importantly, these costs are initially substantially higher at present than the cost of mixed collection. As such the major issue facing international countries hoping to shift towards more intensive recycling and re-use is how to finance this shift towards collection, which is more consistent with intensive recycling.

In the developing world, however, the problem is exponentially more complex. The first area of complexity relates to the reality that in poorer nations, refuse removal services are not generally available to all communities. As such, implementing higher cost options of separate curbside collections to affluent communities when rural, peri-urban and informal settlements have limited or no services available, becomes a difficult social and economic policy to defend. The second highly contentious and complex issue relates to the role played by the informal sector in waste collection and sorting. The complexity of this issue and the importance of the role of informal waste collectors and sorters in developing countries can be seen in the shift in local economic service delivery policy advocated by the World Bank regarding waste management. In the 1980s the World Bank provided assistance to several developing countries and officially supported a policy of formalising and adopting Westernised refuse systems in these countries. Today the World Bank view officially supports the formal incorporation of informal waste collectors into any waste management policy devised by developing countries.

The shift in thinking about the appropriate form of waste collection in developing countries was catalysed by a body of research based on the role of the informal sector in waste management in Asia, specifically in India, Malaysia and Indonesia. Furedy (1989) found that in most Asian cities, informal activity was responsible for more waste recovery and recycling than formally sanctioned and organised recovery and recycling activities. These activities were of such a scale that they were found to fundamentally alter the amount of waste that needed to be disposed of by authorities in landfills. In Indonesia, the decrease due to informal waste-picker activities amounted to 33% of all waste disposed, and in India a figure of 37% was noted for Calcutta. The scale of this activity meant that informal activity was in fact a crucial part of the waste management system.

Given the volume impact of these activities, studies began to focus on understanding this informal activity more clearly. In characterising these activities, Furedy (1989) found three groupings of activities – dump pickers who salvage off municipal dumps once waste has been collected, itinerant collectors who retrieve waste directly from households, institutions and offices by rummaging through their waste on-site before it is collected, and a range of waste middlemen and traders who purchase recovered materials from dump pickers and itinerant collectors and on-sell this waste to reprocessers. This work was followed up by the World Bank (2000), which found that although these activities appear to be highly informal, they are in fact usually highly organised, although often by 'shady' characters operating in mafia-type organisations. The scope of these activities is enormous. In Calcutta it was surveyed that 40 000 people made their living from picking waste, in Manilla the figure stands at 60 000, and in China's Guangdong province 100 000 people find employment dismantling electronic equipment in specialised municipal dumps (Furedy, 1989:3). These two studies led the UN Centre for Regional Development to argue that because informal waste recovery and recycling is such a large activity in developing countries, its existence and operation should be formally facilitated by these countries and that ideas to remove informal waste activities from overall waste management strategies were not seen as either an optimal or a desirable goal.

This approach was internationally highlighted in India in 1989 when officials sought to upgrade municipal waste collection in Calcutta and to minimise informal activities, resulting in mass public demonstrations and eventually a series of high-profile court cases. Essentially it was argued that the "poor have a social right to use urban waste" and that removing such rights "would cause irretrievable hardship to the poor by depriving them of their livelihood" (Furedy 1989:13). The Calcutta municipal authority eventually backed down and agreed to maintain the system that was operating.

While this approach of respecting the role of the informal sector in waste management in poorer countries is accepted at a notional level, no one appears to have solved the issue of how such a role is to be accommodated on the ground. A host of case studies have been collected, but no generalised solution has appeared to date. For example, in Manilla, authorities attempted to register pickers and established a selling channel for pickers to sell recovered materials to a single reprocesser. The system failed as it created competition between registered and unregistered pickers. In Thailand, the government sought to develop self-help programmes by purchasing land adjacent to waste dumps and assisting registered waste pickers to form co-operatives and recycle and add value to recovered materials on site. The Thai pilot programmes were successful but a broader roll-out failed due to a lack of local authority support. Public support for the programme was also limited as it created an insider-outsider dynamic.

Informal activity is very important in South Africa, and itinerant pickers going through curbside collection bins on the streets of affluent areas is a common sight. Waste pickers on municipal dumps are also commonplace, although several local authorities are seeking to limit access to these dumps, citing safety and health hazard concerns. The number of people earning a living from informal waste activity is hard to estimate; however, one initiative provides an indication of the organisation and magnitude of informal activity in this area in South Africa. Collect-a-Can was launched in 1993 and immediately achieved a 25% recovery rate of the three billion beer and soft drink cans produced annually in the local market. 98% of this recovery was achieved by informal collection, with only 2% being achieved by school schemes and recycling banks where households could drop off cans without receiving payment for these cans. By 1995, word had spread and the recovery rate rose to 50%, reaching an astronomical 68% by 2006. This rate, achieved predominantly by informal collection, has led South Africa to be able to boast higher recovery rates of tin plate and aluminium from beverage cans than the US (49%), France (30%) and Norway (66%). It is estimated by the National Packaging Forum and Collect-a-Can that upwards of 36 000 individuals in South Africa earn a living from this programme alone. Average income ranges from R300 to R500 a month for itinerant collectors and upwards of R12 000 a month for middlemen who purchase cans, crush them and deliver them to Collect-a-Can. Collect-a-Can runs a graduated fixed-pricing system where monies paid reflect the amount of value add. Those who collect cans but cannot transport them to Collect-a-Can are paid the lowest amount per kilo of recovered material and usually sell to middle men who also operate informally but in a highly organised fashion. Those who collect and deliver to a Collect-a-Can branch are paid a higher price. Those who collect cans and then compact or bale them receive the highest prices. The success of the project is related almost entirely to the constant pricing offered by Collect-a-Can to suppliers of recovered cans. In most recovery industries, the price paid for recovered materials changes according to supply and demand. Collect-a-Can, by fixing a price, has created certainty amongst informal collectors and has thus achieved higher recovery rates than other similar projects where price has varied according to market conditions.

Equivalent figures for programmes such as those run by the paper companies and scrap metal companies are harder to pin down as their variable pricing strategies have resulted in large swings in recovery rates and informal activity levels. For example, 10 years ago, waste paper recovery was a viable informal activity, but with supply of waste paper outstripping demand, the value of waste paper paid to itinerant collectors has decreased below the point where such recovery occurs on a meaningful scale.

Interviews with industry players suggest that between 90 000 and 115 000 informal waste participants earn an income via the recovery and resale of recyclables. If these figures are correct, this would make the informal waste sector's employment levels higher than those of the formal textile industry.

The picture which emerges from considering developed and developing countries and the recovery rate of potential recyclates is that greater recovery appears to occur in developing countries than in developed countries, simply because recycling is a means of earning an income in developing countries and is hence 'market driven', albeit by the informal market. Countries such as South Africa, Brazil and India appear to have higher recycling rates than their developed counterparts because of this market behaviour. However, this only occurs for materials which have a high unit price. Recovery rates for lower value recyclates such as glass, paper and plastics are not traditionally high in developing countries because they cannot yield a sufficiently high income to make their collection worthwhile for itinerant collectors and informal middlemen. In these categories of recyclates, higher recovery rates are observed in developed countries where regulation and economic instruments ensure high levels of recovery. This point is made clear in the two tables below.

Table 7 – Percentage of materials recovered: various countries (%)

	Plastic	Paper	Glass	Aluminium cans
South Africa	29	52	17	68
Brazil	15	46	47	95.7
US	22	48	n/a	49
Germany	60	68	75	n/a
Norway	30	n/a	84	60

Source: SA National Packaging Forum, Cempre (Brazil), Eurostat Database

Table 8 – Average price paid for recycled materials per kilogram in South Africa

Material	Price per kilo in Rands
Mixed paper	0.50
Newspaper	0.13
White office paper	1.10
Coloured office paper	0.60
Cardboard	0.40
Magazines	0.30
Mixed plastics	0.60
Clear plastics	0.65
Copper	8.00
Aluminium	5.00
Radiators	3.50
Steel	2.50

Source: Jarrad ball & Associates, 2001

From this we can summarise that substantial recovery does occur in South Africa. A very large percentage of this recovery occurs via informal sector collection, possibly employing in the region of 100 000 people. Further, we know that informal activity is driven by itinerant pickers and other informal workers recovering material so as to earn an income. As such it is unsurprising that recovery rates for different materials are driven by the price informal collectors can sell their recovered materials for and the consistency of these prices. Formal sector waste recovery is at present not offered by local authorities in terms of curbside collection at source; however, waste-specific municipal dumps do exist which separate out organic waste, building rubble, inert waste and general mixed waste. In December 2006, the Johannesburg City Council opened the country's first seven e-waste dumpsites.

In terms of sorting and transport of waste in either the formal or informal sector, very little information exists because of the highly dispersed nature of the activities. While some information could possibly be amalgamated using local authority contracts issued to transport service providers and working backwards from the reprocessers and middlemen to identify who delivers materials to their collection centres, no such study has been completed to date and insufficient secondary material exists to estimate the size of this activity or its employment. As such, we are unable to analyse these activities and their employment potential in South Africa. However, we would be remiss if we do not at least cover some ideas related to MRFs.

MRFs are commonly found in most developed nations, and several entrepreneurs are attempting to introduce this system in South Africa. Sorting of waste occurs at different levels. As mentioned earlier, it is possible to separate glass from other waste – this is characteristic of level 1 sorting. Level 2 sorting would include separating out different types of glass from each other. Level 1 sorting occurs where separate collection occurs; however, in many European nations this separate waste is then transported to off-site facilities where level 2 sorting occurs so that higher value is added to the waste from the perspective of the reprocessers. In other nations where separate collection does not occur, off-site sorting at level 1 and 2 occurs. A MRF is an off-site facility that can undertake either level 1 or level 2 sorting or both. MRFs are usually strategically positioned, either close to landfill sites or in some cases close to reprocessers (usually this only occurs where separate collection has been undertaken and the MRF is undertaking level 2 sorting.) The MRF is essentially a long conveyer belt along which waste passes and trained workers pick off certain wastes and transfer them into separate collection bins.

Many variables determine the efficiency and effectiveness of MRFs and their employment intensity. The UK's Waste Watch recently published a paper identifying different levels of technology employable in MRFs.

