The Technological Economics Of Glass Recycling

by

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Thesis submitted for the Degree of
Doctor of Philosophy

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20 December 1986

5/87

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Volume 1

December 1986

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ABSTRACT

This thesis examines the technological economics of glass recycling in Britain. Attention was focused on recovery schemes operated within Scotland, comparisons being made with schemes in the rest of Britain and in Europe. An examination was made of general recycling problems and of glass recycling problems in particular. The various systems for glass recycling were reviewed and were put in the context of the waste management system as a whole.

A survey was undertaken of Local Authorities operating glass recycling schemes. The aim was to provide a comprehensive data set to enable a consistent assessment of glass recovery schemes to be taken. This emphasised the importance of taking a standard approach to assessing the viability of recovery schemes. This needs to be done in terms of both private and social costs and benefits to provide a full economic assessment of the system.

A general computer model has been developed to allow local authorities to check the viability of their on-going operations. As they operate under different conditions this model was split into separate assessment of a Bottle Bank scheme and a trade collection scheme. In addition, an investment appraisal model was developed to cover both situations. These allow managers to assess the viability of their schemes and can be used to highlight key costs.

An International review was undertaken to see what lessons may be learned and what actions may be taken by the local authorities, industry, the general public, and by central government.

R MATTHEWS
31/07/86

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Acknowledgements

I am indebted to many individuals and organisations who were kind enough to provide advice and information connected with all aspects of this work. Their help and encouragement is gratefully acknowledged.

I am grateful for the support and helpful contributions I have received from staff and students of the Technological Economics Research Unit and of the Department of Management Science.

I am especially grateful to my supervisor Dr Robert Ball, Department of Management Science for his encouragement and perseverance in ensuring that this work was successfully completed.

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CHAPTER ONE - Introduction

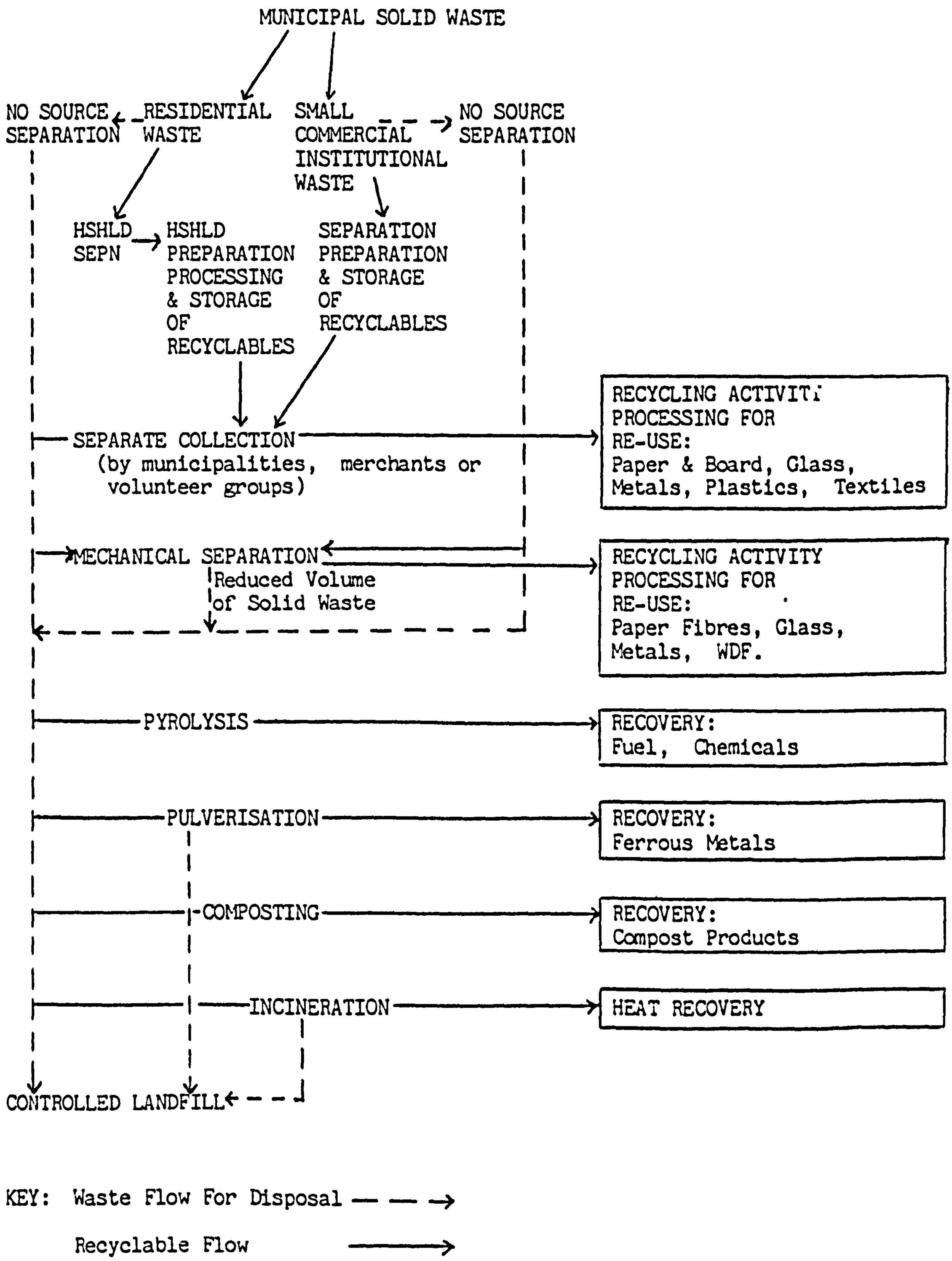
1.1 Background

This study is the third in a series conducted under the auspices of the Technological Economics Research Unit (TERU) at Stirling University that has examined different aspects of waste management. In 1982 HO T K completed work on a systems study of waste paper recovery and recycling. He looked at the possibilities for paper reclamation and the need for local authorities who operated revovery schemes to undertake a detailed assessment of their collection operations. This work sought to provide a uniform basis for assessing paper recovery schemes. RUSHBROOK P E (1984) detailed the costs of collection and disposal operations run by local authorities and produced a series of planning models to assist waste managers in their decision making processes.

1.2 Aims Of Thesis

This work on glass recycling follows on from these two studies by seeking to provide a detailed assessment of glass recycling practices. After paper, glass is one of the main fractions of the municipal waste stream (MWS) accounting for around 10% by weight, which amounts to 1.8 million tonnes. Yet to date, only a fraction of this waste material is recovered in Britain. In 1984 this was about 162,000 tonnes, nearly 9% of the potential resource. This compares adversely with other European countries where recovery rates are higher and has reached 50% in the Netherlands (Chapter 12). In Britain glass recycling has been promoted at a Local Authority level and was initiated in 1977 by the Glass Manufacturers through their trade organisation the Glass

FIGURE 1.A Simplified Municipal Waste Management System



SOURCE: TURNER, R K (1981) An Economic Evaluation Of Recycling Schemes

Manufacturers' Federation (GMF). It has been built up on a piece-meal basis, with no real guidance from Central Government.

The objectives of this work are thus threefold:

1. To review the existing systems of glass recovery in Britain.

2. To establish a data base on the costs of schemes run by Local Authorities.

3. To provide a consistent basis for assessing the viability of glass recycling schemes.

1.3 Waste Management System

Waste is a by-product of many activities in Society. These by-products can be viewed as part of an open system where raw materials are extracted, processed, consumed and finally discarded as waste (SIMMONS 1974). As Society has progressed and developed the management of this waste has become increasingly important in the maintenance of the well being of the people. Waste management has become a complex set of interrelated functions that lead from waste collection to final waste disposal. Figure 1.A shows a simplified waste management system. It shows some of the connections of the system. If glass can be recovered from household or trade sources this will reduce the amount of waste that a local authority will have to collect, therefore reducing the amount of material that has to be processed. The removal of glass can improve the incineration process, as glass residue clogs up the grates. Also the removal of glass from the waste stream can improve the quality of products such as compost or waste derived fuel (WDF), from mechanical separation. Ultimately the removal of glass from the waste stream will mean that less waste will have to be finally disposed of by landfill.

With the increasing complexity of waste management and mounting

public concern on environmental issues, waste disposal and collection costs have risen. It is this background of rising costs, environmental awareness and the inherent value of recovered materials that has lead to the drive to recycle waste materials, thus seeking to close the loop on mixed wastes.

1.4 Legislative Framework

This review of glass recycling needs to be kept in the context of the waste management system with its interdependant activities, and the National legislative framework for waste management.

The United Kingdom has had a long history of legislative involvement with solid waste disposal practices (FORSTER 1977). Any changes in the law have occurred within established boundaries, eg the control of disposal practices, rather than the establishment and development of management programmes. The extension of the law to cover hazardous wastes and recycling have been linked to the existing system, resulting in a non-integrative approach.

The Control of Pollution Act 1974 is the main piece of legislation. Part 1 establishes a new legal framework for the planning and regulation of waste disposal operations. Under this Act, the collection and disposal of domestic waste becomes the statutory duty of the local authorities. In England it is the duty of the collection authority (District Council) to collect all household waste in its area and of the waste disposal authority (County Council) to dispose of the waste. This split between collection and disposal authorities has been criticised as it inhibits a cohesive approach to waste management. This is not the case in Scotland and Wales where the functions of collection and

disposal are combined at District Council level.

Section 2 implemented on July 1 1978 requires Waste Disposal Authorities (WDA's) to survey the waste arisings and disposal facilities in their areas, to draw up and periodically revise a waste disposal plan. Such a waste disposal plan should include information on:

- the kinds and quantities of waste which will arise in the area, or be brought into it, during the period of the plan;
- what waste the authority expects to dispose of itself;
- what waste others are expected to dispose of;
- the methods of disposal, eg reclamation, incineration, landfill;
- the sites and equipment being provided; and
- the costs.

This should lead to the preparation of comprehensive long term plans for waste disposal, to the operation of licensing systems for all waste disposal sites and plants and to the safe disposal of hazardous wastes. Special reference is made to recycling giving the WDA's the power to assess the possibilities of reclaiming wastes in the preparation of their waste disposal plans. These surveys should provide the first comprehensive data set on waste arisings in Britain, as they will cover all 'controlled' waste arisings, general industrial as well as household and commercial waste. However, there was no deadline for the completion of these surveys and few have as yet been finished. PEARCE (1984) noted that at the end of January 1984, only 23 counties out of 45 in England had prepared waste disposal plans. In Scotland and Wales, where the plans are the responsibility of the District Councils even fewer plans had been prepared. In Wales none of the 37 districts had prepared plans

and in Scotland only 3 out of 53 Councils had completed plans. In 1980 the Government repealed the section of the CPA 1974 that could have been used to set timetables in which Councils had to complete their waste disposal plans.

Section 20 of Control of Pollution Act 1974 makes provision for the separate collection of different types of waste, although this remains a discretionary rather than a statutory power. It states:

> 'Without prejudice to the powers of disposal authorities, apart from this section, any disposal authority may:-
>
> a. do such things as the authority considers appropriate for the purpose of:-
>
> 1. enabling waste belonging to the authority, or belonging to another person who requests the authority to deal with it in pursuance of this section, to be used again, or
>
> 2. enabling substances to be reclaimed from waste;
>
> b. buy or otherwise acquire waste with a view to its being used again or to the reclamation of substances from it, and
>
> c. use, sell or otherwise dispose of waste belonging to the authority or anything produced from such waste.
>
> (Commencement: 1st January 1976; CPA 1974)

It is under Section 20 that recovery schemes like Bottle Banks are allowed to operate, either run by the WDA, the WCA, or other local organisations. This section allows local authorities to recycle materials, but does not seek to encourage or enforce them. Under the present financial stringencies there is an unwillingness amongst local authorities to commit themselves to the extra expenditure involved in recycling schemes. There needs to be a positive approach from Central Government informing local authorities that they must recycle, in the same way as they dictate that they have a duty to collect household refuse. The publication of the Wealth of Waste Report (1984) and the

appointment of a Minister with responsibility for Waste (Anon 1985) may lead to a more positive approach by the Government to recycling and reclamation.

1.5 Private And Social Costs of Recycling

As well as reducing the problems of waste management increased reclamation can improve the quality of the environment through the extension of resource life, energy savings and in reduced levels of pollution. Despite these environmental benefits of recycling the controlling factor in the development of recycling schemes as in all industries is COST. There is a need to estimate the relative costs of disposal and of reclamation on the basis of a comprehensive study of the total costs of disposal including social and environmental costs.

Recycling needs to make a financial return in an economic climate which demands the justification for any capital expenditure.

Apart from the private costs and benefits of recycling which include collection costs, processing costs, and revenues received, there are social costs and benefits that need to be considered.

Social benefits of recycling include:

a. Present value of any extended resource life due to recycling;

b. Any reductions in pollution due to the reduction in residues disposed of directly to the environment;

c. Reduced demand for land for disposal purposes, releasing it for alternative social uses;

d. Savings in imports of raw materials;

e. More efficient use of available resources.

Social costs of recycling can include:

a. For some recycling processes there will be increased pollution costs;

b. Problems of industrial dislocation if 1-trip containers are banned.

PEARCE (1976) saw nothing intrinsically beneficial about recycling, it is a matter of weighing up the social costs and benefits. As the cost of recycling itself consumes resources, it is necessary to balance the social value of resources used against those resources saved. It is necessary to define the waste disposal costs as a set reference point against which recycling options can be assessed. If recycling cannot do better in cost terms than other conventional means of dealing with waste, then it is not 'worthwhile'.

Thus private decisions alone are not adequate guides to the 'social' desirability of recycling. It is Central Government's role to account for the social costs and benefits of individual actions, and to enforce by legislation actions for the benefit of the whole of society. Legislation in effect internalises externalities making concerns account for their actions or face the penalties. This work seeks to look at recycling schemes on two levels: the private financial costs of recycling schemes and the social costs and benefits of recycling.

1.6 Outline Of Thesis

The objective of this research was to examine the different methods of glass recovery and produce a consistent approach in the assessment of the viability of schemes in terms of private and social costs to provide a full economic assessment of the system. It was decided to concentrate on schemes run in Scotland,

comparing them with schemes run in the rest of Britain to account for the different legislative structure.

This dissertation has been organised into 13 chapters:

Chapter 2 outlines some of the general problems of recycling materials from the general waste stream. It treats recycling as an integral part of the waste management system. This chapter provides a definition of waste and an analysis of the potential for recovery of the different materials. In addition it introduces the concept of high and low technology options for the recovery of the different materials.

Chapter 3 - Problems Of Glass Recycling - This chapter looks at problems of the quantities of glass available, the need to colour sort and the question of container numbers and sizes.

Chapter 4 - Returnable/Refillable Containers - The reuse of containers is examined. This chapter looks at the potential benefits, and the legislative framework that has been used in other countries to promote reusable containers.

Chapter 5 examines the various recycling options available. Both source separation and mechanical separation of material is examined with examples being cited.

Chapter 6 provides a detailed appraisal of the Bottle Bank system. It looks at the various operating systems and the role played by Local Authorities, Industry, Volunteer Organisations and the General Public.

Chapter 7 - Local Authority Survey - This Chapter looks in detail at the questionnaires undertaken to gather information on the glass recycling operations run by Local Authorities. It looks at attitudes of both the Operating and Non-Operating Authorities. The results emphasise the importance of national considerations behind local decision making processes.

Chapter 8 - Social Factors In Glass Recycling - Apart from financial appraisal, recycling can have wider social and environmental costs and benefits. This chapter provides a qualitative assessment of employment opportunities and energy consequences of recycling glass. Such an assessment is important in providing a total appraisal of any recycling scheme.

Chapter 9 - Financial Viability - This chapter uses data gained from the questionnaire (Chapter 7) in examining three viability measures. Emphasis is put on using a standard framework of appraisal that takes into account all the costs and benefits of operating a reclamation project.

Chapter 10 - The Viability Model - This chapter provides details of the Management Model, with background and justification of the factors used. A hypothetical scheme is examined to illustrate the affects on viability of changes in the key variables.

Chapter 11 - The Trade Model - A separate management model for trade scheme has been assessed to account for the different collection scheme based on a 'door-to-door' collection. Both Local Authority and Private collection schemes were examined to provide the background for the Trade Model.

Chapter 12 - International Comparisons - An review of actions taken by other countries has been undertaken. This was done to see if there were any reasons for their generally better recycling rates and to see if any lessons could be learned and practices adopted in Britain to improve recovery.

Chapter 13 Conclusions and Recommendations. This chapter brings together the main points of this research. Emphasis is placed on the importance of treating recycling as one option of a waste management system. A clear assessment of costs should be made both in terms of the narrower financial costs and in the wider economic considerations.

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Chapter 2 Waste And Recycling

2.1 Introduction

This chapter looks at problems of waste and introduces the recycling option as an inherent part of the waste management system. First, it examines the problems of waste production and views it as part of an 'open' system which can be related to the flow of money. It goes on to introduce the concept of externalities and stresses their importance when assessing waste management options. This area of external costs and benefits is expanded in Chapter 8.

A definition of waste is provided and the importance of the analysis of domestic waste is considered. A general assessment of recycling problems is given. This provides a definition of reclamation, recovery options and recycling rates. Finally, PEARCE's (1976) model for establishing the optimum level of recycling is introduced. This model brings together the private and the social costs and benefits.

2.2 The Waste System

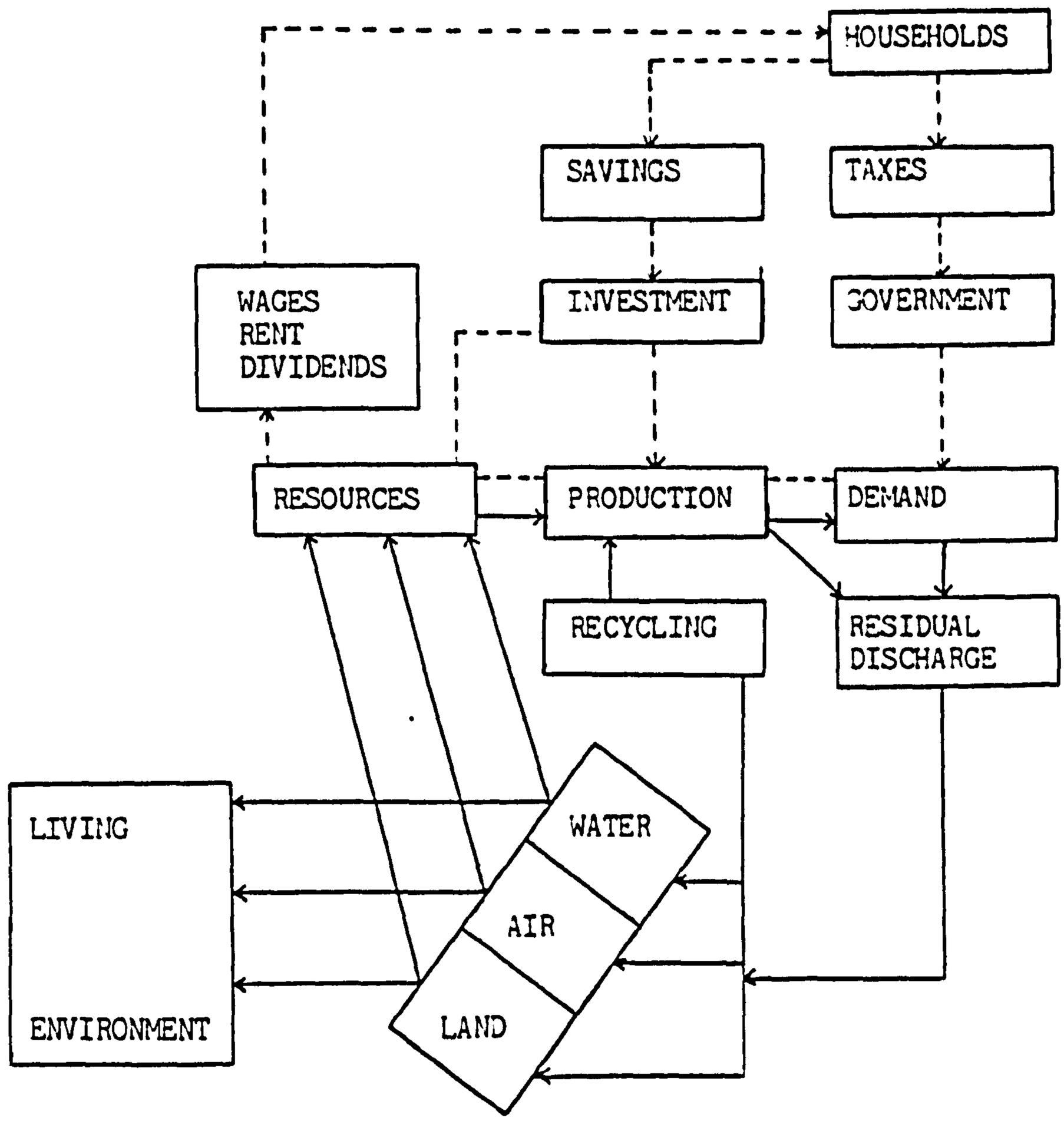
There are a number of technical constraints associated with waste treatment. Waste has a complex, rapidly changing multi-component composition. Waste arisings are widespread with a large and continuous production. It is the quantity and the type of material in a given location that will condition the extent of any recycling scheme or disposal option. When a recyclable material is mixed with other refuse there is both a loss of homogeneity and a contamination problem. Materials consistency, in both form and

quality will affect the potential for the use of secondary materials in the production process. In general after mixed collection domestic waste is recycled into products of a lower grade than that originally. The extent and variety of contamination is determined as materials pass through manufacture, usage and handling after consumption changes in the economy. Advances in separation, cleaning and up-grading technologies help to reduce the contamination constraint on recycling.

Problems of waste management arise from the production and consumption of goods and services. The importance of looking at the waste management system as a whole was developed by TURNER (1981), with a simplified waste management system being shown in Figure 1.A. Section 1.3 notes that reclaiming glass will have consequences on other sections of the system which need to be considered when assessing waste management options. NORTON (1984) compares the flow of waste with the movement of money through the economy. This is shown in Figure 2.A. It shows that as the flow of money through the economy from consumers to resource owners is completed by the payment of wages, rents and dividends; so the flow of material and energy involved in producing goods and services is completed by waste disposal. Recycling seeks to close this 'open' loop.

Natural resources often act as receivers of waste materials. As these services provided by natural resources in receiving wastes tend not to be bought or sold on the open market, costs to society in the form of pollution damage are incurred outside the market system. Such non-market effects are known as externalities. The incidence of pollution externalities, depends in part on the level and form of activity in the economy, which is influenced by:

Figure 2.A The Economic Problem



KEY: Flows Of Materials And Energy ⟶
Flow Of Money — — — — →

SOURCE: NORTON G A (1984) Resource Economics

the size of population

the influence of the population and its consumption preferences

the type of technology employed

the form of government intervention in terms of economic, technological and environmental policy.

As the rate of flow of materials and energy also affects the rate of resource depletion, current economic activity will influence future welfare, as well as the present balance between economic and environmental welfare. It is important when assessing reclamation schemes that private, social and environmental costs and benefits are taken in to account to provide a comprehensive data set to assist the decision making process.

2.3 Definition Of Waste

The Control of Pollution Act (CPA 1974) provides definitions for controlled waste which covers industrial, household and trade wastes (CPA Section 30(1)). It is under these definitions and within this Act that waste management systems operate.

Industrial Waste (CPA Section 30(3)(b)) is made up of waste from any factory within the meaning of the Factories Act 1961.

Household Waste (CPA Section 30(3)(a)) is one of the three components of controlled waste and consists of:

> 'waste from a private dwelling or residential home or from premises forming part of a university or school or other educational establishments, or forming part of a hospital or nursing home'.

Commercial waste (CPA Section 30(3)(c)) is the third component of controlled waste, and consists of:

> 'waste from premises used wholly or mainly for the purposes of a trade or business or for the purposes of sport, recreation or entertainment'.

Waste collection and disposal is largely a local government function. Central Government has reserve powers including an appelate role over any disputes, but is mainly confined to the development of broad policy, the sponsoring of research and the issuing of advice.

The White Paper 'Disposal Of Solid Toxic Wastes' (DOE 1970) notes that the 'producer's' definition of waste is presumably that which it is cheaper to throw away than to make further use of. This does not mean that the waste material is valueless, as it might be 'economic' for one user to throw the substance away but 'uneconomic' for the nation (or for mankind) particularly in the long run.

From the perspective of the waste producer, it is cheaper to throw the material away, otherwise they would keep it and utilise it for another purpose. There is a need to account for different interest groups evaluation of what is waste. The production of waste can be seen to make commercial sense, but not necessarily economic sense. This is where economic refers to the whole system, whereas commercial refers to a particular part of the system. The onus is on the Government to account for the social costs in line with the private costs and where necessary to use fiscal policies to internalise externalities within the commercial decision making process.

2.4 Analysis Of Domestic Waste

It is important to analyse the composition of domestic refuse, when considering waste management options because:

a. the nature of refuse influences the mode of collection;

b. the lives of landfill sites can be forecasted; since changes in composition, density, and output per person per day will affect the life of landfill sites;

c. the design of a refuse disposal plant is influenced by the nature of the refuse;

d. an assessment can be made of the material available for recycling or re-use;

e. an estimate can be made of heavy metals or other biologically active substances that may affect the future use of reclaimed land.

The aggregate of wastes which collection authorities have a duty to collect is termed municipal waste, and includes: household, commercial, civic amenity and street cleansing wastes; and wastes from other municipal udertakings. The Royal Commission On Environmental Pollution (RCEP) 11th Report on waste, shows that WDA handled 19.5 million tonnes of waste. This figure was based on information supplied by CIPFA, which showed that 15.3 million tonnes was collected by WCA, and 4.2 million came from Civic Amenity Sites. Table 2.1 shows that this is a relatively small amount of the total waste produced annually in Britain.

A problem is the value that should be put on these figures. CIPFA provide information on volumes, organisation and costs for all districts and waste disposal authorities. However the volume of waste collected is often based on estimates as not all the material collected is weighed. Due to this CIPFA tend to qualify their figures by advising their use as a general guide rather than a working standard. ERL (Environmental Resources Limited) (1985)

noted that one material recovery scheme foundered because actual refuse flows were below the quantities estimated by the collection authorities. This emphasises the need for a sound local data base being available on which to base a sensible waste management policy.

Households throw away on average 1 tonne of refuse per annum. A breakdown of this is shown in Table 2.2. The main constituent is paper at 33% by weight, about half of this is packaging the rest being made up by newspapers and magazines. Glass accounts for 8% by weight (INCPEN 1981), along with metals particularly ferrous cans. Also the plastic component is significant and has been rising with the introduction of Polyethylene Terethphalate (PET) bottles into the drinks markets. Table 2.2 illustrates the considerable changes that have occured in the make-up of waste. The proportion and quantity of cinder and dust in waste has decreased dramatically, due in part to the Clean Air Act 1956 and the resultant move to 'clean' heating systems. This also accounts for the change in weight of refuse.

Table 2.2 does not show the change in volume of waste. Bulkier less dense items - packaging - have increased rapidly relative to other types of waste. This has led to a considerable reduction in density of waste: with a parallel increase in the volume. Packaging material accounts for much of this growth. The impact of packaging has been looked at by INCPEN (1981) and is shown in Table 2.3. Packaging constitutes nealy 30% by weight of domestic waste, but nearly 40% by volume; and these figures are expected to rise. Volume is in many ways more important than weight in assessing the problem of domestic waste, for it is the growing volume that creates the need for a second dustbin. This may in

TABLE 2.1 Type And Quantity Of Waste Produced

TYPE OF WASTE	QUANTITY (Tonnes/annum)
Household & Commercial Waste	18 million
General Industrial Wastes	23 million
Building Waste	3 million
Power Station Waste	12 million
Mining Waste	60 million
Quarrying Waste	50 million

SOURCE: WMAC, Waste Management Paper No 1

TABLE 2.2 Waste Per Household Per Week: Average Weight and Percentage Composition

	1935		1968		1973	1980'	
	kg	%	kg	%	%	kg	%
Fine Dust & Small Cinder up to Cinder 1	9.7	56.98	2.3 0.6	17.44 4.45	19.00	1.8	12.00
Vegetable & Putrescible Matter	2.3	13.71	2.3	17.61	18.00	8.4	17.00
Paper	2.5	14.29	4.9	36.91	33.00	6.3	43.00
Metal	0.7	4.00	1.2	8.87	10.00	1.3	9.00
Rag	0.3	1.89	0.3	2.35	3.50	0.4	3.00
Glass	0.5	3.36	1.2	9.11	10.00	1.3	9.00
Plastics	1.0	5.57	0.3	2.14	0.30	2.0	-
Unclassified Debris	-	-	0.1	1.12	1.50	0.7	5.00
TOTAL	17.0	100.00	13.2	100.00	100.00	14.5	100.00

' 1980 figures are forecasts

Source: Refuse Disposal, Report of Working Party DOE 1971

TABLE 2.3 Composition Of Household Waste And The Contribution Of Packaging

CONSTITUENTS	Kg/hshld /week	Percentage By Weight	Proportion Of Househld Waste That Is Packaging	OF Packaging In Waste (%)
SCREENINGS	1.4	13	0	-
VEGETABLES & PUTRESCIBLES	3.0	28	0	-
PAPER & BOARD	2.9	27	0.34	9.2
METALS	0.8	8	0.85	6.8
TEXTILES	0.3	3	0	-
GLASS	0.9	8	1.00	8.0
PLASTICS	0.5	5	0.75	3.8
UNCLASSIFIED	0.8	8	0	-
TOTAL	10.6	100	-	27.8

Source: INCPEN Figuring Out Rubbish 1981

turn lead to the expansion of collection facilities and a subsequent increase in disposal needs.

The composition and quantity of domestic waste also varies from area to area due to the presence of different industries, different types of housing, densities of housing and the different qualities of life style. It is for these reasons that each disposal authority should undertake a comprehensive analysis of waste produced in their area, to enable them to devise and implement the optimum management plan.

TURNER (1981) produced a 'Household Generation Function, R' indicating some of the variables that affect waste generation:

$$R = f(T, Y, Wc, P, G, Hs, H, Sl)$$

Where:

R = Quantity & composition of waste generated.

T = Households Tastes & Preferences.
Y = Disposable Income.
Wc = Vector of Waste Co-efficients for goods and services.

P = Vector of Final Prices for consumption goods.
G = Geographical & Climatical factors

Hs = Household size & composition.
H = Size & Character of Dwelling Unit.

Sl = Level of Waste Management Service.

P, will reflect the price competition between the various package options - glass, plastics, metal cans - as well as the differences in price between returnables and non-returnable glass containers. There is a need to determine consumers perception of price when comparing Non-Returnable with Returnable containers in light of the contribution that the bottle deposit makes to the full price paid. A contributory factor is the attitude of Retailers at the point of sales in accepting back returnables

which is aligned with their stocking policy. Allied with this is the consumer perception of the relative merits of returnable versus non-returnable containers (FISHER & HORTON 1979). These areas are expanded in Chapter 4 which deals more fully with the issue of returnable containers.

Technology has a role with the development of new lighter, stronger packages with specific properties to suit specific markets - e.g. plastic with PET bottles, and the development of 'plastic cans'. In addition glass manufacturers are joining together to produce a lighter glass bottle (ANON 1985).

The potential recovery of materials will be based on the assessment of the availability of materials in terms of both quantity, location and time. This will require a detailed analysis of domestic waste which will be carried out as part of the general preparation for waste disposal plans which Local Authorities are duty bound to carry out (Section 1.4). The quantities of materials in a given location will condition the extent of any recycling scheme or waste disposal option.

2.5 Definition Of Reclamation

Reclamation refers to the process of making material which has come to be considered as waste, available for further use; this re-use is termed RECYCLING. These two terms - reclamation and recycling - tend to be used synonymously. With scarce resources there is the possibility of maintaining supply through reclamation and recycling. Recycling, the process of reclamation includes several variants (Porteous 1977):

1. Recycling For Re-Use
   - eg Returnable Glass Milk Bottles

2. Direct Recycling For Raw Material recovery
   - typified by paper recovery and the Bottle Bank scheme for recovery of cullet

3. Indirect Recycling - Recovery as a fuel/chemicals
   - where either a much lower grade or completely different product is made from recovered material; or ultimately energy can be recovered.

2.6 Recovery Options

There are two recovery options: High Technology
Low Technology

Table 2.4 shows a comparison of the two technologies. Low technology is labour intensive with small capital expenditure, whereas high technology tends to be capital intensive. Low technology is easily and 'cheaply' implemented and the inertia of the working system is provided by labour mobility and the level of public participation. High technology schemes once established, require construction time and capital investment and the inertia of the system is provided by the burden of loan charges. Both systems have options that provide means for the recovery of glass (Chapters 5 & 6).

TABLE 2.4 Comparison Of High & Low Technology Schemes

	HIGH TECHNOLOGY SCHEMES	LOW TECHNOLOGY SCHEMES
REPRESENTATIVE PROJECTS	Warren Spring, Doncaster. Flakt (RRR) Plant	Bottle Banks, W. Europe.
CAPITAL COST	High, uses sophisticated machinery for all operations.	Modest - use machines for processing, manual sorting.
LABOUR COST	Low	Maybe high, or low if use Voluntary Labour.
EMPLOYMENT CREATION	Poor - skilled maintenance trades	Good - unskilled jobs; openings for disabled.
SCALE	Large - City size	Small - Town or Community size.
SITING	Separate from residential areas.	Can be within communities which generate waste.
POLLUTION	Complex controls - high volume of input and sorting media.	Not serious - modest volume pre-sorted input.
FLEXIBILITY IN RESPONSE TO CHANGES IN WASTE COMPOSITION OR MARKETS	Inflexible - capital & maintenance costs continue regardless of degree of use encourages continuation even if unprofitable.	Highly flexible - output varied or stopped by the redeployment of labour & basic equipment.
COMMUNITY INVOLVEMENT	Civic pride, little public involvement.	High - depends on householder cooperation in separation at source.
ECONOMICS	Influenced by variations in market.	Low profitability, plus social benefits, and flexibility.
EFFECT ON MATERIAL GRADES	Down grades materials.	Segregates valuable high grade materials.

Adapted from: SIMS F A (1982) Recycling Of Waste Materials - The Reality CHART MUN ENG 109 p17-19

VOGLER J A (1978) Muck & Brass Oxfam

The main reclamation methods currently available are:

1. Mechanical processing and separation of waste components at central capital intensive units. It provides a low grade feedstock for non-critical products and a fuel (WDF). E.g. Doncaster & Byker Recovery plants In Britain. (High technology)

2. Source separation and collection systems. This can provide high grade materials for re-processing. E.g. Bottle Bank system for cullet collection; 'Green' sack collection being developed in West Germany. (low technology)

3. Pyrolysis systems can produce fuel, gas or oil, char and other chemicals. (High technology)

4. Energy recovery from Incineration of refuse by public and private users. (High technology) E.g. GLC's Edmonton incinerator produces electricity for sale to CEGB; burning of refuse for district heating schemes at Sheffield and Nottingham; burning of refuse by private companies such as at Blue Circle's cement works at Westbury.

These recovery sub-systems have been shown in Figure 1.A as part of the overall waste management system, where it lists the secondary materials most likely to be recovered. To mitigate the solid waste problem a systems approach should be adopted in which the waste management operation is regarded as a total system of interdependant activities. This management system can be thought of as three inter-linked activities (Quimby 1975):

a. handling, processing and storage of waste materials by the generator;

b. collection and transport of waste materials to a refuse transfer station, recycling centre, or disposal facility;

c. actual disposal and/or recycling.

Thus municipal authority can treat refuse mechanically to separate out the glass fraction. Alternatively, the consumer can be asked to keep glass out for separate collection. There is a need to either separate glass into colours, manually or mechanically; or to develop a system to process the mixed glass. In all schemes the

financial framework needs to be established to cover both private and social costs to assess the viability of the options. In the absence of any positive Government strategy or financial support, recycling schemes should operate on the basis of low technology scheme (SIMS 1982). In times of financial constraint low technology schemes are more easily implemented by Councils or voluntary groups. They are more flexible in adapting to meet the demands and conditions of local sources and markets for the reclaimed material.

2.7 Recycling Rate

As well as reducing the problems of waste disposal, materials recycling can improve the quality of the environment through the extension of resource life, energy savings and in reduced levels of pollution. However, there are factors that will limit the rate of recycling. In particular: growth in consumption, product life, cost factors, energy limitations, handling losses and cross contamination will put an upper limit on the proportion of materials that can be recycled. As 100% recycling of materials is impossible, recycling can only be part of the answer to waste management problems and not their complete solution.

The concept of a 'recycling rate' is difficult to define. TURNER & GRACE (1977) produced two measures: 1. Utilisation Rate, and 2. Recovery Rate in their examination of paper recovery. To some extent these can be adapted for glass. Both measures account for imports and exports of materials. In the past trade in glass was limited. Recently, reduced glass container production in Belgium and high glass collections in Holland has led to increased exports of waste glass (110,000 tonnes in 1985; ANON (1986)).

The two recycling rates are:

1. Utilisation Rate, $U = \frac{\text{Waste Glass Usage}}{\text{Total Glass Usage}}$

so that:

$$U = \frac{W_D - W_X + W_M}{TCU}$$

where:

TCU = Total Cullet Usage
W_D = Domestically Recovered Waste Glass
W_X = Exports of Waste Glass
W_M = Imports of Waste Glass

2. Recovery Rate, $R = \frac{\text{Domestically Recovered Waste Glass}}{\text{Apparent Consumption of glass}}$

thus:

$$R = \frac{W_D}{B_D + B_M - B_X}$$

where:

W_D = Domestically Recovered Glass
B_D = Domestically Produced Glass
B_M = Imported Glass
B_X = Exported Glass

The utilisation rate represents the quantity of secondary material used in the domestic production of the material and can be considered as a measure of the demand for the secondary material (GRACE P 1978). This can be seen as a measure of recycling effort, the amount of material that is reused. The recovery rate represents the proportion of domestically recovered material to the total amount of material available for recovery, an indicator of the supply of the material. This is a measure of recycling activity, the amount of material recovered as a proportion of the material available.

The combined activities of the highly competitive private materials reclamation industry and the wide variety of voluntary organisations and local authorities involved in recycling levels, have pushed recycling rates to significant levels. Table 2.5 shows the levels of recycling achieved within various industries. It illustrates the relatively high levels that occur within the

metals industry. The results exclude most in-house recycling.

TABLE 2.5 RECYCLING OF MATERIALS IN BRITAIN 1980

INDUSTRY	TOTAL CONSUMPTION (Tonnes * 10^3)	RECYCLED WASTES (Tonnes * 10^3)	RECOVERY RATE (%)	NUMBER OF RECYCLING ESTABSHMENTS
PAPER	7,093	2,028	29	580
PLASTICS	1,960	55	3	
RUBBER	338	14	4	150
GLASS	1,996	55	3	30
FE METALS	15,600	9,256	59	2,800
COPPER	409	92	22	
ALUMINIUM	683	162	24	2,800
LEAD	2,462	211	9	
TEXTILES	n/a	325	n/a	470

Source: Vogler J & Bollard A (1982) Remoulding The Future: The Plastics and Other Recycling Industries

The recovery rate for glass was 3% but this excluded any in-house recycling that occurred (In 1985 it reached 12% (See Table 6.2). In industry any scrap generated in a process is of a known quality and is relatively easily recycled.

Predictions of future levels of consumption of secondary materials have been related to a country's GDP. For instance, HO (1982) linked future demand for waste paper with GDP, and this proved to be accurate in the short run. Such forecasts may need to be adjusted in the long term because of effects of technical change, and structural changes in the economy.

Several models have been developed to establish the recycling rate under steady state conditions (BANKS (1976) & PEARCE (1976)). DEADMAN & TURNER (1987) noted that with these models both economic growth and average product lifetimes have a significant role to play in determining the extent of recycling's contribution to resource conservation.

In a growth economy, the contribution of recycling to resource

conservation will be limited, with any shortfall being met by increased use of primary materials. How quickly materials reach the wastestream will be influenced by average product lifetimes. DEADMAN & TURNER (1987) report that the higher the growth rate of the economy and the longer the average product lifetime the smaller will be recycling's relative contribution to resource conservation.

In practice, a major factor affecting the actual level of recycling will be the cost per tonne of recycled material compared with the cost of primary material. As depletion of resources continues and the price of primary material rises a breakeven point will be reached where recycling can be expected to commence. NORTON (1984) shows this as Price, Po in Figure 2.B. As raw material prices increase beyond this point recycling can be expected to increase. But, as the marginal cost of recycling (MC_R) can be expected to increase with the declining quality of scrap available and its increasing disaggregation the substitution of recycled material for primary material will diminish. For some materials - Iron in UK (Table 2.5) 50% recycled - there is little scope for further recycling.

Also as primary materials costs rise, there will be substitution effects as different materials are introduced. The effects of substitution can be seen in the packaging market, where plastics, metals and glass containers compete. This competition will primarily be influenced by price. An additional factor is the relative weight of the package which can influence consumption patterns. The dominance of a particular packaging type can be influenced by government policy. In West Germany the government has put restrictions on the use of PET bottles, until suitable

recycling schemes have been developed. Substitution in the packaging market will be influenced by relative price, legislation and government policy.

Table 2.5 shows that recycling levels are relatively high, with the least cost opportunities already being exploited. The main sources are industry and commerce where there are large quantities of material of known quality. Any extra recycling effort should concentrate on the more dissipated sources of residential and small trader wastes, where the quality of the material is less assured (O'RIORDAN 1979). The availability of the glass fraction in refuse and the development of techniques of recovery, collection and re-processing will favour the further development of a secondary glass recycling industry.

2.8 Optimum Level Of Recycling

PEARCE (1976) has produced the following model that seeks to establish an optimum level of recycling. It seeks to bring in the social costs and benefits of recovery as well as the private costs and benefits faced by recoverers when assessing the viability of recycling operations.

A Private Firm will aim to minimise the total cost of resources used in production; that is to minimise:

$$C = TC_V(X) + TC_R(X)$$

where:

C - Total Costs

$TC_V(X)$ - Total Cost of virgin resources, as a function of output X;

$TC_R(X)$ - Total Cost of recycled resources, as a function of output X.

The total cost of resources will be minimised for the private firm when the two marginal costs are equal (Figure 2.B). Thus the actual level of recycling will be influenced by the cost per tonne of recycled material as compared with virgin material. As depletion of a resource continues and the price of the primary material rises, a breakeven point will be reached where recycling can be expected to commence. This is shown as Po in Figure 2.B. As raw material prices increase beyond this, the contribution of recycled resources can be expected to increase. However, there will be a point as the cost of recycled materials increase due to the declining quality of scrap and its collection from more disaggregated sources where there will be a limit to further recycling and the possible substitution of other materials (Section 2.7).

Whereas Society's objectives will be to minimise:

$$S = TC_V(X) + TC_R(X) + TEC_{P,E}(X) + TEC_{P,V}(X) + TEC_{P,R}(X) - B_{ERL}(X) - L(X)$$

where:

S - Total Costs To Society

$TEC_{P,E}(X)$ - Total External costs associated with extractive industry as a function of output X;

$TEC_{P,V}(X)$ - Total External costs of pollution from virgin material processing as a function of output X;

$TEC_{P,R}(X)$ - Total External costs of pollution from recycling process as a function of output X;

$B_{ERL}(X)$ - Present Values of gains in resource life;

L(X) - Present values in gains in land.