Table 9 – MRFs: quantities and employment

MRF type	Annual tonnes process	No. of full-time equivalent employees (No. of sorters)	Tonnes/year/ employee	No. of transport employees
High tech	60,000+	22 (9)	2,700+	71
High tech	60,000	20 (8)	3,000	79
Low tech	9,550	11 (6)	870	13
High tech	41,000	30 (20)	1,370	18
Low tech	12,500-15,000	50 (30)	250-350	22

Source: Waste Watch (1999:13-14). Transport figures from case studies identified in Waste Watch report.

The MRF, which is currently being shopped around South African local authorities, would, according to the entrepreneur responsible, cost R6-million to set up. It would process 75 000 tonnes per annum, employing 40 sorters directly per shift and it would run on a three-shift basis. However, the catch is that the MRF only accepts dry waste, which means that local authorities would need to have separate collection at source. While these particular numbers do not stack up, the idea of increasing the use of MRFs should not be underestimated. First, given that South Africa produces about 15-million tones of domestic and commercial refuse of which nine million tones is dry waste, a low-tech MRF roll-out programme using the most labour-intensive technology could possibly create 30 000 direct sorting jobs (based on an average tonnage per employee of 300 tonnes) as well as countless transport jobs. Possible co-ops of MRF sorters, who add value to the sorted materials by making craft products or other household products from this sorted waste could also be considered, as has been done in Egypt and Thailand, thus increasing the job-creation potential of sorting further. The final advantage of the MRF system is that the quality of recyclates increases, resulting in reprocessers being prepared to pay a higher price. The economics of MRFs and the social implications in South Africa with respect to the impact of MRFs on itinerant pickers make the assessment of this option highly complex. It does, however, appear sufficiently interesting as to warrant further research.

As we have mentioned, a lack of data and the questionability of data related to employment in waste collection, sorting and transport make any summary of the data and any analysis of future growth potential a highly speculative and possibly useless exercise. However, in the spirit of developing some view, we summarise the employment data and potential job creation of waste collection, sorting and transport determined so far.

Table 10 – Summary data

Data	Jobs
▪ SIC 9400 (formal sector waste collection-mixed)	7,000
▪ Industry estimate (formal sector waste collection-mixed)	25,000
▪ Industry estimate (informal sector collection and sorting)	95,000-115,000
Variations/potential	
▪ Shift from mixed collection to basic separate collection (wet/dry)	
(using LEPU estimates – 1.6 times labour requirement)	11,200 (7,000 x 1.6) 40,000 (25,000 x 1.6)
▪ Institute MRFs	
(300 tonnes per employee; assume 25% waste to MRD)	7,500
(300 tonnes per employee; assume 50% waste to MRD)	15,000
(300 tonnes per employee; assume 25% waste to MRD)	30,000
▪ Institute MRFs with value-adding co-ops	As above 10% - 20%
Net job impact	
Separate collection and MRF job creation would negatively impact employment in informal sector	
Increased transport employment impossible to estimate	

What appears from Table 10 is that potential obviously exists in the collection, sorting and transport of waste. The net effects on employment are not immediately obvious, given the impact that these changes may have on the informal market. However, when we revisit these statistics after looking at the employment creation of actual recycling and reprocessing, it may appear that if employment increases in the value-adding activities of recycling and re-use are substantial enough due to improved sorting and collection, then the net effect may be positive overall. One last point to make is that we have not included in Table 10 the fact that increased employment will occur even in the absence of the variations and options suggested above, purely due to the increase in waste which will be generated by the economy. After eight years of unprecedented economic growth and the growth of a substantial middle class, waste arisings in South Africa's urban areas are expected to grow at least 10% per capita per annum (Gauteng Waste Management, 2006). This growth will increase demand for current waste services, provide a potentially growing source of potentially recoverable materials and hence increase the scope for recycling and re-use.

5. Recycling

We now turn our attention to the job-creation potential of recycling. So far in this paper we have not made much distinction between different types of recycling. In this section we begin with an introduction into the different categories of recycling of general domestic waste and then move onto a more detailed description of these activities and their growth levers and employment creation potential. The sections are thin due to scant information, limited data and little existence of secondary research bar anecdotal and descriptive publications found in annual reports and on websites. The literature and personal interviews suggest that key companies in these fields have undertaken substantive research and analysis of recycling in their industry but none of the companies interviewed are at this time comfortable with releasing these reports. This lack of transparency is not unexpected, given the uncertainty these companies face with respect to national policy-making and the legislative changes which are anticipated. These research documents are strategic documents from the corporate perspective and will be used as a basis for negotiation with DEAT regarding the parameters of potential MOUs with the state. Despite the lack of information and data available, it is sincerely hoped that this section will be expanded upon in the follow-up study mentioned in this paper's introduction. At this point, the section aims to provide an overview of current activities, a view on the commercial dynamics and demand drivers of these activities, and some view on the potential employment prospects which could arise if these activities were geared up. We begin our introduction to this terminology section by explaining the waste hierarchy as it appears in the NWMS (1999).

Figure 4 – South African waste hierarchy

Waste Hierarchy		
Cleaner Production	Prevention	
	Minimisation	
Recycling	Re-Use	
	Recovery	
	Composting	
Treatment	Physical	
	Chemical	
	Destruction	
Disposal	Landfill	

Source: NWMS version D (1999)

This waste hierarchy depicts the government's dual approach to waste management. First, via cleaner production it seeks to prevent and minimise waste production *at source* by influencing activities undertaken by *the generators of waste*. As such, waste minimisation is defined as "any activity to prevent or reduce the volume and/or environmental impact of waste that is generated, treated, stored or disposed of" (NWMS, 1999, Appendix A). This activity is obviously undertaken by industrial and commercial enterprises rather than consumers and is often referred to as internal recycling. Several examples of these activities will assist in understanding these concepts. First, South African packaging firms have over time implemented campaigns to light-weight or thin wall containers, reducing the amount of raw materials used in the production of a container. For example in 1955, 73 grams of raw materials were used to produce a soft drink can. This has been reduced to 16 grams in 2002. Similarly, PET bottles (plastic cool drink bottles) have decreased from 66 grams of plastic in 1979 to 47 grams in 2003 (Packaging Council of South Africa, personal interview)[6]. In Japan, waste prevention and minimisation have developed to a higher level due to the government's adoption of a cyclical economy model. In the vehicle manufacturer sector, Toyota is leading the way. It has reduced the kilograms of waste per vehicle produced on the assembly line from 15 to two in the last 10 years. In addition, they have changed the materials used in the construction of their vehicles so that 85% of a motor vehicle is now recyclable as opposed to 62% 10 years ago. Cars have also been specifically designed to assist the disassembly process (Murray, 1999). Overall, South Africa lags behind its international, developed world counterparts in waste minimisation activities and it appears by reviewing the literature produced by government that at present these activities are not accorded a high priority, even though they are desirable.

The second tier in the hierarchy is recycling which is aimed at the external recovery, re-use and/or reprocessing of *post-consumer* and *post-production* wastes. External recycling is focused on recovering and reusing that waste which emerges after all waste minimisation opportunities have been exhausted and is waste that arises either from a production process or after consumption. Post-consumer waste would include not only the obvious waste related to discarded packaging items but also to the goods themselves once they have reached the end of their useful life for the consumer, i.e. a laptop computer, a fridge or a motor vehicle. Formally the NWMS defines recycling as "any activity where materials are re-used or reprocessed outside the operation where the materials are originally produced; the recycled material may or may not return to the company of origin" (NWMS, 1999, Appendix A). This is a broad

[6] There are in fact three reasons for this shift, only one of which supports the argument made by DEAT. The first reason for light-weighting is obviously cost reduction. This is an activity which firms would undertake without any legislative or regulatory compulsion. Secondly, light-weighting has occurred because technological advances allow lighter weight manufacture without decreasing container integrity, a process which was not previously available to manufacturers. The third reason why lightweighting occurs is to support governmental campaigns regarding the waste hierarchy. However, personal interviews suggest that these activities are undertaken grudgingly as preventative measures by firms to protect themselves against government-imposed legislation rather than because of any meaningful buy-in to the environmental agenda.

definition of recycling and includes not only the traditional view of recycling where discarded material is cleaned, reduced and re-processed into an equivalent material, such as glass cullet being recycled into glass bottles or paper pulp being reprocessed into paper, but also all re-use activities and composting. The terminology related to all three of these activities appears to be quite country-specific and very little standardisation occurs. South Africa has not specified terminology in relation to these concepts, hence the definitions explained below and used in the remainder of the document are those which local industry players use and understand. Because of the catch-all nature of the term 'recycling', it is not a term which we will use, except when discussing the entire range of recycling activities; rather, we will use the terminology re-processing, re-use and composting.

Reprocessing is what is commonly understood by the layman as recycling. Reprocessing for our purposes will refer specifically to the reprocessing of a virgin raw material which after production or consumption finds its way into the waste stream and is then processed to produce a secondary material of an essentially similar characteristic as the virgin material. Reprocessing of this nature varies enormously between materials, both from an economic perspective and from technical perspectives. The reprocessability of material relates to the quality of the final reprocessed material compared to the quality of that material as a virgin material. Reprocessed copper for example contains exactly the same qualities as virgin copper, hence it is highly reprocessable and virgin and secondary materials are indistinguishable in terms of quality, purity and use. Paper pulp derived from reprocessing waste paper, on the other hand, will always be inferior to virgin paper no matter how carefully the reprocessing is conducted; as such secondary material paper and virgin paper differ fundamentally in terms of quality, purity and use. As such, paper appears lower on the reprocessability scale.

Re-use is a more amorphous concept than reprocessing. It is often broken down to include terms such as reconditioning, remanufacture and re-use. No local official definitions or distinctions exist, hence our understanding of these concepts derives from international literature and discussions with local industry players.

First there is re-conditioning. Reconditioning is the making good of an appliance or piece of capital equipment or machinery so that it can be traded. The use of the appliance or machinery is not altered in the reconditioning process. Reconditioning differs from repair in that reconditioning is not a remedial activity to fix an identified problem that impedes the working of the appliance or machine, but is an overall improvement of the working of the appliance/equipment to bring it back to its initial standard of performance, i.e. the amelioration of wear and tear. The outstanding difference between repair and reconditioning is that repair is usually undertaken on behalf of the owner of the equipment who then reclaims the equipment and continues using it. In reconditioning, however, the asset is usually disposed of by its owner, is then reconditioned and sold on to a third party. Reconditioning thus involves a trade aspect rather than merely a service aspect.