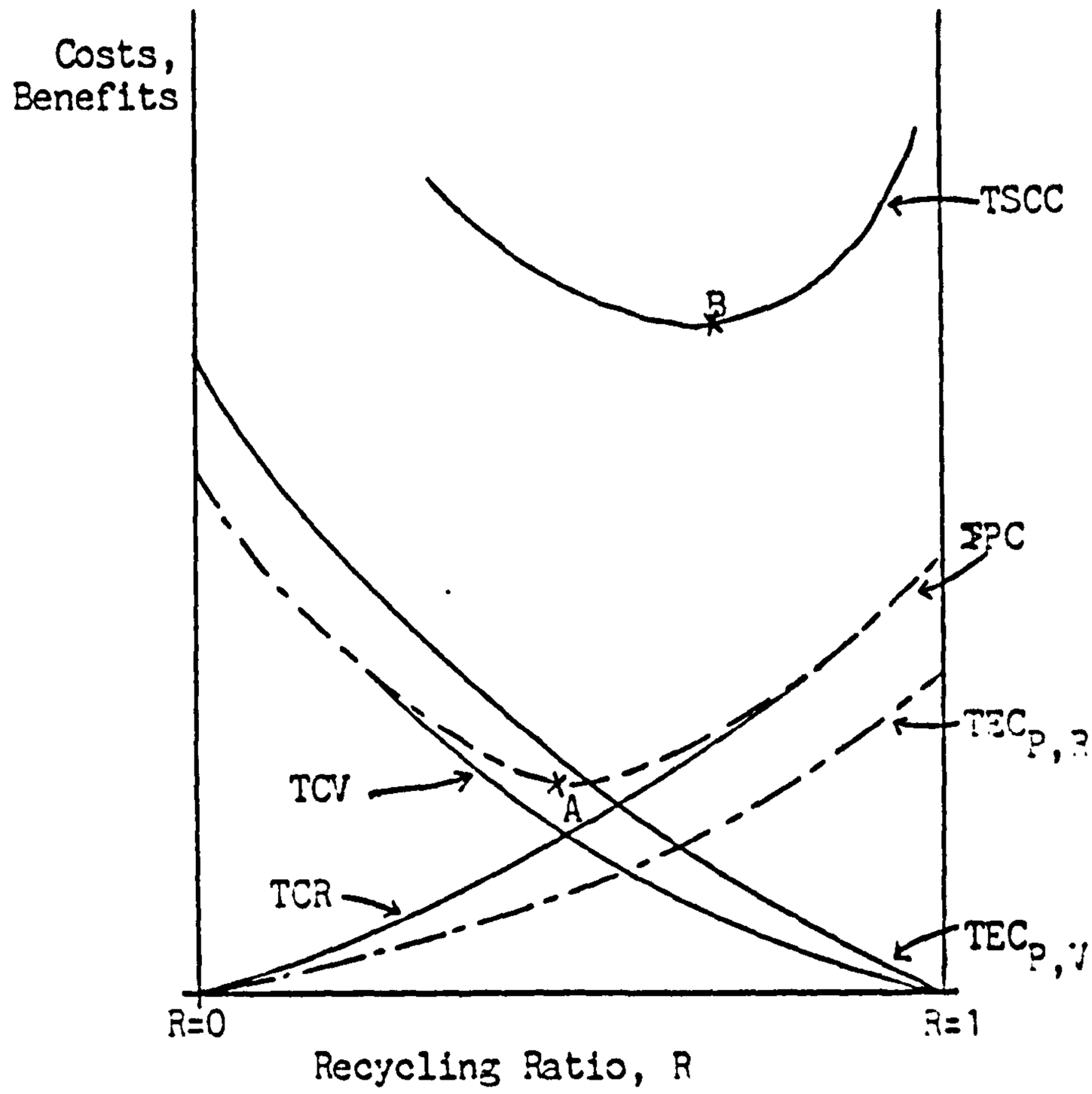
Disposal costs are included in TC_V and TC_R. If it is assumed that $TEC_{P,E}$ B_{ERL} and L are minimal; then the problem is reduced to one of minimising:

$$SC = TC_V(X) + TC_R(X) + TEC_{P,V} + TEC_{P,R}(X);$$

which is depicted in Figure 2.C.

The horizontal axis shows the the recycling ratio such that at R = 1, 100% recycling occurs; and when R = 0, production is met from primary raw material sources only. The total cost of recycled material (TC_R) will increase as R approaches 1. This is because poorer quality material is recovered resulting in need for more processing costs and material is recovered from more dispersed sources raising the costs of collection. The total cost of primary materials (TC_V) will be zero when R = 1; and positive when R < 1; thus costs of primary materials will decline as recycling approaches 100%. Similarly the total external costs of pollution from primary processing ($TEC_{P,V}$) will decline as recycling increases; and external costs of pollution from processing

FIGURE 2.C Optimum Rate Of Recycling



KEY: A = Privately Optimal, R_{PRIV}

B = Socially Optimal, R_{SOC}

TSCC = Total Social Cost Curve

TPC = Total Private Cost Curve

Source PEARCE D W (1976) Environmental Economics

recycled materials ($TEC_{P,R}$) will be expected to rise.

The policy objective of minimising total social costs is equivalent to maximising net social benefits. In Figure 2.C gross benefits are shown as straight lines, as they are invariant with the recycling ratio. Net social benefits are the distance between the total social cost curve ($TSCC = TC_V + TC_R + TEC_V + TEC_R$).

Figure 2.C shows that Private Optimum, R_{PRIV}, lies to the left of the Social Optimum, R_{SOC}, suggesting that more recycling is desirable than the recycling industry provides. Industry are ignoring external costs of their production processes. To redress the balance and force industry to account for these externalities Government can intervene through a number of measures. A depletion tax can be imposed to reflect the future social value of the resource. This will have the effect of raising the price of primary materials relative to that of recycled materials; suggesting that more recycled materials would be used. A rise in price would also reduce demand and encourage more efficient use of the resource and may stimulate the development and use of substitutes as well as improved techniques for recycling. Governments can encourage recycling by constructing the necessary institutional structure, by providing tax incentives and subsidies, or by operating recycling schemes themselves. Legislation can be introduced with regard to the quantity of recycled materials in a product and by the buying policies of Government departments. For instance the DOE are seeking to increase the amount of recycled paper they use in their documents (ANON 1985), which will lead to an increase in demand and more stable markets. These measures seek to achieve a social optimum in' the level of recycling, by forcing companies to account for their

externalities and by the Government taking a positive lead in the promotion of recycling.

Figure 2.C can be drawn to illustrate the opposite effect, with the socially desired level (R_{SOC}) being to the left of the private optimum (R_{PRIV}). This could be the case if recycling technologies adopted are more polluting than the current disposal practices and can be countered by environmental legislation.

It is only from the study of individual cases of materials recovery that optimal measures can be adopted.

Presently, a high proportion of the wastes arising from industrial sources (in-house) are already reclaimed and re-processed. Any increase in recycling will be through the development of other sources of scrap. The development of such sources as municipal waste will be influenced by collection, sorting and separating costs which maybe too high and militate against their use in replacement of primary materials without Government intervention.

The increasing dissipation in use of materials in the final product, makes it more costly to recover the individual materials. For example tin-plate is applied in finer layers to products so more items will have to be collected, sorted and separated to reclaim a given amount of tin. The Second Law of Thermodynamics states that energy must be expended to generate order from disorder, thus imposing energy costs on all recycled products. Although these energy costs may be less that those exacted when obtaining the product from virgin materials.

The development of composite products like cans cause problems of separation and processing. Aluminium ended cans and tinned cans have to have materials separated. Plastic products are now

developing polymers of thin layers compounding problems of separation and limiting recycling to energy recovery.

As the act of recycling itself consumes resources, it is necessary to balance the social value of resources used against those resources conserved. It is necessary to define the waste disposal costs as a set reference point against which recycling options can be assessed. If recycling cannot do better in cost terms than other conventional means of waste handling, then it is not 'worthwhile'. Thus private decisions alone are not adequate guides to the 'social' desirability of recycling (PEARCE 1976).

2.9 Summary

This chapter has provided definitions for waste, based on its sources. A problem with the term waste, is that it gives the perception of having no value. This is despite the fact that there are materials like glass and paper which are treated as waste, yet if reclaimed have a resale value to manufacturers. This emphasises the importance of viewing reclamation as an integral part of the overall waste management system.

In looking at recycling opportunities, it is important to carry out an analysis of domestic waste arisings, as part of the preparation of waste disposal plans. Such surveys should look at the availability of materials in terms of weight, location and when they are disposed. An assessment of household waste generation is provided by TURNER (1981) through the household waste generation function.

There are several possibilities for the recycling of waste materials, the choice being dictated by the market for the commodity and the service for which there is the greatest need. A

need is not a static thing, it is dynamic and in the recycling context the price paid for energy and raw materials has a major effect and influence on the amount of recycling that occurs.

Two measures for calculating recycling rates are introduced. These can be used to establish how efficient reclamation practices are on an industrial basis. VOGLER (1981) shows that recovery rates within certain industries has reached significant levels and further recycling would be difficult to achieve. Thus the expansion of reclamation needs to concentrate on the more widespread sources of materials, such as from households.

PEARCE's model (1976) to establish the optimum level of recycling is examined. As there is nothing intrinsically beneficial about recycling, it is a matter of weighing up the social costs and benefits.

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Chapter 3

Problems Of Recycling Glass

3.1 Introduction

This chapter looks at some of the more specific problems of reclaiming glass from the waste stream. It looks in more detail at domestic and trade sources of glass. Problems with the range of glass products is then outlined and of the colours used. These two areas are of interest as they will affect the quantity of material that is available for reclamation, the ease of recovery and the possible uses that can be made of the recovered glass. As an adjunct to this area the potential outlets and markets are highlighted. The final sections of this chapter look at aspects of public participation, as the level of public support will affect the potential viability of reclamation schemes.

3.2 Quantity Of Waste

As outlined in Section 2.4 glass is just one element of a multi-component substance. The magnitude of an economically recoverable supply of secondary materials from municipal waste will be influenced by the physical characteristics of waste. These characteristics in conjunction with the economic background will influence the way that the waste is handled.

There are three possible sources of waste glass, which follow closely to the CPA's definition of 'controlled waste', which grouped together waste from households, trade and industry (Section 2.3). The type of glass available from these sources is outlined below:

1. Household - after the consumption of glass packed food and drink products.

2. Commercial (Trade) Waste - glass used by Restaurants, Hotels, Public Houses, Etc.; and glaziers.

3. Industrial (Manufacturers/Bottlers) - those who produce or package in glass containers; and as a result of damage or rejection accumulate quantities of unwanted glass as part of their waste arisings. And from bottlers who dispose of obsolete stock at the end of a run.

The weekly quantity of waste glass will vary, with a 'typical' household generating up to 1kg (INCPEN 1981). A large hotel may generate up to 1 tonne; and a bottler many tonnes of waste glass per week (COOK 1983).

Local Authorities are in the main concerned with wastes arising from the general public and certain commercial sources. Bottlers are going to be restricted in area and will probably arrange to transport their own waste to processor or for final disposal. Attention in this work has concentrated on glass from households and glass from certain traders, as it is in these areas that recycling schemes have been developed by Local Authorities.

National figures indicate that waste collection authorities (WCA's) throughout Britain handle in the order of 19.5 million tonnes of waste per annum. The amount of glass present is around 8% (INCPEN 1981) that is about 1.56 million tonnes of glass potentially available for recovery. At present (GMF 1984) about 10% is recovered that is about 162,000 tonnes.

3.2.1 Domestic Waste

An analysis of the composition of waste will establish the potential for materials recovery. This has been looked at in Section 2.4. In this section Table 2.3 provides a breakdown of

the different materials in waste and the proportion that is packaging. It is important within an area to establish the type of material that is available and the quantities that are present at different locations.

Waste from households is going to be the prime source of glass to local authority collection schemes. HO (1982) has shown that the average weight of material waste generated can be related to population levels and the number of households within the authorities area. The contribution of glass waste from domestic premises is found by:

Domestic Premises (Contribution per annum - Tonnes)

$$GRT = \frac{52 * M * W * ID}{1000}$$

$$= 0.052 * M * W * ID$$

where:

GRT = Domestic Glass Wastes Production Tonnes Per Annum

M = Participation ratio of households: M = 1 represents 100% participation.

W = Average weight (kg) of glass generated per premises per week.

ID = Number of Domestic Premises.

The success of any recycling scheme will be dependant on the level of waste generation. The weekly quantity of waste glass will vary, with a 'typical' household generating up to 1kg (INCPEN 1981 - 0.9 kg per household per week; DOE - 1.1 kg per household per week, Wastes Man, April 1984). For instance, an area with 40,000 households (ID), having 20% (M) of householders supporting a recovery scheme by separating out 1 kilogamme (W) of glass per week, this would give a recovery of 416 tonnes. If there was a 100% support, 2080 tonnes of glass would be available in the local area. These figures would be influenced by whether all the glass is recovered from households. In some cases there will be losses

due to breakages and by the use of glass containers for storage jars, or in jam and wine making.

Although on a National scale there is about 1.56 million tonnes of waste glass available in the wastesteam, it is widely spread throughout the country. Theoretically this is a valuable resource, with a market value of £31 million (based on £20 per tonne paid for mixed glass) that is being lost. However on a local scale there might not be enough glass available to justify setting up a glass collection scheme. Based on the above example the recovery of 416 tonnes would generate sales income of £8320, which would be set against capital charges and operating costs. The quantity of glass available is dependant on: the urban fabric, population density and peoples life style.

3.2.2 Trade Waste

There is a need to relate the quantity and composition of trade waste to the number and type of premises in an area. This has been expanded in Chapter 11 and Appendix G which deal with the trade model. For waste paper a link has been shown between the average weight of waste paper generated in trade premises to the population size which Ho (1982) used in his examination of paper recycling schemes. There is a need to see if a similar relationship exists for glass waste. While all premises are likely to use paper in significant quantities, only a few such as licensed premises and double glaziers are going to have significant quantities of glass. Also of importance is whether Trade Charges are levied as this can act as an incentive for Traders to look for the most cost effective means of waste disposal, which can lead to the development of paper and glass recovery schemes.

HO (1982) uses the following formula to calculate the contribution of waste from all trade premises:

TRADE PREMISES (Contribution per annum - Tonnes)

$$= \frac{50 * Z * IP}{1000}$$

$$= 0.05 * Z * IP$$

where:

Z = Average Tonnes of Trade Waste generated per Thousand Population Per Week

IP = Population Of The District

50 = Number of weeks per year Trade Waste collected by authority.

However only a proportion of this waste will be glass and only a certain number of trade premises will generate glass in large quantities. Most offices will use the odd coffee jar, whereas licensed premises can be expected to generate glass in significant quantities. Although most sales are either by barrels or returnable containers, licensed premises trade in spirit and wine bottles which tend to be non-returnable.

Within the Stirling District area 10% of the trade premises were licensed and these were made up of

Hotels	105
Public Houses	58
Restaurants	25
Guest Houses	51
Miscellaneous	10
TOTAL	249

The Falkirk Trade glass collection scheme collected from 150 premises, which represented 7.5% of the total number of trade premises. In a review of waste generation, Falkirk's catering premises produced on average 1.32 tonnes of waste glass per year,

ranging from 0.2 tonnes to 5.0 tonnes per premise per year (Appendix G.2). Based on these figures Stirling's catering premises could generate up to 330 tonnes of glass per year. This information can be used to produce the following function for the generation of glass from trade premises:

TRADE PREMISES (Contribution per annum - Tonnes)

$$= \frac{50 * X * IC}{1000}$$

$$= 0.05 * X * IC$$

where:

X = Average Kilogrammes Of Glass Waste Generated Per Premise Per Week

IC = Number Of Catering Premises In The District served by collection system

50 = Number of weeks per year Trade Waste collected by authority.

For example the quantity of trade glass waste generated from 150 premises (IC), with an average generation of 26 kilogrammes (X) of glass per week, will give rise to 195 tonnes of glass per annum. This figure will need to be adjusted to the number of premises that participate in separating out their glass for a recovery scheme.

A further trade source of waste glass is from glaziers, both replacement window firms and double glazing companies. This category of waste is more likely to be collected separately and privately, due to the quantity available and the need to protect the quality of the material.

The introduction of a charge to collect Trade Waste could influence the level of recycling attained in an area. As to avoid being charged - thus reducing operating costs - Traders may then divert what waste they can into recycling streams: such as waste

paper and glass. The CPA 1974 (Sn 12-14 - not yet enacted) makes the collection of trade refuse obligatory for a local authority if so requested. This Act also defines what is Trade and Household waste fractions. It also provides the Councils with the right to waive charges in specific instances. The enactment of these sections of the CPA 1974 was one of the recommendations of the Wealth of Waste Report by the Trade and Industry Select Committee (1984). However, due to the expected costs of implementation the Government is opposed to enacting these sections 12-14 of the CPA 1974.

3.3 Specific Problems Of Recycling Glass

The ideal conditions for recycling are a singular supply of clear dry waste of a single grade that is of a known and consistent quality. For glass recycling the aim is to minimise the level of contraries and to keep the colours separate. Apart from colour, glass used in packaging is of a singular nature which is a benefit when it comes to recycling the material. The glass used in packaging can be split into three groups by colour - flint (clear), green and amber (brown). This contrasts with paper, where there are over 20 different grades used to classify waste paper for marketing. Characteristics of glass that affect recycling are:

- Colours of glass
- Compatability of colours
- Sortability - from refuse
  - colour sort
- Impurities in mix - tops
  - labels
  - glues

3.3.1 Reasons For Use Of Colours

Container glass is coloured for a number of reasons, which include:

- protecting the quality of the packaged product;
- the identification of particular brands or grades of product;
- aesthetic appearance of container itself.

Amber/green containers are frequently used for foods (eg wines) that may deteriorate in quality if exposed to ultraviolet radiation. Specifications for glass containers are dictated by the producer of the final packaged product rather than the initial manufacturer of the glass container. Fillers may specify brightness, colour, purity and the dominant transmission wavelength of glass, but they do not usually specify chemical composition. Glass colouring is a complex physical/chemical process influenced by the use of colourants in varying oxidation states. Iron and chromium oxides are the most important colouring agents (CUMMINGS J P 1975). Under reducing conditions, iron oxides in the presence of sulphides produce an amber colour. Chromium oxides (principally Cr_2O_3) are used to produce green glass. For common shades of green glass, chromium is kept in a reduced state, for green glass designed for enhanced absorption of ultra violet light, a portion of chromium is oxidised.

The quantitative relationships between colorant concentrations and transmission spectra are not well-defined, glass manufacturers have developed batch formulae of colourants to produce given colours of glass. Such formulae are proprietary, and will vary according to container customer.

The colour mix of the recovered cullet may affect its use in glass

container manufacturing, as it may not conform to required specifications. This is the main reason why recycling was confined to in-house cullet, where quality was of a known factor. The specifications are based on industrial experience in using raw material and clean factory cullet. To maintain quality manufacturers keep close control over the batch of raw materials. With the development of glass reclamation from outside sources, the recovered glass needs to conform to strict quality controls. An example of quality specifications, used by United Glass is shown in Figure 3.A. This shows the importance of keeping colours separate and for keeping to a minimum the number of contraries. The presence of 'refractory' particles and the concentration of colourants are the two main characteristics of glass from waste that affect its suitability for recycling. Refractory particles are fragments of certain materials which will not melt in the furnace and may cause inclusions ('stones') in the glass product. These inclusions are a point of weakness which can lead to breakages. Recovered cullet may contain chemicals that can affect the colour of the final product. Chemical compounds (Iron & Chromium Oxides) are used as colourants in amber or green container glass and will be present in cullet recovered from mixtures of flint and coloured glass. An additional source of chemical colourants in cullet is contamination by particles of iron oxide carried over in the recovery process.

In the manufacturing plant colour control is accomplished primarily by the addition of chemical colouring agents to the batch of raw materials charged to the furnace. Such additions include Iron or Chromium colourants, oxidising agents (eg $CaSO_4$) and reducing agents (eg Carbon). Products are sampled to assess their composition and to allow adjustments to be made in the batch

Figure 3.A

Quality Specification For Waste Glass (Cullet)

This specification is intended to give guidance to Local Authorities, Bottlers, Contractors or Merchants who deliver cullet to the Recycling Plants of United Glass Containers Limited at Harlow or Kelliebank.

Whilst our Recycling Plants are designed to remove bottle caps and the odd can or plastic bottle, it is important that foreign materials are kept to a minimum, for two reasons.

(a) It is a waste of everyone's time and resources to deliver rubbish that has to be removed and dumped.

(b) The more contamination in cullet, the greater the risk that some will get through to cause damage to furnaces or produce defective containers.

If suppliers collect a badly contaminated load it is better to reject or sort it there and then, rather than to waste money delivering it to the Recycling Plant. UGC is ready to assist in finding means to minimise such contamination on the basis that "prevention is better than cure".

Each load delivered to the Recycling Plant is examined on receipt and the supplier notified if unacceptable contamination is present. Whilst common sense and practicality are used in applying tolerances, UGC reserves the right to reject consignments that fall outside the specification detailed below.

TYPE OF GLASS

Glass is used for various products and is of three major different chemical compositions. THE CULLET WE WANT COMES FROM BOTTLES AND JARS OF CLEAR, GREEN OR BROWN GLASS. If suppliers wish to offer other types of cullet e.g. imported bottles of special colour etc., they must obtain prior agreement from the Recycling Plant.

›LOUR SPECIFICATION

The scope to use cullet of mixed colours is very limited since it can only be put into Green furnaces and then in limited quantities.

WE THEREFORE URGE SUPPLIERS TO KEEP COLOURS SEPARATE WHEREVER POSSIBLE. The following limits define the acceptable extent of colour mixing.

Clear

The chemicals in *Green* bottles produce the worst discolouration in Clear glass. At our Recycling Plant the inspectors will be able to pick out wrong coloured bottles provided they are not broken and there aren't too many. Consignments of Clear cullet will be accepted therefore with up to the following percentages of coloured bottles.

Green	1%*
Brown	2%
Pale Green	5%

*Note: We may have to be more strict on Green if the cullet is already crushed.

Brown

We need a minimum of 80% Brown. The most problems are caused by *Clear* bottles. We can accept the following mixed with Brown cullet.

Clear	5%
Green/Pale Green	15%

Green

We need a minimum of 70% Green. Other colours included should be limited to a maximum of

Brown	20%
Clear/Pale Green	20%

CONTAMINATION

For all practical purposes, it is impossible to specify accurately the permissible limits to contaminants in the cullet. The various possible contaminants present different degrees of hazard to our manufacturing processes. They also present different problems of removal! Even if an attempt was made to set limits, it would prove impracticable to attempt to measure the weight of a particular contaminant in a consignment of cullet.

WE ASK ALL CULLET SUPPLIERS TO ARRANGE COLLECTION SUCH THAT THE RISKS OF CONTAMINATION ARE KEPT TO THE MINIMUM POSSIBLE. As a guide, we give the following "blacklist" in terms of degree of seriousness.

Enemy No. 1

Inorganic materials such as brick, concrete, soil, stones etc.

Enemy No. 2

Metals. Particularly aluminium and other non-ferrous which are non-magnetic.

Enemy No. 3

Wire, strapping, lumps of wood and plastics/textiles which can damage or clog-up the works.

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composition to meet any changes in chemical composition or oxidation state. Manufacturers set upper and lower quality control limits for colourant concentrations. Limits are low especially for chromium in flint glass. In general its preferable for these concentrations to be below specification than above, as it is easier to compensate through the addition of more colourant. For industry an incentive to recycle material exists when the operation gives rise to no penalty in terms of costs, resources, productivity or technical hazard.

3.3.2 Recovering Glass From The Waste Stream

Ideally, cullet recovered from domestic waste would be 100% glass and would be colour-sorted. There are two techniques for recovery of useable cullet:

1. Optical sorting of large (>6mm) glass particles, places emphasis on colour separation of cullet.

2. Froth flotation of finely sized (<1mm) glass particles, emphasises removal of refractory particles from cullet.

3.3.2.a Optical Sorting

Optical sorting involves two levels of separation:

- separation of opaque (non-glass) particles from transparent particles;

- separation of transparent particles by colour.

Separation of glass from non-glass particles is based on the use of photocells to measure light transmission through individual free falling particles. When an opaque particle blocks light, it triggers a blast of air which ejects particles from the free-falling stream. The separation of glass by colour is based on the measurement of light reflected from each particle as

compared with an illuminated, coloured background. As particles fall in front of the reference background, photocells measure the reflected light. Particles darker than background trigger the ejection mechanism. STIRLING (1983) noted that the quality of the output can be improved by reducing the flow through the system, or by passing the material through more than once. However, there will be trade offs between improved quality and the extra costs.

Optical sorting of glass has been demonstrated at the EPA sponsored Franklin, OHIO State plant operated by Black Clawson and at the DOE/DEn sponsored plant at Doncaster (Section 5.7). The Franklin subsystem has shown that colour sorting of the glass rich fraction taken from domestic waste is technically feasible. Although optical-sorting approach has been technically successful in separating flint from non-flint cullet particles, optically sorted cullet from Franklin did not meet glass container industry specifications for refractory contamination. During operations the system was developed and improved and the manufacturer (Sortex Ltd) has announced the development of an improved opacity sorter which is to be installed at the Hampstead plant. The Doncaster project also proved that it was technically possible to recover glass from the mixed domestic waste fraction. But it met a lot of problems meeting the quality constraints demanded by the consuming manufacturers and has since been abandoned (JACKSON 1984).

3.3.2.b Froth Flotation

Froth flotation is a minerals processing technique adapted for use in waste glass recovery. It is based on the tendency for hydrophobic particles to accumulate at the air-water interface of the aqueous system. The aqueous mixture of glass and non-glass particles is treated with a compound which selectively absorbs on

the glass (eg a fatty amine) and the glass particles become hydrophobic. Air is blown through the mixture causing the treated glass to rise with the air bubbles to form a froth on the surface of the water. The froth is then skimmed off the top of the water to recover the glass; the tailings (primarily non-glass particles) remain as the sediment at the bottom.

Froth flotation for waste glass recovery has been tested by the Bureau of Mines 1971, at a pilot scale by Occidental Research Corporation and by NCRR. It has been tested at laboratory scales but not yet at commercial levels. The product is low in refractory particles and it can be used to produce a glass product that is virtually free of solid inclusions. The importance of minimising the refractory content is reflected in the inclusion of this process in several full scale resource recovery plants to be built in the USA.

Froth flotation process yields particles of colour-mixed glass cullet in size range minus 20 mesh to plus 140 mesh (<0.85mm, >0.08mm). Cullet in this size range has the appearance of sand.

To date, no practical method for colour-sorting froth floated cullet has been developed (HEGINBOTHAM 1978). Cullet particles are too small to be optically colour-sorted with commercially available equipment. Theoretically, large particles of waste glass could be optically colour-sorted first, then crushed and froth floated, but this is unlikely to be commercial under present market conditions. The possibility of using selective reagents for floating specific colours of glass has been investigated, but it was unsuccessful in trials (CONRAD 1977).

With the success of froth flotation in removing refractory

particles it has been adopted by most recovery plants, which will result in most of the glass being recovered from municipal waste being of mixed colours. This will limit the capacity of the glass manufacturing industry to utilise the recovered mixed glass due to the presence of colourants.

3.3.3 Colourants In The Municipal Waste Stream

DUCKETT (1979) has made estimates of colourant concentrations in mixed wastes based on the colour mix of glass in the waste stream and on analyses of samples from pilot recovery plants. The USA nationwide colour mix is: 60-70% flint, 15-20% amber, 12-20% green, plus small amounts of blue, opal and ruby container glass. This is a similar mix as to that in Britain, with 75% flint, whereas in continental Europe there is a higher concentration of green glass due to the presence of the large wine trade. In all countries colour mix can vary geographically, with industry and on peoples consumption patterns. Based on chemical composition of coloured glasses and on colour mix shown, DUCKETT has produced the following estimates of colourant concentrations in colour-mixed cullet (TABLE 3.1).

In Table 3.2 limits for colourant concentrations in container glass (from Table 3.1) are compared with the reported colourant levels in MSW cullet and with the colourant levels that might be expected to be found in an MSW cullet of national average colour (65% flint, 20% amber, 15% green).

TABLE 3.1 Colour Mix Of Glass Containers And Estimate Of Colourant Concentration In Colour-Mixed MSW Cullet

	COLOUR MIX IN MSW (% By Weight)			ESTIMATED COLOURANT CONCENTRATIONS IN COLOUR-MIXED CULLET (% By Weight)		ACTUAL COLOURANT CONCENTRATION (% By Weight)	
	FLINT	AMBER	GREEN	Fe_2O_3	Cr_2O_3	Fe_2O_3	Cr_2O_3
FRANKLIN, OH.	61	36	2	0.121	0.003	0.228	0.0078
PALO ALTO, CA.	69	9	22	0.100	0.033	0.137	0.011
SAN FRANCISCO CA.	67	10	23	0.104	0.034	0.106	0.043

Based on assumed average concentrations as follows:

	Fe_2O_3	Cr_2O_3
FLINT	0.05	3-5 ppm
AMBER	0.24	3-5 ppm
GREEN	0.2	0.15

Source: Duckett E J (1979)

TABLE 3.2 Calculated Maximum Charging Rates For MSW Cullet For Use In Container Glass Based On Colourant Concentration

	MSW Cullet Colourant Conc (% By Weight)		Maximum Charge To Glass-Making Furnace (%)*					
	Fe_2O_3	Cr_2O_3	Flint	Limitng Factor	Amber	Limitng Factor	Green	Limitng Factor
FRANKLIN, OH.	0.228	0.0078	6	Cr_2O_3	>90	-	>90	-
PALO ALTO, CA.	0.137	0.0110	4	Cr_2O_3	>90	-	>90	-
SAN FRANCISCO, CA.	0.106	0.048	1	Cr_2O_3	51	Cr_2O_3	>90	-
ESTIMATED AVGE. MSW CULLET '	0.108	0.022	2	Cr_2O_3	>90	-	>90	-

* Reported Limits for maximum concentration of Fe O and Cr O are as follows:

	Fe_2O_3	Cr_2O_3
FLINT	0.06 wt %	0.001 wt %
AMBER		0.025
GREEN		0.2

The calculated maximum charging rates assume 5ppm (0.0005%) Cr_2O_3 is already present in flint and amber glass; thus lowering the tolerable limit for Cr_2O_3 added with the cullet.

' Not including 'external iron'; and based on colourant levels shown in note to Table 3.1 and on a mix of 65% flint, 20% amber and 15% green.

Source: Duckett E J (1979).

This Table shows that there is no limit to the use of mixed glass from municipal solid waste in green container glass production and no severe limit to use in amber glass production. The calculated maximum charging rates are in excess of 50% for the production of amber and green glass. Chromium is the limiting factor in use of mixed glass in flint manufacture, with a maximum charge to flint glass furnace, range of 2% to 6%. Most container glass manufacture is flint and for some geographical areas, flint furnaces may be only economically attractive market for mixed glass. The restricted use of mixed glass in flint glass furnaces may represent a significant potential limit in the use of cullet from municipal waste by container manufacturers. A similar problem could face British manufacturers with the dominance of flint glass manufacture and at present the large proportion of mixed glass that is collected from the domestic waste stream.

The variability of cullet colourant concentrations from municipal sources may be as important as the absolute level of colourant as manufacturers maintain colourant levels within strict quality limits to assure specified properties. Variations in concentrations would require compensating adjustments being made to the batch.

Limitations are especially important in case of flint glass production. Technological developments may increase the percentage of furnaces producing or at least melting flint glass, with colouring of glass in forehearth, rather than the furnace itself. This permits manufacturers to devote furnace to flint glass and to colour only a portion of the output, avoiding the costs of changing colour within an entire furnace. As colourants are not added until glass is molten, all materials charged to glass

furnace must meet the requirements for producing flint glass.

Assuming MSW cullet could be consistently recovered at 0.022% (by weight) Cr_2O_3, as calculated from Table 3.2, cullet could theoretically be charged at 4% to flint glass furnaces. Such charging rate would not introduce colourant levels in excess of specified maximum, yet could (if applied to all flint glass production in USA) consume 300,000 tons per year of MSW cullet. Manufacturers would err on the conservative side in their use of MSW cullet, that might jeopardise colour of glass product. At best, they may reduce MSW cullet charge to 1% or 2% affording a measure of protection against a batch of MSW cullet with unusually high colourant content. At worst, they may decide to use no mixed glass cullet from municipal waste stream.

A number of approaches exist in overcoming the limitations on use of mixed glass recovered from domestic waste, which include:

- changing colour specification for container glass;
- using de-colourising agents to offset effects of cullet colourants;
- monitoring colourant levels in cullet as a feed to the glass furnace.

Adjustment of colour specifications is influenced by consumer acceptability, aesthetic factors and demands of fillers and their advertising campaigns. The concept of replacing flint glass with green-tinted glass ('Eco-glass'), has not yet been adopted on a significant scale. The barriers of taste or fashion (consumer tastes) may be more formidable than those of technology.

De-colourising agents can be used to compensate for colourant impurities in batch materials. Iron colourants (to a maximum of 0.07% Fe_2O_3) in flint glass can be decolourised by the addition of

trace amounts of selenium and cobalt oxide. Their addition produces complementary colours which mask the effect of the contaminant colourant. De-colourising agents have little effect on chrome oxides. As chrome, rather than iron, is the limiting factor in the use of recovered cullet, de-colourising additives do not appear to solve the problem.

Another approach is to add blends of cullet to the furnace from different sources, or from several days production, based on their chemical composition. Such mixing is dependant on cullet sampling and chemical analysis. Segregation of cullet by type (eg by colour) and by source (eg factory vs recycling centre cullet) is already an established practice of many glass container plants.

On the basis of iron and chromium levels in mixed glass and on the specifications laid down by manufacturers, cullet from the domestic waste stream could be charged to furnaces producing all three major colours. With colourant concentrations of mixed glass there would be no limit on its use in the production of amber and green glass and 2% for flint. The main limiting factor is the presence of chromium oxide, particularly when used in flint manufacture.

3.3.4 Degradation

There is no problem of degradation through repeated processing of glass material, with no affect on appearance, chemical resistance, processability and mechanical characteristics. Changes in properties occur due to contamination, the presence of inclusions and the presence of different grades of glass. These need to be monitored when processing glass. Unlike paper where repeated processing degrades the fibres and leads to a poorer product,

glass, as long as the grade is consistent, can be reprocessed repeatedly without any affect on quality.

3.3.5 Volume

There is a problem in collection with the bulk of containers, with an estimated 3000 bottles making up 1 tonne. This bulk will be reflected in transport costs. To counter this bottle crushers could be used (Rankinco) to reduce problems of volume and thus of transport and storage.

3.4 Range Of Glass Products

The term 'glass' covers a family of materials of varying properties and uses, with one main type used in packaging. The singular nature of the material is a benefit when coming to recycle the used material. Unlike with paper where there are many different grades glass can be split into 3 groups by colour - flint (clear), green and amber (brown). In the worst case the glass can be processed in a mixed state as part of the input to a green batch (Section 3.3.5).

The number of container shapes and sizes has come under criticism. There is a need to examine the reasons behind the number of shapes and sizes used in packaging to see whether they are really necessary. In addition its identification in litter and domestic waste has brought pressures on the glass industry to recover the waste (Chapter 8). Environmental groups - FOE - have condemned the whole packaging industry not just singling out glass for its lack of initiatives in confronting the problems of glass waste other than in factories, as well as against the number of different shapes. Different colours must either be separated to ease recycling, or downgraded and processed as the lowest common

denominator - mixed glass in the green furnace. Glass can be separated manually or mechanically (Chapter 5).

Within product ranges - beer, whisky, coffee - are the variations in container design really necessary. The issue of the number of container shapes in packaging has not been developed here and is more related to use of returnable containers (Chapter 4). One approach is that of Denmark which has sought to standardise bottle types by legislation (Chapter 4.8.3). Characteristics of packaging should be viewed in terms of products required needs, costs and the ease of recycling. Following on from such moves, even in the interim, a code of practice could be adopted to limit the number of sizes and shapes. A suitable lead in time should be provided and if not adopted voluntarily, legislative means could be examined, as adopted by other countries such as Denmark and several states across America.

The level of materials available can be assessed through an analysis of waste produced (Section 2.4) or from a breakdown of national levels of packaging totals. Table 3.3 looks at the potential availability of glass in a town as a proportion of national packaging totals.

TABLE 3.3 Glass Packaging Materials Available In A 'Town'

Product Groups	National (M Units)	Town (10^3 Units)	Potential Tonnage
Total Food	1,663	88.139	28
Wines & Spirits	1,333	70.648	23
Soft Drinks	1,186	62.858	21
Chemicals & Drugs	523	27.179	9
Dairy Products	484	25.652	8
Beer & Cider	338	17.914	6
Toiletry/Perfumery	120	6.36	2
Household	120	6.36	2
TOTALS	5,767	305.65	102

Based on: National Population = 56 million
'Town' Population = 30 Thousand
Town as a proportion of National population = 0.053

3.5 Public Participation

Mixed waste at the consumer end, is seen to have a negative value and so is thrown away. It is essential that consumer co-operation is attained to achieve source separation of waste material, to increase their value. 'Bottle Bank' schemes throughout Western Europe have shown the willingness of householders to meet the separation requirements demanded. The development of recycling schemes requires an educational and information programme to bring home the need for segregated materials. This programme would be directed at manufacturers, converters, merchants and consumers: the chain in the production cycle from raw material to a waste product. Recycling needs to establish a backward distribution channel - consumers to collectors (merchants/local authorities) to processor to the manufacturing industry - thus treating the waste product as a raw material that can be delivered to the 'consumer' in this case the Manufacturing industry.

There is a problem that if the sorting and preparation specifications laid down by the producers are overcomplicated then participation rates may not reach desired levels. At worse participation rates will fall substantially, or faulty sorting will produce a lower quality feedstock. In the case of 'Bottle Banks' participants are asked to remove the metal/plastic tops and to segregate the glass by colour - flint, amber and green. The colour segregation depends on market demands. Whereas for the PET-a-Box scheme that recovers plastic - PET - bottles, the consumers are asked to remove the base (HDPE) as it is a different polymer, remove metal tops, paper labels and adhesive to reduce contamination problems and finally to crush the container before putting it in the box to reduce the volume. It is said that those

who will make the effort to recycle will comply with these demands, but it is the marginal recyclers who will be discouraged from participating. If there is a failure to meet the requirements this will necessitate at the minimum a preliminary sorting and cleaning section at the processor before it is taken on to the manufacturer. This event has been confirmed with the establishment of glass cullet reprocesssing plants at several of the main manufacturing sites throughout Britain.

End product specifications will largely determine the acceptable degree of contamination tolerable in the feedstock. In this consumer acceptability and their perception of aesthetic factors (of final product) are important. With a non-homogeneous feedstock the material could be of a dull colour. Contamination could affect the physical strength of the final product, eg aluminium particles can cause points of weakness in glass products.

Participation rates have been examined by Kuylen & van Raaij (1979) and by Cohen (EPA 1978). These two studies emphasise the importance of education and social scale to motivation and the participation rate. These factors will influence the siting of recycling skips, and their operation:

1. Banks need to be convenient for people to use as part of their normal activities, ie shopping and work patterns.
2. The public must be kept informed and motivated.
3. The design and location of Banks should minimise any inconvenience to neighbours.

A more detailed review of the publics role and perceptions to recycling is looked at in terms of returnables (Chapter 4.9) and in the operation of Bottle Banks (Chapter 6.9).

3.6 Markets For Recovered Materials

The municipal waste stream contains 8% of glass, most of which is container glass. With the manufacturers specification limiting the input of mixed glass to cullet, there is a need to look at alternative uses and markets for the recovered cullet. Without suitable markets for recovered material the development of collection schemes are of little value. Municipal waste glass can either be directly recycled in the manufacture of new containers, or more indirectly in the production of other products (THOMAS C 1981) which include:

- aggregates in road surfacing;
- building materials with cement or clay;
- cement or resin in tiles (Culltex Ltd);
- beads in reflective paints;
- abrasives in glass paper;
- foamed glass fibre insulating materials.

Recovered glass is used as a replacement for raw materials. The value of the glass reflects the price of the raw materials being replaced. For example glass recovered for the use as road bed aggregate materials - slag, gravel, etc. - and may be priced at $2 - $3 per ton (DUCKETT 1979). Glass recovered as cullet for use in container production must be low in contaminants and is priced upwards of £20 per tonne dependant on grade, reflecting advantages beyond the simple replacement of glass-making raw materials.

Work has been carried out in the USA and by the GMF who sponsored work at Cardiff University into alternative uses for recovered glass. At Cardiff they converted waste glass containers to decorative floor, wall and working surface tiles, which are now

being developed by Culltex Ltd. A firm in Belgium - Mineral Products - are producing resin/glass tiles for street paving and moulded products such as waste bins, lamp-posts and bollards. A problem with new product development is one of untried products in highly competitive markets and the conservatism of buyers.

The establishment of markets for glass is the key to achieving viable recycling schemes. There is a need for competitive, stable markets to encourage recycling. Without an outlet there would be little point in collecting glass from wastes. In Britain the glass manufacturers offer a guaranteed market for the glass recovered through Bottle Bank schemes provided it meets certain quality specifications.

3.6.1 Cullet Merchants

There is a need to assess the practical problems of glass recycling through approaching some of those involved on glass recycling. Specific information should be provided on:

1. Sources of glass - Industrial
   - Retail
   - Domestic
2. Types of glass collected, and quantities.
3. Methods of collection.
4. Methods of treatment.
5. Preferences for sources/types of glass.
6. Involvement with voluntary collection schemes.
7. Problems of contamination.
8. Value of materials collected.
9. Markets for recovered materials.
10. Dealings with industry.

3.7 Summary

Ideal conditions for recycling are: a regular supply of clean waste, of a single grade (colour). There is a need for a regular supply in quantity and quality to meet production requirements of a continuous manufacturing process that depends on matching processing conditions to feedstock. Items are designed so that a given property or affect is achieved with the minimum usage of material. Any collection processing system that allows discontinuities to be present in the final product that may give rise to failure in use will be shunned by the manufacturers.

It is important for the user to know the concentrations of colourants entering the furnace, so that he may take any compensation measures that may be necessary to the batch mix. Mixed glass can be used relatively freely in amber and green glass manufacture, but only sparingly in flint production. This is a problem as 75% of production is flint, thus imposing a limit on the possible use of mixed glass from mechanical resource recovery plants. It is important to try and keep the glass colours separate, which has been best done at source being typified by the Bottle Bank system (Chapter 6).

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Chapter 4

Returnable/Refillable Bottles

4.1 Introduction

In the ranking adopted by PORTEOUS (1977) (Section 2.5) the first recycling option to be considered is the re-use of the container. This is where the container is re-used for the purpose it was originally manufactured, being epitomised by the returnable/refillable glass bottles used in the liquid beverage market. This form of recycling is confined to a small and diminishing section of the market covering: soft drinks, beers, wines and other liquid beverages. It is within this market that there is a fierce competition between packaging types - glass, metal cans, paper cartons and plastic bottles. Although these other packaging types can be 'returnable' they are not necessarily 'refillable'.

The OECD (1978) report defines these terms as:

> RETURNABLE is a general term used for beverage containers that are intended to be re-used or recycled.
>
> REFILLABLE specifically refers to returnables that are designed to be re-used in its original form as a beverage container.

The distinction between these two terms is often blurred, with the more general term returnable being adopted. However, in certain circumstances this distinction is necessary, eg metal cans under mandatory deposit legislation are returnable but are not normally refillable.

This chapter briefly examines the value of returnables, as a recycling option. It makes reference to three major studies: OECD (1978), WMAC (1981), and FISHER (1982). Also reference is made to the role of the public (Section 4.9) and the affect of legislative measures on the use of returnables (Section 4.8).

4.2 Background

Refillable glass bottles are the simplest form of recycling in energy and 'economic' terms. Despite this the OECD (1978) surveys showed that the use of returnable glass containers in OECD Member countries is in decline. They are being replaced by one-trip glass bottles, metal cans, plastic bottles and cartons.

Competition between returnable and non-returnable beverage containers can be compared by examining the market shares of alternative systems. Data gathered by the OECD (1978) for beer and soft drinks in the USA and UK showed a strong positive trend towards non-returnable containers (Tables 4.1 & 4.2). They noted similar trends for Australia and Canada.

The major reasons for these trends are attributed to:

- Increased distribution distances from centralised filling plants.
- Decrease in relative price advantage of returnables over non-returnables.
- Increasing relative costs of labour to materials and capital.
- Reluctance of retailers to handle returnables.
- Consumer preference for the convenience of non-returnables.

The OECD (1978) study has shown that market forces encourage the development of non-returnable systems. Thus to stop this trend

TABLE 4.1 Beer - Beverage Container Market Share (%) USA (Fillings Of Packaged Beer)

YEAR	RETURNABLE GLASS BOTTLES	NON-RETURNABLE GLASS BOTTLES	METAL CANS
1963	46	16	38
1964	42	18	40
1965	41	19	40
1966	38	19	43
1967	35	21	44
1968	31	21	48
1969	29	22	49
1970	26	22	52
1971	23	21	56
1972	22	20	58
1973	19	21	60
1975'	(12)	(13)	(75)

' forecast

SOURCE: OECD (1978) Beverage Containers

TABLE 4.2 BEER & SOFT DRINKS MARKET SHARE BY CONTAINER TYPE (%) UK (Fillings Of Packaged Products)

YEAR	RETURNABLE BOTTLES	NON-RETURNABLE BOTTLES	METAL CANS
1970	84	5	11
1971	81	6	13
1972	76	8	16
1973	73	9	18
1974	70	9	21
1975	66	10	24
1979'	(54)	(12)	(34)

' forecast

SOURCE: OECD (1978) Op Cit

active Government involvement is required, possibly through the use of deposit legislation. This would allow Governments to bring in the social costs and benefits into their assessment of what is the optimum beverage system. The use of legislation to promote the use of returnables is examined in Section 4.8.