Re-use on the other hand pertains to the extraction of working parts from a piece of equipment, machinery or appliance for the production of a *new* piece of equipment/machinery or appliance. For example, if two PCs that do not work are stripped of their parts and the salvaged working parts are then put together to make an entirely new PC which works and can be traded, this would constitute re-use. In some countries it appears that re-use is used when parts are stripped and then put together to produce a product different in use from the product which was initially stripped, while re-manufacture is the terminology used when parts are stripped and re-used in the production of the same product. The NWMS and its concomitant document do not provide any guidance on this issue, hence we will assume the broader definition of re-use, constituting activities whereby salvaged parts can be used to produce a product either the same as or different to the original product that was stripped down.

Finally in the recycling hierarchy comes composting. Composting includes a range of activities whereby organic waste streams are subjected to a decomposition process of which the outputs are called compost, which can then be treated to produce a variety of products that can be traded.

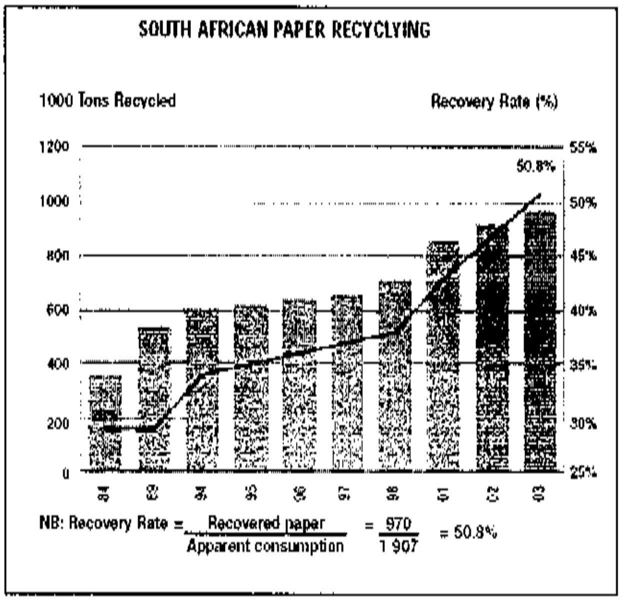
5.1 Reprocessing in South Africa

5.1.1 Paper and board

Paper and fibre reprocessing is well developed in South Africa and occurs mainly within four large companies – Sappi, Mondi, Nampak and Kimberly Clark. Two thirds of all South African mills can operate using recycled paper, and hence as mill investment increases (R17.1bn in 2003), so too does the capacity for recycling paper. South Africa's paper recovery rate has increased steadily, from 29% in 1984 to 38% in 1998 to 51% in 2003 (PAMSA, 2005:16). Almost every paper product in South Africa comprises some component of recycled paper – paper cartons are 100% comprised of recycled paper, cardboard boxes contain 50% recycled paper and newspapers have 25% recycled content. Not only do the paper mills recycle paper, but work is developing on recycling waste products from the production process itself, such as producing concrete bricks from boiler ash.

The paper industry's view regarding recycling is driven by an entirely commercial agenda seeking on the one hand to improve international competitiveness via decreasing costs of production and on the other hand decreasing operational costs by reducing costs related to environmental compliance. On the compliance side, using recyclates instead of virgin raw materials creates savings related to dealing with pollutants. Recycling paper reduces air pollution by 70% and water pollution by 35% (NWMS, 2000:13). From a cost perspective, water usage is reduced by 55% and energy consumption by 40%. In terms of material input costs, no figures are provided but 17 pine trees are required to produce one tonne of virgin paper.

Figure 5 – South African paper recycling



Source: Paper Manufacturers Association of S.A, 2006

In terms of sourcing waste paper for recycling, the four main paper companies in South Africa have developed a dual strategy. On the one hand they have undertaken vigorous outsourcing activities where small enterprises are contracted to collect waste on their behalf. In most instances some financing is made available for the purchase of a vehicle, and client lists are provided by the paper company. These schemes are usually aimed at commercial waste paper collection. The second strategy has been to offer curbside collection (Mondi's Ronnie Bag collection scheme) and to establish buy-back centres where informal paper collectors can sell collected waste paper for cash. These schemes focus more on domestic and household paper waste. Due to the high bulk and low rand per kilo value of paper, fewer itinerant pickers focus on paper recovery than the recovery of metals and tins, although substantial itinerant collectors focus on cardboards and higher quality papers, which fetch a higher resale price. The majority of paper collected is received from wholesalers and retailers (20%), with only 2% arising from households and 2% from offices (NWMS 2000:14). The paper industry foresees that "the potential for additional recycling from wholesalers and retailers is 362 tonnes per annum (19%), 317 tonnes from households (17%) and 194 tonnes per annum from offices (10%)" (NWMS, 2000:16). Over an above the potential for increased recovery, paper usage appears to grow per capita as GDP grows, hence with strong economic growth, these quantities should continue to increase. At present employment data is scant. The Paper Manufacturers' Association of South Africa (PAMSA) estimates that 13 000 informal workers earn a living from paper recycling activities. The Mondi and Sappi websites indicate that they formally employ 2 500 and 2 200 workers, respectively, who are entirely involved in recycling. In European studies it is common for environmental economists to multiply the percentage of paper recycled by the formal employment data for the paper industry and to ascribe this quotient as the number of people employed in paper recycling. In South Africa this would be 55% of the 60 000 employees in the paper and pulp producing sector. While this may be appealing in terms of supporting an argument for the job creation potential of recycling, it is not a particularly useful calculation, as these jobs would not cease to exist if paper and pulp mills shifted from using waste paper to virgin materials[7]. So we are realistically looking at approximately 20 000 formal and informal jobs in the paper recycling industry at present. In principle these figures could double if all the potential paper available for recycling was indeed recovered.

From what we understand, based on industry interviews, South African mills which can recycle recovered waste paper are running at near to or full capacity, although additional capacity is coming on stream. As such it appears as though the supply of recovered waste paper exceeds the demand for such waste. This is the only waste stream where supply outstrips demand in South Africa, although it appears to be a common international problem faced by this industry, especially in Europe where legislation which requires paper recycling has led to substantial exporting of waste paper from Europe to developing countries due to insufficient local capacity to recycle. Nevertheless, PAMSA believes that the paper industry and specifically the paper recycling industry is a growth industry and are working with **the dti** to determine the extent of this growth and the benefits which will arise in terms of job creation. The report was expected in the first quarter of 2007. As such, from our limited insight into paper reprocessing, it appears as though the sector will grow naturally as paper consumption increases as the economy grows and as paper industry players attempt to continually decrease production costs. The apparent excess supply of waste paper suggests that additional market development is crucially required if activity in this area is to grow. Numerous international projects have been undertaken to try to support increased demand for reprocessed paper. Some of the initiatives continue to support demand for reprocessed paper into paper products, i.e. recycled paper, and this is usually done via procurement policies for government stationary. For example, in support of the London Remade strategy analysed above, the London Mayor's Office and Local Authority specified that they would only procure office stationary that was made of 100% recycled paper. In the US, the EPA endorses support initiatives such as positive procurement, but also suggests that alternative uses for paper pulp other than reprocessing it into paper may be required to fundamentally support a secondary materials market in paper (and all other waste streams). As such in the US, recycling support schemes generally incentivise small enterprise development and R&D development related to new uses for recycled products.

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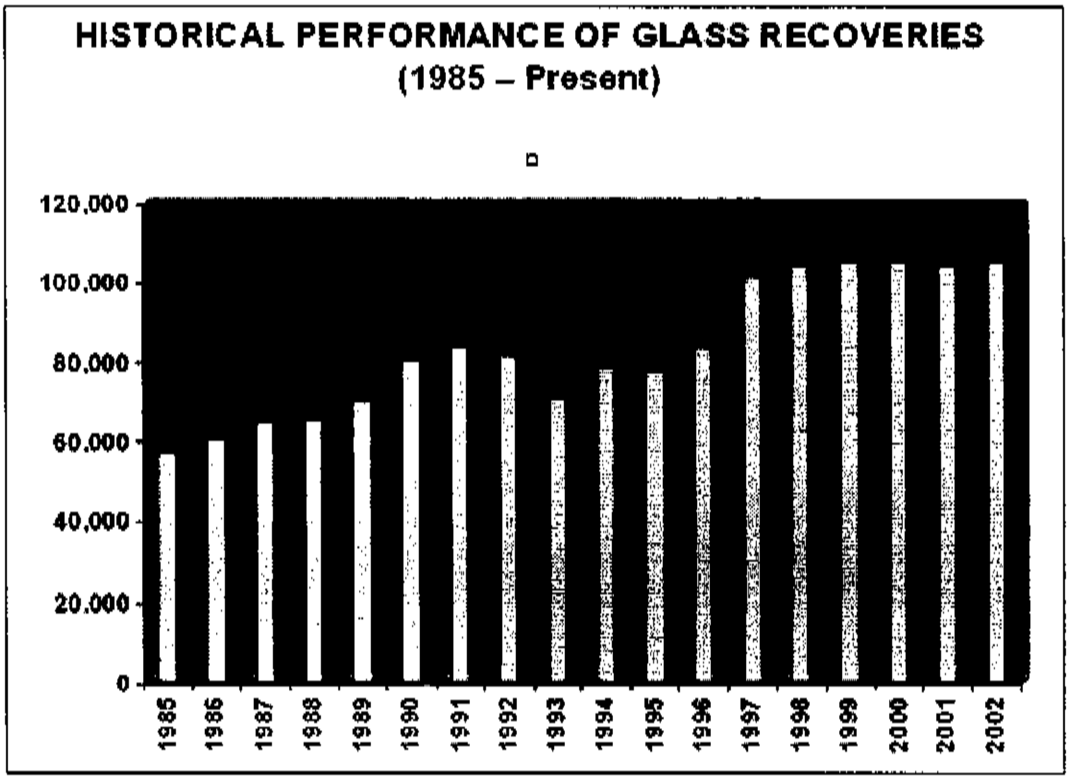
[7] Although some jobs certainly would be lost, as the cost of paper production would increase substantially, and in all likelihood local production would be negatively impacted by cheaper importation of paper.

5.1.2 Glass

The Glass Recycling Association was formed in 1986 by Consol Glass and Metal Box Glass. However, recovery rates have been low, reaching just 20% in 2004, compared to 90% in the Netherlands, 45% in the UK and 40% in Brazil (The Glass Recycling Company, 2006).

Figure 6 – Glass recovery in South Africa



Source: The Glass Recycling Company, 2006

The reprocessing of glass is particularly interesting. Glass is 100% reprocessable and loses none of its intrinsic qualities during the process. As there is no fusion loss during the melting process, one tonne of cullet (broken, recyclable glass) will produce one tonne of bottles. In contrast it takes 1.2 tonnes of virgin batch materials to manufacture one tonne of glass. Not only is reprocessed glass more efficient in terms of material utilisation, but cullet also melts at a lower temperature than the temperatures required to produce glass from virgin materials, requiring less energy and hence being more cost effective. At present manufacturers supplement raw material usage with cullet at rates varying between 25% and 70%. The economic problem in terms of collecting cullet and increasing reprocessing rates is that glass is a low-value material, the raw materials are readily available, transport costs of glass are high and colour sorting and removal of metal caps, collars and lids must occur before the glass is received by the reprocessers.

To date what collection has occurred has been sourced as shown in the table below.

Table 11 – Glass recovery by source

Source of collection	Tonnes per annum
Bottlers	38 000
Bottle banks	31 500
On premise consumption outlets	18 250
Informal collectors	7 250
Neighbouring states	5 500
Schools and charities	4 050

Source: NWMS, 2000:15

Generally the system at play is similar to that found in paper where glass agents purchase collected glass and on-sell it to Nampak, Consol or other reprocessers at buy-back depots. Prices vary according to volume, quality and degree of sorting, and range between R250 and R300 a tonne.

The poor performance of glass recycling and the government's satisfaction with the plastics MOU led DEAT to enter into negotiations with the National Glass Recycling Forum to sign an MOU which would increase glass recycling levels from 20% to 50% in under five years. The MOU was signed in May 2005 and a non-profit implementing company, the Glass Recycling Company (GRC) was formed and launched in January 2007. The MOU, according to officials, has addressed all the problems which arose with the plastics MOU and has the support of the entire industry supply chain, from glass manufacturers to fillers to reprocessers. The GRC also emphasised the need for retailers to join the initiative. The forum and government investigated various options before deciding to adopt an advanced repurchase system (ARS) similar to those found in Germany and the UK, but to run it in parallel with the already established re-use glass system favoured by some leading South African beverage producers.

The ARS system is a levy system whereby glass manufacturers and fillers contribute an amount per kilo of glass sold to the GRC. The levy is around R2 115 per kilo. The GRC uses these funds to finance its operations, which include increasing awareness and education, rolling out glass recycling bins and supporting entrepreneurs to establish glass collection businesses. The industry business approach is further developed with the introduction of two large new reprocessing plants, which have cost Consol R35m. These reprocessing plants incorporate the most sophisticated technology available, which allows waste glass to be delivered without it being sorted or cleaned or metal fasteners removed. Essentially this allows collectors and glass agents to focus entirely on volume collection and for all quality issues to be handled by the glass manufacturing company itself. In a press release issued by GRC, the adoption of this technology aims to allow "wider participation in the collection drive and more direct economic benefit for collectors". This finding appears to be contrary to the literature researched earlier in this paper, where it was found that sorting and cleaning were value-adding, labour-intensive activities. Hence, despite one of the goals of the GRC being job creation, the extent to which these opportunities have been optimised is uncertain.

In relation to employment in glass reprocessing, no data is available regarding formal employment related to recycling within the formal sector. Within the informal sector the GRC estimates that between 500 and 800 glass agents already operate. Each of these agents is believed to 'employ' between 10 to 50 collectors. This would put the informal sector activity attributable to glass recycling at approximately 20 000 (650 agents employing 30 people each). To complement this, the GRC seeks to establish 80 additional agents a year and is calculating that 4 000 informal jobs will be created by these 80 additional agents. If their forecasting is accurate, then the drive to increase glass recovery rates from 20% to 50% in less than five years, using an additional 400 glass agents (80 agents a year for five years) should result in an additional 20 400 jobs being created. The programme to roll out additional glass agents and to provide financial support to them, however, is a contentious issue on the ground as it has been suggested that it may be viewed as unfair competition from the perspective of those already earning a living in the industry. The matter is before the Competition Board at present.

Alongside the ARS business approach, several beverage companies use a glass re-use system where bottles are collected, and instead of being broken into cullet, are washed, cleaned and re-used. Bottles are either collected from restaurants and retailers free of charge or in many cases a deposit system is in place. SAB, the largest supporters of this option, sold 6.8-million units in 2004 in returnable, reusable glass containers versus 5.6-million in non-returnable, non-reusable containers. Deposit schemes generally receive limited support in developed countries where they are viewed as cumbersome and create storage difficulties for retailers, while they are favoured in developing countries where the income received from returning bottles is seen as an import supplement to the income of the poorest of the poor.

The last issue related to glass reprocessing is to consider the possibilities of extending the ambit of recycling glass to cover not only reprocessing but, as with paper, alternative uses for glass. Projects such as SAB's Corporate Social Investment Programme, which assists crafters to fashion drinking glasses out of recycled bottles, is a case in point. These schemes are highly labour intensive. The industry feel related to these options appears to be two-fold. First they argue that the use of glass other than for packaging (and excluding glass panes and windshield) is only 5% of all glass manufactured, and is hence too small a volume to require substantial attention, when only 20% of packaging glass, which accounts for 95% of glass production, is being recovered. The second argument is that the size of the craft industry is itself limited. More viable alternative glass recycling uses are in the manufacture of abrasives, road-marking paint, ceramics and as an aggregate in road-making. Most of these activities, however, are not labour intensive and essentially involve crushing cullet into fine powders of varying densities.

In summary then, the glass reprocessing industry seems to be on the cusp of fundamental change. With a fixed target for job creation and recovery rates in five years, it should provide a timeous case study of the potential of reprocessing this particular waste stream. The GRC's programme will also be an interesting test case to see how the market dynamic play out in terms of introducing a formalised recycling system within a system which has operated in an informal manner in the past. The reactions of informal glass agents to the new supported agents created by GRC will hopefully provide some insight into the implications of future policy options.

5.1.3 Plastics

The plastics reprocessing sector in South Africa is notably different from the glass and paper sector in that there are a large number of plastic product producers as opposed to the highly concentrated glass and paper sectors. The NWMS and the Plastics Federation list upwards of 120 plastic product producers (officially called converters). The industry is highly fragmented. The South African plastics sector is relatively unique as most of the industry draws its raw materials from feedstock from Sasol, i.e. it is coal based. Over 60 different types of plastic resins exist. High-volume commodity polymers such as low-density polyethylene (LDP), high-density polyethylene (HDP), polyvinyl chloride (PVC) and polypropylene (PP) are all produced in South Africa by Sasol Polymers or Safripol/Plastomark. Other polymers, most notable polyethylene terephthalate (PET), is manufactured using imported raw materials or imported directly.

Plastic recycling is a complicated area from a technical and marketing perspective as well as a collection perspective. The different types of resins mentioned above melt at different temperatures, hence they must be separated accordingly prior to reprocessing. The Enviromark number imprinted on the bottom of all plastic containers indicates within which class of plastic the container falls. These marks are not always easy to see, hence the quality of sorting is a major issue. The second difficulty in plastics reprocessing is that only some plastics can be reprocessed back into their original use while others can only be used for alternative packaging. For example, fresh food packaging is always done using virgin plastic materials. A third difficulty regarding plastics reprocessing is the fact that plastics are very light, hence enormous volumes are requires to deliver a single tonne of plastic waste to a potential reprocesser. As such, reprocessed polymers are limited to about 60% of the virgin polymer price, which is in turn subject to normal supply and demand market forces. Imported resin prices are particularly variable, as most are made from oil which fluctuates enormously in terms of price.

The plastics industry in South Africa received a massive wake up call in 2003 when the government introduced a levy on plastic bags in an attempt to limit litter. The levy of 3c per bag "decimated the industry, resulting in a decrease in production of 80% in 2004", which has levelled off to "a level of 50% of pre-levy production volumes in 2005" (PetCo AGM, 2006). With this reality burning in the minds of the industry and with an overall rate of plastics recycling in South Africa of only 13% – which is below international rates of 20% across the whole of the EU, 27% in the Netherlands, 60%

in Germany and 17% in Brazil – the industry began to review its approach to recycling and the environment.

In 1997 905 000 tonnes of virgin plastics were produced in South Africa, of which 50% was converted into packaging. Of this 445 000 tonnes of packaging plastics, the largest single category was 87 000 tonnes of PET plastics, of which 57 000 tonnes were used in the production of beverage bottles. This PET production was chosen by the industry and government as the focus area for plastics recycling in South Africa going forward. The reasons for this focus are numerous. First, plastic beverage bottles are a large source of litter and hence a visibility issue from government's perspective. Secondly, PET is not produced from feedstock from Sasol but is oil-based, which is imported. Closer management of imported costs through import substitution was viewed as desirable not only from an inflationary perspective but also from a foreign exchange perspective. Industry estimates suggest that if recycling rates of PET increase in line with the DEAT MOU signed in 2004, up to R72m of foreign exchange can be saved that would otherwise have been spent on imported virgin polyester and oil necessary for PET production. The final appeal of PET lay in the good existing market conditions for recycled PET products.