PORTEOUS (1978) viewed the imposition of the non-returnable bottle on the British public as having been done without their consent, and is an example of a business practice which treats both the consumer and the environment as resources to be exploited.

This move away from returnables has generated a great deal of public concern over the use of packaging and its social and environmental impact. This lead to two important studies being commissioned, by the OECD (1978), and by WMAC (1981); which are reviewed briefly below. In addition FISHER (1982) has carried out research that looked at the social costs and benefits of returnable systems.

4.3 OECD Study

The OECD (1978) undertook a study that looked at the impact of packaging systems upon resource use and the environment. This study examined the external factors - energy costs, waste disposal, litter, air and water pollution - for different packaging systems. It drew on information and experiences from various OECD member countries.

4.3.1 Energy

The analysis of energy by the OECD looked at the requirements for energy use at various stages of the beverage container system. These energy requirements will vary with each container system due to distribution methods, and on their different material characteristics. They found that in energy terms it was the refillable containers that were the best option. This ranking, and the energy savings are dependant on the returnable system reaching a certain trippage.

4.3.2 Waste Management

Waste disposal may be judged as an external cost where the pricing mechanism for waste is indirectly levied. This occurs when waste management is undertaken by the Local Authority and met through the rates. Here the impact of a product upon the waste stream and thus the environment is not considered by either the producer or consumer in their purchasing decisions.

If collection costs are costed directly on a product to product basis, the impact on solid waste collection is likely to be more than marginal. Alternatively, solid waste can be broken down into its major constituents and policy may be directed towards those

constituents. With glass making up 8% of waste stream a policy directed to glass would have more than a marginal effect on solid waste.

Disposal costs are linked more closely to the quantity of solid waste handled, and therefore the allocation of average disposal costs on a weight or volume basis is more straightforward. However, any reductions in solid waste will yield disposal cost savings which, in the short run, will be less than the average disposal costs on account of any fixed cost element of disposal costs.

The total cost of solid waste collection and disposal varies from country to country, but the split between collection and disposal is relatively constant and of the order of 70% to 30%. As collection costs are the major determinant of total costs it is important that these costs are not omitted in policy formulation.

Plastics and paper cartons have very low impacts on solid waste, but they are mainly used for non-carbonated beverages. Returnable glass and metal cans are better than non-returnable glass containers which constitute the major impact. Many of these conclusions are based on weight, whereas with volume the returnable system may be superior.

4.3.3 Litter

Beverage containers constitute a major part of litter. On a unit count basis, beverage containers account for 7 - 30% of total littered items. This may understate the true impact on litter, as bottles and cans have a larger visual impact. In addition their non-biodegradable nature may result in a cumulative effect if the litter is not cleared.

The probability of being littered was highest for the metal can, followed by the non-returnable bottle. The refillable bottle has the smallest impact. This suggests that a move towards a returnable system would create favourable improvements upon the environment.

4.3.4 Pollution

The measurement of the impacts of air and water pollution emissions is difficult. Although the quantity of emissions from the various container systems may be assessed, it does not necessarily give any indication of the impacts of such pollution. They found the least polluting in terms of both air and water was from the use of returnable containers, followed by metal cans and the non-returnable bottle. Again, this ranking is dependant on trippage. For ranking to apply the returnable bottle must achieve a trippage of 5 in the case of air pollution, and more than 10 for water pollution. If these trippages are not achieved the returnable bottle may cause greater pollution than returnable containers.

This pollution problem is more attuned to a national pollution control programme, as it is unlikely that beverage pollution will be a significant proportion of total pollution.

4.3.5 Health & Hygiene Problems

The OECD study found no evidence to support the view that returnable bottles are greater risks to health and hygiene than non-returnable containers. Strict food regulations in most countries have ensured that cleanliness of all containers is of a sufficiently high standard.

However, the survey of Councils stressed Environmental Health Officers' (EHO's) concern over hygiene that could be caused through the use of refillable containers. This area needs to be reassessed.

4.3.6 Summary

The OECD report concludes that the returnable container system will in general achieve lower external costs than non-returnable containers; provided a certain trippage rate is achieved. The most significant of the external costs are in terms of litter and solid waste, and any Government intervention will primarily be concerned with these two areas.

4.3.7 Policy Options

The second part of the OECD report looked at the various policy measures a Government might undertake to counter any adverse environmental effects of beverage containers. First, it outlines a criteria for policy selection that any country can follow to fit a policy to its own set of circumstances. It then runs through the alternative policy measures:

Non-Intervention Policy
Ban on Non-Refillable Containers
Mandatory Deposits On Beverage Containers
Oregon Type Legislation

High-Tax on all Beverage Containers
Product Charges On Packaging
Low Litter Tax
Standardisation Of Containers

Recycling
Encouragement To Technical Developments
Combination Of Policies

4.3.8 Recomendations

On the basis of this report came the 'Recomendation of the Council Concerning The Re-Use and Recycling of Beverage Containers', which was adopted by the OECD Council on 3rd February 1978. This recommends:

1. ..... that policies should be designed to ensure that costs of adverse environmental impacts of manufacture and use of beverage containers are effectively borne by producers and users of such containers.

2. ..... adopt appropriate measures to maintain, or introduce, a system of distribution by refillable containers covering as much as possible of beverage trade, where it minimises social costs.

3. ..... efforts to standardise containers in conjunction with other countries to minimise trade barriers should be undertaken.

4. ..... regardless of measures taken to promote re-use of beverage containers, Member countries should encourage recycling of ultimately disposed-of containers, and take any other necessary step to reduce as much as possible any adverse effect on the environment.

4.4 WMAC Study

4.4.1 Introduction

The UK Waste Management Advisory Council (WMAC) established a working party in 1977, to look at Returnable and Non-Returnable Containers. This study was established due to concern over the environmental consequences of the move from returnables to non-returnables, and in light of the initiatives taken in this area by the EEC. The final report of this working party was not presented to the WMAC for discussion, or approval; but was published after its demise in 1981.

This report has been criticised for the lack of emphasis it gave to the external cost savings resulting from a move to an all returnable system in its conclusions. This lead to CAWDELL presenting a Minority Report to counter this omission. It has also been criticised for its dismissal of data and information that reflects what has happened in other countries. It did, however, lead to the collection of significant data on various aspects of different beverage systems.

The WMAC study looked at the external costs of the various beverage systems. WMAC defines external costs as those which are incurred by society as a whole, but are not paid for by the consumers in the price of the product. Some of these costs are met by Local Authorities - waste management, litter control - through their rate payers. But the person littering a container does not pay for this specifically. Other costs - loss of amenity from litter - are more difficult to assess.

4.4.2 Waste Management

The report is largely dismissive of the potential savings from a reduction of beverage containers in the solid waste stream. WMAC claims that beverage containers are comparatively cheap to dispose of when compared with other kinds of waste. If removed from the waste stream, this could result in savings that are half average costs of disposing of all waste. The costs saved per container, considered by volume for cans and by weight for bottles may vary from 0.01p for 10-12 oz cans, to 0.13p for a litre bottle (1977 prices).

4.4.3 Litter

Littered containers are clearly a source of external costs, that need to be collected and be properly disposed. They are also a visual disamenity and can be a hazard to both animals and Man. In addition, there is a need to consider waste that is put into litter bins, as this will need to be collected and be finally disposed.

The WMAC study found limited data available on the quantity, composition or control costs of litter. The extent of the control will also affect the size of the problem - as some items will accumulate, others will decompose, or blow away.

In agreement with the OECD report, WMAC found that cans are more likely to be littered, followed by Non-Returnables and then Returnable Containers.

4.4.4 Road Congestion

The replacement of cans and Non-Returnables by returnable containers will result in additional road congestion: for a given

volume of packaged beverage more vehicle miles will be needed with more deliveries to outlets and more congestion with vehicles parked at kerbs. In addition to road congestion, there will be associated costs of noise, fumes, etc.

4.4.5 Pollution

Effects of pollution varies depending on the types of pollutant, where it occurs, its concentration on discharge and dispersal, the density of settlements, and whether other pollutants are present. Emission data in isolation is of limited value. It needs to be reviewed in light of these other factors.

Returnables with a trippage of 4 use less energy and raw materials than non-returnables for a given volume of beverage packed, and therefore result in less pollution, except in respect of transport (pollution from vehicles) and washing. The major savings in pollution from replacing non-returnables with returnables are in electricity generation, burning of other fuels in manufacture, and manufacture of soda ash and associated quarrying.

The WMAC study concluded that while the returnable system is not pollution free, pollution from it is less serious than that associated with steel and aluminium manufacture, and less in quantity than that from an equivalent non-returnable system

4.4.6 Health & Hygiene

It is possible returnables may lead to health and hygiene problems, if misused. Although with regulations and codes of practices, fillers have an obligation to ensure their product is free of contaminants. In addition foreign matter can be found in non-returnables and cans on occassion, so the problem is not

confined to returnables. With current practices hygiene problems associated are small.

4.4.7 Summary Of External Costs

In concluding they found that the external costs of waste, litter and road congestion associated with packaged beverages are small (0.5p per litre sold in 1977 prices). The returnable although involving relatively higher external costs in terms of road congestion, has low external costs in other aspects due to trippage. The can seems to have higher costs in terms of litter, but has lower waste and road congestion costs. The non-returnable has the highest external costs of the three because it is disposed of (or littered) after one trip and is heavier than the can. The can is responsible for the most pollution per unit of packaged beverage sold, and the returnable the least, mainly because the can is associated with steel and aluminium production, but the proportions of the various pollutants associated with beverage containers are relatively small.

In summary the external costs associated with waste disposal, litter, pollution, road congestion, and health and hygiene taken together are slightly lower on balance for returnable than for non-returnable systems. However, these costs per container are extremely low.

4.4.8 Energy

With present trippage rates (estimated at 4 for off-premise sales and between 10 and 20 for on-premise sales), WMAC estimate that an all-returnable system would save some 21% of the total energy consumed by the present mixed system. This represents about 0.13% of national consumption, which could be increased to about 0.22%

through improvements in trippage.

4.4.9 Conclusions

Conclusions from the WMAC Study on Returnables and Non-Returnables, 1981; can be summarised as:

1. Resource costs of returnable systems are generally lower than for non-returnable systems.

2. Returnable bottle systems, with a certain trippage consume less energy per litre sold than corresponding non-returnable systems.

3. With present trippage rates, an all returnable system would save some 21% of total energy consumed by present mixed system (equal to about 0.13% of National energy consumption).

4. Move to all-refillable system would reduce material for can-making, may increase for glass (dependant on trippage).

5. External costs - waste disposal, litter, pollution, road congestion, health & hygiene - are marginally lower on balance for returnable than non-returnable systems.

6. Move to all-refillable system would result in closure of beverage can-making and canning lines - estimated loss of 7000 to 9000 jobs (many in South Wales).

On the basis of these conclusions the WMAC report recommended:

1. All returnable bottles should have a mark of returnability

2. Schemes for recovery and recycling of used beverage containers should be developed by collaboration between Industry, Local Authorities, consumers and voluntary organisations.

3. Beverage manufacturers should provide more information on returnability, deposits, etc.; and generally promote bottle returns.

4. Continued efforts to achieve a greater measure of container standardisation should be made.

4.5 WMAC Study - Minority Report

CAWDELL (1981) a member of the WMAC working party, produced a minority report. This placed more emphasis on the external cost savings, and felt that the Government should take a leading and more positive role.

CAWDELL recommends:

1. The introduction of legislation to impose mandatory refundable deposits on beer, cider and carbonated soft drinks under 4 litre capacity;

2. Require container fillers to initiate deposits, and subsequent handlers to pass these on to the consumers;

3. Permit certification of standard containers, defined as those used by more than one filler and achieving retail sales of at least 5 million units, which would carry lower deposits; and

4. Require retailers to accept back all containers of type, size and brand sold by them, and to accept back any standard container stocked, up to some limit per customer per day.

CAWDELL, supported the recommendations in the majority statement that said:

1. .... efforts should be made to improve trippage of existing returnable systems;

2. .... standardisation of glass bottles by voluntary agreement between fillers should be encouraged; and

3. .... recycling programmes should be encouraged.

4.6 Comparison Of OECD and WMAC Studies

The OECD (1978) report offers comparisons between Member Countries, whereas the WMAC (1981) report restricted itself to the system operating in Britain. The WMAC report has been criticised for this narrow viewpoint it adopted. Both of these reports concluded that in general the returnable container system would have lower external costs than non-returnable containers. This was provided a certain trippage is achieved.

The reports differ in their treatment of external costs, as is shown below:

External Factors:	OECD REPORT	WMAC REPORT
	Energy	
	Waste Disposal	Waste Collection & Disposal
	Litter	Litter
	Air & Water Pollution	Air & Water Pollution
		Road Congestion
	Health & Hygiene	Health & Hygiene

The WMAC study incorporates energy analysis within the main body of the report, but is largely dismissive of its importance. Whereas, the OECD Report puts more emphasis on the role of energy in assessing the merits of the different beverage systems. In addition the WMAC report includes problems of road congestion resulting from the delivery and distribution of more returnable containers.

The OECD views the main areas of concern as problems and costs of litter control and solid waste management. The WMAC report is largely dismissive of the relative impact of solid waste savings on operating costs. WMAC see the disposal of beverage containers as being relatively 'cheap'. Thus any savings will be marginal in the short term. In addition collection cost savings are unlikely

to result as these are largely fixed. However, if a significant reduction occurs in the proportion of glass and other containers in the waste stream, then significant savings in collection and disposal costs may arise.

There are problems with the lack of data available on the quantity of litter and on the proportion each material that makes up of litter. There are few figures available on the cost of cleaning and the disamenity value of litter. Both reports noted that the most likely container to be littered was the metal can, followed by non-returnable bottles and then returnable bottles. Thus a move to a returnable system could lead to a reduction in the quantity of litter. It is in the area of litter control, that most methods of mandatory deposit have been introduced (Section 4.8).

The recommendations are similar, with both seeking to encourage industry to develop and promote returnables. This is through information programmes and the possible standardisation of containers. In addition they sought to encourage the development of recycling programmes to recover materials at all levels (Table 4.3). These measures are voluntary with no force of legislation. The minority report, sought legislation to promote returnables and use of deposits. In addition they looked for Central Government to take the lead with positive action.

TABLE 4.3 Comparison Of Recommendations

OECD	WMAC	CAWDELL
... external costs should be met by producers and users of containers	... establish mark of returnability for all returnables	Introduce legislation to impose mandatory refundable deposits on beer, cider & CSD under 4 litre capacity
... maintain and promote refillable containers, where it minimises social costs.	... Fillers should provide more information on returnability, deposits and promote returns.	... fillers should initiate deposits and subsequent handlers to pass these on to the consumers.
... standardise containers Nationally, and Internationally to minimise trade barriers.	... efforts to standardise containers should be pursued.	... certify standard used by more than 1 filler & with sales of 5 million units, which would carry lower deposits.
... encourage recycling.	... encourage recycling with collaboration between Industry, Local Authorities, Consumers & Voluntary Organisations	... require retailers to accept all containers stocked.
		Supported WMAC views:
		... improve trippage of existing system.
		... standardisation by voluntartry agreement.
		... recycling programs should be encouraged.

4.7 Benefits Of Returnables/Refillables

4.7.1 Trippage

The returnable bottle provided it achieves a certain trippage - the number of return journeys a container makes - has considerable potential for energy and raw materials savings. Methods of calculating trippage used by the OECD (1978) are shown in Appendix A.1. To achieve the associated savings the OECD report saw a need for a trippage of between 1 to 4 for soft drinks and beer, and 3 to 10 for milk containers. Both reports made reference to trippage, and WMAC noted the need to seek ways of improving trippage. Table 4.4 shows that the trippages are achievable in OECD Member Countries.

TABLE 4.4 TRIPPAGE RATES ACHIEVED IN VARIOUS COUNTRIES

COUNTRY	TRIPPAGE (Tt)	
	BEER (& Cider)	SOFT DRINKS
United Kingdom	13	9
Canada:		
Ontario Total Mkt	33	13
Urban Mkt		5-7
Quebec	33	
USA	14	10
Oregon	6-20	12-24
Switzerland	60-80	20-70
West Germany	25	9
Sweden	17	
Finland	30	
Norway	35	
Denmark	31	

SOURCE: OECD (1977) Beverage Containers

4.7.2 Energy Savings

Table 4.5 shows the energy required to produce 1 million 12 fl oz containers from various materials. This data emphasises the importance of trippage rate in attaining energy savings.

TABLE 4.5 Energy Used To Produce 1 Million 12 Fl Oz Containers

MATERIAL USED	Tonnes Of Oil Equivalent
Returnable Glass Bottle (1 Trip)	138
All-Aluminium Can	117
35g Plastic Bottle	110
Non-Returnable Glass Bottle	96
Tinplate Can (Aluminium End)	81
25g Plastic Bottle	80
All Tinplate Can	64
Returnable Glass Bottle (8 Trips)	34
Returnable Glass Bottle (16 Trips)	25

SOURCE: Open University Municipal Waste Disposal Pt 272 Unit 9

TABLE 4.6 Systems Energy Requirements For Various Containers Per 4,546 litres (1000 gallons) Beer (1974)

CONTAINER SYSTEM	ENERGY (GJ)	INDEX (19 Trips = 100)
Returnable Glass Bottles		
Making: 19 Trips	16.78	100
10 Trips	22.28	136
5 Trips	45.24	270
'Steel' Cans	56.89	338
Non-Returnable Glass Bottles	67.93	405
Aluminium Can	79.16	472

SOURCE: PEAKER A 'Resources Savings From The Re-Introduction Of A Returnable System Of Beverage Containers: A Case Sudy Of Experience In Oregon' RESOURCES POLICY Sept 1975

TABLE 4.7 Break-even Trippages For The Returnable Bottle To Have A Lower Environmental Impact Than Three Non-Returnable Container Systems For Beer And Soft Drinks

NON-RETURNABLE CONTAINER SYSTEM	ENERGY	SOLID WASTE WEIGHT	SOLID WASTE VOLUME	POLLUTION AIR	POLLUTION WATER
Non-Returnable Bottle	2	1.5	1.5	1.3	5.4
Can (Bi-Metallic)	1.5-4	7-8	2-3	1.8	14.8
Can (Aluminium)	1.0-2	16-21	5-7	1.0	0.8

SOURCE: FISHER J & HORTON P (1979) Op Cit

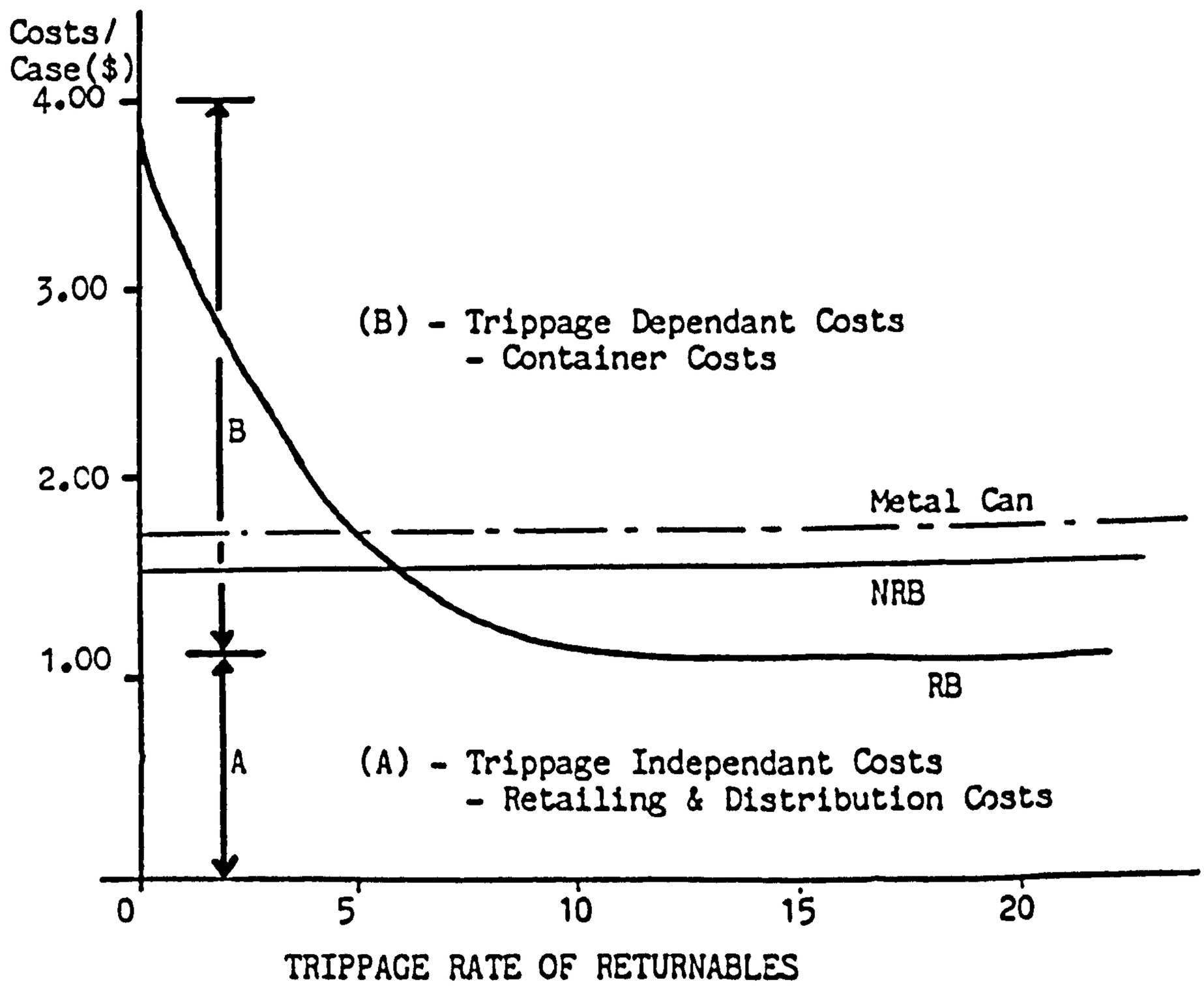
PEAKER (1975) looked at the benefits and costs arising from the promotion of the returnable system in Oregon, USA; through the use of Deposit Legislation. This work showed that significant savings in energy could be achieved by the use of returnables (Table 4.6).

PEAKER also noted that a returnables only system, would result in material savings through reducing the quantities required. This will also lead to reductions in energy demands of extraction, processing and disposal. The introduction of deposit legislation nationwide (USA) could result in significant savings in materials consumption and energy usage.

FISHER & HORTON (1979) view the trippage rate as having the central role in determining the social and private viability of the system. They define trippage as the number of times that a returnable bottle is used for filling and delivering beverages. The individual returnable bottle is heavier and more expensive than its non-returnable counterpart, and the returnable system will incur greater distribution and retailing costs. However, each time a bottle is returned, savings are achieved in the costs associated with the acquisition of their raw materials and their manufacture into new containers. Figure 4.A shows that a returnable bottle needs to achieve a trippage of about 5, to realise cost savings compared to the alternative non-returnable containers.

Table 4.7 indicates the breakeven trippages that a returnable system has to achieve, so as to reduce the demand for energy, and generate less solid waste, water and air pollution than for comparable non-returnable systems.

Figure 4.A Comparison Of Total Internal Cost Of Supplying Packaged Beer In Non-Returnable Containers And Returnable Bottles With Different Trippages.



NB Trippage dependant costs are those costs that will vary with trippage achieved (costs amortised by the Number of Trips achieved by the container).

Trippage Independant costs are those costs which are invariant of trippage rate and are incurred regardless of whether bottle returned (eg filling, retailing, and distribution costs).

SOURCE: Fisher J & Horton P (1979) The Return Of Returnable Bottles Resources Policy 5 (4) pp279-297

Table 4.6 shows that a returnable bottle has to achieve a trippage of 2 to reduce the demand for energy as compared to non-returnable bottle. To use less energy than an all-aluminium can the returnable bottle will need to achieve a trippage of between 1 and 2.

Table 4.7 also indicates the break-even trippages that are necessary to generate less solid waste, water and air pollution by a returnable bottle, as against the non-returnable containers. In terms of solid waste a returnable bottle will have impacts with regards volume and weight factors. Volume is important as it is the volume of waste that decrees the need for extra dustbins and to a certain extent more landfill sites. With a bi-metallic can weighing 1 oz a returnable bottle weighing 8 oz will have to make at least 8 trips to be less environmentally damaging than the can. This applies in terms of the volume of waste as well, with a bottle if it remains whole taking up to 3 times the volume than the can. It will need to make over 3 trips to have a smaller environmental impact than the can. By reducing the volume and weight impacts there can be resultant benefits in terms of waste disposal and collection costs. In addition returnable bottles providing a certain trippage rate is achieved can be less environmentally polluting than alternate non-returnable systems.

The determination of whether the returnable bottle is the socially preferable container in economic and environmental terms depends critically on the trippage rate achieved. With high trippage rates, returnable bottles are the best recycling option, with concomitant savings in raw materials and energy, and environmental benefits of reduced pollution levels and lower disposal costs.

4.7.2 Analysis Of Mandatory Deposits

PORTER (1978) tried to quantify the effects of mandatory deposits on Michigan State, USA. With the imposition of mandatory deposits, PORTER identified five resource effects as:

1. Litter - collection and aesthetic effects.
2. Solid Waste - collection and disposal costs.
3. Container Costs.
4. Production and Distribution Costs.
5. Consumer Convenience.

PORTER (1978) found that the desirability of mandatory deposits depends on the average value of time taken by consumers to return containers, the average value of the aesthetic costs of litter, and the container mix in the market.

PORTER's (1978) initial analysis was based on a move to an all-refillable system. The costs per filling were established for the resource effects that were identified (Table 4.8). The source of these costs are briefly reviewed below.

Litter imposes two costs on society: First the cost of collection, and second the amenity cost of the stock of litter. The latter includes 'eyesore' costs, and physical damage to man, wildlife and farm machinery.

Litter collection costs (uplift and disposal costs) varied from 1c to 4c per container. PORTER (1978) estimated that pick-up costs per filling would be between 0.04c and 0.26c/f (c/f=cents per filling). The eyesore cost of litter - while it lies on the ground - will be influenced by the rate of uplift. There is a need to evaluate specific damages caused by litter (Chapter 8.3.7).

It is difficult to assess people's willingness to pay for a reduction in beverage container litter. The study was concerned with mean willingness to pay ($\bar{x}$). PORTER (1978) estimated that

converted to cents per filling the social benefit of litter reduction is 0.23c/f. Thus the net benefit of mandatory deposits for litter - first of enduring it and then collecting it - is $(0.23\bar{x}+0.15)$c/f.

In 1974, Michigan generated 5.76 million tons of municipal solid waste, of which 6% was beverage containers. The decline in the number of beverage containers that were disposed of as solid waste was 91-96%. Studies suggest that their would be a reduction of 2.1% in solid waste in Michigan, which would mean that there would be 121000 tons less waste in 1974 with an all-refillable system.

Waste collection and disposal costs in Michigan was $22 per ton. Thus a complete conversion to refillables would save $2.66 million (0.07c/f). This suggests that the current solid waste system disposes of containers relatively cheaply.

While refillable bottles initially cost about twice as much as one-way containers, the average refillable bottle is reused many times. This means that the cost of containers per filling would decline significantly if only refillable bottles were used. The saving in container costs, weighted for beer and soft drinks consumption patterns is 3.08c/f. This saving is the private container costs faced by industry. For social costs, there is a need to account for raw material pricing, and possible oligopoly effects on container pricing.

Refillable containers cost more than one-ways for filling and distribution. At the filling stage, bottle lines run slower than for cans. Refillable bottles are heavier, more costly to load and to transport. Return for reuse requires additional storage, handling and washing. The total stock of containers required to

maintain a given flow of fillings is increased when a complete system of returnable bottles is achieved. Cost estimations for these components for retailers, bottlers and brewers are difficult to make.

PORTER (1978) estimates these production and distribution cost increases at 2.77c/f. This represents a net cost of mandatory deposits. The increase in production and distribution costs is less than the decrease in container costs (3.08c/f). These figures are highly uncertain, and since they are so large and hence so critical there is a need to undertake sensitivity analysis of these factors.

There are social costs of switching to an all-refillable system - consumer convenience. As people have switched to one-ways, despite price differentials in favour of refillable bottles - people have shown that easy disposal of containers is worth something. There is a need to identify the source of this loss of convenience that occurs in a move to a system of refillables. Factors to be considered are:

- time taken to return empty bottles,
- loss of choice in container size, & brand numbers,
- storage costs at home, and
- financial return costs.

To put inconvenience on a per-filling basis, must recognise that return cost, $\bar{y}$; only applies to bottles returned under mandatory deposits and which were not previously returned. Making this adjustment yields a net cost of mandatory deposits from the viewpoint of consumer inconvenience of $0.68\bar{y}$ c/f.

These resource elements are summarised in Table 4.8. The total does not depend on cost of litter uplift (+0.15), or solid waste savings (+0.07). The container cost savings (+3.08) depend on a

trippage of 15. The critical uncertainties are in the unknowns x and y, and in the production and disribution costs (-2.77).

TABLE 4.8 The Social Benefits And Costs Of A Change To Mandatory Deposits In Michigan, 1974.

ITEM	BENEFIT (+) OR COST (-)
Litter	$+0.15+0.23\bar{x}$
Solid Waste	+0.07
Container Costs	+3.08
Production & Distribution Costs	-2.77
Consumer Convenience	$-0.68\bar{y}$
NET	$+0.53+0.23\bar{x}-0.68\bar{y}$

Source: PORTER R C (1978)

PORTER (1983a) revised his views on the impact of mandatory deposits after reviewing what had happened in Michigan. He found that beverage litter had fallen by 85%, and that the rate of container return was around 95%. The container mix remained relatively constant, with cans retaining a significant share of the market. The evaluation of mandatory deposits rests on whether beverage producers pass on container cost savings, or whether new costs are imposed by the bottlers.

Based on this second survey (1983a), PORTER (1983b) reassessed his social cost benefit analysis of mandatory deposits in the State of Michigan (1978). This review was based on the assumption that the container mix is 50% refillable bottles and 50% aluminium cans.

TABLE 4.9 shows the findings of the earlier study with money figures adjusted by 90.6% to put them into 1981 figures. The two variables $\bar{x}$ and $\bar{y}$ remain: $\bar{x}$ is the public's mean willingness to pay for an environment that was to have 75% less litter, and $\bar{y}$ is the mean consumer inconvenience cost of returning containers.

The resource costs need to be adjusted for a 50:50 container mix.

The greater the use of cans, the smaller the container cost savings would be. As the State already had 25% refillables a switch to 50%, only provides a third of the savings of a switch to 100%.

Refillable containers cost more than cans to fill and distribute, so with more cans the filling and distribution costs will be lower.

Cans will be recollected and recycled under a mandatory deposit system. The price of a used aluminium can is roughly 1.7c, equivalent to 0.79c/f. The value of recovered cans needs to be incorporated into the cost benefit analysis.

TABLE 4.9 The Social Benefits And Costs Expected From Mandatory Deposits In Michigan (1981)

ITEM	CONTAINER MIX 100% Refillables	50% Rflbls/50%Cans
Litter	+0.29+0.23$\bar{x}$	+0.29++0.23$\bar{x}$
Solid Waste	+0.13	+0.13
Containers	+5.87	+2.03
Production & Distribution	-5.28	-4.44
Consumer Convenience	-0.68y	-0.68y
Recycling Value	n.a.	+0.79
Net	+1.01+0.23$\bar{x}$-0.68y	-1.20+0.23$\bar{x}$-0.68y

SOURCE: PORTER R C (1983b)

There is an important set of values of $\bar{x}$ and y for which a mandatory deposit system provides a net social benefit if it induces a complete conversion to refillables, but a net social loss if only a partial conversion (50:50) is achieved. The social value of mandatory deposits is dependant on achieving an increase in the level of refillables in the container mix, with associated return rates.

4.8 Legislation

4.8.1 Introduction

Given, that returnables are the better solution in economic and environmental terms and in the light of a decline in their sales, some form of Central Government action is necessary. This can be done in the form of active 'encouragement' of voluntary practices to promote the use of refillables in the first instance. If this is not effective, the adoption of legislative measures to enforce the use of refillable/returnable containers should be examined.

Knowledge of the effects of legislative measures comes from experience gained in the USA, and in Denmark. Voluntary measures have been adopted in France and Germany. These experiences are drawn on by the OECD Study, but have largely been ignored by the WMAC Study.

In the USA legislation has largely been introduced as a form of litter control. Other benefits in disposal savings that occur as a consequence are a bonus. A review of the American system counters these benefits by noting adverse effects on sales, prices, revenue and employment. A clear assessment of both the advantages and disadvantages of deposit legislation needs to be undertaken.

4.8.2 The British Bottle Bill

Following on from their participation in the WMAC working party that looked at returnables FOE initiated the introduction of a Bottle Bill in the House of Lords in 1981. This Bill required all containers for beer, cider and carbonated soft drinks to bear refundable deposits. The Bill made provision for the use of 'standard' containers that would be used by more than one

manufacturer and would bear a reduced deposit. These provisions were similar to the policies adopted in Oregon.

The Beverage Containers Bill was defeated in the Lords by 69 votes to 30, a decision that was endorsed by the Government. The Earl of Avon, the Government Spokesman said that there was little evidence that a Bill would lead to reductions in: litter, energy conservation, waste disposal savings, or raw material savings. This view runs counter to the findings of the WMAC working party, and the OECD report.

Lord Sainsbury spoke against the Bill as it would restrict consumer choice, cause commercial and industrial dislocation. Sainsbury felt that the objectives of the Bill could be achieved through anti-litter campaigns, and national voluntary programmes.

Although the Bill was defeated its objectives may be achieved through the EEC Directive (Section 4.8.6).

4.8.3 Denmark

Since 1971, Denmark has banned the sale of carbonated soft drinks in non-returnables. In addition they reached a voluntary agreement for beer sales to phase out non-returnables by the end of 1981. However, the use of returnables is challengable under EEC regulations as a barrier to trade. Although, this may change with the introduction of the EEC Directive. Beer sales are now in standardised bottles, achieving trippages of 25. In addition the Government has a legislative framework under which it can control material types and introduce deposits. More details of these two Acts are provided in Appendix A.4.

4.8.4 West Germany

The West German Government has adopted measures to retain and promote the use of returnables. In association to these moves it encourages general recycling schemes. Recently, the Aldi retail chain was criticised for failing to stock returnables alongside non-returnables. Where voluntary measures have failed the Government is examining the adoption of fiscal measures to control waste production.

The Government can control wrappings and container types, which in their view of material type, composition, volume or quantity would be costly to dispose of in comparison with other wrapping and container types. For example, the use and sale of PET Bottles was prohibited until the dumping or burning of used bottles was prevented.

These moves on beverage containers show the Government's intention to force those sectors of industry and commerce that market problematical articles, to contribute to the solution of the problems of waste generation in accordance with the 'Polluter Pays' principle. The Federal Government believes that private activities should have priority in the context of an overall approach which integrates both re-use and disposal of waste materials.

4.8.5 The American Experience

Oregon was the first State to introduce deposit legislation. This was done in the first instance to control litter which was felt to be a problem. Since Oregon, nine more States have introduced Deposit Legislation. More details are given in Appendix A.5 on the Oregon experience and an assessment of its merits. The Oregon

legislation required that all beverage containers carry a refundable deposit. This is a two tier system of $0.05 and $0.02; the latter being used for 'standard' containers. The work of PEAKER (1977) (Section 4.7) has shown that deposit legislation has lead to a decrease in solid waste, a decline in raw material use, and a decline in overall energy consumption. Despite these benefits a report in GLASS VIEW (1980) criticises the introduction of deposit legislation as having adverse effects on: prices, sales and employment.

In Oregon, litter levels fell after the introduction of legislation. This may be associated with an increase in expenditure on litter collection and anti-litter publicity in Oregon. An alternative approach to litter abatement was adopted by Washington with advertising, public education and voluntary recycling schemes. This approach compared favourably with the results achieved in Oregon. The Washington system was funded through a local 'tax' based on the level of sales achieved by commercial undertakings.

RASMUSSEN (1984) looked at whether the public are sensitive to litter and would value a less littered environment. Respondents felt that litter was a problem, which was consistent with positive views on environmental issues. These concerns need to be 'costed', which encounters the problem of putting a monetary value on the amenity value of litter free roadsides and parks. Rasmussen examined how much respondents would be 'willing to pay' for a particular benefit. He showed that 75% of respondents were willing to pay $0.10, and 42% were willing to pay $0.15. This work showed that people were willing to pay extra costs for refillable beverages, to gain the perceived environmental

benefits. There is a need to evaluate peoples stated willingness to pay with their actual behaviour patterns.

A move to refillables is likely to lead to a decline in solid waste management costs in terms of both collection and final disposal. The Glass Industry feel that a more effective way to reduce solid waste is to recycle glass. Such a system was used in Washington State. In Germany the Industry feels that the success of their recycling scheme counters any need for the introduction of deposit legislation.

These benefits from the improved energy consumption, a reduction in litter costs, and waste management costs are dependant on the trippage attained by the returnable system. The success of the Oregon scheme is due to the high return rates, which reflects the ease with which consumers are able to return containers. The system of lower deposits for 'certified standard bottles' indicates that it is the ease of return that is of greater importance than the size of deposit for increasing return rates.

Prices may rise as retailers employ extra people to handle bottle returns. In addition the imposition of a deposit can be perceived as a price increase, although the deposit is reclaimable. In general the States have shown an increase in price following on from deposit legislation, although it is not clear what is the contribution of deposits to the price increase. RASMUSSEN (1984) showed that people stated that they were willing to pay the extra costs for refillable beverages, to gain the perceived environmental benefits.

In two examinations of the effect on the beverage industry in Oregon, one showed that there would be an operating surplus the

other a deficit. GUDGER & WATTEN (1976) show that savings in container costs from use of refillable bottles would increase the operating income of the beverage industry by $16.5 million. Offset against these savings are losses by container manufacturers and increased distribution costs faced by manufacturers, distributors and retailers. GUDGER & WATTEN estimate these costs at $12.5 million, giving a net operating surplus of $3.9 million. In contrast a survey by ADS showed a decline in income of $6.9 to $8.6 million. This difference is due to the fact that the ADS study uses a lower trippage which means that the container costs saving figure is lower. This highlights the importance of trippage to the success of the policy measures.

With higher prices there may be a fall in sales. GLASS VIEW (1980) reports a general decline in sales, although these need to be reviewed in light of trends in national consumption patterns. With changes in prices and increase in handling time it can affect consumer choice by reducing the variety of beverages stocked, the number of brands stocked and the size range stocked. The reduction in beverage sales can have a knock on effect in terms of a fall in revenue from federal taxes.

A move to an all-refillable system will have employment impacts. Oregon had 365 extra full time jobs and a net labour earnings increase of $1.6 million. Within the job market there has been a transfer from skilled to unskilled jobs.

As the aim of deposit laws has primarily been to reduce litter, other methods of control should be examined. Education programmes and voluntary recycling schemes have been successful in Washington State both in the control of litter and in the reduction of waste. In addition energy savings can be attained if certain trippages

are reached. Despite these more environmental benefits, other factors need to be considered. The effect on prices, sales and employment needs to be reviewed. Although, the retail distribution network and consumer trends are different in UK, many similarities can be drawn and lessons learned.

4.8.6 EEC Directive

The Directive 'on containers of liquids for human consumption' was formally adopted on 27 June 1985. Work on this Directive arose from concern within the Community over the environmental impact of the increasing quantity of drinks containers being produced. The Directive passed through many drafts in attempts to balance the conflicting interests it encountered within industry and trade, and consumer and environmental organisations, as well as wishes of the different countries.

The Directive has moved away from an interventionist position towards a more pragmatic one in which countries would be free to choose their own means to achieve the objectives, whether by voluntary or legislative methods. This discussion took place over 9 years. In the face of opposition from Industry and certain Government representatives the Directive moved away from specific statements on how the reduction of waste was to be achieved to more general policy statements. The main compulsory objective is that Member States should report their intentions within two years, and their progress every 4 years. The Directive is attached in Appendix A.6.

A statement from the EEC Council on the Environment lays out objectives for member states as follows:

- to develop consumer education.

- facilitate the refilling or recycling of containers.

- promote the selective collection of non-refillable containers, retrieve these containers from household waste and extend outlets for materials recovered from the containers.

- encourage development and placing on the market of new types of container; that use less energy and raw materials.

- maintain and increase the proportion of refillable and recyclable containers.

The methods adopted to achieve these objectives was left to individual countries to decide. Suggestions in Britain are that this responsibility has been pushed aside by Government and left to Industry to formulate an initiative. Waldegrave the Under Secretary for Environment entered a 'reservation' pending further examination of the directive. This means The Government will discuss matters with the packaging industry and will not move until industry reservations are overcome. COOK (1985) reports that these discussions are likely to begin in April 1986. Four working parties have been set up for each basic material - glass, metal, paper and plastic - with representatives from producers, packers and users. It is important that Local Authorities are invited to participate, and that Central Government takes a co-ordinating role.

The outcome of these discussions is as yet unclear. Although the Directive asks for plans to be submitted within the next two years the 'reservation' means that the Government can stall any action for some time.

The Directive can be seen as legitimising the stand taken by Denmark in banning non-returnables, and by West Germany in their promotion of re-use and recycling of beverage containers. Although confined to a small section of the market the Directive

is a major step in the development of a rationale framework to minimise waste and promote recycling. The Directive provides an International framework to develop control policies for beverage containers.

4.8.7 Summary Of Legislation

The use of deposit legislation must be clearly assessed in terms of its advantages and disadvantages. In America, legislation has focused on litter control. In that case other methods of litter control should be examined to see whether they would be more effective.

Experience of deposit legislation has shown that it has lead to litter reductions, household waste reductions, and energy savings. These changes need to be put into perspective of any changes in local conditions, ie if there has been increased expenditure on litter control.

In addition, to these improvements, changes have been noted on sales, prices and employment. Again, these changes need to be put into the context of changes in consumption patterns, and general economic conditions.

The latest form of legislation is the EEC Directive, which seeks to promote the use of returnables, as well as encouraging recycling. This Directive focuses on a limited section of the market.

4.9.1 Public Participation

A key area is public participation, as without public support a system of returnables would not be effective with or without legislation. Public support is a balance between consumer convenience, willingness to return, and ease of return to retailers. A number of surveys have been undertaken into the value of returnables. TURNER & O'RIORDAN (1978) looked at public attitudes to recycling in the city of Norwich. FISHER & HORTON (1979) looked at the ease of returning returnables to retailers. A National survey was undertaken by FOE (1981) that looked at returnable systems.

4.9.2. Norwich Survey

When TURNER & O'RIORDAN (1978) carried out their survey, returnables were the only glass recycling option available. Now, Norwich operates Bottle Banks to recover glass, thus a revision of this part of the survey could be considered. Returnables were not always available and were slightly more expensive to purchase, even excluding deposit. The study found that 8% of Norwich householders purchased returnable bottles regularly, and 64% never bought them. This is contrary to the findings of the FOE Study (Section 4.9.3).

The actual behaviour toward bottle recycling was not demonstrated. This contrasts with the study's findings that the public were willing to use returnables. It highlights the problem of judging people's intentions towards recycling, when compared with their actual recycling behaviour. Results indicate a willingness to respond to an initiative to recycle glass bottles, with strong motivations based on the reduction in litter, and savings in raw

material use. Only 64% were disposed to see the City make a bigger effort to recycle bottles. This attitude may be influenced by the introduction of the Bottle Bank system.

4.9.3. FOE Survey

The FOE Survey looked at public attitudes towards glass recycling. The study was carried out by members of local FOE groups in November 1981. The aim of the study was to assess which type of containers people purchased, which type they prefer, and which they would like to see sold more in the future.

Interviews were conducted in 47 areas, covering a representative number of cities, towns and rural areas, including areas with Bottle Banks. In the interview areas a quota of 20 shoppers were questioned outside a variety of shops: 7 outside a supermarket, 4 outside independant grocers, 3 outside off-license chain, 3 outside independant off-license, and 3 outside unlicensed confectioner tobacconist newsagent (CTN). This quota was based on sales of beer, cider and soft drinks through these outlets.

The study found that although shoppers currently buy non-returnable (NRB) containers, more prefer returnables. This study confirms findings of GMF Study (Section 6.9) that most respondents had heard of Bottle Banks, with the majority thinking them a good idea. Despite this only half made use of them, due to inconvenient siting.

Less than half of respondents had heard of the FOE campaigns for returnable containers. But 80% thought that it was a good idea as a way of reducing litter and waste, and saving money and raw materials.

Once the respondents were made aware of the arguments for each container type, they opted willingly for greater use of returnable bottles and cans to reduce litter and waste, and save energy, resources and money. Giving the arguments for the different container types may guide respondents into giving the desired answers. A larger majority of respondents would prefer to see returnable containers than had been willing to use Bottle Banks. This focuses on the division shown by O'RIORDAN & TURNER on the need to distinguish between a person's present intentions and possible future actions.

FOE felt that the results of the survey showed the shopping public's preference for a returnable system of Bottles and Cans, and their growing appreciation of the environmental advantages of such a system.

The survey found the respondents in the main bought non-returnable containers. In fact 44% bought only returnables, 34% bought both non-returnables and returnables, 15% bought returnable containers only, 3% had no preference, and 4% bought no bottled drinks at all. The preponderance to purchase non-returnable containers, reflects their wider distribution and problems of returning returnables.

This practice contradicts their answers to what they preferred. With 49% preferring returnables, 35% non-returnables, and 16% liking both. It suggests when challenged people put forward the more environmentally acceptable options, as opposed to their normal practice of using non-returnables. This illustrates the division between an individuals present and actual intentions, and possible future actions and behaviour. Any assessment of these results needs to bear these possible contradictions in mind.

The following reasons were given for preferring returnable containers:

Avoid/Reduce waste	35%
Reclaim deposit	18%
Ease of disposal	11%
Reduce litter	10%
Cheaper	9%
Habit/Prefer Glass/Energy & Resource Saving	-

The following reasons were given for preferring non-returnable containers:

Convenience/Less Bottles/Laziness	70%
Wasted deposit by discarding Returnables	7%
Preferred Plastic Bottles for safety	6%
Cheaper	3%
Effort of finding & returning returnables	-
Non-Returnables lighter to carry	-

Shoppers expressed a preference for greater use of returnable bottles and cans in the future. 80% thought returnable bottles should be used in the future, and the main reasons for preference for returnables were: litter prevention, waste reduction, saving energy and resources, and cheaper. The 12% who used non-returnables felt they were more convenient, and would not bother with returnables.

The proportion of shoppers who opted for returnable containers exceeds the number who made use of Bottle Banks. This suggests that returning containers to shops is more convenient than taking them to Bottle Banks (inconveniently sited), and perhaps less wasteful and cheaper than smashing Bottles in Bottle Banks.

The surveyed population seem to prefer a more rational use of the Earth's resources in the future, than currently manufacturers give them opportunity for. This survey gives clear indications of peoples support for returnables, but throws doubts on whether they would use returnables in practice.

4.10 Summary

The issue of returnable/refillable bottles is one more directed at the level of National policy, rather than that at the level of influence of Local Authorities. In recent times cognisance of the impacts internationally have to be considered to minimise any problems of trade. This can be seen in the promotion of the EEC Directive, which should overcome the problems created by Denmark with its solitary stance on returnables. In policy matters, Governments need to be clear about the aims of policy, whether it is a matter of litter control, or impact of wider environmental benefits.

Returnables are seen as desirable as every re-use reduces 'manufacturing' costs per bottle. But recent trends are away from the use of returnables to one-trip containers. This reflects a move by supermarkets to maximise the use of space, and away from storing and handling returned bottles. There is also the consumer preference for more 'convenient' packaging.

The one-way container increased bottlers costs, which are passed on to the consumer. But the response in the market place demonstrated consumers willingness to pay extra for convenience. Studies showed that consumers were willing to pay extra for returnables for the perceived environmental benefits. There is a conflict here between practice and public intentions. Further work needs to be undertaken on establishing the motivations behind peoples actions in using one-trip containers, and their willingness to pay extra for returnables for perceived benefits.

Returnable systems are dependant on the cooperation of consumers, even if deposit legislation is introduced. The trend to one-way

bottles suggest that the public has become accustomed to convenience packaging and the throw-away attitude. This is exemplified by the 'loss' reported by INCPEN of £20 million (If 0.10p per bottle it is equivalent to 200 million bottles) in returnable deposits annually. The loss reflects consumers unwillingness to return containers, or the impracticality of returning bottles to the retailer. The willingness of people to participate with Bottle Banks, suggest people are wanting to divert glass from the waste stream.

The essence of any recycling plan must be to motivate the consumer to sort and return his waste products. Existing financial incentives such as Bottle Deposits alone are not likely to elicit his cooperation. This is especially significant if returnables make up a small proportion of the beverage market. Thus legislative measures may be required. The introduction of such legislation is dependant on a clear assessment of the costs and benefits. Legislation can have impacts on energy, raw materials, litter, employment, prices and sales. A balance of the pros and cons will lead to the development of policy decisions.

Returnables depend upon public and retailer cooperation and reliability. Market economics will exert continuing influence, eg transport and energy costs. Returnables could reduce the volume of glass presently discarded indiscriminately, despite the advent of the Bottle Bank system. Many felt that legislation would not be practical on its own. Legislation needs to be considered in conjunction with Bottle Bank Ststem and other waste management options. The EEC Directive offers such a balance promoting the use of returnables/refillables as well as encouraging the recycling of other containers.

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Chapter 5

Glass Recycling Options

5.1 Introduction

After returnables the second option in the recycling hierarchy is direct recycling. This is where the material is recovered from the waste stream for use in similar products. This chapter briefly describes several different collection and recovery schemes, giving examples of both high and low technology systems.

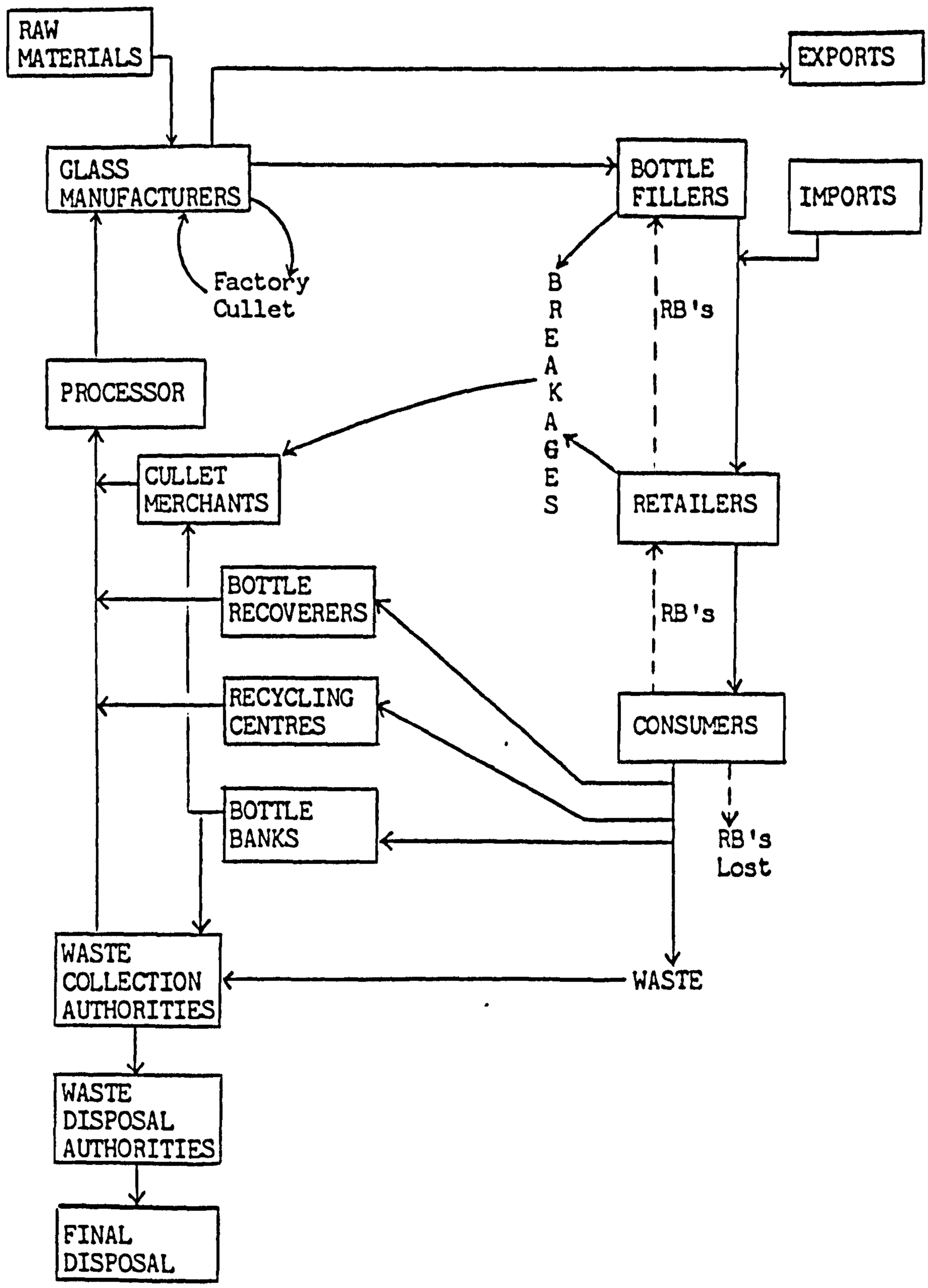
First, examined are house-to-house collection schemes and the development of recovery centres. Second, a number of schemes that have been adopted by local FOE groups are assessed. Third, Bottle Recovery schemes are briefly looked at. Fourth, the concept of central site collection is introduced. This option is dealt with in more detail in Chapter 6 on Bottle Banks. This final option has been developed into collection centres where several materials are gathered, eg SWAP scheme in Leeds and Civic Amenity Sites in Greater London.

The final section introduces the possibility of glass recovery through mechanical separation, a high technology scheme. The main example of this for glass recovery was the plant built at Doncaster.

These various recovery systems are shown in Figure 5.A. It emphasises the importance of looking at all options, as one will affect the success/failure of other schemes.

Glass Recycling Options

Figure 5.A Materials Flow (Glass) UK



5.2 Source Separation

DOE (1977) defines source separation as:

> '.... all those activities necessary to make certain constituents of waste available to collecting parties, and to transport those components to recovery industries.'

Transportation can be provided either by: the waste generator, the waste collection authority (WCA), the waste disposal authority (WDA), private hauliers and scrap dealers, or through voluntary organisations. A system of separate collection is technically suited to the following situations:

1. Where wastes of different types arise in essentially separate form (most process waste).
2. Where waste products are easily separated by the user; and are not seriously contaminated in use (paper, glass and plastics).
3. Where a large amount of waste arises at each place visited for collection (domestic paper bundle).

The main advantage of separate collection lies in the fact that waste can be recovered in a form close to the original product. This reduces the level of contamination that occurs from the collection of mixed waste. It also reduces the need for processing treatment before a useable material or product can be recovered. Source separation can adapt quickly to changes in market demands, by stopping or increasing the collection of those materials that are/are not required by the market. These schemes tend to be less capitally expensive than mechanised resource recovery (RRR) plants (VOGLER 1978) (Section 2.6). Success or failure depends on the level of public participation achieved which will be influenced by social conditions, education and self discipline of the population (TURNER 1981).

The reduction in the quantity of waste through materials recycling can be a motivation for source separation. Recycling is effective in two ways in reducing waste for ultimate disposal (MIESZKIS & THOMAS 1979):

1. Percentage of potential waste at source, can be recycled before it becomes waste; reducing the generation of waste.

2. Separation of waste 'upstream' can increase the chances of resource recovery in the following processes of treatment, and reduce the amount of waste for ultimate disposal.

Two systems of source sepation are distinguishable:

1. House-to-House Collection

2. Centrally sited containers/Recycling Centres/Bottle Recovery Schemes (CEC 1979)

5.3 House-to-House Collection

5.3.1 York/Redfearn Pilot Scheme

This was one of the initial schemes tried to recover glass. In May/June 1974 Redfearn National Glass (RNG) in conjunction with York City District Council ran a scheme to assess the feasibility and cost of household collection of used glass containers. The schemes objectives were threefold:

1. To determine the viability of house to house collections of glass in terms of: cost, and the public response.

2. As a contribution to waste reclamation considerations.

3. To respond to growing public pressures on environmental and ecological grounds.

York Council's Engineering Department estimated that 7.5% of all waste was glass. A recovery scheme would reduce the non-combustible content of refuse and make productive use of the

glass. If the scheme was a success it could:

1. Make a contribution to the City rate fund.
2. Provide an additional source of glass cullet.
3. Test the attitudes of householders towards direct waste recovery for commercial use.

A representative sample of 1021 households in the Acomb district of York was selected. It included: Detached, Semi-Detached, Terraced and Corporation Houses.

The scheme was launched with press releases on March 27 1974 outlining the scheme and its aims and a Press Conference was held on April 18 1974 achieving both local and national publicity. Leaflets were distributed with the paper collection sacks on April 24 1974 by the Cleansing Department, and posters were displayed on Council lorries and in local shop windows. The trial was to run from April 22 to June 17 1974. Two large paper sacks, one for clear the other for coloured glass was delivered to each house. The aim was to encourage householders to separate glass containers from other household waste.

The publicity programme advised householders to:

1. Remove metal and plastic caps and lids.
2. Separate glass by colour in labelled paper sacks.
3. Avoid disposing of: returnables, window glass, mirrors and light bulbs.

The selected area was split into two sections of approximately equal size. Each house was visited fortnightly by a two man team using an open lorry. Full sacks were removed and replaced with empty sacks. The collected glass was emptied into containers at the Council's Beckfield Lane depot in Acomb. Before the glass was transported to RNG's York factory the collected glass was analysed

to see:

- the effectiveness of separation,
- the cleanlines of salvaged glass,
- the amount of NRB containers, and
- the level of contaminants (lids & caps).

Throughout the 8-week period a number of factors were monitored:

- public's response rate,
- types of bottles separated out for collection,
- running costs.

During the initial collection in each sector collectors were occupied for a full 8 hours each day. As the scheme progressed, collection times fell to 6.5 hours per day. This reduction was attributed to householders familiarisation with the scheme and that collectors were no longer delayed by having to answer questions.

The initial reaction from public ranged from good to very enthusiastic. The first collection round was good, as people had stored bottles following the scheme's advanced publicity. The public had also taken the opportunity to clear bottles and jars from their storage cupboards, garages and sheds. Towards the end of the 8-week trial there was a noticeable reduction in the quantity and quality (by the non-removal of lids) of glass. Ordinary waste was also being put in to the sacks with the glass. Returnables, made up a proportion of each collection from the Corporation area, with the last round bringing in bottles worth £12.

Householders expressed concern regarding the lack of storage space and the potential danger to children from broken glass.

TABLE 5.1 Sets Out The Number Of Sacks Issued In The Trial Area And The Number Recovered With Glass In Them

COLLECTION DATE	SACKS ISSUED	SACKS RETURNED	PERCENTAGE RETURN
April 29	864	113	13
May 5	1178	498	24
13	864 *		
20	1178	302	25.6
29	864	401	46.7
June 3	1178	284	24
10	864	275	31.8
17	1178	286	24.2

* Expressed as joint figures as mixed up.

Source: RNG Glass Container Recovery: Its Viability (Undated)

Of the estimated 5 tonnes per week available the trial scheme recovered less than 1.5 tonnes (30%) a week. In total the scheme yielded 11 tonnes of glass for recycling, made up of 8.25 tonnes clear and 2.75 tonnes of coloured glass. The glass collection costs were £388.50 and the revenue received was £71.50, a gross loss of £317.00. All costs for the trial were met by RNG. In light of these figures The Council decided not to pursue the development of a full scale scheme.

The Engineer felt that it was not possible with these small quantities to assess the effects on incinerator or landfill sites. If disposal cost savings were attributed to the scheme: landfill at £1.00 per tonne and incineration at £7.00 this would reduce losses to £27.00 or £21.00 respectivly. If collection cost savings were attributed to the scheme this could bring the scheme into breakeven.

York Engineer drew up a second plan, based on a trailer. But this still would be in deficit (Table 5.2). This is similar to some paper collection schemes operated by Local Authorities (HO 1982). The scheme was based on collection from around 5000 properties.

TABLE 5.2 Proposed Glass Recovery With Trailer

Proposed Expenditure for 1 week:

	£
Bonus for collectors	5.00
Running Costs - Trailer	3.00
Skip Hire & Emptying	7.25
5000 sacks @ £37 per 1000	185.00
	200.25

Proposed Revenue

Assume 11 tonnes (£10 per tonne)	110.00
Results, in loss of	£90.00 /week

Had RNG not been within the City, labour and transport costs would have been much higher. If collection levels were at a similar rate to the trial, the trailer would recover about 50 tonnes bringing a positive return of £300. The trailer scheme would have needed to collect 20 tonnes to break even. If disposal and collection cost savings were attributed to the scheme, it would improve the economics of the scheme.

The trial scheme found that it was too expensive to reclaim glass in isolation from household waste. However, it did show the willingness of the public to participate, and the need for high participation rates for the scheme to breakeven. The RNG analysis confirmed that deposits on bottles are not the answer to recovery and litter problems, as sections of the public will still throw away returnable bottles. They felt that collection from houses is only likely to be viable if other recoverable materials are reclaimed - paper, metal and plastics - as well as glass. Schemes that tried to do this Are Oxfam's Wastesaver (Section 5.3.2), Avon's Resourcesaver (Section 5.3.3), and the West German Green Sack System (Section 5.3.4).

5.3.2 Oxfam Wastesaver

In early 1975 OXFAM set up the Wastesaver scheme in conjunction with Kirklees Metropolatan Council based at Huddersfield. The aim was to recover materials from waste and use the revenue to finance Oxfam's work abroad. This scheme was the first of its kind in Britain and encountered many problems. Wastesaver could not have been worse timed from the point of view of the national economy (HOLMES 1981). From 1975-77 transport costs, wages and costs of running the centre rose sharply while revenue obtained from sales of reclaimed materials remained static. This scheme has been extensively analysed by BLACKMORE & TURNER (1978) who found that if a social cost benefit appraisal was used the scheme could be viewed favourably.

The Oxfam Wastesaver scheme involved the separation of waste by 5000 households into four fractions (VOGLER 1978):

1. Newspapers
2. Mixed Waste Paper & Magazines
3. Glass Bottles, Plastics and Textiles
4. 'Jumble' - clothes, books, toys.

To aid this recovery each householder was provided with a tubular steel stand - a 'dumpy' - that held four different coloured plastic sacks. The putrescibles and kitchen wastes were still collected by the Waste Collection Authority (WCA).

The sacks were collected from households and brought to the central sorting area; where the staff sorted, processed and packaged the materials for sale primarily to industry. Although the 'dumpy' was successful in terms of householder cooperation, the lengthy operation to remove and replace sacks led to high collection costs. In light of this they looked to rationalise

collection processes. One scheme looked at was where participants brought the waste to central pick-up points on car parks. Here the amounts of the various materials collected was markedly reduced. A second option was to reduce collection of recyclables to one sack, with putrescibles being collected by the WCA. The make-up of the recyclables would be dependant on local markets and could be adjusted to suit changes in conditions. This division into two sacks was linked with moves to develop a collection vehicle to pick up both types of waste in separate compartments with compactors. This option was not developed further as the scheme was making large losses and the programme was reassessed. This idea has been looked at extensively and further developed in West Germany (Section 5.3.4), and the Department Of Environment is looking at this option (RCEP 1985).

The extent of the losses was intolerable for an organisation wishing to maximise its funding of overseas projects (Oxfam 1977). In 1977 the range of materials collected was reduced, with the loss makers being abandoned. The collection of tin plate, glass, plastic and paper were stopped. This left the collection of textiles and aluminium which had ready markets and relatively high values. The collection from households was abandoned in preference for the material to be collected nationally through the local Oxfam shops.

The project showed the willingness of householders to participate in a sustained fashion. The scheme provided 30 permanent jobs plus a number of temporary jobs through the Youth Opportunities Programme. Wastesaver illustrated the problems of establishing a recycling scheme in the UK economy. It indicates the need for a National Policy on recycling. Schemes for collection of raw

materials and research into processing them must be developed from a central policy.

It was suggested that the scheme could not operate other than at a loss for the collection of waste paper from households. PEARCE in OECD (1979) extracted data from BLACKMORE & TURNER (1978) to cost the Wastesaver waste paper processing operation and found that the waste paper collection scheme as a whole made a distinct loss (Table 5.3). Of a total expected revenue of £26403 from waste paper, about £17011 or 64.4% of it goes into direct costs and a further £14848 or 56.2% of it goes into collection costs under 'payments to transport department'. There is an average loss of £5.88 per tonne of waste paper salvaged. On strict accounting terms this scheme is not cost effective. BLACKMORE & TURNER (1978) see that it is socially beneficial. The manpower used would otherwise have been unemployed and hence its 'shadow price' is zero or near zero. Both savings in waste collection costs and disposal costs which would have been incurred need to be considered. If average savings are equal to or exceed £5.88 per tonne then Wastesaver was socially beneficial even though it may not be profitable in private terms.

TABLE 5.3 Oxfam 'Wastesaver' Project (Annual Waste Paper Recovery Cost)

	£	£
Processing Costs		
Leasing of Equipment	5882	
Maintenance	600	
Processing Expense'	1130	
Wages & National Income	3601	
TOTAL		11213
Administration & Overhead Charges		
By Space Utilisation	4656	
By Wage Bill	1142	
TOTAL		5798
Total Processing Cost		17011
Payment To Transport Dept For Operations		14848
Total Operating Cost		31859
Revenue		
772 tonnes mixed waste paper @£26.31 per tonne	20338	
156 tonnes KLS (Kraft Paper) @£38.88/tonne	6065	
TOTAL REVENUE		26403
NET REVENUE		(5456)
Average Loss Per Tonne Of Recovered Paper		£5.88

NB: ' Costs of consumable goods and general expenses (£2597) minus internal credits from other departments for use of machinery.

Source: OECD (1979) Waste Paper Recovery - Economic Aspects And Environmental Impacts
OECD Paris 1979

5.3.3 FOE (Avon) Resourcesaver

In 1980, when Bristol City Council stopped its paper collection Bristol FOE looked to continue this service. Resourcesaver was set up as a company to be managed by FOE and financed by the MSC. Once paper collections were established, collection was broadened to include rags, textiles and sump oil. Glass was examined but later dropped. In 1983 Resourcesaver recovered: 1500 tonnes of waste paper, 100 tonnes of glass, 1000 gallons of sump oil and 150 tonnes of rags. This showed the willingness of the public to participate in recycling schemes.

Publicity and marketing are key factors in maintaining public interest and support. Leaflets are the main contact with the public, providing information on: what is collected, where it is collected, and when it is collected (Figure 5.B). They deliver 30,000 leaflets per month with 2 leaflets per house per year. Leafleting is labour intensive with 8 people being able to cover 1.5 rounds per day. There are 53 collection rounds each of about 3000 households covering the Bristol area. It is estimated that leaflets cost £0.01 each - with £300 per month spent on publicity.

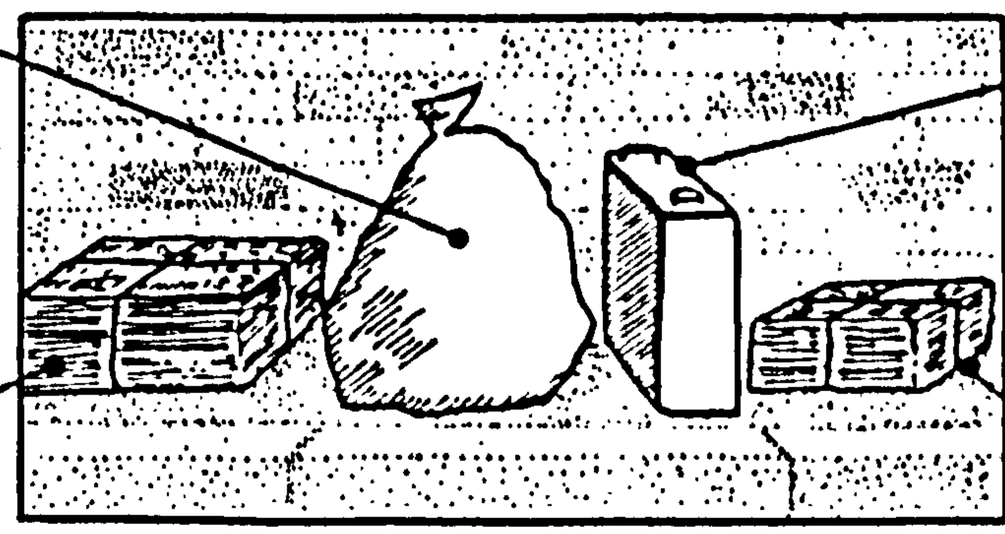
The second point of public contact are the collection vehicles that visit the areas to pick up the materials. Vehicles are emblasoned with the Resourcesaver Logo. Labour needs are driver plus mate and two loaders. From a round of 3000 households they collect on average 3.5 tonnes of waste paper. The driver is provided with a map of the area which highlights any problem areas - OAP's who leave sacks in particular place and people who are likely to complain. Resourcesaver receives £30 per tonne for baled paper and £40 per tonne for unbaled.

Figure 5.B FOE (Avon) Resourcesaver Publicity Leaflet

AVON FRIENDS OF THE EARTH

SAVE AND RECYCLE

RAGS
(No shoes please) Put in plastic bags & secure

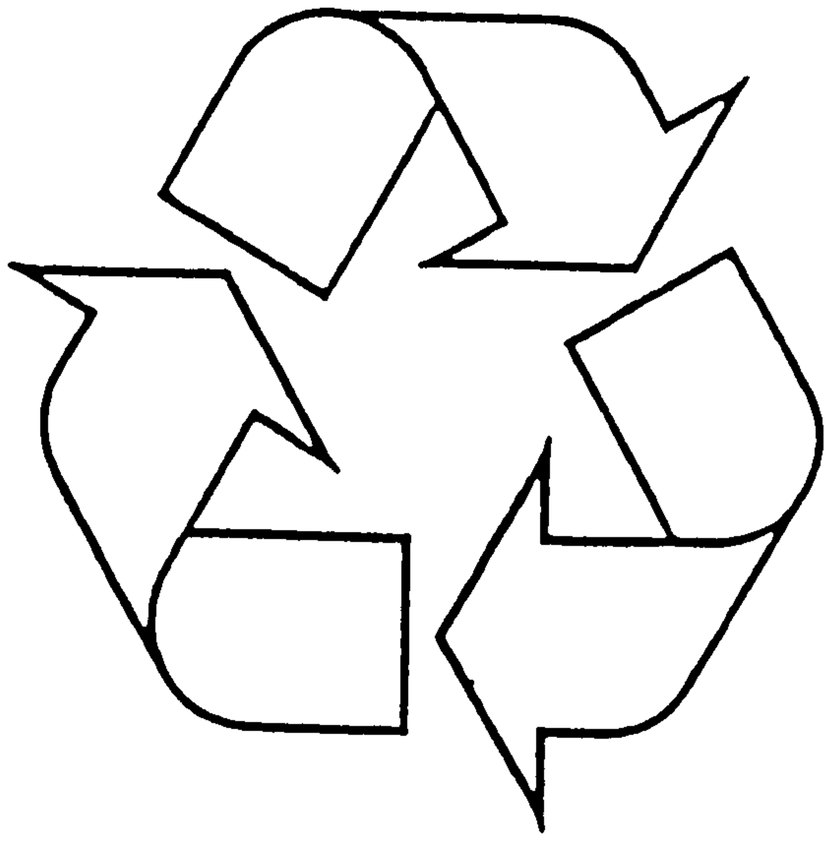


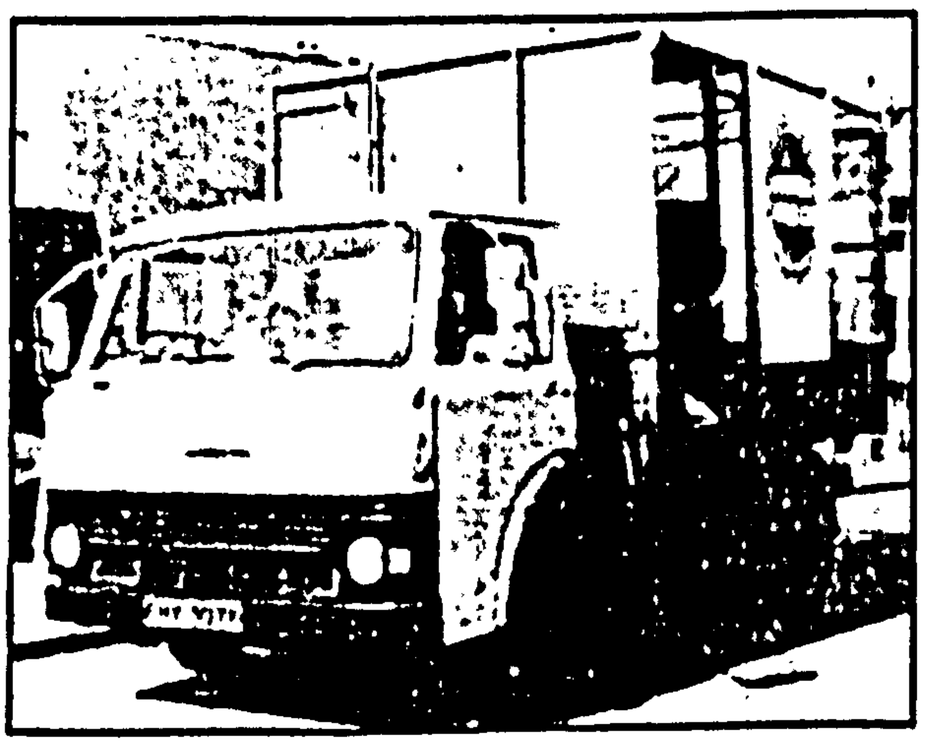
SUMP OIL
- Leave in clean 5 litre cans

NEWSPAPERS
- Secure bundles with string

MAGAZINES
- Bundle & secure with string

KEEP RECYCLABLES SEPARATE





MONTHLY COLLECTION DATES

PLEASE LEAVE RECYCLABLE ITEMS FOR COLLECTION WHERE THEY CAN BE SEEN FROM THE ROAD

DUE TO YOUR SUPPORT A NEW COLLECTION DATE HAS BEEN ARRANGED, THANK YOU.

THURS 7th FEB	THURS 7th MARCH	THURS 4th APRIL	THURS 2nd MAY	THURS 6th JUNE	THURS 4th JULY

AND EVERY 1st THURSDAY OF THE MONTH THEREAFTER

WE START AT 9.00AM AND COLLECT IN ALL WEATHERS EXCEPT ICE AND SNOW

Enquiries to - RESOURCESAVER LTD., AVON FRIENDS OF THE EARTH, ST. JOHN'S STREET, BEDMINSTER, BRISTOL. BS3 4JF TEL: (0272) 666266

Now that it is successfully established Resourcesaver plans to establish its own Collection Company with full time employees, to remove its dependance on MSC funding. This will initially operate with one lorry and a crew of four. Seed money has come from Avon FOE, and a vehicle will be provided by the local Paper Company.

Resourcesaver shows the willingness of people to separate waste at source and to meet collection dates. It has been built up from a hand-to-mouth existence with funding from the MSC to a viable organisation that seeks to establish itself on a more permanent basis. With its experience it is now willing to provide help and advice to organisations seeking to establish similar operations.

5.3.4 West German 'Green Bank' System

The Germans are looking to extend their recycling schemes through improving their separate collection schemes by the use of 'Green' containers. The high costs of labour in the area of collection and transport of waste and the fluctuating returns for secondary materials have led to the development of several integrated collection systems eg 'Green' System.

Under the 'green' system each household has two containers:

1 Grey 120 litre bin - for putrescibles;

1 Green Bin - for recoverable materials (Glass, Paper & cardboard, Ferrous, Plastics, Etc.).

This is similar to a Japanese system, with the aim of getting an enriched material for recovery. The Grey bin takes wet household and putrescible wastes. With the reclaimed materials being mixed there is the need for an initial sorting process which can be manual or mechanical. Quality problems may occur which will affect their value in the secondary materials market. The type of materials recovered will be determined by market conditions and

can be adjusted to any changes that occur.

It was thought that with two waste streams to collect from, that overall collection costs would be more expensive: DM 25 per tonne higher than old system.

If Collect: Green in 1st, 3rd and 5th weeks
Grey in 2nd, 4th and 6th weeks

Under this collection system it looks as if the costs of the new system would be comparable with the existing single bin. An extra cost would be the additional green bin and facilities for sorting the recovered materials. There is a need to look at the health aspects of collecting putrescibles once a fortnight, to ensure there are no problems for householders. In addition there is a need to look at the long term markets for recoverable fractions.

More than 60 Counties operate the integrated green collection system, which now covers 20% of West Germany.

An important factor in the development of recycling options, is the political situation in West Germany. The promotion of the Fourth Party - 'The Greens' - has brought issues of Environmental Protection into the political debate. Greens are now members of most local Governments and they have achieved National Representation. They are against centralised mechanical plants and actively promote alternative integrated systems that fit better into local conditions.

Concern has recently been expressed that the waste paper market is being swamped by paper from Local Authority schemes (ANON 1986). Authorities are seen to be responding to 'environmental' pressures, without thought for the wider consequences. Prices have fallen threatening the future of the paper reclamation industry.

5.4.1 F.O.E.

As well as FOE (Avon) other local FOE groups have been involved with recycling schemes with varying degrees of success. One of FOE's campaigns is to reduce the waste of resources and encourage recycling, although this campaign has largely been neglected.

FOE activities are two phased:

1. Active lobbying of Government;
2. Practical activities to recycle materials.

National campaigning started with the 'Schweppes Bottle Dump' in 1972, to publicise the demise of the returnable container and the increasing dominance of non-returnable one-trip containers in the beverage market. They actively sought to promote a counter to this trend through the advocation of returnable bottles. They saw the alledged 'demand' for the convenience of one-trip bottles as a product of the glass manufacturers' and the retailers' desire for profits. GMF figures highlight this trend in packaging types:

	1969	1979
BEER & CIDER (Returnable Bottles)	244m	192m
(Non-Returnable Bottles)	60m	176m
CARBONATED SOFT DRINKS (Returnables)	259m	285m
(Non-Returnables)	290m	738m

FOE's active opposition to the dominance of returnables culminated with the promotion of a Bottle Bill by Lord Beaumont in the House of Lords (Section 4.8). Its ideals can be seen in the introduction of the EEC Directive on Beverage Containers and the importance of recycling (GMF 1985). FOE also have had representation on the WMAC working group and to the EEC Environmental group. But national activities have largely been neglected, with the leading role being taken by local FOE groups: Edinburgh (Section 5.4.2), and Cumbria (Section 5.5.2).

5.4.2 FOE (Edinburgh) Recycling Project

The project was funded for 6 months under the Jobs Creation Programme supported by the Manpower Services Commission (MSC) and was run in conjunction with FOE (Edinburgh) and the Scottish Council of Social Services 'BATES 1976). The scheme folded soon after funds run out. They employed 5 people to recycle (collect/sort) paper, glass and aluminium (HOPKINS 1983).

Glass was sorted into returnables and non-returnables by hand, and individually smashed by throwing them onto a heap. The broken glass was loaded with spades and barrows into a 12 tonne skip. The District Council's Cleansing Department transported the glass to United Glass (FOE Scotland 1983)

To reduce transport costs, satellite centres were set up to bulk deliver to a central site. The areas concerned were leafletted (10000) and 650 collections were made, with the satellite sites being manned on Wednesday. They received £10 per tonne for the glass and over the life of the scheme delivered 10 tonnes at a transport cost of £20.

5.5.1 Bottle Recovery Schemes

There are two examples of Bottle Recovery schemes: private commercial recovery scheme, and a voluntary scheme. The private schemes (Appendix B.1) were developed to primarily serve the milk bottle industry. The voluntary scheme recovers all types of glass containers, both bottles and jars. Such a scheme may be developed as a central site depository for collecting all types of containers. This would remove the onus from retailers to handle returnables and overcome storage problems. Such a move would need to be linked to some form of deposit legislation (Section 4.8).

5.5.2 FOE (West Cumria)

In 1978, FOE (W Cumbria) started a voluntary scheme to re-use bottles and jars, instead of crushing them all for melting down as occurs with Bottle Banks. Public response was enthusiastic and the scheme soon out grew the church hall, moving to the ground floor of a former cinema where it now operates 5.5 days a week.

Over 200,000 bottles and jars were recovered in the first year of full time work (ANON 1983a), and in the four years of part time operation 330,000 jars and bottles were re-used. The 83 tonnes of bottles and jars recovered in 1982-83 represent about 12% of glass containers disposed of in the Whitehaven area.

The organisation recovers more than just bottles and jars, it also recovers: newspapers, magazines, cardboard, polyethylene sacks, aluminium drinks cans, and aluminium and lead foil bottle seals. Bottles and jars are received from the public and sorted into over 100 categories of re-use, this excludes many types sold for re-use to the general public. The work covers:

a. dealing with the public - receiving bottles and jars; answering enquiries about the scheme and recycling in general;

b. sorting - sort into about 100 categories; metal caps and rings are removed and sorted;

c. crushing - clear and coloured glass crushed separately in a hand-operated rotary crushing machine;

d. warehousing - boxing, counting, labelling, and stacking re-usable containers; boxing and stacking crushed glass; loading and despatch of bottles and glass; storage of by-products for recycling.

No cleaning is currently undertaken, but the addition of a bottle washing machine is a possibility which would increase the number of bottles re-used, by enabling types of container not currently accepted by existing bottle merchants to be sold (cleaned)

directly to bottlers who do not have a bottle washing plant.

Bottle recovery is labour intensive. For the initial three years the scheme ran with volunteers on Saturday mornings only until overwhelmed by the response. The voluntary phase allowed the scheme to develop into a full-time viable operation, by providing income to fund the purchase of equipment. The scheme is run by FOE (W Cumbria) with the assistance of Copeland Borough Council (who administer the MSC funded employees), the MSC (who re-imburse the Council for their wages) and Graves (Cumberland) Ltd a local firm of cinema owners who provided the premises rent free. Whitehaven now operates full time employing:

FOE - 1 full time at present; aim to increase to two, if Urban Aid application is successful.

MSC - 3 full time; 6 part time when MSC Community Programme replaces CEP.

Plus volunteers.

Outlets for the materials are varied, and include:

Soft Drinks Manufacturers & Bottlers - for returnables and some Non-returnables.
Breweries - for returnables.
Dairies & Farm Milk Bottles - for milk bottles.
Bottle Merchants - who buy used wine, liquor, squash and sherry bottles.
Beekeepers - for honey jars.
Preserve Manufacturing Cottage Industries - for jam jars.
Shops - for wine, returnables, medical & pill bottles.
Water Quality Laboratories - for medical flats, etc.
Members of the Public - for ornamental, home-brew, wine & jam.

Glass Manufacturers - for cullet.
Scrap Metal Merchants - for aluminium and lead.
Waste Paper Merchants - for paper and card.

FOE Report states:

The first year has proved that bottle recovery is viable. The second year will concentrate on boosting this percentage by recovering every possible bottle and jar which cannot be returned through the usual channels.

5.6 Voluntary Return To A Central Site

Another method of source separation of waste is to ask the public to bring their separated wastes to a central site. This reduces the costs of collection, as long as the trip to the site does not involve any extra costs to the consumer. In Britain there are a number of such schemes, from local groups collecting paper on a specific day (ie FOE Edinburgh) to National schemes recovering materials ie Bottle Banks, Save-a-Can, PET-a-Box.

The Bottle Bank scheme started in 1977 in Britain and is now operated by 306 District Councils who operate 2000 Banks (785 Bottle Banks and 1215 Modular Banks) in 783 towns and cities (GMF 1984). More details of this scheme are provided in Chapter 6. Following on the 'success' of this scheme, the recovery of other materials has been looked at by other materials packaging organisations.

Alcoa of GB set up the 'Cash-a-Can' scheme to recover aluminium cans, which paid 0.005 to 0.01p per can. This scheme folded in 29 February 1984 (ANON 1984a, FORSEY 1984). It was followed by the establishment of a scheme to recover tin cans promoted by Materials Recovery Limited (MRL) that operated at two levels: Mechanical Processing and Central Skips. These schemes have been combined under the Save-a-Can scheme, promoted by the Can Makers' Information Service. Since the demise of the Alcoa scheme, the Ali-Can scheme operated in the Greater London area (ANON 1984b) has been established.

The latest scheme was the PET-a-Box which was set up under the auspices of the British Plastics Federation (BPF), to collect PET bottles. This scheme was stopped following the withdrawal of

funding by the BPF, as there was no market for the recovered material (Anon 1986). But the long term prospects look favourable, as PET penetrates the market and Leeds City Council are looking to set up a new scheme.

These central collection schemes can be combined into 'recycling centres' where people bring their used materials - paper, glass, metals, plastics and textiles. Such a development has occurred in Leeds with the Save Waste and Prosper (SWAP) scheme, that the Council succesffully promotes. The revenue from this scheme is passed onto local charities. A similar concept was being developed by the Greater London Council which put collection skips on its' Civic Amenity Sites to collect different materials. Again, revenue goes to a charity which is nominated on a monthly basis. This development of 'recycling centres' is the next stage in the progess of recovery through central skips.

All these schemes can be viewed as measures to recover materials. Their establishment reflects the growing pressure on the packaging industry to control waste arisings from their products. There has been pressure from the public, environmental groups and from the impact of National policy. Each central collection scheme is dependant on a clear assessment of the costs and benefits. These central collection schemes follow similar lines and it is possible to draw comparisons between them. The Bottle Bank scheme has been running the longest, and their are more details available.

5.7 Mechanical Separation

Mechanical separation is an example of high technology reclamation process (Section 2.6). Mechanical developments to separate out the recoverable components from the waste stream are mainly based on dry sorting processes (BIRCH & JACKSON 1979). Examples of this process in Europe are: Doncaster, Flakt (Appendix B.3), and Sorain Cecchini (Appendix B.4).

The basic processes used are magnetic separation, screening, and air classification. Magnets are used to recover ferrous elements from the waste. The air classifier separates out the lighter fractions - paper and plastic, from the heavier elements - glass, stones, metals.

Flakt is based on front end shredding to reduce incoming waste to a convenient size for handling. Whereas Doncaster and Sorain Cecchini have rejected primary shredding in favour of primary screening. A disadvantage of primary shredding - use of hammer or flail mill - is it results in additional cross-contamination which can affect the quality of material produced and represents an energy and capital intensive operation (BARTON 1984).

5.7.2 Doncaster Waste Treatment Plant

The Doncaster Waste Treatment Plant has been built by the County Council in conjunction with the Department of the Environment, and with technical support from the Department of Industry's Warren Spring Laboratory. The purpose of this plant was to effect the recovery of valuable materials from waste, which are lost under conventional waste disposal methods. In addition it met the basic requirements of reducing the volume of refuse to be finally disposed to landfill. Such recovery and recycling of resources is

environmentally beneficial, and needs to be assessed economically to its costs and benefits.

The plant has been designed to operate as a refuse transfer station, as well as to recover materials. The initial design was a single stream unit, which could treat 800 tonnes per week (HOLMES 1981). The design allows for a second stream to be added which would increase its capacity to 1600 tonnes per week.

The capital cost of the plant was £2,227,000 for the plant that handles between 10 and 20 tonnes per hour. The aim was to develop a system using low cost and readily available techniques that can be incorporated into a flexible system that is adaptable to local conditions. Figure 5.C provides a schematic of the plants processes. An outline flow sheet of the plant operating system is shown in Appendix B.2.