PET collection for recycling grew from 2 000 tonnes in 2000 to 11 500 tonnes in 2005, a 475% increase. There are 12 PET recyclers currently operating in South Africa, with the two largest being Hosaf Recycling and SA Polyester Recyclers. Collection of PET in South Africa is dominated by collection from landfill sites, which yields 99% of all PET waste recovery. This differs substantially from international experience, where 40% to 60% of PET recovery occurs through curbside collection, 10% to 15% through drop-off centres and 15% to 20% from return vending machines. This example demonstrates very effectively the role of the itinerant collector in South Africa. Whereas paper, tin and glass recovery rates directly from landfill sites are low because of itinerant collectors diverting this waste prior to landfill, the bulkiness and low weight of plastics make this waste stream not commercially viable for itinerant collectors. Rather, PET recyclers and their contracting agents negotiate access to landfill sites with local authorities to undertake recovery at this point. This is not an effective set-up from the recycler's perspective. In line with this constraint, one of the undertakings of DEAT in the MOU is to assist in recovery. DEAT has agreed to "the establishment of sorting and baling centres that separate PET pre-landfill, ensuring further access to landfill sites, resolving potential issues between landfill operators and recyclers/collectors, providing alternatives to dumpsite collection such as curbside PET collection initiatives, buy-back centres and MRF" (DEAT, PetCo AGM, 2006). Absolutely no data has been published concerning how many people are employed in plastics collection. The choice of options open to the PET industry and DEAT regarding which collection option to favour will impact on the job creation potential of this initiative.

While job creation in the collection phase of plastics reprocessing may be limited (but we do not know), the job creation potential of downstream activity which can arise from recycled PET is far larger than with any of the waste streams considered so far. The fundamental reason for this is that recycled PET, which emerges in the form of pellets, has an abundance of alternative uses other than reprocessing back into beverage bottles. Not only do numerous alternative uses exist, but contrary to other secondary materials, the markets for these alternative uses is already established, both locally and internationally. Recycled PET can be used for fibrefill for duvets and pillows, it can be turned into polyester carpets which are currently used by the motor manufacturers for all car carpets, it can be used as insulation material in roofing and it can be produced into geotextiles such as those used for road stabilisation. Finally, PET pellets can be converted into ecofleece and made into tracksuits and parkas. At best we have been able to establish (and this will need to be checked by more in-depth primary research) that South Africa's current recyclable PET pellet production is of a sufficiently low volume that PET recyclates are exported and then pillows, duvets, tracksuits, etc. are re-imported. If PET recycling volumes increase, these products could, in principle, be produced locally. Our research suggests that under the DEAT MOU, the co-ordinating Section 21 company, PetCo, will run various projects, one of which is the local production of roof insulation made from PET recycled pellets. The product will compete with the traditional Aerolite Think Pink product common in South Africa and will be marketed under the tag line of Think Green.

The business model adopted under the plastics MOU is similar to that of the glass industry explained above. Resin producers and plastics converters (manufacturers of plastic products) will pay a levy of R200/tonne. This funding is administered by PetCo, set up under the MOU, that will use these funds to "increase the economic viability of collection and recycling" and to "increase visible recycling" in terms of education, awareness, collection centres and downstream production activities such as 'think green' insulation. The levy will be passed on to the consumer in the form of higher prices. In this model, collectors will recover PET from landfills and then sell this material to recyclers based on the best price they can achieve. Reprocessers will receive a subsidy from PET but will need to compete with other reprocessers on price in order to establish supply.

Although we have no data on job creation in this particular area, the PET recycling story is of particular interest because of its potential to create downstream activity based on a series of alternative uses for recycled PET pellets. PET recycling is also enormously interesting in that many small businesses and community projects internationally have been developed for plastics recycling. It appears to be a waste stream which can be diverted to alternative uses using low-technology processes and which need not be undertaken on a large scale. Much literature has been found on community projects based on plastics recycling and these projects could be of substantial interest to DST and **the dti** and will require further investigation.

5.1.4 Metals

Except for e-waste, very little household metal waste is generated outside of beverage cans and metal food tins. The only well-documented case study and information relevant to this waste stream is that of Collect-a-Can, which was discussed in detail above. Other instances of scrap metal collection will be considered in the next section under 're-use' and in the 'industrial waste' section.

5.1.5 Organic materials

According to NWMS, "very little recycling of organic waste currently takes place in South Africa", and organic waste recycling has not been identified as a priority area in the NWMS (NWMS, 2000:20). This appears to be an interesting oversight for two strategic reasons. First, if organic waste were separated from the general waste stream, it would substantially improve the recovery rates and quality of non-organic recovered materials such as paper, glass and plastic. Secondly, in South Africa it is estimated that 30% of landfill is used to dispose of garden refuse and other organic waste. This is also an interesting oversight for non-strategic reasons. First, organic waste can be recycled into compost and organic fertilisers with virtually no investment and very little resources requires. Secondly, the value of the recycled compost is substantial, if not in monetary terms then in terms of improving agricultural production.

While organic recycling may not have made it onto the national waste priority agenda, it has certainly begun to appear on the agenda of local authorities. Traditionally, garden refuse has not been picked up by the local authorities as part of their weekly curbside collection, although increasing volumes are now flowing through the system. Rather, specialised garden sites are operated by the council where residents can come and offload their garden waste. Over time these sites have been unable to cope with increasing demand. Pick-it-Up in Johannesburg and the local authorities in Cape Town have recently responded by developing plans to increase composting, mainly as an answer to dealing with volume growth. Pick-it-Up has even gone so far as to state that, "composting remains an essential business focus for the company" (Pick-it-Up, 2006). The approach has been to set up a business. Garden refuse centres will soon install shredders which will chop garden refuse into smaller pieces. These pieces are then transported to the Panorama Composting site where they will be fed into a new R900 000 heavy-duty composting machine, which will increase turn-around times ten-fold. Compost is then bagged and available for sale, either directly through Pick-it Up or through agents at a cost of R7 a bag, which is about half the price of normal retailer compost found in nurseries. The product is officially registered as a Group 2 fertiliser with the relevant authorities. This is a new enterprise and the financial results are not yet in; however, it is likely to continue even if it does not make a profit, simply because the alternative costs of developing new landfill sites and garden centres are too high. Pick-it-Up has no data available in terms of job creation, but additional employment has occurred, especially in relation to transport (both from the garden centre to the centralised composting site and delivery of bags of compost to wholesalers, retailer and members of the public). Organic composting sites in other international studies such as the London Remade study show modest job creation prospects.

5.1.6 Building rubble

The NWMS does not confer priority status to the recycling of building rubble and the Starter document produced by DEAT claims that "no readily accessible information on building rubble could be found for South Africa" (NWMS, 2000:20). This is certainly so with respect to industry information pertaining to companies operating in this market. The only interesting work on the subject appears to have been undertaken by Boutek, a unit within the CSIR which completed some interesting research pertaining to the potential of reprocessing construction and demolition waste (C&DW).

The Boutek report[8] reveals that over one million tonnes of C&DW waste is landfilled every year in South Africa. Close to an equal amount is estimated to be dumped illegally as demolition companies seek to avoid gate fees, which are charged at most specialised C&DW sites run by the local authorities. With only two C&DW waste recycling operations existing (one in Durban and one in Cape Town), C&DW waste is used predominantly for daily landfill cover, as well as final cover when landfills have reached the end of their life span. Because of the bulk and density of C&DW waste, it takes up greater volume in landfills than any other waste materials. Due to the nature of this waste and the scarcity of landfill space in most European and Asian countries, C&DW waste policies in these countries are well developed. One of two models is usually adopted internationally. The first and most stringent is called closed-site policies, which prevent developers from removing any C&DW waste from the site whatsoever, even for the purpose of recycling it. In these instances, C&DW waste is factored into the construction and planning process at the outset and is often used for landscaping, as loose sub-base for roads or hard standing for driveways and car parks. The second option is the less stringent recycling option where C&DW waste is allowed off-site but must be transported by the developer or contractor to a centralised processing plant where materials are crushed, magnetically separated to remove any metallic materials and finally converted into a variety of aggregate grades.

Different types of aggregates can be utilised in different uses. Most often courser aggregates are used in road construction, back fill for civil engineering works such as airport embankments, land reclamation and bedding materials for roads and railways. Finer aggregates have the potential to be reprocessed into a variety of concrete products, which can be used to construct drainage pipes and block work for low-cost housing. Due to our inability to source the full Boutek report, we are unsure why reprocessed C&DW into block work is only applicable to low-cost housing. We have been unable to ascertain the quality of C&DW recycled concrete versus its virgin alternative.

From the limited information available, it is difficult to gauge the job-creation potential of this waste stream.

5.1.7 Other domestic waste streams

Finally, a variety of smaller recycling activities occur related to smaller volume waste streams generated in the post-consumer phase. These include the reprocessing of tyres, lubricating oil, paint cans, chemical drums and aerosol cans. Most of these projects are driven by NGOs or in some instances manufacturers, often due to the

[8] The original document could not be located. A summary of the report's findings on the Boutek website is the source of this information, but it cannot be expanded upon.

hazardous nature of the waste. Most of these projects create employment within a range of 100 to 350 jobs. Most are based on a business model of buy-back centres and financed through a voluntary industry levy.

5.2 Summary of reprocessing in South Africa

Despite the lack of a strong direction related to reprocessing by the government, South Africa does in fact undertake a substantial amount of reprocessing. Although policies and legislation are being developed which will begin to regulate and control reprocessing targets and disposal costs, local industries have anticipated this and through the NWMS and other stakeholder processes developed a more enlightened self-interest approach to dealing with these waste issues. The opening slide of the PetCo AGM presented by the chairman establishes this view in an unequivocal manner. It states that "international experience confirms that it is possible through voluntary industry co-operation to move from a downward spiral of growing consumption and inadequate recovery to a benign, upward spiral that is self-reinforcing and self-sustaining" (PetCo, AGM, 2006). This approach is being endorsed by DEAT in terms of the MOUs it is signing regarding the reprocessing of key materials with industry players. While industry's motivation may not be optimal in the short to medium run, it should via the MOU process with DEAT result in improved recovery levels and increased levels of reprocessing. In turn, this can potentially lead to new job opportunities and the creation of new products. However, the reality that all these major initiatives still rely on a levy-based system to subsidise reprocessing indicates that market conditions have not fundamentally changed, nor will they be changed under the current process. As such, reprocessing will remain an ad hoc activity (albeit at a higher level) but will not move into the realm of intensive reprocessing or a closed-loop economy. Perhaps this is a necessary first step and a viable step within the context of a developing nation which has a large socio-economic backlog to address.

In terms of job creation potential and current employment, we summarise the little data we have assembled to generate an overview of employment in these areas.