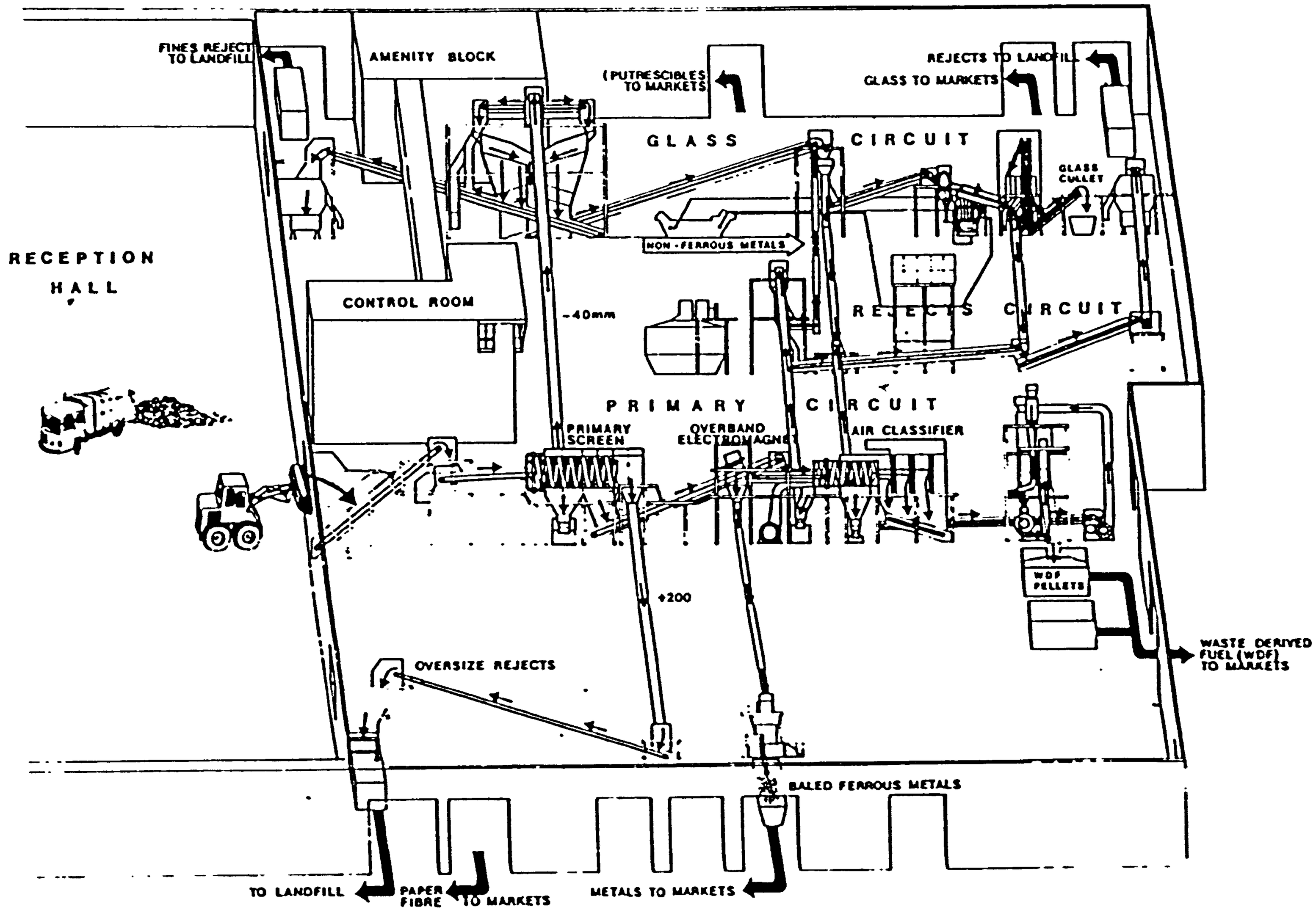
The preliminary stage is to free the refuse from the bags. Then it can be fed to the rotary trommel separator. This produces four main fractions:

0- 15 mm Fines and Cinders
15- 40 mm Putrescibles, Glass, Ferrous Metals
40-200 mm Paper, Tin-plate, plastics
>200 mm Largely Board & Textiles.

Screening of 0-15 mm removes fines and cinders at an early stage. These are regarded as contaminants and will if not removed seriously affect the efficiency of the sorting process. Fines are removed to landfill, where they can be used as an inert covering.

Materials in 15mm-40mm fraction are dense and easily handled. This fraction is conveyed from primary to a secondary screen where the material is further sized. The portion less than 15mm is rejected to landfill. The rest of this fraction contains about 50%

FIGURE 5.C DONCASTER RECYCLING PLANT PROCESS FLOW DIAGRAM



glass. It is from this section that attempts to recover glass have been made by optical sorting.

The 40-200 mm section consists largely of paper, plastics and ferrous metal. The ferrous metals are recovered by a magnetic separator, and are then baled and sold. This leaves the lighter fraction which is used to produce Refuse Derived Fuel (RDF).

The fourth fraction is made up of paper and board. These can be distinguished by use of a laser source. The separated board is bailed and marketed.

5.7.2.a Products And Market Assessment

The initial marketable products from the Doncaster plant were: Ferrous Metals, Glass, Densified RDF, and a Paper-Rich product for fibre recovery (Appendix B.2). Table 5.4 shows prices for secondary materials based on 1979 figures.

TABLE 5.4 Reclaimed Products Expected From Doncaster Refuse

PRODUCT	WEIGHT (Tonnes /Year)	PRICE (£/tonne)	REVENUE (£/Year)	REVENUE PER TONNE OF REFUSE (£)
WDF	14,000	7 - 10	98 - 140,000	1.46 - 2.09
FERROUS METALS	4,000	12 - 24	48 - 96,000	0.72 - 1.44
GLASS	3,000	8 - 10	24 - 30,000	0.36 - 0.42
PAPER	2,000	12 - 20	24 - 40,000	0.36 - 0.60
				2.90 - 3.95

SOURCE: BIRCH P R & JACKSON D V The Industrial Potential Of Materials Recovered From Municipal Solid Waste
Paper To Second World Congress, Manilla 1979

Estimates of capital and operating costs for the Doncaster plant handling 67,000 tonnes per year give a cost of £9.70 per tonne. This does not make allowances for savings in waste disposal costs. With the revenues indicated in Table 5.4 the net disposal costs is equivalent to £6.00 to £7.00 per tonne.

Operators need to maximise income by attention to product quality and yield and to efficient marketing. Also, allowances for disposal cost savings should be assessed, as this would improve the financial framework of the scheme.

5.7.2.b Glass Recovery

The desirability of glass recovery is debatable as raw materials are readily available and cheap. However, several factors favour glass separation - the conservation of raw materials and energy.

In the primary sorting process glass is initially recovered with putrescibles and heavies. The putrescible fraction has a potential for use as a compost, and this would be improved if the glass is removed. The heavies fraction can be reworked for non-ferrous metal recovery but this requires the removal of glass. Although glass recovery may in it self be marginal, it is essential to evaluate the full potential for refuse reclamation.

The glass rich fraction is dusty and mixed with vegetable material. Passage through two fruit stoning machines in tandem takes out the vegetable matter and allows the glass to fall on to a conveyor (PORTER 1979). After a final magnetic screening the glass fraction reaches the rising current separator. An upward current of water carries lighter items up and over the top lip of the separator, and allows the heavier glass and ceramic pieces to fall into a circular trough. The material falls onto a spiral

conveyor. Shaking rapidly as it turns, the spiral conveyor lifts the glass fraction into a light-tight room where it passes through a bulk sorter, dividing glass from non-glass.

A second spiral conveyor, which is heated dries the material, lifts the glass to an optical sorter with six channels. After two passes through this sorter, using three of the channels for each pass, the cullet is claimed to be 99.9% (PORTER 1979).

Unfortunately, in practice the technology let down the glass recovery option. It now stands idle taking up to a third of the enclosed building (AYRES 1984). For every half tonne of unsorted materials that was fed in for recycling 10-15 kilogrammes of cullet were recovered. The sorting process rejected stones and threw cullet out with them. It also reacted to what it considered impurities in cullet that in fact was suitable for processing and rejected them. The operation required two supervisors to monitor the system, which affected the costs. Then the introduction of Bottle Banks in the local area reduced the quantities of cullet for processing declined. This challenge further reduced the effectiveness of the mechanical separation of glass.

The problems of glass recovery at Doncaster were in part technical, with an over complex system dependant on continual supervision; but in the main it came down to cost considerations. JACKSON (1984) feels that further development in mechanical sorting of glass are unlikely in the short term, apart from in the area of composting where the aim is to improve the quality of the product. Glass recovery from the fines may be advantageous in the final marketing compost.

5.8 Summary

In the initial recovery stage of reclamation, the main problem is that wastes are collected together in a mixed form. This gives rise to a problem of contamination, which limits their value. It is necessary either to recover individual materials by separating these out from mixed waste, or to derive some saleable by-product through processing. This basic choice lies between:

1. Separate collection of each type of material, to avoid contamination.

2. Separate out materials from mixed waste by mechanical means.

Within each system, the costs and benefits need to be clearly assessed. This needs to be done within the framework of a total waste management system.

The source separation methods range from house-to-house collection to delivery and collection from central sites. In both the RNG and Oxfam system they had problems in collecting sufficient quantities to cover collection costs. Both schemes showed the willingness of the local people to support recovery schemes. Resourcesaver, confirmed these levels of support and in this case the collection costs were reduced with the involvement of MSC Community Project funding.

A more systematic scheme is being developed in West Germany, where recyclables are collected from households. This should produce larger quantities of recoverable materials. The development of this scheme has occurred in a favourable political climate where environmental concerns are prominent, although recently concern has been expressed about materials being recovered without there being a viable market to receive them.

A more confined scheme is the collection of bottles for return and re-use. This has primarily been done by dairies to recover stray milk bottles. A similar scheme was developed by FOE (Cumbria), but this recovers a wider range of glass containers as well as other materials. These schemes could form the basis of a national framework of local depositories to recover containers, which could be linked to the introduction of some form of deposit legislation.

A more recent scheme is the Bottle Bank scheme which is dealt with in Chapter 6. This project lead to the development of similar schemes to recover other materials - plastics, metals, paper - at central sites. These schemes are being drawn together into a form of 'recovery centre' where all materials can be brought. This is illustrated by the GLC and SWAP schemes.

These are all various options of source separation, and need to be examined to establish which is best suited to local conditions.

The second option was to separate out various materials by mechanical means. This has been seen not to be successful in the recovery of glass. As seen with Doncaster, the introduction of the Bottle Bank scheme reduced the quantity of glass in the waste stream. This linked with technical problems adversely affected the economics of the glass recovery option, which has been discontinued.

It is important to look at all the options, and how they might affect each other. At present mechanical separation has not been successful leaving source separation as the workable option for glass recovery.

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Chapter 6

The Bottle Bank System

6.1 Introduction

The Bottle Bank System is an example of source separation used to recover materials for use in the manufacture of new glass products. This scheme puts the onus on the general public to separate out their glass waste from the waste stream, and to deliver the glass to a centrally sited skip. This form of collection pushes part of the collection/delivery costs on to the consumer. These costs need to be kept to a minimum by combining the delivery of glass with other activities, ie movements to work, or shopping patterns.

This Chapter briefly describes the establishment of the scheme, and provides a general comparison with European achievements. It then looks at how the scheme works and compares the differing systems that operate. The roles of the various participating bodies are examined: Manufacturing Industry, Local Authorities, Private Companies, and the General Public. This provides a background framework to the assessment of the Bottle Bank system as a glass recovery process.

6.2 Background

Though raw materials for glass manufacture are abundant and relatively cheap, cullet (waste glass) has played an important role in the production process (COOK 1979). When cullet is spread through the raw materials mix it improves the heat transfer within

the batch reducing the energy demands. Thus the operating 'norm' was to have 20% of the batch comprising cullet from in-house breakages. With improved production techniques there has been a reduction in the level of factory breakages, forcing manufacturers to seek alternative sources of cullet. This is one of the reasons behind the establishment of Bottle Bank schemes.

Also Bottle Banks can be seen as a response to the growing pressures on manufacturers from the Environmental Lobby to reduce the quantity of glass packaging waste reaching the waste stream (Section 5.4). It also has been viewed as an answer to the calls for deposit legislation (Section 4.8), as if most glass is recovered and recycled then deposits would not be necessary. This argument is being used in West Germany where the recovery has been very successful in terms of quantity recovered and they aim to recycle 100% of all one-trip containers (Anon 1986c).

From being a replacement of in-house cullet, 'foreign' cullet is now being used to replace raw materials used in the manufacturing process. This extra use of cullet can lead to savings in energy and raw materials (Section 8.8). Some furnaces in Britain have worked with 50% cullet, and Vetropak of Switzerland operated with 80% cullet in the production of green bottles (COOK 1979).

6.3 Start Of Bottle Banks

The Bottle Bank scheme started in Britain in 1977, with pilot schemes in 5 areas, under the aegis of the Glass Manufacturers' Federation (GMF) who coordinated and promoted the scheme. Britain was divided into four areas to which was assigned a Glass Company with responsibility for setting up recycling schemes and to provide a Recycling Plant to serve them (Section 6.6).

Initially, Local Authorities were approached to operate Bottle Bank schemes as they had the necessary infrastructure (Section 6.7). The operation involved the rent or purchase of purpose built skips - 'Bottle Banks'. These skips were positioned where people could easily bring their used bottles and jars. When the skips are full they are taken and emptied at a central storage depot. Once 20 tonnes of a grade - colour - had been accumulated, it is bulk transported to the nearest Recycling Plant. At the receiving plant the cullet is decontaminated, cleaned and crushed, before it is taken and added to the furnace to manufacture new containers.

After 3 years of the operation the limitations of the above system were noted, and this lead to the examination and development of other collection means (Table 6.3).

6.4 Present Situation

Glass recycling has extended across Britain and is now operated by 60% of Local Authorities. In 1984 334 District Councils ran 2144 sites (830 Large Banks and 1215 Modular Banks) in 830 towns and cities (GMF 1986). Since its inception the amount of glass recovered has steadily increased (Table 6.1). A set of Council returns to the GMF is shown in Appendix C.1.

TABLE 6.1 Total Glass Recycling Tonnage

1977	1978	1979	1980	1981	1982	1983	1984	1985
25000	30000	37000	55000	82000	110000	128000	162000	210000

Includes Industrial & Commercial Tonnage

Source: GMF (1986) Glass Recycling So far ... so good.

Although the tonnages recovered have continued to increase they have yet to reach the 1984 target set by the GMF. They aimed to recover 250,000 tonnes of glass, equivalent to 17% of its glass container production. Such a level of recovery could lead to an energy saving equivalent to 115,000 barrels of oil, worth (£1.5 million (1980 prices). However, in 1984 Britain's recovery of glass was 128,000 tonnes (T & Ind 1985). Targets set have been over ambitious and are still to be achieved.

When compared with Europe, Britain's recovery rate is less satisfactory. Table 6.2 shows this with Britain recycling a far lower proportion of its glass consumption. More details on European operations are provided in Chapter 12. The differing recovery rates reflect the much more energetic attitude adopted towards waste reclamation by Cental Government on the continent than in Britain. This attitude has resulted in a much more intensive recovery system in other European countries than in Britain (Table 12.2). This difference may also reflect the predominance of the use of green bottles for wine in Europe. Green glass is easier to recycle, than clear glass which predominates in Britain as it can tolerate more easily the presence of other colours in the mix (Section 3.3.5).

6.5 How The Bottle Bank Scheme Works

Bottle Banks can be established by the Waste Disposal Authority (WDA) under Section 20 of the Control of Pollution Act 1974. Also the Refuse Disposal (Amenities) Act 1978 Section 3 allows the WDA to sell or otherwise dispose of any waste collected at Civic Amenity or other disposal sites.

Although Local Authorities operate recycling schemes, many are

TABLE 6.2 Glass Recycling In Europe

YEAR	1980	1981		1982		1983		1984	
COUNTRY	TONNES RECYCLED	TONNES RECYCLED	PROPORTION OF PRODUCTION	TONNES RECYCLED	PROPORTION OF NATIONAL CONSUMPTION	TONNES RECYCLED	PROPORTION OF NATIONAL CONSUMPTION	TONNES RECYCLED	PROPORTION OF NATIONAL CONSUMPTION
AUSTRIA	-	44,000	20%	42,600	20%	44,000	20%	47,000	30%
BELGIUM	100,000	100,000	33%	100,000	32%	100,000	32%	120,000	36%
DENMARK	-	20,000	8%	21,500	10%	23,000	10%	25,000	20%
FRANCE	336,000	416,000	20%	478,000	20%	522,000	24%	540,000	25%
GERMANY	600,000	673,000	24%	750,000	28%	832,000	30%	884,000	31%
GT BRITAIN	50,000	85,000	4.5%	110,000	6%	127,000	8%	161,000	9%
IRELAND	-	6,000	8%	6,600	8%	6,000	8%	6,000	7%
ITALY	320,000	350,000	20%	355,000	21%	400,000	22%	428,000	24%
NETHERLANDS	-	180,000	33%	200,000	47%	210,000	48%	230,000	53%
SWITZERLAND	-	92,000	36%	105,600	42%	112,000	42%	127,000	45%
SPAIN	-	-		-		123,000	12%	124,000	13%
PORTUGAL	-	-		-		28,000	12%	23,000	10%
TOTAL	1,406,000	1,966,000		2,169,800		2,527,000		2,715,000	

Key:

Trade & Industry Committee 'Wealth From Waste' October 1984 HMSO
Spain - 119,000 from Industrial sources
- 4,000 from Bottle Banks
Financial Times Aug 25 1982
Glass Gazette April 1984 No 10
Glass Gazette June 1985

half-hearted, and many others are reluctant to become involved in a recovery scheme. This attitude exists even though investment in Banks can be relatively small (5 skips at £900 each and storage at £5000; a total of £10,000).

Local Authorities have been unwilling to commit finance to recovery schemes. As this has accorded with Government attempts to curb their expenditure, there has been little pressure from Central Government to become involved in recycling. With the recent appointment of a Minister with responsibility for recycling there may be changes in the level of support and active promotion from the Government (Section 1.4).

This has left development and promotion to National Trade organisations such as the Glass Manufacturers Federation (GMF). To promote the scheme the GMF through its local representatives offers Local Authorities three important safeguards:

1. A guaranteed price for cullet.
2. A guaranteed market for the cullet.
3. An assurance that if the scheme is introduced it would be viable.

These assurances contrast sharply with the schemes offered to paper recoverers, where operators are subject to the fluctuations in the market. The prices received for paper tend to be cyclic following periods of boom and bust (TURNER 1984). Whilst, in a period where demand has collapsed paper merchants will try to take paper recovered by regular collectors, it will be restricted by storage space and cash flows. Paper schemes tend to be supported by local merchants and do not operate within a national framework supported by their trade federation as offered by GMF. A more detailed examination of paper recovery is offered by HO (1982).

The Bottle Bank container is at the heart of the glass recovery scheme. It is important to choose the right system/container to suit the local conditions. Although it is possible to expand from one container, to other types of containers.

6.5.2 Bottle Bank Systems

In Britain, there are two basic types of Bottle Bank systems in operation. This distinction is based on the way each system has the banks emptied (GMF Undated). The main characteristics of the two systems are outlined below:

a. The Large Bottle Bank Scheme

The main characteristics that define this system are:

1. The Bottle Bank containers have to be removed from the site to a central storage site or processor, where they are emptied.

2. The containers are 'usually' large, with internal partitions to separate the three glass colours.

3. The containers are emptied by tipping the glass through hinged flaps at the back of the skip or out of the top.

4. An ordinary skip vehicle is used to transport the container.

b. The Modular System

The main features of the system are:

1. The Modular Banks are emptied on site into the back of a vehicle/truck via a crane/mechanical lifting arm.

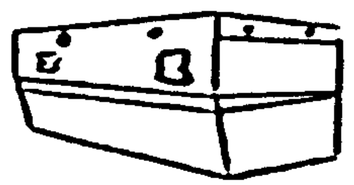
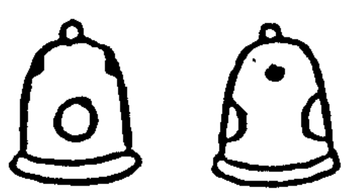
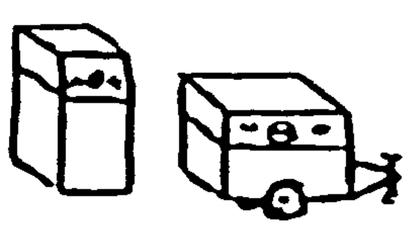
2. The Modular Banks are smaller and hold only one colour of glass each.

3. The glass is discharged through the base/top of the container.

4. A specialised vehicle is normally required.

The main distinguishing feature between the two systems is the method of emptying: with the large banks removed to a central

TABLE 6.3 BOTTLE BANK SYSTEMS

TYPE OF BANK	DESCRIPTION	SITING	HANDLING	COSTS/REVENUE
Bottle Bank - Standard 	Large Skips - compartmentalised for colour separation - green, amber & flint Size: 12 m to 20 m Capacity: 3 to 5 tonnes Removed from site for emptying to storage/processor. Mainly used by General Public.	Shopping Centres - ease of access by skip vehicles	Need Specialist Vehicle & central storage depot unless close to the processor	Cost: £750-900 per skip Uplift: £5-20 per lift Operated By: LA Priv Co If LA receive all the revenue; if private Co receive a rebate (£2/t)
Bottle Bank - Jumbo	As for 'standard' bank Capacity: 8-10 tonnes Emptied less frequently	Shopping Centres	Specialist Vehicle	Cost: £2200 per skip Spread costs over larger tonnages
Modular Bank (Beehive) 	Small Banks - one for each colour - fibreglass or GRP Size: 1m , 1.5m , 2.5m Capacity: 0.5 to 1.5 tonnes Empty on site	Restricted sites - rural areas, pub car parks, and more residential areas	Vehicle with crane - compartmentalised Bottom discharge to specialist vehicle on a milk round	Cost: £250-350 Operator: LA Priv Co - offer rebate
Envirobin 	Round Skip, internal sections Capacity: 2 tonnes Site emptying/ advertising	Central/busy sites	Specialist vehicle - with crane, empty colours together	Operator: Priv Co Rebate to LA
Modified Banks 	Adapted from refuse containers - take mixed glass empty on site Adapted from oil drums	Smaller car parks	Use standard refuse vehicles with lifting arms - tips into rear Adapt LA vehicles	Cost: £200 No Investment in specialist vehicles

storage site, whereas the modular banks is emptied into a vehicle on site. Table 6.3 lists the various Bank systems available, with some of their key characteristics. The operating criteria for the two main systems are examined in more depth below.

Within each system different sectors can be responsible for and benefit from the operation of Bottle Banks. A GMF survey (Section 6.9) asked the public who was responsible for and benefited from glass recycling operations. The results of this survey are shown in Table 6.4. It shows that people's perceptions of who benefits from and who is responsible for Bottle Banks do not coincide.

TABLE 6.4 Who Is Responsible For And Benefits From Bottle Banks

	Responsible For B B	Benefits From B B
Local Authorities	57%	12%
Manufacturers who 'use' containers	16%	30%
Makers of containers	14%	17%
People living in the area	8%	32%
Others	6%	10%

Based on Bottle Bank and Non-Bottle Bank Areas

Source: GMF Survey

Within the two main systems the role of Councils, Contractors will vary with them taking on differing responsibilities. The various systems are outlined below:

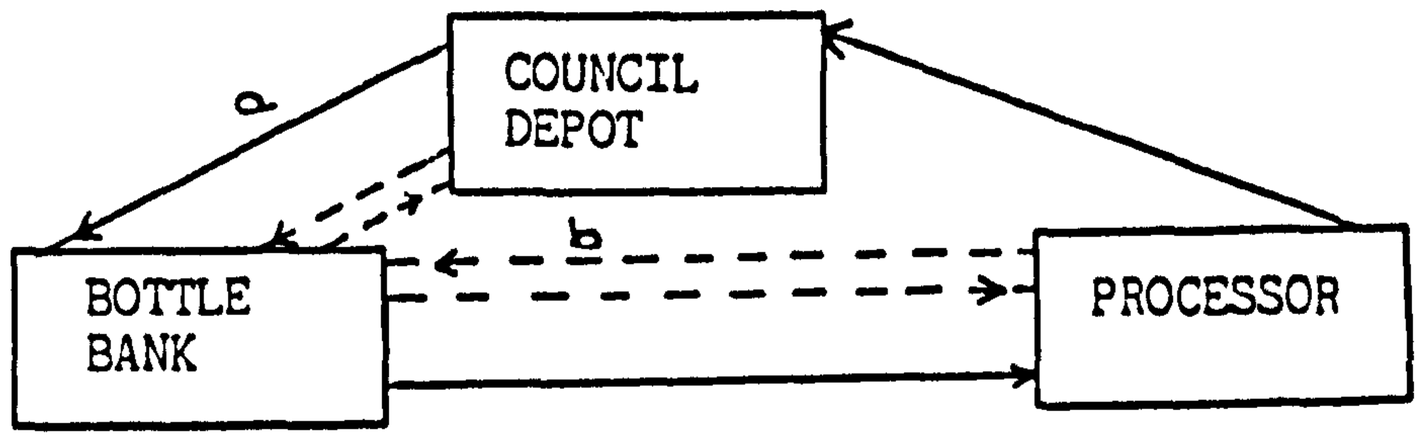
A. Large Bank System

1. Council operated direct to the processor
2. Council operated to central storage
3. Council/Contract operated to the processor
4. central storage
5. Contract/Council operated to the processor
6. central storage

B. Modular Bank System

1. Private Operators to processor
2. central storage
3. Council Operated to processor
4. central storage

A.1 Large Bank - Council Operated Direct To Processor



a Local Authority can take empty skip to the site and exchange for full skip; this maintains service to the site.

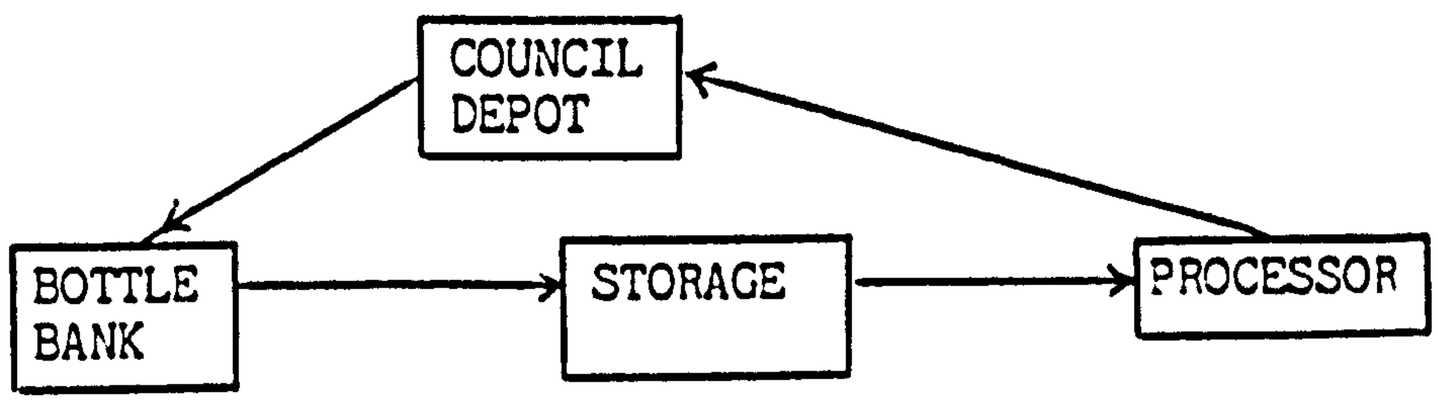
b Local Authority can pick-up the full skip, transport it to the processor, and then return the emptied skip back to the site. This leaves the site unserviced for a period.

A potential problem is access by the skip vehicle to the site, which can necessitate uplift being undertaken early in the morning or late in the evening. This may involve overtime payments, and result in a noise nuisance to neighbours to the site.

Factors to be considered:

1.	Bank provision	- Capital purchase of new skip - Modification of existing skips - Lease skips - Sponsorship of skips
2.	Bank maintenance	- Varies with material type - Maybe offset by grants
3.	Site Provision	- Agreements - Infrastructure - concrete base, railings, litter bins - Effect on car park revenue
4.	Site Maintenance	- Street Cleansing
5.	Bank Uplift	- Sensitive to distance and quantity transported - If take and swap skip - Ease of access to site - Availability of Council resources
6.	Administration	- Planning - Supervision/monitoring filling rate - Invoicing & payments - Marginal, unless employ Recycling Coordinator
7.	Other Factors	- Publicity - influence respose rate - Insurance - Equipment provision

A.2 Large Bank - Council Operated To Central Storage



The use of a storage site enables the transport costs of cullet to the processor to be spread over larger tonnages. However, the use of storage incurs the extra costs of storage provision and bulk transport.

Such a scheme will include those factors outlined for direct delivery to the processor (A.1). These are:

1. Bank
2. Bank Maintenance
3. Site Provision
4. Site Maintenance
5. Bank uplift
6. Administration
7. Other Costs

plus:

8. Storage costs
9. Bulk Transport

Storage Costs

Storage can be provided through the Council or by Private resources. For example Glasgow D.C. stores its cullet at the United Glass Cook Street Depot, from whence it is bulk transported to Kelliebank for processing. Storage can make use of an existing Council site, or it may necessitate the construction of a new compound. Storage located at a Council Depot may keep transport costs to the minimum. Council costs will include:

a. Site Provision
b. Provision of storage bays
c. Administration costs
d. Maintenance of storage site

If Council makes use of a Private Company's site they may pay a

fee for storage, or receive less for glass delivered to cover storage and transport costs.

Bulk Transport

Bulk transport can be undertaken by Council vehicles. The costs will include:

a. Loading - Mechanical Shovel
b. Transport - To processing plant
c. Capital equipment costs - vehicles

A.3 Large Bank - Council/Contract

An option available to Local Authorities is to subcontract bank uplift to a private haulier. This avoids the need for special skip lifters, and allows Council to 'hire' vehicles when required. The Council could also subcontract bulk transport requirements if it does not have the vehicle capacity. In operating the Bottle Bank scheme the Council will still be faced with the other costs described for A.1, and will need to monitor any subcontracted service.

A.4 Large Bank - Private/Contract

Although some schemes can be operated by Private Companies with the approval of the Council, the Council will still be faced with some costs. These include:

1. Administration
   - Invoicing/monitoring of skips
   - Planning Permission
   - Liason
   - Publicity
2. Site Maintenance - Street Cleansing

To offset these costs there are small rebates from the operating company to the Council for each tonne of glass recovered. This revenue is usually less than if the Council operated the scheme

themselves: eg United Glass pay £2 per tonne for each tonne of glass they collected from their schemes in Scotland; Cleanaway also paid £2 per tonne, but have discontinued this for recent schemes; Falkirk Glass Recycling Company do not make a return to the Council as they cannot cover their own costs.

Private Companies who operate Bottle Bank schemes will be faced with similar costs as the Councils. These will include:

1. Skip Purchase
2. Skip Maintenance
3. Site Provision
4. Site Maintenance
5. Skip Uplift
6. Storage
7. Bulk Transport
8. Administration
9. Rebate to Council for tonnage collected

Within this scheme the Private Company can use the option of delivering direct to the processor or making use of a storage site. This decision will depend on distance and the relative costs of the two schemes.

B.1 Modular Banks

Modular systems were initially introduced by private companies, and now some Councils have taken up their use. HECKFORD (1984) reported that their scheme is based on 10 sites each generating one tonne of glass per week which would provide a full lorry load. The vehicle takes glass to processor, without intermediate storage. Whereas, Suffolk District Council only uplift when bins are full, and divert a lorry to the area from other activities. The glass is delivered to storage before being bulk transported to the processor.

B.1 Modular System - Private Operator

Factors needing to be considered:

1. Modular Bank provision - '10' make up a route (£300)
2. Bank Maintenance - remove graffiti
3. Bank Emptying - empties on site
4. Vehicle Costs - Capital
   Insurance
   Excise Duty
   Depreciation
   Maintenance
5. Labour Costs
6. Administration - Invoicing/monitoring
7. Rebate to the Council

Council's role:

1. Administration - Feasibility/approval of site
   Monitoring
   Planning Permission
   Invoice
   Rebate
2. Site Maintenance

6.6. Role Of Industry

6.6.1 Glass Manufacturers' Federation (GMF)

The GMF has provided a coordinating role in the development of glass recycling projects. The role and commitment of the GMF has varied. For the first schemes in Oxford the bank costs and advertising costs were met by the GMF. With subsequent schemes the GMF has supported local advertising as well as mounting national advertising campaigns.

From being instigators of glass recovery schemes the GMF and its members now see their main role as purchasers and processors of the recovered cullet. The industry is prepared to help and advise where possible, but feel that this type of operation seems to work best if decentralised, with each Council deciding on the type of scheme it prefers and choosing how it should be run. One effect of this is that local people feel that it is their scheme and get the benefit from their own endeavours. This is not to say that there may not be advantages in adjacent authorities working together, by sharing some of their operating facilities, eg storage and skip vehicles.

The glass industry is concerned that while encouraging collection of cullet that there is a ready outlet for the material recovered. Thus along with the setting up of collection schemes, the Industry has invested £5 million in recycling plants to process the collected cullet. This allows the cullet to meet the standards set by manufacturers to be used in their furnaces.

6.6.2 The Container Industry

There are three main manufacturers of container glass in Britain.

These are: United Glass with 28% of the market, Rockware with 26%, and Redfearn National Glass (RNG) with 15%. Other manufacturers are: Beatson Clarke (6%) who cater for the pharmaceutical industry, the Co-operative Wholesale Society (CWS) for milk bottles, and Canning Town Glass (8%). More details on Rockware and Redfearn Recycling practices are given in Appendix C.

In the early 1980's the glass manufacturing industry faced declining sales and rising costs. This lead to a period of rationalisation and re-organisation with closures of furnaces and a 20% reduction in the work force. In the past two years, the operations of most manufacturers have seen a return to profitability and a maintenance of market share against other packaging types.

6.6.2.A United Glass

United Glass (UG) has been one of the main proponents for the establishment of successful glass recycling schemes. In 1983 the company held two seminars to present an 'economic model' to Waste Disposal Authorities (WDAs). This work divided the assessment into two sections: collection and the industrial process. The boundary between the two is the price of conversion. However, details on Industrial process costings are confidential (COOK 1983). On the collection side UG found no consensus on the Local Authority side. This was confirmed by the survey carried on Local Authorities (Chapter 7).

For the company, use of recovered cullet risks damage to the furnaces and the production of substandard bottles. This is offset by benefits from energy savings and raw material extraction (Section 8.8). To counter adverse effects UG have built two

recycling plants at Kelliebank and Harlow.

Kelliebank, Alloa

The recycling plant at Kelliebank was finished in 1980 at a cost of £0.5 million (BISSET 1983). Cullet has an important role in glass manufacture - aids heat transfer, reduces temperature necessary to melt the batch (1500°C to 900°C). The cullet acts as a flux in the process.

Kelliebank offer a guaranteed price, which is reviewed in line with material costs every six months. There is no restriction on the amount of cullet taken in by Kelliebank, because 60% of bottles in Scotland are used for whisky and are exported.

At present Kelliebank recycles 20,000 tonnes of glass per annum, processing 400 tonnes per week. Of which 5% ends up as waste (20 tonnes) and goes to a landfill site operated by a private contractor. The 'cleaned' cullet goes to the local UG plant at Alloa. The total of 20,000 tonnes processed in a year accounts for only 7 weeks supply for 1 furnace. They have provided up to 50% for one furnace with no deterioration in the final quality of the product. BISSET (1983) felt that the limits of recovery in Scotland is 30,000 tonnes of a potential of 250,000 tonnes available. The Kelliebank plant is costed to breakeven at 200 tonnes per week.

Kelliebank Process

Glass - clear, green, brown and mixed - is delivered to Kelliebank by various operators of glass recycling schemes. Kelliebank itself operates collection through the use of Modular Banks, usually by siting two - clear and mixed - on each site. They have

sited 300 modular banks within a 25 mile radius of Alloa. They operate a special two compartment lorry (clear/coloured) 6 days out of 10. The scheme is just below breakeven. This system is suitable for rural and smaller areas. They pay £2 per tonne to the Local Authority for each tonne of glass collected.

The delivery vehicles are weighed on arrival and on leaving to establish the quantity of glass delivered. The delivered glass is then unloaded into storage bays, where colours are kept separate. The Centre processes clear and coloured glass separately, through the same process.

Cullet is loaded into a bulk hopper by a mechanical shovel. It then falls onto a conveyor, which operates at a fixed flow. Within, the building the process is monitored by two workers who remove plastic bags, wood, and other large contraries (Kelliebank employs 6 people). The cullet then passes under a magnetic separator to remove metal tops. The glass is then crushed and screened to remove metal (Aluminium) foil. The paper is sucked off. The 'cleaned' cullet is then stored, before being bulk transported to the manufacturing plant.

The manufacturing process can tolerate up to 1% in contraries to furnace. Any paper and plastic that is delivered, is vapourised in the furnace.

With the coloureds that are delivered to the furnace there is a need to maintain 60% green glass. The green coloured with chromite can mask amber colour in glass.

Outlying areas instead of separating glass can send in mixed glass which the plant can handle. The drawback to the collector is that they receive £4 per tonne less, than if the clear glass was kept

separate. This is worthwhile, where the amount of glass is low.

The current price (1984): Clear 22.50 per tonne
Mixed 18.50 per tonne

Prices are linked to raw material prices and are reviewed every 6 months.

Kelliebank's recycling rate has grown steadily since its opening as shown in Table 6.5. These improvements have been linked with a steady growth in the number of Councils participating and in the number of sites they operate.

TABLE 6.5 TONNAGE CULLET COLLECTED
(Handled Through Kelliebank)

SOURCE	1981	1982	1983	1984	1985
COUNCILS	4731	6281	7905	8002	8304
INDUSTRIAL	11825	10031	8953	10947	12716
TOTAL	16556	16312	16858	18949	21020

Harlow Recycling Centre

Harlow has a capacity of 1000 tonnes per week. It is established (costed) to run on 500 tonnes per week (COOK 1983). At present (1984) the plant processes 250 tonnes (loss of £20,000). The plant was officially opened on November 26 1982, and cost £750,000. Industry's latest contribution from UGC is a £2.5 million expansion of its recycling plant at Harlow, Essex (McRAE 1985). The new automated batch plant at Harlow, which should be ready in the summer of 1986, which will provide a third furnace to handle brown glass in addition to clear and green glass furnaces. UGC states that with reduced energy input required with recycling will have saved 1.5 million gallons of oil this year.

6.7. Role Of Local Authorities

6.7.1 Introduction

As shown in the breakdown of the systems (Section 6.5.2) the role of Local Authorities can vary markedly. They can be responsible for operating the whole scheme, or just take account of the administrative responsibilities. A more detailed appraisal of their attitudes to the various factors is provided in Chapter 7.

An area of potential conflict is the division between WCAs and WDAs in England and Wales. This is of concern as benefits to Local Authorities tend to be in disposal cost savings rather than in collection cost savings, particularly in the short term. Thus if the WCA runs the scheme, it may not receive all the benefits due. Although, some WDAs are offering rebates related to disposal cost savings (Chapter 8).

The role of the Local Authority is to provide sites and monitor schemes. In addition, most Authorities make a profit on selling the glass to Industry. Some Councils channel these returns to local charities or community projects.

6.7.2 Feasibility Of Recycling

Before establishing a recovery scheme there are a number of interrelated problems that have to be examined as part of an initial feasibility study. The factors to look at, are:

1. Local Authority waste management policy.
2. Outlets/Market.
3. Quantity/Sources.
4. Location.
5. System Of Collection.
6. Need For Storage.
7. Method Of Transportation.
8. Colour Separation.

6.7.3 Local Authority Waste Management Policy

The first step is to establish how a recycling scheme would fit into the Council's waste management policy. Whether it is compatible, as at WCA level it will affect collection levels, and how manpower and vehicles are allocated; and at WDA level it may have consequences for the efficient running of disposal facilities. There is the opportunity to see if there is any spare capacity in collection facilites that could be utilised in developing a recovery scheme. This will apply in terms of availability of labour and vehicles. Whether the Authority has ready access to specialist vehicles eg skip vehicles, can influence the collection method a council adopts. These factors need to be reviewed when examining the possibilities of establishing a reclamation project.

6.7.4 Outlets/Markets

Without an outlet for the recovered material there is little point in collecting glass. With glass the established market is the glass container manufacturers who can be supplied directly or through an intermediary - cullet merchant. The Local Authority should ascertain which is the nearest producer, his willingnes to take the glass and the price that he will pay. Manufacturers offer a guaranteed market for cullet subject to set quality constraints and give guaranteed minimum prices.

For instance, prices at UG Harlow and Kelliebank cullet treatment plants in mid-1984 were:

	Harlow	Kelliebank
Flint (clear)	£30 per tonne	£22.50 per tonne
Green	£26 per tonne	
Amber (brown)	£22 per tonne	
Mixed	£20 per tonne	£18.50 per tonne

The Local Authority could look at supplying to a cullet merchant, but is likely to receive a lower price. In addition it should examine the possibilities of linking up with other operators to share storage and bulk transport costs.

6.7.5. Sources/Quantity

There are three main sources of broken/unwanted glass (Section 3.2):

1. Households
2. Trade/Commercial Premises
3. Industry/Fillers

Although the main source of glass for Bottle Banks is from households, the Local Authority should examine the possibility of exploiting the other two sources.

As manufacturers deal in large quantities of raw materials on a continuous basis, the minimum amount they will accept is 1 tonne (equivalent to 3000-4000 containers). However, unless the authority lies near the processor it should look for bulk loads of 20 tonnes to spread the transport costs.

A critical area for the success of a scheme is the level of public participation that is achieved. A survey suggests that the minimum number of people needed in a Bottle Bank's catchment area to generate one tonne of glass in a week is 4,500 people. Active promotion will be necessary to maintain people's interest and inform them of the progress of the scheme. A 'good' response rate for a recycling scheme is 25% of the people in the area.

6.7.6. Location

A Local Authority should examine where its population centres are, where skips can be sited, nearness to markets and nearness to

other operating schemes. Principal sites are large car parks at supermarkets within towns. These are sites that people use frequently in everyday activities and do not have to make special trips to reach.

6.7.7 System Of Collection

There are several options available and each needs to be considered on its own merits to find the one that is best suited to local conditions. The options are (examined in Section 6.5.2):

1. Large Banks (3 tonne capacity) - direct to processor
   - to storage
   - These schemes can be operated by: L Authority
     Private Company
     Local Group

2. Modular Banks (1 tonne cap) - direct to processor
   - to storage
   - Operated by: Local Auhority
     Private Company

6.7.8 Storage

Dependant on the system of collection chosen, lies the need for a storage site to be found. Such a site needs to hold up to 20 tonnes of each colour collected. With storage there is the option of using existing facilities, building new ones, or sharing with other Authorities. Storage is justified when the distance to the market is great, so making the bulking up of glass a viable alternative.

6.7.9 Transport

This is influenced by the collection system chosen and whether storage is used. The availability of existing skip vehicles for large banks, or vehicles with crane attachments for modular banks needs to be examined. Transport costs need to be kept to a minimum, particularly between storage and the glass source. Once

collected and stored there is a need to arrange for the cullet to be delivered to the recycling plant. This can be done either through use of Council vehicles, by private haulier or through the cullet firm.

6.7.10 Colour Separation

With large banks compartments keep colours separate. With the Modular Banks there are a number of banks on the site to take the different colours. If glass is collected separately, it will need to be stored separately in separate bays each with a capacity of 20 tonnes. The extra revenue achieved should cover the extra costs of storage, for colour separation to be worthwhile.

6.7.11 Summary

Within the examination of the differing systems (Section 6.7.6) a clear assessment of the likely costs needs to be made to determine the best system to suit local conditions. This is important as the main objective of Local Authorities is to provide a service to the people it serves. An evaluation of how Local Authorities cost their recycling schemes is provided in Chapter 7. In Chapter 9 a review of viability assessments is provided. This leads into Chapter 10 the viability model which provides a systematic assessment of glass recycling schemes.

6.8. Glass Recycling By Private Companies

6.8.1 Introduction

A number of private companies have established glass recycling schemes based on the Bottle Bank scheme, with examples of large bank and modular bank systems. The success of the schemes has varied markedly. Appendix C.4 lists some of the Private Companies involved in glass recycling, several of these were contacted to get more details of their operations.

6.8.2 Background

It was with the introduction of the modular system that glass manufacturing companies began to establish their own collection schemes, eg by United Glass. With the support and encouragement of local glass manufacturers and the GMF several private haulage companies, cullet merchants, and waste disposal firms have set up recovery schemes in conjunction with Local Authorities.

The reason why companies became involved was primarily based on the assumptions of future profitability. This has been achieved with varying degrees of success. The Manufacturers became involved to support Local Authorities and to show that it could be done successfully. Waste disposal companies saw glass recycling as a logical extension of their business. The independant companies saw it as a profitable means of supporting the company and thus justifiable to the shareholders.

6.8.3 Links With Local Authorities

Liaison with Local Authorities varies from formal contracts to spoken agreements. Before establishing a scheme Cleanaway (Heckford 1983) circularised Local Authorities in the area,

outlining what the company offered and what they expected from the Council (Appendix C.6). Once the interested Councils were identified they were brought together for discussions.