Table 12 – Summary

Material	Current recovery rate	Current employment estimate	Potential employment growth based on improved recovery rates	Potential areas of job losses	Areas of potential job creation based on alternate uses for reprocessed materials	Other sectors where potential job gains can be achieved
Paper	51	20,000 13,000 informal 7,000 formal	+20,000	Timber industry, timber haulage	Concrete bricks made from boiler ash	Chemical sector which provides inputs for paper reprocessers; Capital equipment sector +plant production; Transport
Glass	20	20,000 15,000 informal 5,000 formal	+20,000	Sand production and transport	Crafts Abrasives Road marking paint Ceramics Road aggregate	Chemical sector Capital equipment sector + plant production Transport
Plastic (PET)	13			None unless to bottle to bottle reprocessing occurs	Track suits Pillows Duvets Insulation material Crafts	Capital equipment sector +plant production; Transport, clothing and textiles
Tin plate	68	36,000 informal	7,000	Virgin tin production		
Other areas						
MRFs			35,000	Itinerant collectors, landfill		
Separate collection			15,000	Itinerant collectors, landfill		

Several other issues must be borne in mind when interpreting the above table:

- Due to South Africa's economic development relative to other sub-Saharan African countries, the country is well positioned to import recyclates from neighbouring states, which would increase the supply of recyclates. This is already being done in some areas, such as tin cans from Namibia and Botswana, where local volumes are insufficient to support a local reprocessing industry.
- We have no data on the potential job-creation potential of alternative uses for recyclables shown above. For example, if PET recycling increases to sufficient volumes so that pellets can be transformed into fibres locally, what would the job-creation potential in the textile industry be? Van Beurkening (1999) argues that developing countries have a comparative advantage in converting secondary materials, and this potential would need to be investigated.
- The current employment figures shown above are likely to be an underestimation of reprocessing-related employment, especially in the formal

sector. Management positions are not included, employment in association and fora are not included, employment related to the environmental goods and services sector are not included, R&D employment is not included and neither is the largest category, which should be those employees within the paper, glass and plastics firms, whose jobs are entirely related to reprocessing within the larger organisation. The difficulties of non-discrete reprocessing jobs, non-transparent inputs which can be separated from virgin input costs and capital all make estimating formal employment in this area very difficult.

- Transport plays an important part in the collection of recyclates. We have been unable to quantify the amount of employment generated by these activities or the potential of this sector's employment to increase if reprocessing rates increase.
- Reprocessing usually requires different inputs from the production of virgin materials. Cleaning agents, purifying products and chemicals related to sludge are likely to be used in most processes. If reprocessing increases demand for these products, it is also likely to create increased demand for labour in the chemical sector.

It appears then that reprocessing is a large and growing sector in South Africa. It also appears evident that we do not have sufficient information or insight to understand the extent of the industry, but that it is relatively large and relatively labour intensive, especially in the collection phase of recyclates. Upstream opportunities do exist and will become more viable as volumes increase, suggesting that additional job creation opportunities exist. Two cautions must, however, be noted. Fist, the majority of employment in the sector at present exists in the informal sector. As industries formalise their recovery and reprocessing plans, it is likely that formalisation will occur and the negative impact on informal workers will need to be borne in mind. Secondly, reprocessing and the creation of secondary materials are a commodity-based activity. While the economics of secondary material markets are fragile at present, they are especially vulnerable to price fluctuations, making the industry relatively precarious. The voluntary levy system preferred by local industry will help to resolve this threat in the short to medium term, but the levy will always be a moving target and final costs will always be borne by the consumer.

5.3 Re-use

As described earlier, re-use is a more amorphous concept than reprocessing. Re-use includes remanufacturing and reconditioning as defined earlier. Perhaps the easiest way to distinguish reprocessing and re-use is that re-use typically does not involve an 'industrial process' where the physical attributes and qualities of an input are fundamentally transformed.

If little is known about reprocessing in South Africa, even less is known about re-use. This is not a phenomenon unique to South Africa. A number of reasons explain why re-use activities are so difficult to identify and measure from a systemic point of view. First, re-use it a concept which is fundamentally different in developed and developing countries. The types of re-use policies and case studies available to developing countries that are appropriate for local conditions are minimal, and with little to focus the debate and research, it remains an uncharted set of activities in terms of research and literature. In the developed nations of the world, re-use is usually associated with community-based organisations and charitable enterprises. Clothing, furniture, electrical appliances and office equipment are donated to charitable organisations that then either sell them on or donate them to people in need. As non-profit organisations, the transactions that do occur are most often not reported in economic data collection systems. There also appears to be limited formal sector economic activity related to re-use activities in more developed countries, except with respect to the export of e-waste, which will be considered later in detail. In the developing world on the other hand, re-use tends to occur more organically and endogenously, driven by need. Low-income households tend to re-use everything at hand as a survival technique. Often when equipment or appliances are re-used, they are re-used within the household or informal businesses and hence there is no traded element and the activities remain undetected.

The second reason why re-use activities are not well understood, locally and internationally, is that they are almost impossible to place within the current SIC system. Whereas recycling does exist nominally as SIC 3951 and 3952, the type of recycling contemplated in the definition requires some "industrial process" to occur in order for an activity to be deemed recycling. Given that re-use usually involves dismantling and rebuilding either the same product or a different product, technically it would not be deemed part of SIC 395. Instead, re-use activities such as the retreading of rubber tyres or the remanufacture of PCs from salvaged parts would need to be found within the appropriate manufacturing SIC code. As this data does not distinguish between virgin production and re-use production, no understanding of the scope of these activities in the formal sector can be arrived at without a detailed micro-economic firm survey.

The third reason why so little is known about re-use is that the majority of this activity (in terms of volume, not necessarily value) is undertaken in the informal sector. These activities are often small scale and frowned upon by virgin producers with which they compete, and are hence pushed underground. A good example of this is the remanufacture of brake pads in the townships, which are sold predominantly to the taxi industry, at 30% of the cost of virgin brake pads. With no quality control, unreliable manufacturing processes and no measurement equipment, these goods are often unsafe. As formal sector operators seek to close down these competitors in the local market, it appears from anecdotal evidence that some of these inferior goods find their way into the rest of sub-Saharan Africa. As will be explained later, Africa is increasingly being seen as a digital and techno dumping ground, with unscrupulous exporters in developing countries dumping re-manufactured or re-conditioned PCs, cell phones and office equipment in African markets, with often only 25% of shipments being usable (Nigerian government, 2006; E-waste Association of South Africa, 2004).

The final reason why re-use activities are so difficult to come to terms with is that virtually anything can be re-used. A plastic ice cream tub which is cleaned and re-used to store household items would constitute re-use. The creation of a new PC from the components of two broken PCs would similarly constitute re-use, as would the salvaging of a car chassis and forming it into a cart to be drawn by donkeys in rural areas. Hence the scale and heterogeneity of the activity are daunting.

The authors believe that a large number of township enterprises exist based on re-use, remanufacture and reconditioning. Without substantial primary research, however, nothing is known about the scope of these activities or the employment they create. As such, the paper has no choice but to focus on the only portion of re-use activities for which there is any existing research, namely e-waste. This emphasis is chosen purely for pragmatic reasons and as will be seen later, it is suggested that additional primary research be undertaken to establish the extent of informal re-use and to understand its job creation potential.

5.4 E-waste

There is no generally accepted definition of e-waste. We will use the definition listed in various statutes and guidelines from areas where the concept of e-waste recycling is already at a more advanced stage, such as the Swiss Ordinance, SWICO, SENS, the EU Directive and the WEEE Tracer definition. Electronic waste or e-waste, in this context, refers to "any old, end-of-life electronic appliances which have been disposed of by their original users, such as:

- Information technology (IT) equipment, for example, PCs, servers, peripheral equipment (monitors, keyboards, printers and scanners);
- Office machines, for example, fax and copy machines, typewriters, paper shredders and overhead projectors;
- Equipment used in the graphics industry, for example, printing systems, lighting and development machines;
- Telecommunications equipment, for example, cellular phones, telephone equipment and telephone exchange systems;
- Consumer electronics, for example, recording equipment, television sets, video projectors, cameras, radios, satellite receivers and loudspeakers;
- Accessories, consumables and packaging, for example, CDs, disks, toner cartridges, headphones, cables and packaging; and
- Household equipment, for example, fridges, washing machines, ovens and microwaves" (HSRC, 2005).

South Africa is a relatively new entrant to the e-waste debate and lags five to 10 years behind international best practices, although new regulations and policies are coming on stream and collection facilities are already beginning to emerge[9]. E-waste is an important area of activity for a variety of reasons. First, with constantly improving technology and innovation, electrical and communications and electronic equipment is becoming obsolete at a faster rate than ever previously experienced. Because of the pace of technological change, planned obsolescence periods have been shortened, so that 10 years ago the life span of a PC was six years, whereas in 2005, the life span of a PC was factored to be two years. A final reason for the importance of e-waste policies is that with GDP growing worldwide and prices of electronics and communications and computing hardware decreasing, demand for these goods is higher than ever, leading to ever-increasing volumes that will ultimately need to be disposed of.

A recent study undertaken by the HSRC with the support of the Swiss government describes the current e-waste system in South Africa, as well as the system they recommend.

Figure 7 – Current e-waste system in South Africa

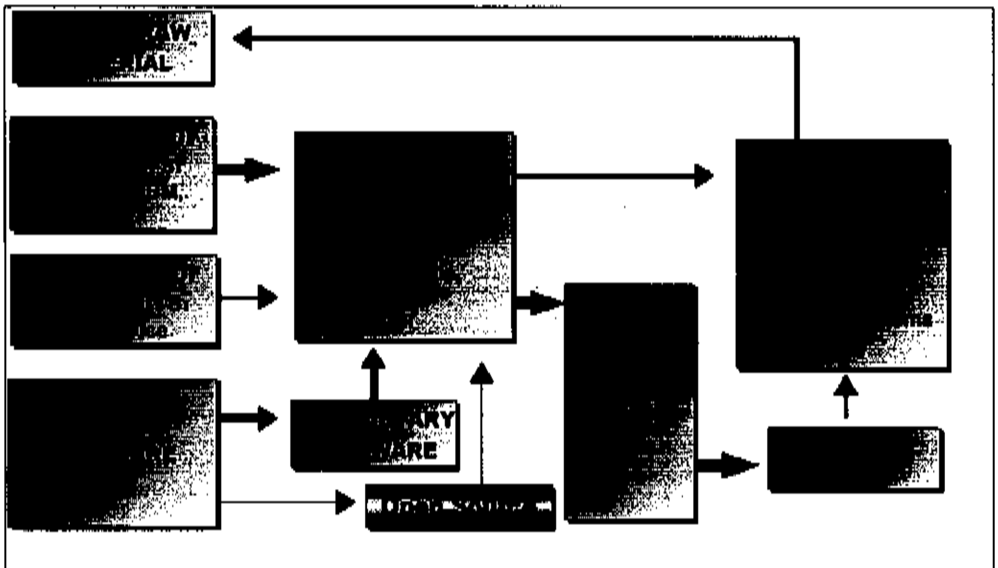


Figure 2: Current WEEE System in South Africa

Source: HSRC, 2005

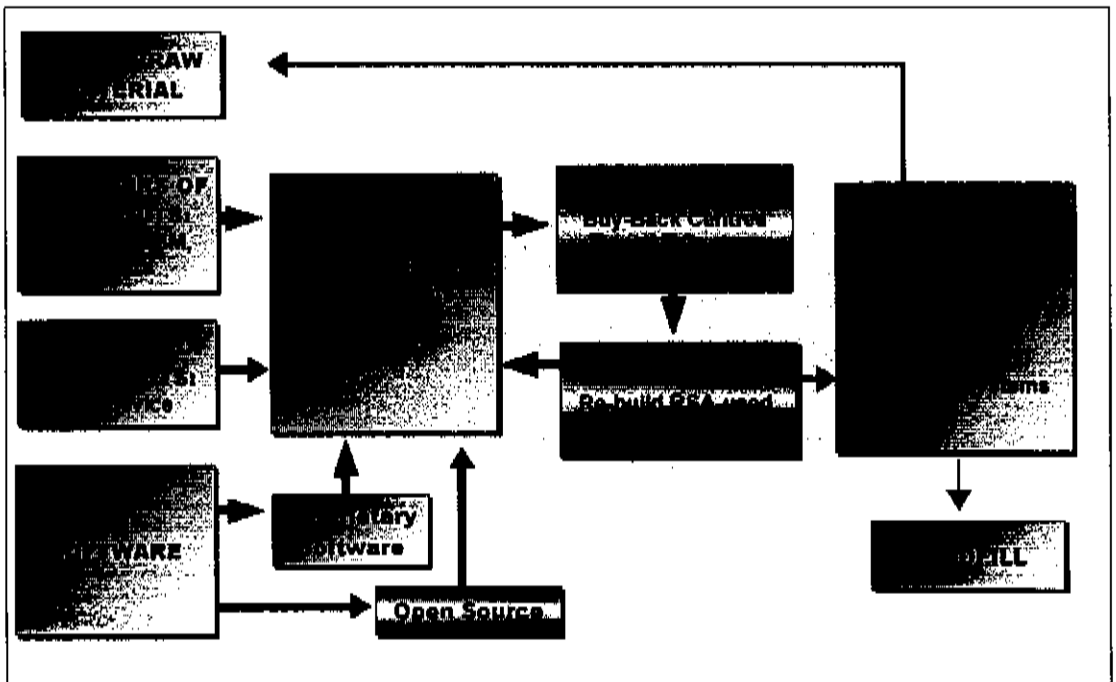
In this first diagram we see limited re-use and recycling occurring due to the lack of extended produce responsibility legislation in South Africa. This, as well as an undeveloped market with few firms who re-use equipment, has resulted in the

[9] In December 2006, the Johannesburg City Council opened the first seven e-waste dumpsites in South Africa.

majority of e-waste being placed in storage and eventually disposed of in landfill sites. This situation is perpetuated by the asset register system in government[10] and large corporations, which prevents discarded equipment and appliances being taken off the premises. A second complication in the current South African system is that the majority of activity occurring in e-waste is not in fact re-use but re-processing, whereby firms purchase e-waste and melt down the various metals found in its componentry, which they sell on. As many of these metals fall into the precious metals category, licences are required to undertake these activities. Rather than re-using components, local firms appear to import e-waste componentry from Europe and Asia and re-manufacture and re-use imported parts rather than local parts. The argument here appears to be a lack of volume of local componentry and a lack of disassembly firms.

In the second diagram below, the proposed approach to e-waste recycling and re-use is shown.

Figure 8 – Suggested future e-waste system



Source: HSRC, 2005

[10] Axis Computers CEO claims that 80% of computer sales in South Africa are made to government.

In this system, resources would be applied to developing a culture and system whereby e-waste is collected. Numerous options exist to achieve this shift, but the most compelling change would be the promulgation of extended producer responsibility legislation. Non-legislative options include establishing buy-back centres, setting up drop-off centres and increasing informal collection. The HSRC report suggests that only 1% of e-waste in South Africa is currently being recycled or re-used, whereas the Chairman of the E-waste Association of South Africa puts the figure at a far higher 30% (Cape Town e-waste workshop, 25 February 2004). Once a collection system has been established, the report suggests that the conditions would be established to allow for the creation of a viable refurbishment sector based on local recovered materials rather than on imported recovered materials.

It appears to be the view of the HSRC report that re-use and refurbishment of e-waste will most likely occur within the formal sector and not lead to the type of informal collection seen in other waste streams such as paper and glass. The reason for this is that little e-waste arises in curbside refuse and that when large disposals of equipment from companies does occur, it is usually on the basis of a contract which is tendered for. This is an important characteristic to keep in mind regarding further development of this area of activity, as it allows (for want of a better term) a clean slate from the perspective of how job creation projects can be formalised without the need to deal with potential job substitution away from itinerant and informal collectors.

At present there are two areas of activity in e-waste. The first and dominant activity is the reprocessing of metals from e-waste. This is largely undertaken within the scrap-metal industry. The scrap-metal recycling industry is tightly controlled by a few major players. There are many small scrap-metal merchants who operate on the 'fringes' of the industry. However, due to the very strictly applied regulations governing the trade in precious metals, as well as the implementation of ISO 14 000 at refineries (which require the screening of the premises of any organisation that has produced metal for refining), it is difficult for any of the fringe operators or informal recyclers to find a refinery willing to process their raw materials if their operations do not comply with the required specifications and self-regulatory framework set up by the Metal Recycling Association of South Africa. As such the job-creation prospects for informal collectors and metals scrap merchants related to e-waste metal recovery are and will continue to be limited.

The market is dominated by two large e-waste recyclers – Universal Recycling Company and Desco Electronic Recyclers – which have cornered the local market. Universal Recycling operates from four locations. They process 1 800 tonnes of electronic scrap per annum using sophisticated technology, including mechanical shredders, pulverisers, rotary magnets, granulators, shears and balers on 'disassembly' lines. Ferrous materials are separated from non-ferrous and aluminium is extracted using an eddy current separator. Heavy and precious metals are shipped to a European refinery, steel is processed locally and aluminium is exported to the Far East. Non-metallic fractions are landfilled. A reliable market for plastics has not yet been located. Current recovery rates of e –waste at Universal are:

- 40% to 50% ferrous content could be recovered – 60 tonnes per annum;
- 7% to 10% recoverable aluminium;
- 6% to 10% recoverable non-magnetic stainless steel; and
- 5% recoverable zinc (Mr Loewenthal, Universal Recycling).

Desco Electronic Recyclers states that it is the largest Printed Circuit (PC) board recycler in South Africa. Desco purchases PC boards from scrap dealers and industry throughout South Africa and neighbouring African countries. They process approximately:

- 400 tonnes of PC boards per annum; and
- 2 000 tonnes of general electronic scrap, including telecommunication equipment, desktop computers, mainframes, medical and radio equipment, etc. per annum.

All electronic scrap is manually stripped, which is a highly labour-intensive process. PC boards are processed with specialised machinery designed and built by Desco. No incineration or chemicals are used in the process. Desco has been in operation in Gauteng since 1992. There is also a branch in Cape Town, which at present generates 100 tonnes of e-scrap per annum.

Other smaller firms do manually strip down e-waste but then on-sell componentry to the two larger recycling firms for metal extraction. From the interviews conducted, it appears that less than 1 000 formal employees work on dismantling and reprocessing the metal wastes from e-waste. Informal employment is hard to estimate, but appears to be small due to refinery requirements. This distinguishes e-waste recovery in South Africa from countries such as India and China where substantial employment is generated in the informal sector in e-waste.

In terms of actual re-use, the HSRC report (2005) finds only two large companies undertaking large-scale re-use activities – Sahara Computing and Device. Shockingly, both source their componentry from overseas, although this importation is strictly monitored and requires state permission per individual assignment. As such, substitution of local componentry for imported componentry could easily be regulated if local supply could be secured. Sahara imports most of its componentry from the Far East and uses it to produce generic machines which are then traded directly into the local and sub-Saharan African market. Device, on the other hand, imports the majority of its components, as well as full-imported refurbished machines, from the Netherlands. Some of these computers are already refurbished, others are processed in South Africa. In the latter case, obsolete or replaced parts are sold as scrap to Desco Electronic Recyclers. Through agreements with manufacturers such as HP/Compaq and Dell, they receive lease-expired personal computers, which they data-wipe and refurbish and then resell, both to dealers (generally consignments of 10 to 50 machines) and the public. Device also runs a substantial donation programme, established in conjunction with a UK initiative called the 'Digital Partnership'.

We have been unable to find any information related to non-electronic appliances such as household white goods. The situation in South Africa regarding e-waste is at present relatively dismal. In terms of the cradle-to-grave approach, shown below, it appears as though the under-developed regulation and e-waste recovery have resulted in a warped reality where in the formal sector items are recycled in preference to being re-used, with re-use activity being based on imported recovered componentry. Informal re-use activity appears to be limited because of limited stocks which appear in the general waste stream. This is because the majority of e-waste is stored and not disposed of, and when disposal does occur, it is usually through a network of contracts which are tended for and hence bypass the opportunity for itinerant collectors. However, with the emergence of e-waste dumps being established by local authorities, this could potentially change.