Cleanaway seeks a 3 to 5 year agreement with Councils to collect and service sites, to ensure that the Company's investment is secure. However, they feel that if they offer a good service there is little fear of losing the contract. Anti-Waste (Appendix C.7) had a two year contract with the relevant Council, although they too hoped to establish a first class service (RACKHAM 1985). Envirobins (ROBBINS 1984) produced a legal document to formalise links, at the behest of Surrey County Council (Appendix C.12).

When establishing schemes, Companies tend to offer Councils a return of between £2 and £3 per tonne of recovered glass as an incentive. However, Cleanaway (HECKFORD 1985) have not offered rebates on a number of new schemes they have proposed.

Surrey County Council are also seeking to raise rates on Bottle Banks operated by Envirobins in their area. This is due to the more permanent nature of the Banks adopted by the operator.

6.8.4 Operating Systems

There are examples of Large Bank and Modular Bank systems. Within each system the Councils role varies slightly. Primarily they look after the site and help monitor and promote the scheme.

A Large Bank system is operated by Falkirk Glass Recycling Company (Appendix C.5). The Bottle Banks (2.5-3.0 tonnes) cost £700 each depreciated over 5 years. However, the Company feels that these are not large enough to spread transport costs and are looking at Banks with a capacity of 8-10 tonnes. Although, an extra capital

cost it allows transport costs to be spread over greater tonnages.

A problem with the sites Falkirk services is their distance from their depot and the processor at Alloa. The company uplifts full skips from the site, leaving an empty skip and takes the load to the processor. Labour is made up of one driver who is paid above standard haulage rates, with hours dependant on distance to sites. They make use of existing Company vehicles (Capital cost of £22,000). GILLIES (1984) estimates that transport and wages account for 90% of the overall costs.

The other companies contacted operate modular bank systems, with cullet being emptied on site direct into the collection vehicle. Cullet is then taken to the processor or an interim storage site dependant on distance.

Cleanaway decided that the optimum was a catchment area of 50 miles around the processor site. There would be no storage and subsequent bulk delivery as this would add to the costs. The glass would be collected from several sites and is delivered direct to the processor. Cleanaway uses its own skips that cost £300 each (overall an investment of £12,000) depreciated over 5 years.

Anti-Waste operate on a similar basis with a specialist vehicle up-lifting and emptying modular banks on site. The banks cost £300 each, and are depreciated over 5 years. At present the lorry is utilised to 25% of its capacity. The lorry is operated by one man. It operates a 'milk-round' and once the collection run is complete the glass is emptied at a central storage site at Thetford. They use storage to bulk up glass due to the distance to the processor. Bulk transport is provided by spare capacity in the company's existing transport fleet.

Envirobins although operating a similar modular system with a lorry following a milk-round, utilise a different design in banks. Envirobins (1980) use a larger bank holding between 1.5 to 2 tonnes that are internally divided to separate the glass colours. This system only requires a single visit to empty all sections, cutting down transportation costs. In addition if banks could be made to look attractive and be placed in a conspicuous position, it would not only collect more glass but prove an attractive sight for 4-sheet advertising posters (Section 6.8.6). These banks are more expensive at £1200 each. Envirobins deliver glass to a central bulking site, before transporting to the processor.

6.8.5 Publicity

Most companies limit publicity to helping establish new schemes, linking up with the local glass processor and the GMF to provide a coordinated publicity programme.

Envirobins, sought to utilise advertisements to help support their scheme. They feel that if Banks are located in good positions they can be used as advertising hoardings. The potential 'reach' of the adverts was investigated by Audience Survey in November 1981, who found a positive reaction (85%) to them among the valuable ABC1 groups. Envirobins would spread out Banks so that advertisements can cover a wide area. This dispersion of banks would increase problems of transportation and collection.

The company consulted Manufacturers and found they were principally in favour of the use of advertising. However, they found that Advertising Agents did not see it as part of a sound marketing strategy. The lack of advertising income brought problems to the financing of Envirobin's scheme.

6.8.6 Problems Private Companies Have Faced

Of concern for some of the smaller companies is their dependance on one outlet for the sale of the cullet. Most have one buyer for their product, who fixes price and can determine quantity it takes through quality constraints.

An example of the problems that can be faced by having one outlet is shown by the case of Envirobins. Envirobins had consolidated its operations in Surrey and Kent supplying cullet to Canning Town Glass (CTG). Envirobins persuaded CTG to set up bulking centres for cullet with depots at Red Hill and Tonbridge Wells.

However, CTG ran into furnace problems which affected the amount of cullet they could take (Appendix C.11). CTG first closed their Red Hill depot without warning as a temporary measure that would not effect the Tonbridge Wells depot. Then CTG closed the Tonbridge Wells depot effectively isolating Envirobins from its market. To continue operations they had to transport cullet to a GLC depot at Twickenham. This lead to an increase in transport costs and a loss in revenue. Faced with a ceteriorating financial position they consolidated operations on Surrey and transferred Kent sites to CTG to maintain service to the consumers. With the GMF they have managed to persuade Surrey County Council to set up a bulking depot, which should improve the Surrey operations.

A number of problems occur in establishing the optimum operation method. Time is taken to ascertain the 'best' sites, co-ordinating pick-up to maximise tonnage recovered from each site. They are still establishing how long banks will last, the best size and the best method of manufacture. It is a question of balancing the distance between sites, the processor and storage depot and the

quantities of material recovered.

6.8.7 Conclusions

The basis of establishment has been profitability. The firms contacted found profitability to be marginal, being dependant on local conditions and the method of operations chosen. A clear approach to the costs and benefits is necessary, with a scheme needing to secure a sound financial basis to work from. This is provided where glass recycling forms part of an existing business, such as with a waste disposal firm and the new operation can utilise existing facilities.

The optimism shown by companies establishing recovery schemes in the early 1980's was shattered by the obstacles they encountered. This lead to a severe retrenchment and rationalisation of operations. For instance Shelogrove Boden ceased operating in the London area in 1982 (Anon 1982), and Envirobins and CTG have contracted their operations. These schemes were over ambitious and over extended. They ran into problems of low quantities of glass recovered, high transport costs, unfavourable attitudes of Local Authorities and dependance on one market outlet.

There has been a rationalisation of several companyts operations. Some feel the use of larger banks with fewer pick-ups might be a viable future option. Also, the establishment of local bulking centres, possibly financed by the GMF and WDAs needs to be considered. In addition the examination of rebates from companies to councils need to be reviewed and the possible rebate from WDA and WCA to the company needs to be assessed. There needs to be more cooperation between collecting companies, and support from Local Authorities and the Glass Manufacturers.

6.9. Public Support

6.9.1 Introduction

The GMF commissioned a series of surveys by England, Grosse and Associates into attitudes of Bottle Bank users and people living within a catchment area. The latest consumer survey took place in 1982 covering 1700 people in 50 towns, with and without Bottle Banks. It looked at the public's awareness of the environmental situation and glass recycling.

6.9.2 General Attitudes To Recycling

Of the respondents 81% felt that it was important to save resources. In the ABC1 classes this proportion was slightly higher at 88%. This supports the hypothesis that environmental 'awareness' increases as income increases noted in the EPA survey of Marblehead and Summerville (O'RIORDAN & TURNER 1979). The attitude surveys undertaken by the EPA in the two communities reveal that the more affluent population of Marblehead was generally much more enthusiastic about recycling.

Of the respondents 76% of the population felt that saving of resources was going to get more important: because 63% thought the World was running out of natural resources and 27% thought there was less money available. A further question examined which methods of saving resources was most important (Table 6.6).

The survey found that 91% of respondents felt that more recycling schemes should be introduced to recover material from non-returnable Bottles and cans. Table 6.7 shows which materials people thought best for recycling and which people thought were most often recycled.

TABLE 6.6 Methods Of Resource Saving

	Most Important	Can Contribute To
Energy Conservation	53%	51%
General Recycling	6%	3%
Recycling Glass	6%	7%
Recycling Paper	5%	9%
More Efficient Farming/Use Of Food	2%	2%
Careful Allocation Of Money	2%	3%
Recycling Metal	2%	1%
Political Comment	2%	1%
Others	4%	8%
Don't Know	24%	26%

Source: GMF Survey

TABLE 6.7 Materials Thought Best For Recycling (Most Often Recycled)

	BEST FOR RECYCLING	MOST OFTEN RECYCLED
Paper	74%	(73%)
Glass	60%	(36%)
Tins	40%	(31%)
Plastic	11%	(8%)
Others	32%	n.a.
Don't Know	14%	(4%)

Source: GMF Survey

TABLE 6.8 How Respondents Heard Of Bottle Banks

	a. First Heard Of Bank		b. Other Ways Heard Of Bank	
	ALL USERS	HOME INTERVIEWS HAVING HEARD OF BANKS	ALL USERS	HOME INTERVIEW HAVING HEARD OF BANKS
Seeing Skips	39%	57%	78%	77%
Local Press	32%	16%	53%	23%
Friends	11%	13%	27%	20%
Radio	5%	13%	23%	4%
TV	4%	2%	20%	18%
Handbill	4%		8%	4%
National Press	2%		13%	5%
Press Adverts	2%		6%	4%
Local Clubs	2%		4%	
Other	2%			

Source GMF (1982) Op Cit

6.9.3 Public's Attitude To Glass

The GMF survey found that 87% of respondents did not like throwing glass into dustbins. It found that 83% felt that Bottle Banks are a more convenient place to put glass than in the dustbin, because it saves valuable resources.

The GMF survey followed with a series of questions on attitudes to and knowledge of the Bottle Bank scheme. In 1978 they found that 75% knew of a Bottle Bank in their area, which rose to 82% in 1981; and 78% of respondents thought that it was a good idea. A later survey of both Bottle Bank and non-Bottle Bank areas showed that 78% had heard of them, of whom 92% thought them a good idea.

The GMF survey established that 62% knew what a Bottle Bank was and 54% made use of them. Comparing surveys of new and old schemes it shows that there is a greater awareness of a local scheme if it has been in an area some time. FOE (Section 4.9.2) confirmed these findings by the GMF. FOE (1982) found that 78% of shoppers had heard of Bottle Banks, of whom 92% thought them a good idea. Some respondents felt that the Bottle Banks were situated in the wrong place, forcing them to use a car to get to them. This could explain the higher response amongst social classes ABC1, where the majority have access to a car for transport. Of the 8% who thought them a bad idea, some thought they were not economical, that they were a waste of time, and that they should not be necessary as bottles could be re-used.

The GMF survey looked at how people had first heard of the scheme. This can give an indication of how effective different publicity measures are and where promotional resources should be concentrated. Table 6.8 shows that it is the sight of the Banks

themselves that is the best form of publicity, suggesting that promotional resources should be spent on expanding recycling schemes.

The GMF survey sought the general public's comments on the operation of Bottle Bank schemes. Of the respondents 77% knew why glass was sorted into colours. Awareness of this is important in maintaining quality and in maximising revenue. They found that using Bottle Banks was straightforward and presented no technical problems (only 3% of respondents said that they had problems). Of respondents, 58% felt that instructions on Bottle Banks were important. However, more than 50% said that there could be improvements made in Bottle Banks. These improvements include:

a.	Emptying them more frequently, or increasing the number of Bottle Banks:	56%
b.	Wanted somewhere to put bottle tops:	10%
c.	Wanted tidier sites:	10%
d.	Wanted them sited nearer their homes/shops:	7%
e.	Wanted Bottle Banks replaced quickly:	5%
f.	Wanted a receptacle for other rubbish:	5%

Of respondents, 90% felt that Bottle Banks should be run for the benefit of the local community. The most suitable way of spending the money which would accrue from glass manufacturers buying the bottles, are:

Helping general rates	64-70%
Helping charities	23-25%
Reduce Refuse Costs	9-11%

When asked which charity should benefit: 25% referred to children's charity and 25% to Cancer Relief.

When asked who operates the recovery schemes: 57% said Local Authorities, 16% said users of containers, 14% said makers of

containers and 8% said people living in the area. This suggests that more pulicity and information is needed to explain the background of the system. There was also a divergence of opinion on who benefits, with: 12% saying Local Authorities, 30% said users of the container, 17% the manufacturers and 32% people living in the area. It would be interesting to establish what benefits people perceive each grouping receiving.

6.9.4 Profile Of Users

A series of questions looked at a profile of the 'typical' Bottle Bank users. It shows that people are clearly concerned with conservation. They found that Bottle Bank users are twice as likely to be involved in the reclamation of other materials, than non-Bottle Bank users. The GMF survey shows that there is a slight bias towards those in classes ABC1, a bias towards older people and a marked tendency for women to use Bottle Banks rather than men.

Bottle Bank users are more likely to use non-deposit bottles:

NO-DEPOSIT BOTTLE	BOTTLE BANK USERS	NON-BOTTLE BANK USERS
FOR: Soft Drinks	79%	49%
Beer/Cider	35%	21%

This is counter to use of returnables which have a higher recycling index. There needs to be a clarification of which is the optimum recycling practice and an examination whether non-Bottle Bank users make use of returnables.

Respondents gave a number of reasons for using a Bottle Bank. They are:

a. to get rid of unwanted bottles 34%
b. referred to safety 25%
c. to recycle & conserve resources 17%

A series of questions looked at the pattern of Bottle Bank users:

distance to the bank, frequency of use, when last used, means of transport and type of carrier used.

The distance people came from varied markedly with: 32% living within a mile of the site, 16% between 1 and 2 miles, 22% between 2 to 5 miles, and 30% of users were further than 5 miles. This shows the willingness of people to make an effort to recycle glass and highlights the need for adequate transport. An examination of the mode of transport used shows the dominant use of the car in taking glass to sites. The car was used by 60% of respondents, followed by foot 30%, Bicycle 8% and Public Transport 2%. The different modes of transports used will reflect the sighting of banks, the distance (5+ miles) some people travelled and the quantity of containers delivered on each trip. If people deliver by car they could deliver larger quantities each visit and not leave behind carrier bags or boxes. If people come by foot or public transport they are likely to bring smaller quantities.

The study found that 67% of users brought their bottles in shopping bags and 25% in cardboard boxes. This information is of importance for site maintenance, as a receptacle needs to be provided to take empty boxes and plastic carrier bags to prevent a litter nuisance.

The older the scheme the more people have been shown to use it. However, the frequency with which they use it tends to decline. This reflects the learning experience, as people became aware of Bottle Banks, their purpose, their willingness to sort out glass, establishing routes to banks and the means of transport and the quantities they deliver each visit. The number of containers brought per visit is 8, rising to 11 in older established schemes. Visiting patterns will fit in with work and shopping patterns. A

breakdown of delivery is:

1 - 2 bottles	17%
3 - 4 bottles	17%
5 - 6 bottles	20%
7 -10 bottles	10%
11+ bottles	35%

This breakdown shows that people collect up their bottles before they take them to their local Bottle Bank, spreading the individual costs of delivery/storage over a greater number of bottles.

The GMF research indicates that 55% of respondents brought bottles only and 41% said they brought all types of glass containers. This suggests a problem with the term 'Bottle Bank' and the need for publicity to encourage the return of all glass types. Table 6.9 provides an indication of the types of glass containers brought, which will reflect shopping patterns.

TABLE 6.9 Percentage Of Users Who Had Brought A Particular Type Of Glass Container

Cordial Bottles	60%
Wine/Spirit Bottles	50%
Soft/Fizzy Drinks Bottles	32%
Jam Jars	26%
Coffee Jars	16%
Beer/Cider Bottles	14%
Others	14%

Source: GMF (1983) Op Cit

The GMF research indicates that future use will be continued at a similar level, with the little fall-out or decline over a period. These surveys found a wide awareness of Bottle Banks, their purpose and the way the scheme works. They showed the public's willingness to support recycling schemes. It showed the need for clearer information programmes and that the scheme should expand to make it easier to use.

6.10. Summary

The Bottle Bank system was established in 1977, and has expanded across Britain. This success is dependant on the strong links forged between the different sectors - Manufacturers, Local Authorities, Private Companies and the General Public. The scheme has been nurtured within a strong National framework that has been developed by the GMF, who advised and promoted the scheme.

From the initial success of the Bottle Bank system, new techniques and methods were developed. This introduced the smaller modular banks and larger banks.

Within the operation of the Bottle Bank system the roles played by Industry, Local Authorities, Private Companies and the Public can be clearly identified. They can fulfill similar functions, with each group able to operate recovery schemes. Although, in each case the Local Authority will have a monitoring role to ensure that service to the public is maintained, whether by reclamation or by refuse disposal. Also, in each case the success of the scheme will be dependant on the willingness and cooperation of the public, to separate glass out from the waste stream and deliver it to the collecting point.

The continuing success of the Bottle Bank scheme depends on the cooperation between Industry, Local Authorities, Private Companies and the General Public. This needs to operate within a National framework with established aims and practices, as developed by the GMF. Such a scheme would be enhanced by the Government taking a more positive role, and could lead to recovery rates comparable with the top European countries. The EEC Directive may push the Government into taking action to provide the right environment to develop and promote recovery schemes.

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Chapter 7 Local Authority Survey

7.1 Introduction

To learn more about the role of Local Authorities in the operation of Bottle Banks a series of surveys was undertaken. Surveys looked at Non-Operators and Operators in Scotland, based on the catchment area of the Kelliebank Recycling Centre. The Authorities surveyed covered both urban and rural authorities.

The survey of Non-Operating Local Authorities looked at reasons why they did not operate recovery schemes, to provide a comparison with operating Local Authorities. The survey of Operators sought to gain information in three areas: Reasons for establishmemt, Benefits from operating recycling schemes, and Cost factors.

These two surveys were complemented by a series of follow up interviews, which clarified a number of points raised in the initial survey. In addition, a number of Local Authorities in England were contacted and interviewed. This group covered the range of options available for operating Bottle Bank schemes (Section 6.5.2). This contact with English Authorities was important to account for the division between collection (WCAs) and disposal (WDAs) authorities.

The results of these surveys are presented below.

7.2 Survey Of Non-Operators Of Bottle Banks

7.2.1 Introduction

The aim of this survey was to establish why Councils did not operate glass recycling schemes, and what their future intentions were. To limit follow up interviews the survey was confined to Local Authorities in Scotland. The Councils were identified from the Kelliebank Newsletter. Seventeen Councils were sent a questionnaire, and all were returned.

7.2.2 Questionnaire

The questionnaire was limited to seven broad areas, covering the future establishment of Bottle Banks, and the general role of recycling in their waste management policy. The questionnaire is shown in Appendix D.1, with Results in Appendix D.2.

7.2.3 Discussion

This survey had a 100% response, reflecting the limited scope of the questionnaire and the willingness of District Council Officers to cooperate with the survey. It was noted that three of the Authorities contacted planned to establish Bottle Banks. This was through the modular bank system offered by United Glass.

Reasons given for not operating Bottle Banks are summarised in Table 7.1. The main reasons are: not economic (10 District Councils), the small quantity of glass available (3), and high transport costs. The Councils are rural in nature, with low populations, thus generating low quantities of recoverable materials. These characteristics limit the possibilities of setting up viable recovery schemes.

TABLE 7.1 Reasons Councils Gave For Not Operating Banks

Not a financially viable exercise
Population and geography are against it.
High transport costs.
Not sufficient volume to cover collection costs.
Not self-financing.
Distance to processor.
Lack of available eqipment.

Eight of the District Councils carried out a feasibility study, however the extent and scope of these studies was not brought out in the questionnaire. The respondents re-emphasised the reasons given for not operating a recovery scheme.

Berwickshire pointed out that it was uneconomical to establish a recycling scheme due to the level of haulage costs, but that it was good for public relations. An assessment of a recycling scheme would need to consider this point.

Lochaber did not carry out a feasibility study due to the inherent costs of such an undertaking. This indicates that the costs of a feasibility study should be incorporated into the development of an investment appraisal model.

Nairn based their decision not to operate a recycling scheme on the advice of the GMF that there would not be enough glass for the scheme to be economic. Thus in assessing the viability of new schemes, and existing schemes the likely generation of glass 'waste' will be a key factor.

Ross & Cromarty emphasised the lack of sufficient population centres to justify a scheme. This links up with the concern over sufficient volume of material available and the adverse affects of dispersed settlements on transport costs.

The Councils regularly received information from Kelliebank. Their

Newsletter indicates the quantities of glass recovered, the Councils running Bottle Banks, and any new recovery methods. The Councils received requests from local groups to establish recycling schemes. An idea of the type of group would be useful in indicating the likely level of public participation, and suitable sites for Banks. There was no support from Central Government towards recycling projects. Although, this may change with the appointment of a Minister for recycling.

Most of the Councils did not proclaim a view on the debate over returnable containers versus non-returnable containers; an issue more directed at National policy rather than at the level of influence of Local Authorities (Chapter 4). Inverness believed that the use of returnable bottles would reduce the level of litter (Chapter 8). Also the rural areas and islands of Scotland have a large Summer influx of tourists, which might make the use of returnable containers impractical.

Apart from the Councils who have already set up a scheme, only Berwickshire are contemplating establishing a Bottle Bank scheme for the future. The reasons put forward reemphasised the views expressed in answer to question one (TABLE 7.2).

TABLE 7.2 Grounds On Which Councils Would Establish A Bottle Bank Scheme

If economically viable.
If modular bank system could be expanded.
If incentives were provided by the Government to those Authorities far from the recycling centre. (Adopted by the French (Chapter 12.).
If can link with neighbouring schemes, and share costs.

In general Councils were not involved in recycling of other materials. Two Councils - Nairn and Wigtown - had discontinued schemes to recover paper and cardboard, due to the poor state of

the market. The Councils felt that the recycling scheme should be financially viable. Problems expressed by Councils in the development of recycling schemes, can be summarised as:

1. Viability (9 District Councils).
2. Transport Costs to recycling centres (2).
3. High labour costs, and low income (1).
4. Public cooperation and participation (Volume).
5. Present equipment and established waste disposal system provide the inertia which new recycling or waste disposal schemes must overcome (1).

7.2.4 Summary

In times of financial stringency new methods developed to handle existing waste problems need to be cost effective. The present schemes and practices are well established and costed into authority budgets, providing the base from which new schemes will be assessed.

Of concern is the need to provide new equipment - Bottle Banks/Bins, Skip Loaders, and Storage - to set up a Glass recovery scheme. The rural nature of the Authorities with low population sizes and densities, results in low levels of glass and high costs of collection and delivery to Kelliebank.

Answers in the survey show that there is a need to establish a Management Model to establish the viability of recycling schemes. This issue is developed with the survey of those Local Authorities operating recycling schemes.

7.3 Survey Of Operators Of Bottle Banks

7.3.1 Introduction

The aims of this survey was to establish the reasons why Local Authorities set up Bottle Bank schemes, and the position of recycling in their overall waste management system.

The survey was confined to Scotland, with operating authorities identified from the Kelliebank Newsletter. A postal questionnaire was sent out to 34 District Councils, and 25 have responded.

Additional to the questionnaire, a series of follow up interviews were carried out. This was allied to a series of interviews conducted with a representative cross section of authorities in England

7.3.2 Questionnaire

The questionnaire was built up in a series of stages. A number of talks were held with three Local Authorities' Officers - Stirling, Glasgow and Edinburgh. With the suggestions from these officers, and the results gained from the survey of non-operators a pilot questionnaire was undertaken. This was developed into the questionnaire that was finally used in the survey.

The questionnaire was divided into two parts:

1. The Overview
2. The Cost Statement

The questionnaires are shown in Appendix D.3.

The Overview seeks to assess the reasons why Local Authorities established Bottle Banks, and the process of setting up the Council used. This is then put into the perspective of the Council's views on recycling, and its role in the waste management

system.

The Cost Statement aims to establish the costing systems Councils used and the factors they consider to be most important. From this data base it is hoped to produce a uniform cost model for glass recycling schemes.

Of the 25 returned questionnaires, one Council (Kilmarnock & Loudoun) did not complete the questionnaire, as their scheme was run by the Glass Recycling Company of Falkirk (Appendix C.5). Since the survey the Council have taken over the operation of their Bottle Bank scheme, and will transport recovered glass to the UGC storage depot in Glasgow for onward bulk shipment to Alloa. In addition, Edinburgh only completed the Cost Statement, so is omitted from the results of The Overview.

The two halves of the survey: The Overview and The Cost Statement are dealt with separately below.

7.4 The Overview

7.4.1 General Characteristics

A general description of District Councils was sought, in terms of: Population, Area, Number Of Domestic Premises and Commercial Premises. These factors are interlinked with the level of waste generation. For Bottle Banks, glass comes largely from consumption within households. Trade schemes are dependant on the number of catering premises amongst commercial premises. Area is important, as population densities and the presence of centres of population will influence collection costs.

Based on 23 replies the 'average' Local Authority has:

	Average	Urban	Rural
Area (Hectares)	- 78,734	26,796	158,592
Population	-132,090	193,019	63,528
Number Of Domestic Premises	- 48,770	66,637	23,168
Number Of Commercial Premises	- 3,871	5,889	1,096

The 'average' figures for urban and rural councils show differences in their characteristics. These will influence the value of using the 'average' figures. The urban figures are biased by the more densely populated councils of Aberdeen, Edinburgh, Dundee and Glasgow. These figures should only be used as guidelines, with any appraisal being based on local data.

7.4.2 Reasons For Establishing

The reasons Councils gave for establishing Bottle Bank collection schemes can be summarised under three main headings:

Local Context
Public/Council Opinion
National Context

Within each group there are several distinct reasons, which are summarised in Table 7.3.

The most important category within Local Factors is the reduction

TABLE 7.3 Reasons Councils Established Recycling Schemes

REASONS: LOCAL CONTEXT	Number Of District Councils
Less refuse to be disposed	9
Reduce glass risk to workers	5
Less broken glass in litter terms	3
Some income, reduced disposal costs	3
Would be economically viable	1
Nearness to Alloa	1
TOTAL	22
PUBLIC/COUNCIL/GMF OPINION/PRESSURE	
Council's Envtl Ctte Decision/Officers	4
GMF Suggestion	3
Requested by the public	1
Saw other Council's schemes	1
Information from National Press	1
TOTAL	10
NATIONAL CONTEXT	
Support recycling (where viable)	5
Support National glass recycling	4
Energy Conservation	4
Ecologically sensible	1
Material Recovery	2
Reduce Imports Of Raw Materials	1
Conserve National Resources	1
TOTAL	18
NO COMMENT TOTAL	1

of refuse to be finally disposed (9 District Councils referred to this), followed by a lessening of the risk of accidents to Council employees from glass in refuse sacks (5). Both these factors will have financial consequences for waste management operations, and need to be assessed in conjunction with any income received from the sale of cullet. With the importance given to transport costs by non-operators, nearness to the recycling plant can be a significant factor.

On a National scale District Councils see benefits in the conservation of resources - energy, and a reduction in the imports of raw materials. With the importance Councils associate to National reasons for establishing Bottle Banks, the Government has an important role to play in co-ordinating and promoting a National policy on recycling.

7.4.3 Feasibility Study

Feasibility studies are important in establishing the level of public participation, the likely costs, and available infrastructure and were carried out by eleven Councils. A number of Councils felt that a feasibility study could only be carried out effectively by setting up the scheme as a pilot project. However, if the scheme is subsequently withdrawn this can disenchant the public and could result in problems of litter.

Feasibility studies could be avoided if there was sufficient guidance from those responsible for the promotion of the scheme. In fact the GMF, and UGC Alloa have been very supportive and offered advice to the Councils in Scotland.

7.4.4 Guidance

The lack of guidance from Central Government is of concern especially in times of financial constraint where Councils need support or funding to set up new projects. With the importance Councils associate with National reasons for establishing schemes the Government has an important role to play and should be responsible enough to undertake it.

7.4.5 Responsible For Running The Scheme

It became clear that however the scheme is organised, the Council will have a role to play in its successful operation. This can range from collection to just site maintenance and the promotion of the scheme. In Scotland, Councils are separately involved with the running of 22 schemes, ranging in size from 1 to 24 sites. Industry is involved in several schemes - Glass Recycling Company of Falkirk and UGC of Alloa. Local groups are involved with two schemes at Dunfermline (2 sites), and in Glasgow (3 sites).

7.4.6 Costs/Overheads Allocated

Separate costing was claimed by 6 of the Councils, but was difficult to justify in light of their replies to the Cost Statement (Section 7.5). Seven Councils said that they allocated no costs and did not separately account for their schemes. Most costs were assigned to existing budgets - street cleansing, transport and collection.

Local Authorities have not adopted a uniform accounting system for the operation of their Bottle Bank schemes. This makes the comparison of similar schemes very difficult, and the judgement of the success/failure of a scheme open to doubt. What is needed is

a uniform, and sensible accounting system to be adopted by all authorities.

The key costs are:
- Bottle Banks (Capital)
- Storage Bays (Capital)
- Uplift
- Site Maintenance - Litter Bins
- Skip Maintenance
- Bulk Transport
- Labour Charges

It is on the basis of a consistent costing system, that a useful comparison and assessment of existing schemes can be made, and the viability of future schemes judged.

7.4.7 Criteria To Assess Success Of The Scheme

Question 8, sought to establish the criteria that success is judged on, how their schemes match up to these criteria, and how the Councils view the success of their schemes. In judging success, the categories that Councils stipulate are: Finance, Weight, and Others. Table 7.4 summarises the answers in these three categories. The categories weight and finance are closely interlinked.

The amount of cullet returned is a function of population size, population density, public response and the rate of filling. The financial considerations mentioned are whether it covers its costs, makes money, or whether it can be justified against public response.

With less glass in the waste stream there maybe less punctures, which will bring running cost savings to the transport department. Energy conservation is primarily within the glass industry. If there is less waste to collect and dispose of, Councils may save energy in transport and processing (incinerators). Performance relative to other schemes can be judged on the financial return or

TABLE 7.4 The Criteria On Which Councils Judge The Success Of Their Bottle Bank Schemes

WEIGHT/PUBLIC RESPONSE	Number Of District Councils
Amount of cullet collected each month	2
- related to popn of catchment area	2
- ° of public response (weight of glass)	4
- rate of filling of skips	5
- improvement in tonnage	2
- weight on each site (total tonnage)	1
TOTAL	16
FINANCIAL	
Does it breakeven?	1
- costs L A nothing to run (makes money)	5
- profitable	3
- can costs be justified against public response	1
- minimal financial loss	1
TOTAL	11
OTHER	
Less glass on tips (less punctures)	3
Energy conservation	1
Performance relative to other L.A.'s	1
TOTAL	5

TABLE 7.5 How The Councils Feel Their Schemes Match Up To The Criteria

VERY WELL	2 District Councils
SATISFACTORY	13
NOT VERY WELL	4
DISSAPPOINTING	2

the quantity of glass collected in relation to population size.

In response to the question whether they see their schemes as a success, 19 Councils did, with the others offering qualified approval. This contrasts with the earlier question where only 15 Councils felt that the Bottle Banks were achieving the targets set for them (Table 7.5). There is a contradiction here with more work needing to be done in this area of whether success is judged on purely financial terms or wider social and environmental factors (Chapter 8). Two Councils viewed the scheme as being unsuccessful. Councils view of success, will depend on how they judge their schemes.

7.4.8 Contracts

An area that raised some confusion was whether Local Authorities had formal contracts with Kelliebank to supply cullet. In their responses 7 Councils said that they had a contract, although one said that it was not a formal one. On the length of contract two said that there was no limit and that it was continuous. The Councils had no agreement on tonnage requirements.

On quality conditions, 8 Councils said that there were formal agreements, but 5 said that there were no constraints. Quality is of major concern to the glass manufacturers, who have invested several millions of pounds in reprocessing centres. The aim is to reduce contraries in cullet, minimising the risk to the furnace and to the quality of the product. Quality conditions have been outlined in Section 3.5.

A second area of confusion is over the 'guaranteed price' paid by the processor. Six Councils said that there was a guaranteed price, and six said that there was not. The price guarantee is a

major plank offered in the promotion of Bottle Banks by the GMF. This confusion may arise as price is reviewed every six months in line with changes in raw material prices.

KINDLEN (1983) the manager of Kelliebank has clarified the links between the processing plant and Local Authorities. He stated that:

1. There are no formal contracts with Local Authorities.
2. There are no specifications on length of link, or on tonnages that can be supplied.
3. There are laid down conditions on quality (Figure 3.A).
4. There is a guaranteed price.

This area of confusion needs to be cleared up, through the provision of more information by the GMF and the receiving glass manufacturers.

7.4.9 Public Relations Exercise

The Bottle Bank scheme has been challenged by 'environmentalists' as being merely a public relations exercise on behalf of the glass industry to counter pressures on them to promote the use of returnable containers. Although Councils saw it as a public relations act to some extent, it is viewed more as a constructive one promoting the ideals of recycling and conservation. It is also seen as promoting the activities of the Council's Cleansing Departments. The Bottle Bank system is seen as a practical and worthwhile method of resource recovery.

7.4.10 Issue Of Returnable Containers

The Councils had not specifically debated the issue of returnable and non-returnable containers; an issue for Central Government,

rather than at the level and influence of Local Authorities (Chapter 4). A number of officers expressed personal views. Their main concern was the potential of abuse of returnables and poor cleansing on re-filling lines. This problem of hygiene is reduced by the use of one-trip containers at a cost to the waste disposal system.

The use of returnables depend upon public and retailer cooperation and reliability. A major problem expressed is the willingness or otherwise of the acceptance of returnables by retailers. Of influence will be market forces which through transport and energy costs will affect policies adopted by Governments. Officers feel that returnables could reduce the volume of glass presently discarded indiscriminately, despite the advent of the Bottle Bank. Many felt that legislation would not be practical. Bottle Banks will need to be operated in conjunction with a returnable system.

7.4.11 Attitudes To Recycling

A series of questions looked at attitudes to recycling by the Council through practice and policy. First, Councils were asked whether they were involved in the recycling of another material as well as glass. This is summarised in Table 7.6.

TABLE 7.6 Other Materials Recycled

Wastepaper	13 District Councils
Cardboard	9
Oil (Waste)	1
Metals	3
None	7

The main waste recovered is that of paper, which is usually combined with the collection of cardboard. Dundee collects about 2000 tonnes of paper and cardboard per annum and Ettrick recovers

800 tonnes per annum. Inverclyde and Nithsdale have suspended their paper collections due to increasing costs. This suggests that there is a favourable environment within Councils for the development and promotion of recycling schemes as part of their overall waste management policy.

The general view from Council Officers is that recycling should be pursued as part of their waste management policy where it is cost-effective. They are interested in schemes that will provide additional jobs at no extra cost. If refuse can be re-used for some benefit then it should be encouraged. The development of recycling schemes are restricted due to the financial strictures at a local level, imposed by National bodies. Also there is a need to have a market for the product before pursuing a policy of recycling a material.

A number of Officers made specific points. East Lothian felt that heat recovery should be looked at, and the effects of recycling on the processing in the refuse pulverisation plant, and at the landfill site. Monklands felt that more research into separation and collection at source should be carried out.

Recycling should be pursued where return on capital invested is acceptable. Inverclyde stated that with the importance of environmental considerations at both National and International levels, recycling programmes would benefit from economic balancing at a macro level. In particular there is a need for planning and coordination, and financial support from central government. Perth feels that there has been insufficient realistic support from Central Government on recycling of wastes.

7.4.12 Where Profits Go

Sixteen Councils allocated revenue from the scheme to the General Funds of the Councils, where it can become 'lost' to the public. To encourage public participation, there is a need to associate the returns from the scheme with a specific purpose: continued development and expansion of schemes (purchase new banks), competitions (Message in a Bottle), local causes (Charities: Kidney Dialysis, Community Projects).

7.4.13 Summary Of The Overview

The Respondents were generally happy with the progress of their schemes, and see recycling as having an important role in the waste management system. They judge schemes on whether they are cost-effective, bring a return on investment, and provide jobs. This is difficult to achieve when there is no clear accounting system adopted by Local Authorities.

Established schemes primarily reduced local waste collection and disposal activities, reducing costs, but Councils were well aware of the scheme in promoting national savings and the need for a National policy on recycling.

7.5 The Cost Statement

7.5.1 Introduction

The Cost Statement was built up from the variables suggested by Non-Operators, and the Pilot Survey of three Operators of Bottle Banks. The information from this part of the questionnaire, will provide the data base for the uniform cost model. The results are shown in the accompanying Tables in Appendix D.6.

7.5.2 Who Runs The Scheme

The Bottle Bank schemes are in the main run by District Councils, with some independently by, and jointly with Industry. Their size ranges from 1 site (Cumnock) run jointly with Industry to 58 sites in Aberdeen (including Trade glass scheme). The largest scheme run by a Council alone is Edinburgh with 22 sites. The largest single scheme operated by Industry is in Glasgow, run by UGC Alloa with 31 sites. In total there are 197 Council sites (an average of 8 per Council), 79 Industrial operated sites (average of 8 for the 10 Councils involved (of 3 for the total number of Councils)), and 5 operated by Local Groups, in Dunfermline (2 Sites) and in Glasgow (3). The average number of sites per Council is very small, comparing adversely with other countries (Chapter 12).

The Councils generally use the large skips (3 tonnes capacity), with several modifying existing units for use as Bottle Banks; or through the adaptation of other types of skip, i.e. oil drums and paladin containers. There are 112 of the large Bottle Banks, and 155 of the smaller Modular Banks. There are 10 other types of 'bank' - Bottle Tanks, 5 cubic yard banks, and Paladin Banks.

Location of the Banks is a key area that will influence the level

of public participation, the ease of uplift and subsequent emptying by the operators. Locations include:

	Number Of Councils	Total Number Of Sites
Supermarkets	13	28
Car Parks	23	88
Civic Amenity Sites	5	5
Other: Cleansing Depots	3	4
Shopping Precincts	3	12
Hospitals	1	1
Hotels	1	5

The most popular sites are car parks. They have space for siting the banks, the public regularly use them, and there is easy access for vehicles to the Banks.

In conjunction with their Bottle Bank schemes, District Councils have established other sources for the collection of cullet. These include:

Licensed Premises	(1,9,10,12,14)	5
Local Firms	(9)	1
Hospital	(9)	1
Milk Creamery	(12)	1
Milk Distribution Depot	(12)	1
Pulverisation Plant	(15,34)	2
Soft Drinks Manufacturer	(17)	1
Lawsons (Distillery) Ltd	(24)	1

Other sources of cullet should be sought, as bulk delivery of cullet offers a better return to the Operators of the scheme, and can be used to subsidise collections from the public. Kelliebank collected 10,919 tonnes of industrial cullet compared to 6,772 tonnes of council cullet in 1982 (TABLE 6.5).

7.5.3 Bank Costs

The cost of banks (capital expense) depends on the type of bank, the size, whether open/enclosed, and whether the operator can modify existing units that are already available. With Cumnock and Kilmarnock the skips are provided and emptied by the Glass

Recycling Company who operate the scheme. This is also the case for the majority of the Modular Banks that are in use, which are supplied and operated by UGC Alloa.

The costs of the large banks range from £200 (9) for a modified one, to £2,200 (10) for a new one, an average cost of £746. Modular Banks varied in cost from £250 to £302.50.

District Councils have purchased outright 96 of the banks. Glasgow hired their 7 Council operated Banks from UGC Alloa at £4 per bank per week.

Sponsorship of the Banks through outside purchase and advertising on the banks is limited. Three Councils have sponsorship: Dunfermline has 80% of one bank offset, Falkirk has two, and Renfrew one.

7.5.4 Litter

A problem with operating Bottle Banks is the attendant production of litter on site. To overcome this it is recommended that sites should have litter bins, and be regularly maintained by the Street Cleansing Teams.

The cost of litter bins (Capital Cost) will be a function of size and type. Eleven of the District Councils operating the scheme do not site new litter bins. Two Councils - Glasgow and Lothian - reposition existing bins to meet the new requirements of the Bottle Bank schemes. Other Councils tend to position a bin on each site, with costs varying from £10 to £80; an average cost of £35 each.

7.5.5 Storage

Storage can be a major capital cost when establishing a scheme. It is recommended that storage sites have a concrete base, and concrete walls with a capacity of at least 20 tonnes. Storage is recommended to bulk up the cullet so that transport costs to the recycling centre can be spread over larger tonnages. In addition, Storage bays can be built to keep the colours separate so as to maximise the potential revenue to the Council.

In Scotland Councils tend to have two bays to keep clear glass separate from the rest. Three Councils just have the one bay. Stirling transports direct to Alloa due its nearness (7 miles). Glasgow and E Kilbride transports to a UGC site within the City, from where it is transported to Alloa.

E Lothian unloads into a demountable body, that once filled is transported to Alloa. Inverclyde uses an old sand storage bay which is costed within the overall rating of the Council Depot. With Cumnock and Kilmarnock, the problem of storage is taken up by the private company operating the scheme, who deliver direct to Alloa.

Nithsdale pay £100 per annum storage charges. The rest have constructed storage facilities on existing Council land. These costs vary from £100 (30) to £2000 (29), an average of £943. Ten are on Council land. Seven have two bays, and three have one.

7.5.6 Equipment Costs

Banff, E Lothian, Kincardine and Perth use and adapt existing vehicles to meet new requirements. Costs met will be labour and vehicle costs for the period used. The price of a skip lifter is

£25,000 (1,9). Operating costs vary from £10.00 per hour (24) to £13.50 per hour (34). Inverclyde (19) charges £10 per uplift. Mechanical shovels have a capital cost of £22,000, and an hourly charge of use varying from £10.15 to £12.95 per hour. Nithsdale hires equipment as required. If use existing equipment, can treat on a marginal basis, costing for extra usage.

7.5.7 Administration

Seventeen District Councils do not separately account for administrative costs, with only four (9,17,27,30) claiming to do so. Dundee said that it was less than £200 per annum, N E Fife said that it was £100 per annum, Roxburgh said that it was £100 per annum, and Strathkelvin although not separately accounting for it estimate it at £15 per annum. There is a wide range of costs, and it is clear that none of the Councils have specifically costed administration.

If recovery schemes are terminated at this stage, administrative overheads will largely remain; so that they can be treated as a marginal cost to the scheme. The administrative figures given ignore central overheads that apply across services.

7.5.8 Publicity/Advertising

Local Authorities should build on this GMF publicity with their own locally orientated campaigns to encourage participation in the scheme by local residents. Nineteen of the District Councils said that they advertised the scheme, although there is no clear pattern on medium adopted. Four (2,14,18,26) rely on articles run by the local press. Three (20,30,34) used material provided by the glass manufacturers. Four (6,17,27,31) have used adverts in Newspapers. E Kilbride advertises within the limits of finance.

Gordon advertised at the outset only. Inverclyde advertised at the start, and since have had intermittent public relations promotions. Six (12,24,27,28,31,32) have utilised Posters to promote their schemes.

7.5.9 Advertising/Sponsorship

There may be an opportunity for Local Authorities to supplement their income by allowing advertising on skips. This is permissable within the law, with content controllable by the Local Authority. Only Banff reports that they advertise on their skips. This route was adopted by Envirobins (Appendix C.8) in England, but ran into problems with the poor response received.

Alternatively a sponsor of a bank could publicise their Company's support for the scheme and advertise their name on the side of the skips. This can offset the capital cost of skip purchase, and greatly improve the economics of the schemes to the District Councils involved. Three Councils (10,15,29) have sponsorship (Section 7.5.3).

7.5.10 Insurance

None of the District Councils separately account for insurance costs. Roxburgh say that it would be of the order of £96 per annum. Glasgow included it in the rental cost of the skips from UGC Alloa. For others costs are incorporated in the general policies held by Councils as part of their employee liability. Insurance costs are likely to be met under general policies held by the Council, and not be specifically assigned to the Bottle Bank scheme.

7.5.11 Skip Uplift

Uplift can be carried out by Council vehicles, or by contracting out to private hauliers. For seventeen of the Councils, Banks are uplifted by their own vehicles, with costs ranging from £4.00 to £15.00 per load, an average of £9.47 per load. This can involve uplift to storage for bulking, or direct to the recycling centre at Alloa. Kincardine uses Council vehicles but the costs are not seperately assessed, as they make use of collection vehicles at the end of their normal collection day.

Five Councils (6,11,26,27,32) used Contract vehicles to uplift their skips. Costs tended to be higher, ranging from £15 to £25 per load, an average of £20 per load. Costs will vary with distance, local conditions and the level of competition between companies. Cumnock costs are met by the Glass Recycling Company who operates the scheme. The difference between Council and Private rates, reflects the need to make a profit, and cover the cost of idle vehicles.

7.5.12 Site Maintenance

Councils do not separately account for the cost of site maintenance, incorporating these costs into their general street cleansing budgets. Two Councils gave estimates: Dundee costed it as £0.15 per load, and Stirling at £6.00 per load. Anti-Waste said that the site would be tidied up during emptying, incorporating costs into uplift (Appendix C.7). Research needs to be undertaken into time taken to clean sites, consequences of having sites, and costs incurred.

7.5.13 Bank Maintenance

Bank maintenance is important in order to encourage participation through promoting a good image. Maintenance is necessary to counter general wear and tear and problems of vandalism. Costs will be dependant on the scale of the problem, the material the skip is made from, and the size of skips.

Nine Councils have had no maintenance bills to date (Dec 1983). Aberdeen assigned £300 to their skips. With schemes operated by private firms, such as at Cumnock, or where the skips are leased as at Glasgow, the costs of maintenance are met by outside agents. Costs have varied from £10 per skip to £30 per skip. The lack of information on maintenance reflects the relative youth of most schemes in Scotland, and the haphazard adoption of maintenance programmes.

To assist Councils, the British Soft Drinks Council provided a one off grant of £50,000 for maintenance costs of existing Bottle Banks. Grants have been received by five Councils (9,15,27,31,34) ranging from £15 to £60 per skip.

7.5.14 Tonnage

Tonnages collected range from 17 tonnes (Cumnock) to 1300 tonnes (Edinburgh) per annum. Only five Councils separated their glass into clear and mixed, so as to maximise revenue. Total cullet collected over 1982/83 was 4,917 tonnes, an average of 223.5 tonnes (22 Councils) per scheme. Seventeen (of 22) collect less than the average. The key collectors are the main urban areas:

Aberdeen	361 tonnes
Dundee	350 tonnes
Edinburgh	1300 tonnes
Glasgow	532 tonnes
Renfrew	210 tonnes

The exception is Roxburgh (a rural area of the Borders Region) which collects 220 tonnes.

Of the total, 2746 tonnes is collected as mixed (19 Councils) and 518 tonnes as clear (5 Councils); with 1651 tonnes uncategorised, probably mixed. Of those Councils that separate their glass, the proportion of clear cullet ranges from 40 to 60%.

Those Councils that do not separate their cullet (14 Council) collect 2171 tonnes (1651 collected by 3 Councils is not categorised). Using the proportions 0.4 and 0.6 these Councils would collect between 868 and 1302 tonnes of clear cullet. With the £4.00 differential in price, this could lead to extra revenue of between £3474 to £5211. To the 14 Councils this is an average extra revenue potential of £248 to £372 each. This extra revenue is offset against additional storage costs, the need to compartmentalise banks, and possible extra collection costs.

7.5.15 Filling Rate

This varies with each scheme, and within each scheme. It is dependant on the level of public participation, which will be reflected in the ease of access, the site location, and the density of the catchment area.

For schemes as a whole it varies from 0.4 tonnes per week (24) to 11.07 tonnes per week (16). These figures are largely arbitary reflecting the size of the schemes and the duration of the schemes operation. A better figure is the rate per site, or the rate per skip. With banks per site and per skip figures are usually the same; but, with modular bins there is usually two banks per site to keep the colours separate. Filling rate per site varies from 0.24 tonnes per week (16) to 1.45 tonnes per week (26) as based on

surveyed figures. With GMF figures, the rate varies over 0.175 tonnes (24) to 3.13 tonnes (26). This difference is due to the time when the figures were taken. As schemes have developed there has been an increase in the number of sites and the number of skips which will be reflected in changes in the filling rates.

7.5.16 Distance

Distance between Bottle Bank system and Recycling Centre is a key factor, as transport makes up a large proportion of the operating costs. Stirling lies closest at 7 miles, with Banff furthest at 130 miles. Dependant on distance travelled the cost of bulk transport will vary. Eleven of the Councils transport the cullet themselves at a cost of £1.20 (15) to £9.71 (19) per tonne transported. Contractors carries 10 of the Councils cullet at a cost of £2.50 (32) to £7.50 (2,21) per tonne. The number of trips made varies with the level of generation.

On transport cost grounds the Glass Manufacturers have set the economic limit for a given glass collection area at 150-200 miles from the nearest glassworks. The Scottish schemes lie within this limit; some of the Non-Operators (section 7.2) are outside this limit.

7.5.17 Bulk Loading

The cost of this operation is marginal, and in the main Councils have not estimated it. This is taken as part of overall mechanical shovels that have already been budgeted for. Five Councils gave estimates: £0.5 (14), £0.66 (15), £1.26 (26), £0.58 (29), £0.10 (28) per load. The rest say that the costs are minimal, this is provided that Council has available the necessary vehicle, and does not have to hire it in.

7.5.18 Price

This is guaranteed by the manufacturers and is a key part of any proposal. Price is reviewed regularly and is kept in line with changes in raw material prices. There are some differences in the stated price they receive with Clear glass receiving £22.00, £22.50 or £25.00 per tonne; and needs to be checked with Kelliebank. For mixed glass there is again this disparity over price received, with prices of £18.00, £18.50, £20.00 and £21.00 per tonne.

Those that have UGC Modular Banks operating in their areas receive £2.00 per tonne, whatever the colour.

7.5.19 Waste Remittance

Although District Councils indicate that one of the reasons for setting up a glass recovery scheme is a reduction in the waste to be disposed of, only one Council - E Kilbride - credits any savings to the Bottle Bank accounts.

7.5.20 Waste Disposal Costs

The main form of disposal is through landfill, followed by incineration and pulverisation. The range of costs is shown in Table 7.7, along with average costs. Disposal cost savings may result from a reduction of glass in the waste stream, although this may be marginal. Removal of glass from incinerators will improve energy conversion, and improve the operating costs of the system.

7.5.21 Collection Costs

Collection Costs reported are shown in Table 7.7. In the short

term these are unlikely to be affected by recycling programmes. In the long run if less waste is available for collection, lorry routes may be lengthened to reduce relative costs. Privatisation may have an influence on collection costs and on recycling activities.

TABLE 7.7 Methods And Costs Of Disposal And Collection

Disposal Method	Councils	Cost Range		Average
Landfill	13	£1.63 (6)	£12.00 (31)	£5.88
Incineration	5	£7.00 (28)	£18.00 (29)	£12.30
Pulverisation	2	£5.49 (9)	£5.80 (32)	
Collection Costs		£3.00 (28)	£34.00 (17)	£18.67

7.5.22 Charity

Only Glasgow has had limited links to a 'charity' with a Bottle Bank sited at Yorkhill Hospital. Altogether this was a rather half hearted scheme with the hospital having to arrange uplift, so they asked for it to be withdrawn.

Three Councils (14,18,29) are thinking of having links with char ties but which charity is undecided. Charity links have been very successful in encouraging public support of the schemes with the Reading scheme having generated £20,000 for kidney dialysis machines.

7.5.23 Benefits Of Glass Recycling

Benefits of glass recycling can be split into three categories: 1. National, 2. Environmental Conservation Ideals, and 3. Local Factors. This division follows closely reasons for establishing recycling schemes (Section 7.4.2) and are shown in Table 7.8.

TABLE 7.8 Benefits Of Glass Recycling

NATIONAL CONTEXT	Number Of District Councils
Saves Energy	7
Resources	4
National Effort	2
Reduce Costs Of Glass Containers	2
New Bottles More Hygienic	1
Service to the Public	1
TOTAL	17
ENVIRONMENTAL IDEALS	
Brings Conservation Ideals To Public	7
Environmental Improvement	4
TOTAL	11
LOCAL CONTEXT	
Reduction In Disposal Costs	15
Income From Sale Of Cullet	8
TOTAL	23
NO COMMENT TOTAL	1

On a National level Councils see benefits of resource saving, particularly in terms of energy conservation. In addition, operating recycling schemes is important to participate in a National effort on recycling. In the second category conservation ideals include making the public aware of waste disposal functions, and encourages the public to be more environmentally conscious. The third group local factors splits into reduction in disposal costs and the generation of income. Disposal savings result from less refuse to be disposed of locally, with the removal of glass from the waste stream. The benefits are wider than the generation of income and any assessment of recycling schemes should consider these categories of National Factors and Environmental Ideals.

7.5.24 Problems In Operating Bottle Banks

There are no specific problems common to all schemes, it largely depends on local conditions. Problems include: lack of support, poor sites, and collection and delivery aspects. A more common problem was vandalism, leading to additional costs of site maintenance and bank maintenance.

7.5.25 Possible Future Developments

Future options were varied. The main possibility is the development of separate collection from Commercial premises with five Councils siting this option. A lot of hope has been linked to the expansion of modular banks, which can serve smaller sites, and more rural areas. More emphasis needs to be focused on education: the public to encourage their support, industry to support schemes, and Central Government to accept its responsibility to promote recycling.

7.5.26 Summary Of The Cost Statement

The results of the Cost Statement show that there are defficiencies in the way Councils assess the costs of their schemes. The costs given show wide variations, and illustrate the importance of using local data when coming to assess the viability of a recycling scheme. This data would need to be used in a realistic costing system such as outlined in Chapter 10 to have any value. Local factors of population densities, distance between storage depot and sites, and the availability of vehicles and other facilities will influence the level of costs and the likely development of successful reclamation projects. Such factors are best looked at the initial setting up stages, possibly through the use of a feasibility study. This is where the mix between the use of private and council vehicles can be established.

Also of note is where an activity connected with the operation of the Bottle Bank scheme is viewed as part of existing budgets and not seperately accounted. For example, site maintenance can be incorporated as part of the general street cleansing duties. The question of whether it should be seperately accounted will depend on whether the operation of the Bank leads to an increase in the work load and thus the cost of the activity.

The cost statement shows the general factors that need to be considered and the need for a local data set to be collected. Of importance is not just the income received from the sale of cullet but the wider effects on waste collection and waste disposal activities.

The information gathered here has been used as a base for the development of the management model described in Chapter 10.

7.6 Discussion

7.6.1 Comparison Of Operators And Non-Operators

The surveys have separately examined Operating and Non-Operating Councils in Scotland. This allows comparisons to be made to establish the reasons why Councils operate or do not operate Bottle Banks. Table 7.9 summarises the differences between the key characteristics of operators and non-operators.

TABLE 7.9 Comparison Of Operators And Non-Operators

	OPERATORS			NON-OPERATORS
	Urban	Rural	Average	Average
AREA (Hectares)	26,796	158,592	78,734	277,440
POPULATION	193,019	63,528	132,090	38,613
DENSITY	9.1	0.43	5.43	0.21
NO OF HOUSEHOLDS	66,637	23,168	48,770	
COMMERCIAL PREMs	5,879	1,481	3,871	

Thirty eight District Councils operate Bottle Banks in Scotland (38/56 = 67%). These Councils are located along the Central Belt of Scotland where the main population centres are found. A total of 4,514,100 people have 'access' - live in Districts that have Banks - to Bottle Banks, from a population of 5,093,300 (88% of the population). Table 7.9 shows that the mean population of operating Councils is 132,090 and 38,613 for non-operators. The more populous districts have taken up Bottle Banks. Some of the non-operators have higher populations than some of the operators. This indicates that population size alone does not lead to the establishment of Bottle Banks.

Operating Councils have smaller areas. The mean area for operators is 78,734 hectares compared to 277,440 hectares for non-operators.

Thirteen non-operators are greater in size than 100,000 ha. The size of a District will effect the distance vehicles have to travel to collect cullet from Bottle Banks, deliver to storage and bulk transport to Alloa.

Operators have smaller areas and higher populations thus higher densities than non-operators. The average density is 5.43 people per hectare. Non-operators with larger areas and lower population numbers, have correspondingly lower population densities; a mean density of 0.21 people per hectare. Nine non-operators have densities higher than the lowest value of operating Councils.

7.6.2 Reasons For Not-Operating - Problems Operators Faced

The main reasons given by Non-Operators for not setting up schemes, were the small rural authorities with small populations and resultant low volumes of glass available for collection. These large areas and small populations will have consequences for collection and final haulage costs. The combination of these two factors - rural authorities, haulage costs - makes the Councils view the schemes as likely to be uneconomic.

Some of the problems faced by operators reflects the concern ventured by non-operators. Four Authorities mentioned the rural nature of their area, with few population centres. Two Councils confirmed problems of haulage costs and small payloads.

Operators use Large Bottle Banks. On average Councils have 1 Bank per 20,000 people. This compares adversely with Holland where they have 1 Bank per 2000 people. These Banks tend to be smaller equating with modular Banks. One of the grounds given by non-operators for establishing a scheme is the possible expansion of 'modular banks'; which could be better suited to smaller

population centres. Operators also see future developments with the expansion of smaller 'banks', aimed at smaller population centres. These banks could be sited at licensed and other commercial premises. The expansion of modulars could be through schemes run jointly by several Councils, covering the present Non-Operators. Another possibility is the siting of an 'orbiting' bank that will be located at various sites for a few specific days. This option could be developed with the use of Civic Amenity Sites. The expansion of modulars needs to be treated with care baring in mind some of the problems private companies faced (Chapter 6.8). Key considerations for non-operators and operators alike is the lack of sufficient population centres, which influence volumes of waste material available; and the adverse effects of dispersed settlements on transport costs.

7.6.3 National Factors

The lack of advice from Central Government to operators or non-operators alike is of concern as a key area in the establishment of schemes was national considerations, as was the case with the benefits perceived by Local Authorities operating Bottle Bank schemes. Central Government involvement will be through calls for financial control and cut backs on Local Authority finances. In light of Local Authorities perception of reasons for establishment and benefits, Central Government should take a national co-ordinating stance, and actively promote and support the scheme through: policy, advice, and finance.

7.6.4 Recycling Other Materials

A number (16 operators (44%), 7 non-operators (37%)) of Councils were involved in the recovery of paper and cardboard. This

reflects the willingness of Councils to establish recycling schemes, and provides a favourable environment for the development in glass recycling. Factors encouraging reclamation of paper may affect recycling of other materials.

Recycling should be viewed as an important part of the waste management system. Councils acknowledge the effects of glass recycling in reducing disposal costs and possible long term effects on collection costs. Councils are generally in favour of recycling, but they should not ignore the economics of the activity. Schemes have to be cost effective. The question is whether schemes should be judged on purely financial grounds or wider social and economic grounds.

The criteria used to judge success (Section 7.4.7) takes into account cost considerations as well as quantity tagets achieved. Several Councils sited the possible creation of jobs and environmental benefits when assessing recycling schemes.

7.6.5 Need For A Costing System

Results from The Cost Statementshowed that Councils had adopted no clear accounting system adopted by Local Authorities. This opens to question Councils judgement of success when based on cost considerations. A clear logical costing structure is required for the appraisal of recycling schemes. This should take into account the wider benefits in terms of disposal cost savings, and long term effects on collection costs. When establishing recycling schemes the possible use of spare capacity in existing equipment and labour should be considered. This allows the adoption of marginal costs, taking account of the extra costs incurred. Such a system has been detailed in Chapter 10.

7.7 Summary

The surveys undertaken of Councils in Scotland showed that operating and non-operating councils make similar considerations when looking at establishing reclamation projects. The key characteristics are population size, rural area and thus population density. These characteristics will influence the level of waste material that is available for collection, the possible methods of collection and their likely costs.

After the initial adoption of the large bank system both groups are looking to the expansion of modular schemes to continue the progress of glass reclamation in their areas and reach new areas. The smaller banks can serve smaller population centres and be used to develop collection schemes to serve commercial premises.

There is a need to look carefully at the costing of reclamation schemes. This needs to be done on a carefull assessment of the operating factors, which can be initially established through conducting a feasibility study. The Cost Statement can be used to gather the necessary information on cost considerations to be used in assessing a projects viability.

Any assessment need to take into consideration the wider benefits of reclamation. Councils are aware of this in the answers they gave to the questionnaire and the importance they associate to national benefits as well as local considerations. They are aware of the importance of returnables as part of waste management activities. Councils are actively involved in the recovery of other materials and look actively at recycling as an integral part of waste management options.

7.8 References

KINDLEN P (1983) Manager Kelliebank Recycling Centre
Private Correspondence 28 November 1983

Chapter 8

Social Appraisal Of Glass Recycling Schemes

8.1 Introduction

Any assessment of recycling schemes needs to consider the social costs and benefits, in addition to private costs and benefits. It is on the basis of such an assessment that the desirability and direction of any Government intervention will be determined. The private optimum is determined by internal factors; while the social optimum is that which evolves when both internal and external factors are taken into account (FISHER 1978). PEARCE's (1976) model (Section 2.8) brings together social and private costs and benefits in assessing the optimum recycling level.

Internal costs and benefits are those factors which the consumer fully perceives when making consumption decisions and which beverage manufacturers, distributors and retailers account for in their decision making. For glass recycling the internal costs of collection for operators are examined in Chapters 6 and 7.

The external costs and benefits are those factors which the individual producer and consumer do not take account in their production and consumption decisions. FISHER (1978) divided externalities into two categories: those that are 'unpriced' in the current market place and those that are considered to be 'underpriced'. Within the first category he grouped: disposal into the waste stream, litter, pollution, health and hygiene aspects. In the second category he put energy. These external costs are imposed on society as a whole and go uncompensated if costs, and

unappropriated if benefits.

Where they are financial they are paid for (WMAC 1981). For example Councils pay for litter collection from revenue received from ratepayers. The litter depositor does not directly pay for this clean up. Some types of external costs - the disamenity aspects of litter - are difficult to assign a monetary value.

The importance of considering external factors has been noted by several studies: OECD (1978), WMAC (1981), TURNER (1981), OECD (1983), FISHER (1982) and BALL & HO (1984). There is no agreement across which factors should be considered, although there are commom items, shown in Table 8.1. This may reflect that the first three studies are reviewing returnable systems, and the latter three reclamation systems. It will also reflect the availability of information. Generally, it is difficult to assess these factors quantitatively and they are largely reviewed qualitatively. These factors are reviewed below.

TABLE 8.1 EXTERNAL FACTORS CONSIDERED BY VARIOUS STUDIES

EXTERNAL FACTORS:	RETURNABLES: OECD 1978	WMAC 1981	FISHER 1982	RECLAMATION: TURNER 1981	OECD 1983	THIS STUDY
Waste Collection		Yes	Yes			Yes
Disposal	Yes	Yes	Yes	Yes	Yes	Yes
Litter	Yes	Yes	Yes	Yes		Yes
Road Congestion		Yes				Yes
Pollution: Air		Yes				Yes
Water	Yes	Yes	Yes	Yes	Yes	Yes
Noise						Yes
Health & Hygiene	Yes	Yes	Yes	Yes		Yes
Energy		In Body Of Report	Yes			Yes
Raw Materials Use	Yes			Yes	Yes	Yes
Reduction In Imports				Yes	Yes	
Employment				Yes	Yes	Yes

8.2 Waste Management

8.2.1 Introduction

With glass being recycled through Bottle Banks, less glass has to be collected and be finally disposed. Glass recycling can lead to direct savings in collection and disposal costs which need to be assessed in the overall appraisal of recovery schemes. The extent of these savings will depend on: how long the project has been operating, the quantity of material recovered, and how the scheme has been assimilated into the waste management system.

In assessing the possible savings it is important to review the project over a set time period. Initially, savings will be on the margin in the short run. With glass being diverted from the waste stream there will be savings in disposal costs, through an extension in the life of landfill sites. As more materials are reclaimed over time it may be possible to reorganise collection and disposal operations. As recycling schemes are incorporated into the waste management system, it may be possible to redeploy labour resources and machinery. Thus savings in collection and disposal costs may reflect average costs in the long term. In assessing collection and disposal costs it is important to assess it over the life of the project.

8.2.2 Waste Disposal

The OECD (1983) noted that because those who generate wastes do not have to pay the full marginal costs of waste disposal this may prevent the market mechanism achieving an economically efficient level of recycling. For instance, the marginal cost of an increase in the quantity of waste discarded by householders is not borne by them as disposal costs but met by fixed payments through local

rates. There is no incentive for the individual to reduce waste through recycling. However, if all householders increase their level of waste this will lead to an increase in costs and possible rate rises. Where charges are made per sack/bin, there is an incentive to keep waste volume down and recycle where possible.

The additional level of waste generation imposes costs on society as a whole which has to dispose of the waste. The actual cost will be influenced by the disposal option adopted by the Local Authority. The average net treatment and disposal costs per tonne are shown below (CIPFA 1981-82):

	£
Landfill Untreated (Rural Areas)	2.77
Landfill After Shredding And Pulverisation	10.27
Direct Incineration	10.49
Shredding, Screening & WDF Production	13.48
Separation & Incineration	18.66

In some cases - incineration and composting - the removal of glass will benefit the process. The removal of glass complements other waste management activities. However, in areas with incinerators, they operate on a continuous process and have to be kept running, so if waste quantities fall it will be diverted from less expensive options to maintain incinerator operations. This will be until the volume reduction is sufficient to justify closing the incinerator. The immediate savings will be in prolonging the life of landfill sites.

8.2.3 Disposal Cost Savings (SRD)

WMAC (1981) felt that if beverage containers were removed from the waste stream it would give rise to savings of about half the average cost of disposing of waste. With an average cost of £5.00 to dispose of a tonne of waste the reclamation of glass would lead to cost savings of £2.50 per tonne. Recovery of 162,000 tonnes would lead to savings of £405,000.

In the short term costs are largely fixed in terms of people and equipment. However, there could be an extension of landfill life with a reduction in the use of 'space'. TURNER & BLACKMORE (1978) examined the value of landfill space savings associated with Oxfam Wastesaver (Section 5.3.2). For this scheme the WDA estimated the value of landfill space at £0.10 per cubic metre, which allowing for the average compaction of refuse is roughly equivalent to £0.25 per tonne of refuse (Table 8.2).

For glass, GMF estimated compactions as 1 tonne of cullet takes up 4 m^3 in Landfill Site. Based on a compaction of four cubic metres disposal space at 1978 prices would be worth £0.40. If 162,000 tonnes were removed, this would lead to a saving of £64,800 per annum. This is a small fraction of the costs of waste disposal operations which include: wages, vehicle costs, material costs, etc. (RUSHBROOK 1984). In the longer term the average cost of waste disposal may be the most suitable figure to be used.

TABLE 8.2 Savings In Local Authority Disposal Costs

		OXFAM WASTESAVER	NATIONAL GLASS
i	Expected Material Recovery (= Reduction in Waste stream)	1228 tonnes	162,000 tonnes
ii	Average Landfill Compaction	2.5m^3/t	4m^3/t
iii	Reduction In Tip Space Requirements (i * ii)	3070 m^3	648,000 m^3
iv	Estimated Value Of Tip Space	10p/m^3	10p/m^3
v	Net Social Benefit (iii * iv)	£307 p.a.	£64,800 p.a.

Source: TURNER R K & BLACKMORE R (1978) A Cost Benefit Analysis Of The Oxfam 'Wastesaver' Scheme

Based on average costs disposal cost savings (SRD) can be found by the following equation:

$$SRD = Y * GRT$$

where: Y = Average Disposal Cost Per Tonne
GRT = Gross Tonnage Of Glass Recovered

The survey of Local Authorities found that the main form of disposal was through landfill varying in costs from 1.63 to £12.00 per tonne, an average cost of £5.88 per tonne (Section 7.5.20). With a recovery of 162,000 tonnes of glass this gives rise to savings of £952,560 per annum.

8.2.4 Savings In Collection Costs (SCC)

Local Authority collection costs are determined by their legal obligations to collect household wastes and by the character of the area in which collections are made. The length of collection rounds and thus the number of vehicles and staff is influenced by such factors as: population density, type of housing development, distance, and the location of waste collection facilities. In the short term collection costs are unlikely to be responsive to small fluctuations in the volume of waste generated by individual households. A view endorsed by WMAC (1981) who said the removal of beverage containers would not lead to any savings in waste collection costs.

However, in the long run if there is a significant reduction in the volume of waste it may be possible to reorganise collection rounds. In the more rural areas where collection distances are greater these savings may be less apparent as it will be more difficult to reorganise routes. The possibility of collecting on a fortnightly basis in line with the German 'Green Bin' System (Section 5.3.3) should be examined. This would be dependant on the households having adequate storage space, to avoid health risks.

The Local Authorities Survey found collection costs to vary from £3.00 to £34.00 per tonne, an average cost of £18.67 per tonne. Average costs of collection from CIPFA figures are shown in Table 8.3. The differences between areas will be due to different amounts of waste arising per head of population and different local circumstances for what constitutes household waste.

TABLE 8.3 Costs (£) Of Collection Of Waste 1982/83

CLASS OF AUTHORITY	1982/83 GROSS COST PER TONNE	1982/83 NET COST PER TONNE	1981/82 NET COST PER TONNE	1980/81 NET COST PER TONNE	1982/83 NET COST PER DOMESTIC HEREDITAMENT
LONDON	35	31	32	31	28
METS	32	28	30	27	23
NON-METS					
- England	26	24	25	24	21
- Wales	18	17	19	17	21
ALL	28	25	27	25	23

SOURCE: CIPFA Waste Collection Statistics 1982-83 Actuals March 1984

In the long term there maybe improvements in collection efficiency, and a reduction in overall collection costs. The savings in collection costs (SCC) can be calculated by the formula:

$$SCC = R * GRT$$

where: R = Average cost of collection (£/tonne)
GRT = Tonnage Of Material recovered

Based on the average collection cost of £18.67 per tonne (Section 7.5.21) the recovery of 162,000 tonnes would lead to savings of £3,024,540 per annum.

8.2.5 Division Between WDA and WCA

A problem occurs in assessing waste management savings due to the

division between collection and disposal authorities in England. This is of concern as it is the Districts who are primarily responsible for the operation of Bottle Banks, with the Counties responsible for disposal. Thus benefits in disposal savings do not immediately come to the operators of a recycling scheme.

This division limits the development of comprehensive waste management plans. The problem is overcome in Scotland where the activities are at the same Council level. Although within some Councils the division between collection and disposal activities are becoming more polarised, so that the benefits of having both activities at the same level are being lost.

The problems caused by this division have been reviewed by the Association Of County Councils (ACC) in conjunction with INCPEN and the GMF. The ACC sought information on the role of County Councils in the following areas:

1. Assistance, with rebates, storage, etc.
2. Designated Officer for recycling.
3. Co-ordination.

From information supplied by the County Councils the ACC has produced a summary of their roles in glass recycling schemes, which is attached in Appendix E.1. Of 46 County Councils, only 9 offerred rebates to District Councils who recovered glass. Other Councils were actively involved in co-ordinating recycling schemes and providing storage and equipment. Table 8.4 illustrates the Councils who pay rebates, and compares them with disposal costs.

Of these Councils it was the GLC who played a dominating role in establishing recycling schemes throughout London. They provided a co-ordinating role through the development of recycling centres at Civic Amenity Sites. With the demise of the GLC on April 1 1986 it is still unclear what future support for recycling schemes there

will be. The aim was to give disposal responsibility back to the Boroughs, but it has yet to be formalised.

TABLE 8.4 Returns Made By County Councils

COUNTY COUNCIL	DISPOSAL COST (£/tonne)	REBATE PAID (£/tonne)
Cambridgeshire	n/a	0.25
Cumbria	3.27	1.50
Gloucestershire	2.84	3.00'
Lancashire	4.04	1.00
Oxfordshire	3.28	3.50
Shropshire	3.24	2.00
Suffolk	4.24	1.00
Merseyside	6.80	1.50
GLC	13.68	7.50

n/a = not available
' = only paid if District Scheme makes a loss

Source: Association Of County Councils (July/1983)

8.2.6 Summary

The recovery of 162,000 tonnes of glass (1984 figures) has consequences for the rest of the waste management system. The extent of any savings depends on the quantity of material that is recovered and the extent that the scheme is assimilated into the waste management system. Initially, the savings are likely to be marginal in the short run, but with possible reorganisation of services in the long run the savings may approach average costs.

Based on average cost figures this could lead to savings in disposal costs of £952,566, and of £3,024,540 in collection costs for Britain in the long term. The savings are in the order of £4 million for glass that accounts for 10% of the total in the waste stream. If recovery rates achieve levels attained in Europe, savings could conservatively be doubled to £8 million, or quadrupled to £16 million. In light of these figures recycling has an important role to play in waste management.

8.3.1 Litter

It is difficult to establish a National figure for the quantity of litter produced or to the cost of its collection. FISHER (1982) estimated that litter collection costs were of the order of £115 million per annum, of which £100 million was met by Local Authorities.

8.3.2 Definition

The Keep Britain Tidy Group (KBTG) defines litter as: waste material that has been deposited in the wrong place. This definition has been felt to be too narrow, as it ignores 'litter' that is put into litter bins. The Scottish Development Department (SDD) (1980) expanded the definition of litter to: 'waste deposited in receptacles - 'litter bins' - as well as that which has been dropped in the wrong place'. The SDD felt that this was justified as the costs of waste collection from litter bins is part of a local authorities general street cleansing duties. This expansion of the definition is important, as those people who use litter bins, may take the act further and recycle materials through Bottle Banks.

8.3.3 Quantification

There are no set standards for the measurement of the litter present. Surveys that have been undertaken have been based on different measurement parameters:

- Number of items.
- Weight.
- Volume.
- Degree of hazard.
- Degree of offensiveness.
- Longevity of endurance of the problem.
- Visual impact/brightness.
- Size of problem.

WMAC (1981) found limited data available on the quantity, composition and control costs of litter. The extent of control will affect the situation: as some items will accumulate, others decompose, and others blow away. Surveys showed that whole glass containers account for 5% of litter by unit number, but it is higher in terms of weight. WMAC agreed with the OECD (1978) finding that cans are more likely to be littered than non-returnables, and returnables. This hierarchy will be linked to the purpose they are sold for.

8.3.4 GMF Litter Survey

A litter survey was undertaken by England, Gross & Associates on behalf of the GMF. It was carried out in 1972, and was repeated in 1977 for comparative purposes. They have recently repeated the survey but it remains unpublished. Each study covered fifty sites: 9 beaches, 10 beauty spots, 21 lay-bys and 10 parks. Each site was categorised as 'controlled' if it had any form of litter bin and 'uncontrolled' if it had not. Each site was surveyed on the Tuesday after the August Bank Holiday. This would be when there would be a maximum amount of litter before any cleaning had begun. The survey is based on unit counts within prescribed areas and recorded weather conditions and catering facilities if any.

Between 1972 and 1977 there was a reduction in the volume of litter present (Table 8.5). But this reduction is not similar across the surveyed sites. On beaches the reduction in litter was very marked. However, beverage container litter at lay-bys and other litter at beauty spots has actually increased.

TABLE 8.5 Volume Of Litter

	1972	1977
Average Number Of Beverage containers found per site	40.1	25.6
Average Number Of Pieces Of All Other Litter Found Per Site	524.9	332.4

Source: GMF Litter Survey 1972-1977

TABLE 8.6 Percentage Change Since 1972

	TOTAL	CNTRLD SITES	UNCNTRLD SITES	BEACHES	BEAUTY SPOTS	LAY -BYS	PARKS
BEVERAGE CONTAINERS	-36%	-42%	- 8%	-68%	-52%	+26%	-14%
LITTER	-37%	-36%	-32%	-66%	+ 7%	-15%	-53%

Source: GMF Litter Survey 1972-1977

More important than volume is the nature of the litter - the types of products present. Table 8.7 shows the pattern of consumption, and that between the two surveys it has remained consistent. It does show a decrease in the volume of milk littering with a proportionate increase in beer. In addition to the use of a product an examination of the material of manufacture needs to be considered (Table 8.8). This indicates that the proportion of glass has dropped, with an increase in competition from other material types particularly plastics.

The increase in beverage container litter in lay-bys consists of plastic containers (+233%) and cans (+52%). The increase in 'unclassified' glass was due mainly to an increase in broken glass. These results show a decline in litter from returnables and non-returnables reflecting changes in demand of packaged products.

TABLE 8.7 Contents Of Littered Containers

	1972	1977
Fruit Squash	17%	16%
Milk	11%	7%
Beer	12%	17%
Fizzy Drinks	56%	54%
All Others	4%	6%

Source: GMF Litter Survey 1972-1977

TABLE 8.8 Material Type Of Container Litter

	1972		1977	
GLASS	34%		23%	
Returnables		17%		9%
Non-Returnables		14%		8%
Unclassified		3%		6%
CANS	57%		56%	
CARDBOARD	4%		6%	
PLASTICS	5%		14%	

Source: GMF Litter Survey 1972-1977

The total figures show that the reduction in litter applies equally to controlled and uncontrolled sites. But the reduction in beverage container litter is much less marked at uncontrolled sites. This survey showed that the total volume of litter has been reduced by 37%. It also shows that beverage containers remain a relatively small proportion (7.1%) of litter. Of this proportion that is beverage containers 34% is glass with 54% of that being returnables in 1972. This is reduced to 23% and 42% respectively in 1977. The latest unpublished survey is important as it is the period from 1977 that Bottle Banks began to be introduced. This survey should examine the existence of Bottle Banks in the area to see if they have any effect on the quantity of glass present in litter.

8.3.5 Control Of Litter

One method of control is through legislation and the imposition of fines. Controls include the Litter Acts of 1958 and 1971, and the

Refuse Disposal (Amenity) Act 1978. In Scotland there were 300 successful prosecutions under the Litter Acts, and 100 for Refuse Disposal (Amenity) Act. The SDD (1980) reports that the Acts are difficult to enforce, and that the level of punishment (maximum fine of £100) is out of proportion to the costs faced of bringing a case to court. This has lead to a lack of proceedings by the police. The SDD feels that on the spot fines which have been adopted in America would be more cost-effective.

This unwillingness of the police to enforce the legislation and derisory level of fines has caused a failure for the Acts to be effective. It is despite a recent report by Lancashire Police where people put litter problems as more serious than mugging, burglary or theft. This surprising set of priorities should be reflected in the level of action taken by enforcement agencies.

8.3.6 Alternative Control

An alternative approach to litter control has been developed by the KBTG, known as 'The System'. (More details are provided in Appendix 8.B). It is dependant on encouraging cooperation between all people involved and through education encouraging them to adopt practices that reduce the level of litter. The system has four distict features: 1. It identifies sources of litter; 2. It looks at attitudes to litter; 3. It provided quantification measures; and 4. It seeks to generate Community involvement in litter control. The system has been adopted in many countries and is now being successfully introduced across Britain. Recycling is a clear part of the system. If effective it can reduce the level of littering in an area.

8.3.7 Costs Of Litter

There is limited data available on the costs of collection and control of litter by Local Authorities. In addition to the financial costs of litter control there are associated social costs to be considered. The inconvenience of littering gives rise to aesthetic stress, injuries to both people and animals, damage to machineries, and the reduced enjoyment of places due to perceived risk of injuries. It is difficult to assess these costs in monetary terms.

LIDGREN reports on several Swedish studies on the costs of injury from litter. He refers to a study that reported injuries to 25,000 people between April to September 1968, and to 3500 dogs by litter; which found injury costs due to litter in the order of 13 million Skr (=£1.3 million). LIDGREN refered to a study on damage to farm animals and machines which gave rise to costs of 3 million Skr (= £300,000) in 1973. This illustrates the need for a comprehensive study of the total costs associated with littering. PHILPOT (1984) noted that in Portobello, Edinburgh 6 people were treated for cuts and abrasions every day. PHILPOT also noted the costs of cleansing motorways and reports on links between litter and accidents.

8.3.8 Summary

Litter is a wide ranging problem with many effects which need to be considered in their wider social context. In examining litter control it needs to be treated as part of a coherent waste management system.

Although the nature of litter may not be conducive to recycling, the process of recycling can affect the level of littering.

Recycling is a major plank of the Action Plan developed by the KBTG System for litter control. WRIGHT (1983) sees the development of Bottle Banks as tremendous opportunity in terms of litter control. People responsible enough to use litter bins may make the further effort of using Bottle Banks.

However, the GMF feel that litter should be kept separate from Bottle Banks. They are not a cure for litter and can be a cause of litter. People using Bottle Banks bring glass in boxes and bags, and the operator should provide large enough litter bins to take them. The impact of Bottle Banks on immediate area could be assessed in terms of litter. It has not been quantified. Most Councils view site maintenance as part of normal street cleansing activities and do not separately account for maintaining Bottle Bank sites.

8.4 Road Congestion

The servicing of Bottle Banks is likely to lead to an increase in the movements of lorries in an area. This can be of particular significance in urban areas with small narrow streets, with lot of vehicle movements. There could be congestion by people parking on roads to make deliveries to the bank, or when the bank is uplifted for emptying. This may be increased if skip is replaced by an empty skip to maintain the service. To some extent this is overcome by the modular bank system which empties on site. A collection from licensed premises in inner city areas can cause extra congestion as the lorry stops at each premise. Apart from problems of congestion itself there will be additional external costs of noise, fumes, etc., but these are difficult to evaluate; and are likely to be minimal.

The number of movements will be influenced by the quantity of glass that is recovered and the size of the banks. The frequency (f) of emptying can be established by the following formula:

$$f = \frac{t}{NV}$$

where: t = breakeven tonnage (i.e. 1128 tonnes)
N = Number of Skips (i.e. 6 skips)
V = Capacity Of Skips (i.e. 3 tonnes)
(f = 94 times/year)

For example, with a frequency of collection of 94 times a year it means a lorry collecting every 3 to 4 days from the bank. This extra lorry movement is likely to result in minimal additional road congestion. There maybe associated 'extra' costs in time taken to make a journey, and in fumes and pollution costs.

8.5 Pollution

Pollution of air and water can be harmful to both man and his environment. The effects of pollution are variable depending on the types of pollutant, where the pollution takes place, concentrations, both on discharge and after dispersal, the density of settlement, the other pollutant present and prevailing winds.

With glass recycling by Bottle Banks, pollution problems are associated with manufacture of skips, collection and processing.

No attempt has been made to assess these likely pollution impacts. They would need to be compared with alternative methods of handling glass, that enters the waste stream and is collected and finally be disposed; to see what differences there are.

8.6 Noise

An associated problem with the use of the Bottle Bank system is noise. Depositing glass containers into Banks causes noise. This can be a nuisance if the Banks are sited near residential areas. But with Banks on supermarket car parks this is not really a problem. To counter this problem the Banks have a 'code of practice' on their side which asks users to restrict use to daylight hours. The introduction of GRP modular banks has reduced the noise problem as compared to the large metal banks. In addition a 'sealant' can be used to coat the bank to reduce the level of noises, when bottles are thrown in.

There will be associated noise during uplift and replacement of large skips. With modular bank noise is created for a short period when the banks are emptied into the lorry on site.

8.7 Health & Hygiene

Containers can create health and hygiene problems in the form of injuries from broken glass and ring pull tabs. There can be environmental pollution from beverage container manufacture, distribution and disposal. The main problems are from hygiene with contaminants in returnables and injuries from broken glass.

WMAC (1981) looked at the problems of returnables through their storage at retail premises and the presence of contaminants. This study found that washing and inspection processes were extremely thorough and that there were limited problems. Environmental Health Officers (EHO's) still expressed concern with the use of returnables over non-returnables.

The Bottle Bank would reduce this problem of returnables. However, if bottles were unwashed it may create a nuisance - odour, pest problem - if left in a Bank for a long period of time. There were no reported problems of hygiene nuisance.

A second concern is the risk of injury from broken glass. If glass is removed from waste stream it will reduce the risk of injury to loaders when handling plastic sacks. There are no figures available for accidents to workers.

Then there is risk to the public from litter. In section 8.3 injury risks to the public from broken glass in the streets were highlighted. If recycling is successful it may reduce the risk of accidents from litter. However, if bottle banks are misused there may be an increase in risk to people around the site.

8.8 Energy Saving Through Recycling

As well as reducing the problems of waste disposal, increased recycling can improve the quality of the environment; through the extension of resource life, energy savings, and reduced levels of pollution. In the development of reclamation schemes, an important factor needing consideration is the potential for energy conservation through processing secondary rather than primary materials. If the material is consigned to landfill, then this energy potential can be lost.

Glass, aluminium, and ferrous metals have to be recycled as materials to gain the savings in energy. Whereas plastics and paper can be recycled as either materials or as energy. In the case of plastics, Milgrom (1979) states that recycling plastics into manufactured products can double the energy recovered, as compared to using it as a fuel.

As noted in Section 2.5, glass has several recycling possibilities, the choice of which being dictated by technological, economic and political factors. These choices are:

1. Re-use - Returnable/Refillable Containers.
2. Direct Use - Using collected glass (cullet) in the manufacture of new glass products.
3. Indirect Use - Use in the production of other products.

The raw materials used in glass manufacture are readily available, and not very expensive; but the fuel and energy required to fuse it into a new product may be costly enough to justify the recovery of glass from waste. With each recycling option there will be energy savings which need to be assessed when examining the benefits of the recovery of materials from waste.

The survey of Local Authorities (Chapter 7) showed that Bottle Banks were set up for both local and National reasons. On a National scale District Councils saw benefits arising in energy conservation. This will primarily be at an industrial manufacturing level, although Councils may reduce energy use in transport and processing (Incineration) of wastes.

Returnable/Refillable bottles have been examined in terms of energy costs by FISHER (1982), OECD (1978) and WMAC (1981) studies (Chapter 4). These studies show that returnable glass bottles are the simplest form of recycling in 'energy' and 'economic' terms, provided a certain trippage is achieved.

Extensive work into aspects of energy analysis with reference to the packaging industry, and the energy costs of different beverage packaging systems, has been undertaken by BOUSTEAD & HANCOCK of The Open University. They have looked at the Bottle Bank system in detail, and their work is briefly examined below.

Recycling glass through Bottle Banks can result in energy savings in three areas:

1. Raw Material Energy

   One tonne of cullet replaces 1.2 tonnes of raw materials, reducing the energy costs of extraction, processing and delivery of batch material.

   Even assuming some people make a special trip to a Bottle Bank, the collection, treatment and delivery of cullet requires 78% less energy per tonne than equivalent raw materials.

   This is primarily because a large amount of energy is used to manufacture soda ash (60% of total energy), one of the main (16% of batch) raw materials used in glass manufacture.

2. Melting Energy

   The addition of cullet to the furnace aids the transfer of heat through the batch reducing the energy required to melt the mix. Generally there is

a 20% reduction in fuel consumption on a per tonne basis when raw materials are replaced by cullet.

3. Waste Management

If cullet is not recycled it will need to be collected and removed for disposal with the rest of the municipal waste. A reduction in the level of waste, can lead to a fall in energy requirements.

Taking the first two areas of energy savings: raw materials and melting energy there is a reduction of at least 25% through using recycled glass (cullet).

An earlier analysis for the GMF (1975) showed that cullet requires less energy than raw materials, given the same delivery distance (Table 8.9). This assumes that no energy is used by the consumers in delivering the cullet to a central site for collection. This means that it is possible to transport cullet further than raw materials, and thus extend the collection area and the potential amount of cullet that can be recovered.

TABLE 8.9 Energy Comparisons - Cullet versus Raw Materials

For 1 kg of raw materials:		
Extraction	3.85 MJ	
Delivery (300 km)	0.31 MJ	
TOTAL		4.16 MJ
For 1 kg of cullet:		
Collection of skips	0.04 MJ	
Bulk Transport (300 km)	0.31 MJ	
Treatment	1.50 MJ	
TOTAL		1.35 MJ

Note: Since 1 kg of cullet replaces 1.2 kg of raw materials, the potential energy saving is 2.77 MJ/kg.

SOURCE: COOK R F (1978). The Collection & Recycling Of Waste Glass (Cullet) In Glass Container Manufacture
Conserv Recycl Vol 2 1978

Boustead & Hancock (1982) were concerned about the amount of consumer energy used in delivering glass to Bottle Bank sites. To assess this detailed information is required on the habits of

consumers visiting Bottle Banks. In particular information should be sought on:

how far they have travelled,
the method of transport they used,
the quantity of glass they brought, and
whether they make a 'special' trip to the site.

Some of this information can be obtained from the GMF Survey on public attitudes to glass recovery (Section 6.9.3). This area needs to be examined in more depth in terms of energy costs and the mode of delivery.

As the melting of glass at about 1500°C consumes about 70% of the energy used in the production of bottles, it is this part of the process that offers most scope for energy savings. Vetropak the Swiss Company reported fuel savings of 2% for each 10% of raw materials that are replaced by cullet.