Figure 9 – Life cycle of e-waste

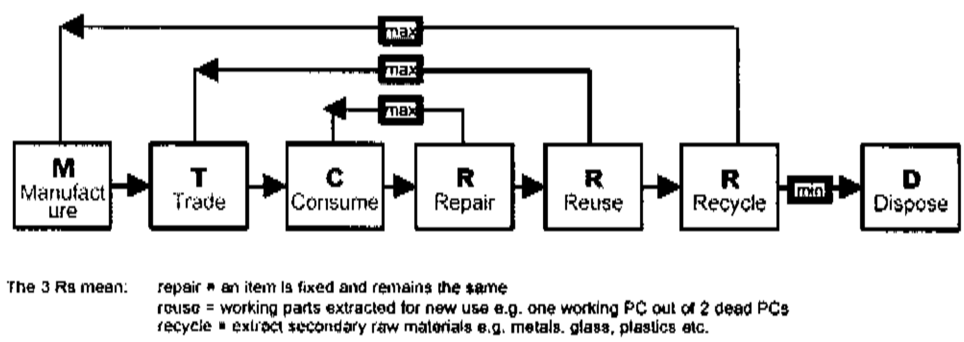


Figure 4: Cradle to Cradle EEE Management System

The dominance of materials recovery rather than re-use of e-waste is not a uniquely South African phenomenon; this trend has also been seen in the EU. The EU (2001) study on the employment effects of environmental policy looked at e-waste as a particular case study and found that new e-waste directives were likely to create only 2 800 new jobs across Europe, with an additional 2 000 jobs being created in related activities. NGOs and development-based agencies such as the EPA suggest that this figures would rise if e-waste recovery focused more on re-use than materials recovery; however, enumerated research and case studies do not appear to exist.

In hypothesising that opportunities may exist to develop the re-use of e-waste in South Africa, the role of international trade must be explicitly accounted for. Higher GDP per capita levels in the developed world and high rates of technological innovation are resulting in electronic and home appliances in these countries being disposed of at an ever-increasing rate, as households and businesses upgrade their equipment. This has led to an increase in the volumes of second-hand goods being exported to the developing world. The concept of digital and techno dumping is becoming increasingly important from an African perspective especially, and **the dti** has put in place stringent controls to regulate such importation. Despite these controls, the economics of developing a local re-use industry in the face of cheaper and often more technologically advanced imports may be difficult. On the face of the limited data available, it does not appear as though this waste stream has substantial job-creation potential in South Africa at present, although this statement is made with low confidence, given the limited information available. Re-use of non-e-waste does occur, especially informally in small township enterprises. No survey of this activity has been undertaken and hence we cannot estimate the size or nature of the activity; however, we would surmise that it is relatively substantial.

5.5 Industrial waste

It was envisioned that this report would consider reprocessing, re-use and general recycling of both domestic and industrial waste. However, the difficulty in obtaining information related to domestic waste and the authors' underestimation of the complexity of the material resulted in little research being undertaken regarding industrial waste. Some general points are made regarding industrial waste recycling in this section, but this work will be carried forward in a subsequent research project to the extent that a scoping exercise shows to exhibit a high level of job creation potential.

Table 13 – Waste tonnage in South Africa by generator

Source	Waste ('000 tonnes per year)
Mining	377,000
Industrial	22,000
Power generation	20
Agriculture and forestry	20
Domestic and trade	15
Sewage sludge	12
Total	**466,000**

Source: Lombard, 2006:2

Industrial waste should, from an economist's perspective, be an important area of focus based on its volume in relation to domestic waste. As shown in Table 13, mining waste is by far the largest category of waste in terms of tonnage, followed by industrial waste. Reprocessing and re-use of waste from mining and industry, however, fall within the category of internal recycling as opposed to post-consumer and post-production recycling, which is external recycling. As such, these activities fall within the operations of the waste generator and are accounted for in terms of economic data collection for that industry and firms. To the extent that internal recycling incorporates some form of transactions with a third party, its scale could in principle be determined. However, to the extent that no external transaction occurs, the accounting of these activities falls within the larger firms' activities. As such, bar using micro-economic surveys at a firm level, it is unlikely that we would be able to determine how many people are employed in these activities. For example, if a large mining house decided that in view of international commodity prices it is worthwhile to reclaim gold dust from old mine dumps, it would do so in-house, the economic data related to these activities would be reported under the general mining activity of the enterprise and would not be distinguishable from data related to virgin mining. On the other hand, if a motor vehicle parts manufacturer produced iron shavings as a waste product from its production process, it is likely that these shavings would be collected and returned to their iron supplier and off-set against future purchases. For smaller companies, such process waste could be sold to scrap metal merchants. Either way, the only way to enumerate the size of the sector and its employment would be to work on an industry-by-industry basis to determine linkages based on a survey. The scope of such an undertaking would be immense.

Perhaps a better approach in light of these difficulties would be to identify areas of industrial recycling and re-use which appear as discrete areas of activity and which are undertaken by speciality firms. Looking at this smaller sub-set of speciality recycling and re-use, areas of activity could be identified which might offer job-creation opportunities based not only on local endogenous growth, but also the potential to export these services to other developing countries, and in a few instances, developed countries, where a particular comparative or technological advantage exists. To some extent this is what the CSIR (2000) survey and Blueprint study (2006) of the environmental goods and services sector (EGS) attempted to achieve. Overall the studies found that within the EGS sector, South Africa tended to be more competitive with respect to services rather than goods and technology. They did, however, identify several niche markets where South Africa was internationally competitive, based on historical activity related to the scarcity of water and dealing with mine waste. Niche markets such as BioCOP copper leaching processes, Bardenpho processes to remove nitrates and phosphates from domestic wastewater, and mining reclamation and rehabilitation are particular examples. Local firms specialising in this type of recycling and re-use generally already operate internationally, but it would be interesting to take these studies further and test the growth potential of these activities, as the drive towards sustainable development increases across the globe.

6 Conclusions

This paper was never intended to be a definitive piece on the employment potential of recycling and re-use in South Africa. Rather, it was an attempt to establish an approach to thinking about recycling and re-use as an industry and economic activity rather than as merely an ad hoc activity undertaken by industry under duress from government and environmentally conscious organisations and households. To this end we have shown that recycling will be an important economic feature in future industrial paradigms, such that entire economic systems will eventually need to morph from linear-based production models to closed-loop production models. In the intervening period, however, the speed at which the recycling revolution occurs will be strongly determined by government policy, as market conditions have not yet matured to a point where market forces will support intensive recycling. As such, the growth of recycling activity and employment will be determined to a large extent outside of the market. In time, however, market forces will increasingly drive the process and lead to new enterprises, new technologies, new occupations and new employment opportunities of a scale possibly larger than the 20st century ICT revolution.

At a micro-economic level we have been able to show the perversity of recycling markets and how limited demand for secondary materials and costly supply of recyclates undermine endogenous growth. Remedial activity to ameliorate these challenges is available but will require time, financial resources and most importantly commitment from central government. First-mover advantages will be substantial for those states which choose to make this investment early, but it is likely that the majority of these opportunities will be harnessed by developed nations which are better positioned to make such an investment.

In South Africa it appears that government policy is in principle supportive of a move towards intensive recycling but that the agenda is firmly driven from a waste management perspective rather than from the perspective of growing a potentially new growth sector. Policy reform in relation to recycling is occurring and various processes are under way to increase recycling, but this is commonly done with respect to the recycling of very narrowly defined specific materials and is largely influenced by the 'enlightened self-interest' agendas of the large firms producing these materials. This approach will yield results for South Africa in the short run in terms of increased recovery rates and increased recycling content, but does not necessarily position the sector as a whole to grow to an intensive and competitive level in the medium to long term.

In terms of understanding the job-creation potential of recycling, the study has spent much time explaining the limitation of data and information available. This limited data is a function not only of systemic difficulties in enumerating these activities which are shared in all countries, but also of the lack of resources which have been applied to undertaking surveys and detailed studies. What has emerged from the scanty data available is that much of the job creation related to recycling occurs at the collection and sorting phase of the supply chain. Reprocessing and composting processes appear to be relatively capital intensive when recyclates are reprocessed into the same product, such as glass cullet into glass bottles. The story appears, however, to be different when reprocessing generates raw materials which are employed for an alternative use. In these circumstances potentially high multipliers exist, such as when plastic PET bottles are recycled into resins, which can then be used to manufacture tracksuits and duvets. This is a recognised trend internationally, and as such developing new markets for the alternative use of reprocessed materials is seen as an important element in maximising the job-creation potential of recycling activities.

A second important finding related to the status quo of recycling employment in South Africa is that it appears that the majority of jobs created are in the informal sector (between 75 000 and 100 000). We believe that this is a misleading finding, skewed because of the difficulty of determining formal sector employment attributable to these activities. If the CSIR and Blueprint EGS studies are to be believed, anything from 100 000 to 500 000 people are employed formally in the EGS sector. A substantial portion of these jobs must be related to recycling, reprocessing and re-use goods and services, hence the perception created that most of the jobs in this area are informal is probably incorrect. This assertion will be tested when a survey of firms is undertaken in the second phase of this project.

It is hoped that this paper has made some contribution towards determining a more focused agenda for follow-on research. On the basis of our current information and data, nothing can be concluded, proposed or recommended other than a general finding that sufficient job-creation potential has been identified as to make a further, more detailed investigation of these activities a worthwhile and useful investment of time and resources. Key issues to be addressed in the follow-up research should include:

- The size and scope of formal sector reprocessing, recycling and re-use and its employment status;
- The size, scope and potential for growing the market for secondary materials, not only as substitutes for virgin materials, but more importantly, from a job creation perspective, the use of secondary materials in alternative uses;
- The size and scope of niche markets in recycling and re-use where South Africa has a comparative advantage and how these niches can be grown and absorb labour;
- The potential of South African recycling and re-use in the sub-continent, given that the local sector is more developed than our neighbouring states and that recycling requires volumes to establish economics of scale, suggesting some potential for South Africa as a regional recycling hub;
- The role of technology in recycling and re-use in decreasing costs, increasing quality and supporting labour-intensive practices. Studies would include technologies such as material recovery facility options and capital equipment development for small-scale recycling, as well as appropriate technologies for

recycling at developing-county scales rather than scales found in developed countries;

- The size, scope, scale and economics of informal sector re-use and its potential for export; and
- A study of the institutional landscape within which recycling occurs and within which recycling policy is determined. This is an area which we were unable to cover in depth in this paper, but which will be a constraining factor if an intensive recycling agenda or growth of the sector is to be dealt with seriously.

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