BOUSTEAD & HANCOCK (1982) have updated their work for the GMF. They examined the energy aspects of five different glass recycling collection systems (Figure 8.A):

1. The standard large compartmentalised Bottle Bank operated by Local Authorities.

2. A large steel skip sited at factories, that is uplifted by Local Authorities to a central storage site.

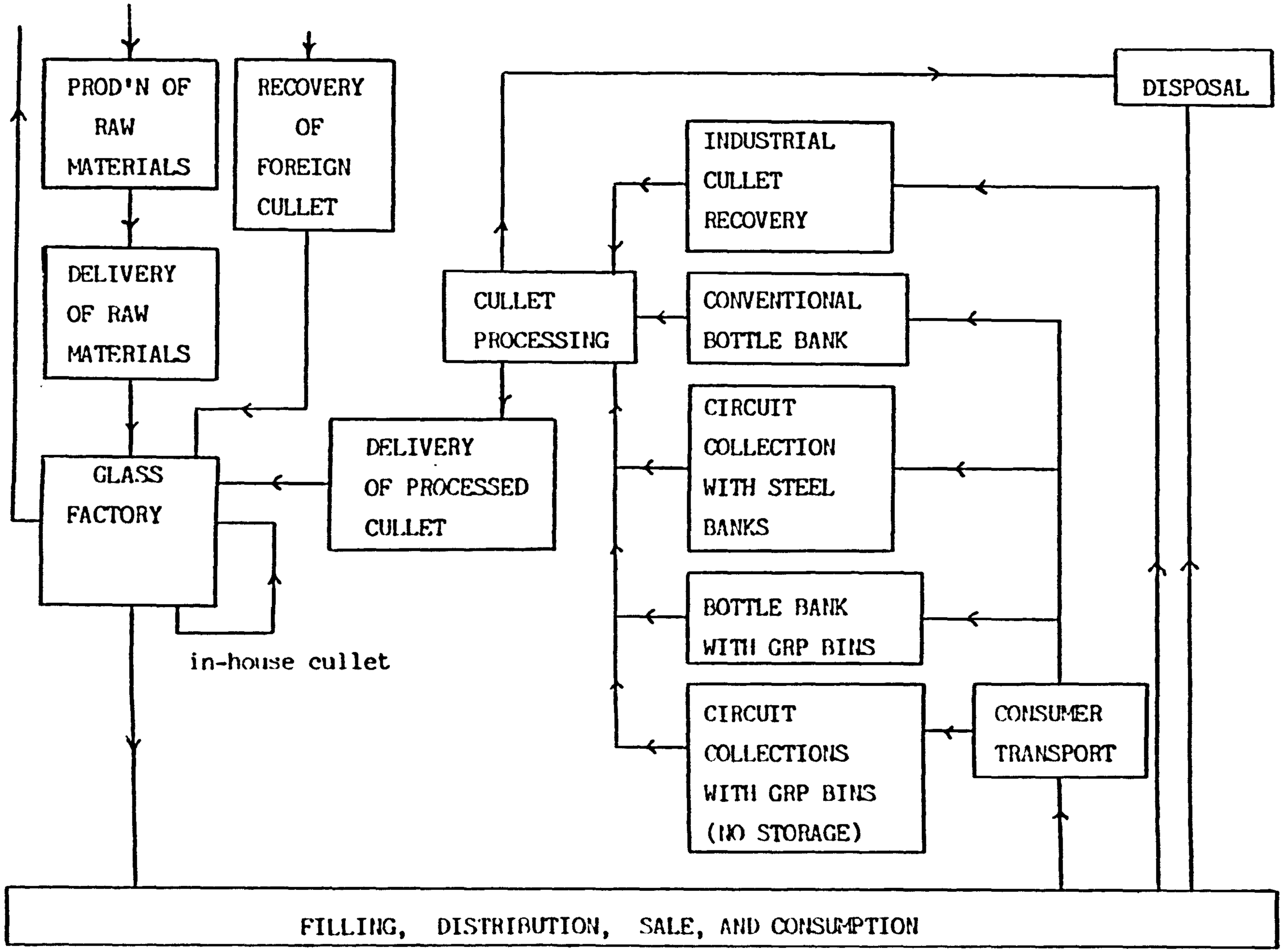
3. A circuit collection of steel skips that are uplifted by one vehicle to a storage site.

4. Use of small plastic bins, in place of large banks.

5. Circuit collection, that avoids storage probably centred on the processing plant.

This work reaffirmed energy savings due from the reclamation of glass. This saving in energy manifests itself in three areas: a reduction in material usage, savings in furnace energy requirements, and a reduction in the amount of material that has to be finally disposed. These energy savings will be offset to

Figure 8.A Flow Diagram Of Operations Used To Calculate Energy Associated With Glass Container Production When Account Is Taken Of Bottle Bank Operations



Source: Boustead I & Hancock G (1982) The Effect Of Cullet Recycling On The Resource Requirements For Glass Container Production
The Open University

some extent by the energy costs of collection. The potential energy savings that can accrue in these areas are shown in Table 8.10. This is based on energy savings for each additional tonne of cullet that is used.

TABLE 8.10 Total Energy Savings Resulting From The Additional Use Of One Extra Tonne Of Cullet

AREA OF ENERGY SAVINGS	
Raw Material Usage	4272.73 MJ
Furnace Energy Savings	1650.35 MJ
Waste Disposal	86.52 MJ
TOTAL	6009.60 MJ

Source: BOUSTEAD I & HANCOCK G F (1982) The Effect Of Cullet Recycling On The Resource Requirements For Glass Container Production
The Open University November 1982

Thus there is a potential saving of 6009 MJ per tonne for each additional tonne of cullet that is used in the manufacturing process. This figure takes no account of the energy required to collect and treat the cullet recovered from external sources.

Boustead & Hancock estimate these energy costs as:

Energy to collect 1.053 tonnes of cullet and deliver to the processor is	315.54 MJ
Energy used in cullet treatment is	96.80 MJ
Energy for final delivery of treated glass	48.89 MJ
Total energy used to obtain cullet	458.24 MJ
Net Energy Saved Per Tonne Of Cullet Used	5531.37 MJ

As 1 gallon of fuel oil contains 186.3 MJ a saving of 5531.37 MJ is equivalent to 30 gallons of fuel oil. This represents about 25% of the energy required to manufacture glass for containers. With a reclamation of 162,000 tonnes this will lead to savings of 4.8 million gallons of fuel oil, equivalent to £1.6 million.

8.9 Raw Materials

Chemical losses from raw materials in the melting process mean that 1.2 tonnes of raw materials are needed to make 1 tonne of glass. Thus recycling of 162,000 tonnes of cullet will reduce the demand for virgin materials by 194,400 tonnes. The principal ingredients are sand and limestone which although abundant are quarried in environmentally sensitive areas of Surrey, Norfolk and Derbyshire. The third main material - soda ash - is a synthetic product of limestone and rock salt, which is a high energy process. A reduction in use of soda ash will lead to energy savings (Section 8.8).

A reduction in raw material requirements will have consequences for: employment (Section 8.11), pollution (Section 8.5) and energy (Section 8.8).

8.10 Import Savings

The use of secondary raw materials in place of imported primary materials can produce savings for a Nation's overall import bill. OECD (1983) notes that this may have political as well as economic implications.

For glass manufacture, most of the raw material are quarried within Britain - sandstone and lime. Any reductions in raw material will affect quarrying and may have consequences on environmental grounds. The main savings will be in energy and will be dependant on whether fuel oils are imported.

8.10 Employment

8.10.1 Introduction

The development of reclamation schemes can lead to employment opportunities. These can be voluntary, part-time or full-time. As well as creating new jobs, recycling of wastes can secure existing jobs. This needs to be put into the context of the whole system, as new jobs here can lead to a loss of jobs elsewhere. In waste management, this can be viewed as a substitution from a reduction in collection jobs to an increase in reclamation jobs. If reclamation leads to savings in energy and raw materials it may have consequences for jobs in those industries.

The benefits of employment are briefly reviewed in terms of the work of TURNER & BLACKMORE (1978). They use shadow pricing techniques, so as to more accurately reflect the social cost of labour in areas of unemployment. The various areas of recycling are briefly examined below, in terms of their possible employment creation.

8.11.2 The Returnable System

WMAC (1981) concluded that a move to an all-refillable system would have consequences for employment. Overall they estimated a loss of between 7000 to 9000 jobs, primarily in South Wales due to a reduction in steel production for canning factories. However, this employment loss could be offset by additional employment in the distribution and retail sectors of the market. WMAC did not attempt to estimate the number of jobs that could be created.

CAWDELL (1982) attempts to put figures on these changes in employment with a move to an all-returnable system. The reduction

in container manufacture and can-filling line jobs could be offset by jobs in retailing, on refillable bottle filling lines giving a net increase of 3,200 jobs. This again excludes changes in employment in distribution.

A report by ECOTEC (1986) concluded that recycling of glass can create jobs, with the biggest potential lying in the sorting and recycling of re-usable beverage containers. They produce the following hierarchy of job creation opportunities:

Sorting & recycling of re-usable beverage containers	5.8 employees/1 million litres processed
Returnable Bottles retailed manually	3.8 jobs/1 million litres sold
Returnable Bottles retailed via automatic vendors	3.5 employees/1 million litres
100% Recycling of non-returnable containers	2.9 employees/1 million litres handled
Disposal of non-returnable bottles as waste	2.0+employees/1 million litres handled

Ecotec concludes that a combination of returnable and recycling systems adapted to local market conditions is the most likely system to generate jobs. Ecotec estimate that the current level of glass recycling in Britain generates about 220 jobs; but a move to an all returnable market would create 3,200 new jobs.

8.10.3 Reorganise The Collection System

Based on the lines of the 'Green Bin' system (Section 5.4), Taunton Think Tank Limited (1984) outlined a proposal to create jobs from waste (Appendix E.2). Each District would have a Reclamation Team equipped to collect materials and a separate team to collect the dirty waste. TAUNTON estimates that 23,250 jobs would be lost, to be replaced by 48,500 reclamation jobs because it is more labour intensive. A net gain of 25,250 full time jobs, based on the assumption that there will be 100 full time workers involved in reclamation for each average sized WCA. The estimate

assumes that the average remuneration for full time employment will be in £5,000 to £6,000 per annum range inclusive of National Insurance contributions. The Inland Revenue will benefit from tax take on extra jobs, and savings in state benefits.

8.10.4 Jobs From Glass Recycling

It has been difficult to establish accurate figures for employment from glass recovery projects. These can be divided into: Bottle Recovery, Bottle Banks, and Processing.

The three commercial bottle recoverers employ 203 people with the largest employing 185 people across the country (Appendix B.1). Birmingham Bottle Exchange employs 5 within one town. FOE (W Cumbria) employs 7 people but these deal with more than just bottle recovery (Section 5.5.2). If, you take an area needs 4 people this could lead to 2,800 jobs in Bottle Recoverers on a national scale.

The second area of employment lies with the Bottle Bank system. Here jobs will be available in the manufacture of skips, and in collection (ANON 1984). Bottle Bank Manufacture is largely by private contractor, although some Councils have modified skips in their own workshops. Collection can be carried out by Council or Private Company. In both cases, it has usually been developed from existing practices. Although, with trade collection schemes, new companies have been formed with varying degrees of success.

In some cases, collection of Bottle Banks, can take up most of an employees duties and can be seen as a permanent occupation. Generally collection will only be part of a workers normal duties. With 334 Districts operating recovery schemes it is likely that at least 334 people will be associated with collection to varying

degrees. In addition Operators will have people looking after storage sites, bulk transport, and administrative duties.

With trade collection schemes, as well as drivers, at least one loader will be required to assist in collection. If trade schemes expanded to 334 Districts it would likely provide work for 334 drivers, and between 334 to 668 loaders for part of their work.

The third area is with the market/processor. Some will be sold to cullet merchants who act as middle men. Then there will be jobs in the manufacturing industry. These will include construction, sorting and administration. In the short term there were construction jobs in the building of new recycling centres, and in the industries providing the equipment. This has lead to permanent jobs in processing. Kelliebank employs 6 people; Nationally, with 5 such sites there would be 30 permanent jobs. It is unclear whether the general decline in manufacturing base that these people have transferred within the company. In addition each site employs administrative support. With recycling and spin offs in raw material savings there can be job losses in associate industries of quarrying, and energy supply.

In glass recycling, jobs are created through Bottle Recovery, Collection and Processing. Estimates suggest that these could provide 3000 to 4000 jobs. There is no attempt to define if they are full or part-time, or whether they can be classed as 'new' jobs. In addition, a large part of the collection scheme is carried out through uncosted activities of the general public or traders who deliver glass to a collection point.

8.10.5 Benefits From Employment

In recycling a degree of sorting will be necessary to improve the

marketability of the recovered product. This can be undertaken manually, and can lead to social benefits from the creation of new jobs. TURNER & BLACKMORE noted that there are a number of problems in assessing the value of work opportunity. This will be influenced by whether the work is done voluntarily or under a Government job creation scheme.

In assessing recovery projects, the price of a factor input is the return that factor would have received from employment in the absence of such a project. This return, or the opportunity cost is taken as being equal to the market price of the input. For full employment this would be the wage rate. However, in areas of high unemployment the market may be distorted which may result in a solution that is not optimal. In such cases TURNER & BLACKMORE suggest that shadow pricing where a factor is given a value that reflects the 'true' marginal social cost, may more accurately reflect the social cost of labour (Appendix E.3). This runs counter to the neoclassical economists argument, which views the economy as being able to make adjustments to absorb unused resources. But in depressed areas where unemployment is endemic it is unlikely that changes in the economy would be able to absorb these unused resources, particularly in the short run. Thus the use of shadow pricing might achieve a more efficient allocation of resources.

8.10.6 Summary

Reclamation schemes provide good opportunities for job creation. This is of importance for the 17 to 25 age group, where unemployment is a severe problem. This can result in significant social benefits for local authorities and society as a whole.

Glass recycling has a number of areas where jobs can be created. The main areas are within Local Authorities waste management operations. Here a distinction has to be made between the establishment of new jobs, and the preservation of existing jobs.

The 'value' put on jobs needs to be assessed in terms of changes from skilled to unskilled, jobs in high unemployment areas, benefits to the exchequor from reduced unemployment benefits and increased taxation.

Reclamation has been used in many developing countries to create jobs. VOGLER has examined this area in several works.

8.12 Summary Of Social Benefits

This review shows that it is difficult to assess the external costs that are related to reclamation projects, and thus provide a clear assessment of total costs. External benefits can be attributed to Local Authorities in terms of savings in the costs of waste disposal, and benefits from changing attitudes to treating waste as a resource. Industry has savings in energy and raw material use, as well as spin offs in good publicity. There are opportunities for the unemployed to gain work experience through community recycling projects, and more long term jobs in the reclamation industry. Society as a whole benefits through a more rational use of resources.

With recycling schemes it is important not to confine the assessment to private costs alone but to look at them alongside social factors. It is this overall assessment that will need to be undertaken by Central Government, to ensure a social optimum solution.

Table 8.11 illustrates some of the wider benefits available from recycling. It also attempts to assign costs. Further work needs to be done in this area, to provide a total systems appraisal of reclamation schemes. It is the negative factors of pollution, road congestion, litter and health effects that need to be assessed. Whereas, with cost savings of waste and employment benefits there inclusion needs to be justified through the coordination of the Government with the establishment of a National framework for recycling.

TABLE 8.11 External Factors Considered In Recycling Projects

EXTERNAL FACTOR:	REASONS CONSIDERED	COSTS	POSSIBLE BENEFITS
WASTE:			
Collection	Reduction in material collected by L.A.'s Reduce risk of accidents to collectors	Colln Cost = £25/tonne	If recover 162000 tonnes (1984) at £18.67 save £2.98 m pa
Disposal	Reduction in material to be disposed Less punctures to vehicles on landfill	Avge Cost = £5.88/tonne Void Space = £0.40/onne	Recover 162000 t = £940,300 p.a = £64,300 pa
LITTER:			
Nuisance	Injuries - people - animals Damage - machines Disamenity - value	Control Cost = £115m p.a. Glass at 5% = £5 m	
ROAD CONGESTION:	Extra Vehicle Movements -	f=t/v 162,000/3 = 54,000 trips	
POLLUTION:	Air/Water/Noise		
ENERGY	Use cullet saves energy at 5551 MJ/tonne = 30 gal/tonne		162,000 tonnes saves 4.8m gln = £1.6 million
RAW MATERIAL	1 tonne of cullet = 1.2 tonnes replaces 1.2 tonnes		162,000 tonnes = 194,400 tones
RED'N IN IMPORTS	Energy		
EMPLOYMENT	Returnables: WMAC: -7,000 to 9,000 jobs CAWDELL: +3,200 jobs ECOTEC: +3,200 jobs		Tax Revenue Benefits Self Esteem
	Bottle Recovery: PRIVATE: +302 jobs FOE: + 7 jobs If National with 4/area creates 2,800 jobs		
	Bottle Banks: COUNCIL: 334 drivers Trade System: 334 drivers plus loaders		
	Processors: + 30 jobs		
TOTAL JOBS FROM RECYCLING	3000 to 4000 jobs £3-4m		

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Chapter 9

Economics Of Local Authority Glass Recovery Schemes

9.1 Introduction

It is important for Local Authorities to be able to assess the viability of glass recovery operations. This is necessary when Local Authorities have to be able to justify decisions made to local electors, and policies adopted to Central Government. Such an assessment needs to be based on a clear evaluation of the costs and benefits involved.

A number of assessment models have been developed to evaluate the viability of glass recycling schemes. These Models are:

1. The GMF/Oxford Assessment
2. The Cleveland Assessment
3. The Stirling Assessment
4. The NPV Appraisal

These assessments are briefly reviewed below. A problem in evaluating the worth of glass recovery schemes is the lack of empirical data. This was one of the reasons behind the undertaking of the Local Authority Survey (Chapter 7). The information gained from this survey, provides an important local data set for reviewing recovery schemes. This data is used to evaluate the Local Autorities under the above assessments. The data covers both urban and rural areas, in addition to the various collection systems.

9.2 The GMF/Oxford Assessment

The initial attempt to devise a costing system was made by the GMF, based on the Oxford operations. This system is used to calculate the breakeven tonnage for the glass recovery scheme. This model can be used as a rough guide to assessing the viability of a Bottle Bank scheme.

Oxford's was one of the original glass recycling schemes established in Britain. As the scheme was on a trial basis, the costs of Bottle Banks (C) and advertising (A) were met by the GMF. The removal of these costs allows the scheme to generate a much better return to the Council. However, in this example they are kept in, to provide a clearer assessment of the overall costs of the scheme.

GMF/Oxford Assessment

Breakeven Tonnage

$$t_1 = \frac{\frac{N * C + S}{5} + A}{P - \frac{(H + M)}{V}} \qquad (1)$$

where:

	1977	1978	1982
N = Number Of Skips	6	6	6
C = Cost Of A New Skip	500	500	880
S = Cost of 3 Storage Bays	500	500	-
A = Annual Cost Of Advertising and Insurance	1500	1500	-
P = Price Paid For Glass (£/tonne)	8	10	15
H = Cost Of Local Skip Uplift (£/load)	5.50	8.25	10.50
M = Cost Of Tidying Skip Site (£/load)	3.00	3.00	9.85
V = Average Contents Of Skip (Tonnes)	1.6	2.0	1.7
t_1 = Breakeven Annual Tonnage	817	612	402
AT = Actual Tonnage (For All Sites)	542	722	800

Figures are based on Oxford's Bottle Bank scheme for three years (1977, 1978, and 1982) are shown. The assessment shows the Oxford scheme to have achieved breakeven tonnages in 1978 and 1982. As the scheme has developed the tonnages recovered have improved. The costs are based on local conditions.

The capital costs - Banks and Storage - were spread over 5 years. A fixed payment is made, with Bank and Storage costs being assessed over the same time period.

Skip Movements

Also, it is possible to ascertain the frequency of filling, and thus on the need for uplift. This relates tonnage collected to the average contents of the skips, and can be found by the following formula:

$$f = \frac{t}{V}$$

where:

t = Actual tonnage
V = Average Content Of Skips

For Oxford this works out as:

	1977	1978	1982
Actual Tonnage	AT 542	722	800
Average Skip Content	V 1.6	2.0	1.7
Number Of Uplifts,	f 339	361	470
Maximum Skip Capacity	V2 3.0	3.0	3.0
Number Of Uplifts	f2 181	241	267

This illustrates the importance of maximising skip contents before uplift takes place. This will require monitoring of skips to maximise skip contents. In 1982, with average contents of skips at 1.7 tonnes there are 470 movements. If uplift was made at 3.0 tonnes the number of movements falls by 43% to 267. In practice would aim to be as near 3.0 tonnes as possible. This problem of

filling rate is affected by colour separation, where one compartment might fill quicker than others necessitating uplift before skip is completely full. Skip movement is one of the main cost components, and needs to be strictly controlled.

This assessment does not include the costs of bulk transport of cullet to the outlet. In most Council run operations cullet is uplifted to a storage point before being bulk delivered to the processor. If bulk transport charges (T) are included the formula can be adapted to:

Breakeven Tonnage

$$t_2 = \frac{\frac{N * C + S}{5} + A}{P - T - \frac{(H + M)}{V}} \qquad (2)$$

With transport costs (T) at £3.50 per tonne (1978) the breakeven tonnage would be 2,514 tonnes, four times greater than that in the original equation (612 tonnes). On this basis Oxford would not achieve the required tonnage to breakeven. It is important to consider all the costs when assessing the operation of recovery schemes.

The GMF/Oxford Assessment has been used to assess the viability of the surveyed Councils. The results are shown in Table 9.1. Based on Equation 1, t_1; all but one of the Councils achieves the breakeven tonnage figure required. The exception is Dunfermline which has to offset higher capital costs of banks, against a relatively low figure for cullet actually recovered. Dunfermline uses large skips, with a 5 tonne capacity which have higher uplift costs at £8 per tonne if the bank is full, compared to an average of £3.00 per tonne. It is important that Dunfermline maximises the tonnage of glass in the skips before uplift, keeping down the frequency of vehicle movements so as to spread collection costs

TABLE 9.1 Assessment Of Local Authority Schemes Based On Oxford/GMF Assessment

$$t1 = \frac{\frac{N * C + S}{5} + A}{P - \frac{(H + M)}{V}} \qquad t2 = \frac{\frac{N * C + S}{5} + A}{P - T - \frac{(H + M)}{V}}$$

FACTOR	GRAMPIAN: ABERDEEN	BANFF	GORDON	KINARDNE	TAYSIDE: DUNDEE	PERTH	FIFE: DUNFRMLNE	N E FIFE	DUMFRIES: NITHSDALE	LOTHIAN: EDINBURGH	EAST LOTHIAN	WEST LOTHIAN	BORDERS: ETTRICK	ROXBURGH
N	10	4	6	5	6	4	3	4	2	25	17	6	4	3
C	750	1750	650	302	200	650	2200	500	645	700	250	750	500	200
S	600	600	1900	300	0	0	0	750	500	0	1800	-	900	100
(N*C+S/5)	1620	1520	1160	362	240	520	1320	550	358	3500	772	900	580	140
A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
H	10.0	12.0	15.0	10.0	11.0	6.0	40.0	22.0	15.0	10.0	12.0	13.5	10.0	4.0
M	-	-	-	-	0.15	-	0.0	-	-	-	0.0	-	-	-
V	3.3	3.0	3.0	3.0	3.0	3.0	5.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
(H+M/V)	3.0	4.0	5.0	3.3	3.7	2.0	8.0	7.3	5.0	3.3	4.0	4.5	3.3	1.3
t1 =	104.6	95.0	85.9	24.0	16.2	31.5	125.7	49.0	27.0	230.0	47.0	64.3	39.0	8.0
AT =	361.0	110.0	100.0	139.0	350.0	185.0	107.0	191.0	151.0	1300.0	130.0	213.0	98.0	220.0
AT-t1=	+256.4	+15.0	+14.1	+115.0	+333.8	+153.5	-18.0	+142.0	+124.0	+1070.0	+83.0	+148.7	+59.0	+212.0
T	8.3	7.5	7.0	7.3	5.6	4.0	8.0	4.0	8.5	-	5.0	5.0	7.0	8.0
t2 =	225.0	217.0	178.5	46.0	26.1	41.6	528.0	77.0	72.0	-	57.0	100.0	85.2	15.0
AT-t2=	+136.0	-107.0	-78.5	+93.0	+323.9	+143.4	-421.0	+114.0	+ 79.0	-	+73.0	+113.0	+12.8	+205.0

TABLE 9.1 (Cont.) Assessment Of Local Authority Schemes Based On Oxford/GMF Assessment

FACTOR	CENTRAL: FALKIRK	STIRLING	STRATHCLYDE: CUMNOCK	GLASGOW	HAMILTON	INVERCLYDE	EAST KILBRIDE	MONKLANDS	RENFREW	STRTKKLVN	ESSEX ESSEX	SUFFOLK WAVENEY
N	4	5	2	8	2	7	6	2	7	1	20	30
C	850	800	750	-	600	683	700	550	500	700	500	290
S	1000	0	0	-	-	-	0	-	2000	-	-	-
(N*C+S/5)	880	800	150	0	240	956	840	220	1100	140	2000	1740
A	0	0	0	0	0	0	0	0	0	0	0	0
P	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5
H	10.0	13.0	n.a.	28.62	10.0	10.1	20.0	10.0	4.6	25.0	40.0	12.5
M	-	2.0	nil	-	-	-	Minimal	-	-	-	-	-
V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.0	3.0
(H+M/V)	3.3	4.3	0.0	9.5	3.3	3.3	11.8	3.3	1.5	8.3	10.0	4.0
t1 =	57.9	56.0	8.1	0.0	15.7	63.0	71.0	14.5	65.0	13.7	235.3	79.0
AT =	150.0	140.0	17.0	224.8	60.0	105.0	132.0	20.0	210.0	92.0	416.0	400.0
AT-t1=	+92.0	+84.0	+8.9	+224.8	+44.3	+42.0	+61.0	+5.5	+145.0	+78.2	+180.7	+321.0
T	1.8	-	-	4.0	3.0	9.7	3.0	4.0	3.4	2.5	-	-
t2 =	169.6	-	-	-	19.7	176.0	229.0	20.0	81.0	18.2		
AT-t2=	-19.6	-	-	-	+40.3	-71.0	-97.0	0.0	+129.0	+73.8	-	-

over the greatest tonnage.

Based on this equation the breakeven tonnages required are relatively low. This reflects the small size of schemes, with few banks, and subsequently low capital costs. Edinburgh, one of the larger schemes with 25 Banks, has a comparatively high breakeven tonnage figure of 230 tonnes per annum. As shown for Oxford, the tonnages recovered for most Councils have increased; so once a scheme is established its position should improve.

When bulk transport costs (T) are included (Equation 2) the breakeven tonnage (t_2) figures increase. Generally, t_2 is twice as large as the original t_1 figure. For Dunfermline it is four times as high. The inclusion of bulk transport costs increases the tonnage required for schemes to breakeven. On this basis four Authorities fail to achieve a breakeven position. The position for the other Councils is less favourable, with surplus tonnages ($AT-t_2$) being reduced.

This emphasises the importance of considering all cost components when assessing a recovery scheme. In addition to bulk transport costs the GMF/Oxford assessment also omits a number of other factors: skip maintenance and administration. These tend to be smaller in value and would have less influence over the operation of the recovery scheme; but can still be significant and should be considered. Without a clear appreciation of the full costs, operating decisions can be based on false premises.

9.3 Cleveland Assessment

The Cleveland Study (1980) was prepared as part of the Councils review of the possibility of establishing a glass recycling scheme. This assessment looks at the possibility of renting or buying Bottle Banks. The latter option of leasing banks was only available in the initial stages of the development of glass recycling schemes. Based on this assessment a scheme for Cleveland would lose £3.01 per tonne if the skips were purchased and £2.99 if hired. With lower filling rates the losses would be higher. Cleveland noted that costs per tonne were similar if skips were rented or purchased.

The cost per tonne for site maintenance, debt charges and skip rental falls significantly as the average filling rate increases. If the scheme expands and filling rates are maintained to each site it can spread costs over larger tonnages.

Capital costs are treated on a similar basis to the GMF/Oxford assessment, with debt charges being treated as a fixed payment over five years. The assessments treat storage and bank costs on the same basis.

The assessment for a scheme for Cleveland is outlined below and where appropriate costed for the Cleveland proposal. The Cleveland assessment incorporates costs of skip maintenance (K), administration costs (A), costs of additional litter bins (L) and costs of bulk handling (T + 1) of recovered glass. However, it does not take account of publicity and insurance costs, which were initially assessed in the Oxford scheme.

6.3.2 Cleveland Formula

The scheme would be viable if:

a. $$\frac{H + M}{V} + \frac{K + A + D}{ti} + T + l > p + d \qquad (3)$$

or

b. $$\frac{H + M}{V} + \frac{n.R + A + D}{ti} + T + l > p + d \qquad (4)$$

where:

H =	Average Cost Of Skip Movement	£11.22
M =	Cost Of Site Maintenance Per Skip Movement	£ 6.81
V =	Capacity Of Skip (Tonnes)	2.5
K =	Cost Of Skip Maintenace Per Year (Included In Rental Charge In Equation 4)	£240.00
A =	Administration Costs Per Year	£300.0
n =	Number Of Skips	4
C =	Cost Of 'Bottle Bank' Skip	£650
S =	Cost Of Storage Bays	£4000
L =	Cost Of Litter Bins	£150
D =	Debt Charges on capital costs - repayment by way of an annuity over 5 years - £1826 per year for total Capital Cost of £6750 (n.C+S+L=D1); £1123/yr for Total Capital Cost of £4150 (S+L=D2)	
ti=	Annual Tonnage Collected (r=2.0) (Tonnes)	312.0
T =	Cost Of Bulk Transport Per Tonne	£5.50
l =	Loading Charge Per Tonne	£0.22
R =	Cost Of Skip Rental Per Year	£234.0
r =	Average rate of filling (Tonnes/week)	2.0
p =	Average Price Paid For Cullet (£/tonne)	£ 16.0
d =	Disposal Cost Savings Per Tonne	£ 1.5

A key difference is the use of average skip contents by Oxford, and skip capacity by Cleveland. This difference is important as the weight of Banks at uplift affects the average collection costs. The Cleveland scheme was assessed on different filling rates.

These costs are offset by revenue earned from the sale of cullet and in savings in disposal costs. The inclusion of disposal cost savings acknowledges the importance of treating recycling as part of the waste management system. The remit from WDAs is likely to improve the returns available to Local Authorities. A problem is that not all WDAs accept that there are savings in disposal costs or that they should pass on any of these savings to operators of glass recovery schemes.

The Local Authorities surveyed (Chapter 7) have been evaluated using the Cleveland Model. The results from this assessment are shown in Table 9.2. Of importance is the relationship between capital costs and operating costs, against the revenue received and the disposal cost savings achieved.

Based on revenue received from the sale of cullet only, 5 of the Authorities make a loss. The main cost influence are the capital costs that each scheme incurred. The assessment relates capital costs to the actual tonnage of glass recovered (K+A+D/ti). This relationship gives a figure, which needs to be offset against revenue received. For the loss making Authorities this figure is comparatively high, and contributes to the fact that the Councils make a loss. The main problem for these Councils is the actual tonnage of glass that their schemes recover. If the tonnages of glass recovered can be increased, it will reduce the impact of capital costs on the viability of the recovery operation.

TABLE 9.2 Assessment Of Local Authority Schemes Based On Cleveland Assessment

$$\text{Profit(Loss)} = \frac{H + M}{V} + \frac{K + A + D}{ti} + T + l - (p + d)$$

FACTOR	GRAMPIAN: ABERDEEN	BANFF	GORDON	KINARDINE	TAYSIDE: DUNDEE	PERTH	FIFE: DUNFRMLNE	N E FIFE	DMFRES: NTHSDLE	LOTHIAN: EDNBURGH	EAST LTHIAN	WEST LTHIAN	BORDERS: ETTRICK	ROXBURGH
H	10.0	12.0	15.0	10.0	11.0	6.0	40.0	22.0	15.0	10.0	-	13.5	10.0	4.0
M	n.a.	min	n.k.	n.a.	0.15	-	0.0	Neg	n.a.	-	-	nil	-	-
V	3.0	3.0	3.5	3.0	3.0	3.0	5.0	3.5	3.0	3.5	-	3.14	3.0	1.5
(H+M/V)	3.33	4.0	4.28	3.33	3.7	2.0	8.0	6.28	5.0	2.85	-	4.29	3.33	2.67
K	300	0	0	0	60	40	0	200	0	0	5	0	50	20
A	0	0	0	0	200	0	0	100	0	0	0	0	0	100
N	10	4	6	5	6	4	3	4	2	25		6	4	3
C	750	1750	650	302	200	650	2200	500	645	700		750	500	200
S	600	600	1900	300	0	0	0	750	500	0		-	900	100
L	60	(57*4)	-	-	0	0	20	720	160	-	-	90	40	-
D	1740	1566	1160	362	240	520	1332	694	390	3500	-	918	588	140
K+A+D	2040	1566	1160	362	500	560	1332	994	390	3500	-	918	638	260
ti	361	110	100	139	350	185	107	191	151	1300	-	213	98	220
(K+A+D/ti)	5.65	14.23	11.6	2.6	1.43	3.0	12.45	5.2	2.58	2.69	-	4.31	6.51	1.18
T	8.3	7.5	7.0	7.5	5.6	4.0	8.0	4.0	7.26	-	-	5.0	6.5	3.50
l	0	Min	n.k.	n.e.	Nil	-	N.A.	-	1.24	-	-	Nil	-	1.00
X	17.28	25.73	22.88	13.43	10.73	9.0	28.45	15.48	16.1	5.54		13.6	16.34	8.35
p	18.50	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5		18.5	18.5	18.5
d	3.0	5.88	11.0	5.88	5.88	2.5	5.88	5.88	5.88	5.88	-	4.0	6.0	8.0
(p-X)=	+1.22	-7.23	-4.38	+5.06	+7.77	+9.0	-9.95	+3.02	+2.4	+12.96	-	+4.9	+2.16	+10.15
(p+d-X)=	+4.22	-1.35	+6.62	+10.94	+13.65	+12.0	-4.07	+8.9	+8.28	+18.84	-	+8.9	+8.16	+18.15

TABLE 9.2 (Cont.) Assessment Of Local Authority Schemes Based On Cleveland Assessment

FACTOR	CENTRAL: FALKIRK	STIRLING	STRATHCLYDE: CUMNOCK	GLASGOW	HAMILTON	INVERCLYDE	EAST KILBRIDE	MONKLANDS	RENFREW	STRTKKLVN	ESSEX ESSEX	SUFFOLK WAVENEY
H	10.0	13.0	Cntrct	28.62	10.0	10.10	20.0	10.0	4.60	25.0	40.0	12.50
M	-	6.0	Cntrct	-	n.k.	0.0	Min	Neg	Nil	-	-	-
V	3.0	5.0	4.0	3.0	3.0	5.0	3.35	3.0	3.16	3.5	4.0	3.0
(H+M/V)	3.33	3.8	0.0	9.54	3.33	2.22	5.97	3.33	1.46	7.14	10.0	4.0
K	120	75	0	0	0	0	100	0	0	50.0	0	0.0
A	0	0	0	0	0	0	0	0	0	15	0	0.0
N	4	5	2	8	2	7	6	2	7	1	20	30
C	850	800	750	-	600	673	700	550	500	700	500	290
S	1000	-	-	-	-	-	0	-	2000	-	-	-
L	812	480	-	-	-	-	300	60	-	90	0	0
D	1042	848	-	-	240	956	900	340	1100	150	2000	1740
K+A+D	1162	923	-	-	240	956	1000	340	1100	215	2000	1740
ti	145	140	-	224.83	180	105	132	20	210	92	416	400
(K+A+D/ti)	8.01	6.49	-	-	1.33	9.1	7.57	17	5.24	2.34	4.81	4.35
T	1.21	n.a.	-	4.0	3.0	9.71	3.0	4.0	2.87	2.50	4.00	5.50
l	-	n.a.	-	-	in above	in above	-	in above	0.58	-	-	-
X	12.55	10.39	-	-	7.66	21.03	16.54	24.33	10.15	11.98	18.81	13.85
p	18.50	18.50	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	25.00	25.00
d	5.57	12.00	-	n.a.	5.88	10.0	5.88	2.0	5.88	4.0	5.0'	(1500)''
(p-X)=	+5.95	+8.11	-	-	+10.84	-2.53	+1.96	-5.83	+8.35	+6.52	+6.19	+11.15
(p+d-X)=	+11.52	+20.11	-	-	+16.72	+7.47	+7.84	-3.83	+14.23	+10.52	+11.19	+12.15

Notes: ' Essex - Average Landfill £5.0 per tonne
Tip Costs £1.7 to £4.0 per tonne
Private Costs £0.5 to £1.0 per cubic metre

'' Waveney - Rebate from WDA

When disposal savings (d) are included, only three of the Authorities would make a loss. For two of these Authorities the average disposal cost (£5.88) from the survey is used. A figure based on local factors and conditions might have a more favourable effect. The influence of disposal cost savings depends on the disposal option, and whether the Council passes on any savings incurred. The inclusion of savings in disposal costs generally improves the viability of all recycling schemes.

From the experience of Local Authorities operating recycling schemes it is not certain that disposal cost savings will be passed on to the operator of the recycling scheme. So the direct inclusion of disposal cost savings into the Cleveland Viability Assessment may not accurately reflect the real situation that recycling schemes operate in. This does not mean that the potential for disposal cost savings should be ignored, but a better method is to have them separately assessed so the operator can adopt the cost system that best suits local conditions.

9.4 The Stirling Glass Recycling Model

This third model has been developed by the author in this work. A more detailed appraisal and substantiation of the factors used in the model is provided in Chapter 10. This work has been developed into a computer based model, which can be used to assess the viability of recycling schemes, highlighting key costs, under varying conditions.

The Stirling model was developed from interviews with all sections involved in glass recycling schemes: Local Authority Officers, Private Collecting Companies, Glass Manufacturers and Processors. In addition, it took into account the two previous models and the criticisms of them. It was on the basis of these sources of information that the questionnaire was developed, to provide a data base for assessing glass reclamation projects (Chapter 7).

The Stirling Model differs from the other assessments in a number of key areas. It attempts to provide a comprehensive framework for evaluating the viability of recycling schemes. This Model can be used as a management tool to check on operating conditions. It also can be used as a basis for a comparison between glass recovery schemes on a like basis.

Capital costs are treated differently. The Model spreads capital costs over a set period at market rates of interest. On this basis Banks are discounted over 5 years and storage costs over 10 years, which reflects their life expectancy. Although initially capital costs are relatively small it is important to treat them on a sound financial basis. If the scheme expands to 30 Banks with its own vehicle support capital costs approach £100,000 and need to be treated accurately.

The Glass Recycling Model is defined by the following formula:

Net Effects:

Private Viability PPT = TRA - (SUC + OPC)

Disposal Surplus SST = TRA + SRD - (SUC + OPC)

Total Surplus TST = TRA + SRD + SCC - (SUC + OPC)

Costs:

SUC = Set Up Costs

SUC = SIC + SKC + STC

where: SIC = Site Costs
SKC = Skip Costs
STC = Storage Costs

OPC = Operating Costs

OPC = CC + SM + SKM + KA + PUB + BTR + STM

where: CC = Collection Costs
SM = Site Maintenance
SKM = Skip Maintemance
KA = Administration
PUB = Publicity Costs
BTR = Bulk Transport
STM = Storage Maintenance

Income:

TRA = Revenue From Sale Of Cullet

TRA = TP1 + TP2 + TP3 + TP4

where: TP1 = Clear Glass
TP2 = Green Glass
TP3 = Amber Glass
TP4 = Mixed Glass

SRD = Savings In Refuse Disposal Costs

SRD = Y * GRT

where: Y = Average Disposal Costs
GRT = Glass Recovered (Tonnes)

SCC = Savings In Collection Costs

SCC = R * GRT

where: R = Average Cost Of Collection

From the interviews, all the cost factors were outlined and have been incorporated in to the Model. It is accepted that not all schemes will incur all the costs, but that it is important that all factors should be considered. Additional factors are: crusher costs, publicity, storage maintenance, skip maintenance and administration. The Stirling Model offers a comprehensive and logical framework for the assessment of glass recovery schemes.

The third area of difference is in the Model's treatment of income. With revenue from the sale of cullet the model makes allowance for the sale of the different colours of glass. This is necessary where operators are trying to maximise their revenue. In addition, The Stirling Model recognises the importance of examining reclamation schemes as part of the waste management system. The recovery of glass will have consequences on disposal costs and in the long term on collection costs. The Model goes one step further than Cleveland by making allowance for collection cost savings.

The Model can be used to calculate the net viability of recycling schemes in terms of private financial costs, including disposal cost savings, and long term collection cost savings. In addition the Model can be used to calculate the tonnage of glass that needs to be recovered for the scheme to breakeven. Given operating conditions it can give what price is required from the sale of cullet for the scheme to breakeven.

The Local Authorities have been appraised under the Stirling Model. The results from this assessment are shown in Table 9.3. This Table shows the three viability measures - Private Viability (PPT), Disposal Systems Surplus (SST), and The Total Systems Surplus (TST) - that can be obtained for the Local Authorities.

TABLE 9.3 ASSESSMENT OF LOCAL AUTHORITY SCHEMES BASED ON THE STIRLING GLASS RECYCLING MODEL

	GRAMPIAN:								TAYSIDE:				FIFE:				DUMFRIES:	
	ABERDEEN		BANFF		GORDON		KINARDINE		DUNDEE		PERTH		DUNFERMLINE		N E FIFE		NITHSDALE	
FACTOR	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t
SIC	600	1.66	280	2.54	0				0	-	280	2.80	60	0.56	720	3.77	160	1.06
SKC	2250	6.23	1450	13.18	1170	11.70	0	-	360	1.03	810	4.37	1980	18.50	600	3.14	387	2.56
STC	120	0.33	120	1.09	380	3.80	60	0.43	0	-	0	-	-	-	150	0.78	100	0.66
SUC	2970	8.23	1850	16.82	1550	15.50	60	0.43	360	1.03	1090	5.89	2040	19.06	1470	7.69	647	4.28
CC	1168	3.24	440	4.00	500	5.00	0	-	1302	3.72	370	2.00	856	8.00	1400	7.33	755	5.00
SM	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
SKM	300	0.83	0	-	0	-	0	-	60	0.17	40	0.22	0	-	200	1.05	0	-
KA	0	-	0	-	0	-	0	-	200	0.57	0	-	0	-	100	0.52	0	-
PUB	845	2.34	320	2.91	261	2.61	176	1.26	746	2.13	503	2.72	479	4.47	273	1.43	220	1.46
BTR	3029	8.39	825	7.50	700	7.00	1042	7.50	1960	5.60	740	4.00	856	8.00	764	4.00	1096	7.26
OPC	5342	14.80	1585	14.41	1461	14.61	1218	8.76	4268	12.19	1653	8.93	2191	20.47	2737	14.33	2071	13.72
TOTAL COSTS	8312	23.03	3455	31.23	3011	30.11	1278	9.19	4628	13.22	2743	14.83	4231	39.54	4207	22.03	2718	18.00
INCOME																		
TRA	6678	18.50	2035	18.50	2098	20.98	2571	18.50	6475	18.50	3422	18.50	2184	20.42	3533	18.50	2793	18.50
SRD1	671	1.86	204	1.86	186	1.86	258	1.86	651	1.86	344	1.86	199	1.86	355	1.86	280	1.86
SRD2	1083	3.0	646	5.88	1100	11.00	817	5.88	2058	5.88	462	2.50	629	5.88	1123	5.88	887	5.88
SCC	6556	18.16	2090	19.00	3400	34.00	2641	19.00	6779	19.37	555	3.00	2028	19.00	3631	19.00	2862	19.00
VIABILITY PPT	-1634	-4.53	-1400	-11.65	-913	-9.13	+1293	+9.30	+1847	+5.28	+679	+3.67	-2046	-19.12	-674	-3.53	+75	+0.49
SST1	-962	-2.67	-1195	-10.87	+186	+1.86	+1551	+11.16	+2498	+7.14	+1023	+5.53	-1847	-17.26	-318	-1.67	+356	+2.35
SST2	-551	-1.53	-753	-6.85	+1100	+11.00	+2110	+15.18	+3905	+11.16	+1142	+6.17	-1417	-13.24	+448	+2.35	+963	+6.37
TST	+6005	+16.6	+1337	+12.15	+4500	+30.00	+4751	+34.18	+10684	+30.52	+1696	+9.17	+611	+5.17	+4079	+21.35	+3825	+25.33

TABLE 9.3 (Cont.) ASSESSMENT OF LOCAL AUTHORITY SCHEMES BASED ON THE STIRLING GLASS RECYCLING MODEL

	LOTHIAN:						BORDERS:				CENTRAL:			
	EDINBURGH		E LOTHIAN		W LOTHIAN		ETTRICK		ROXBURGH		FALKIRK		STIRLING	
FACTOR	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t	£	£/t
SIC	0	-	0	-	90	0.42	40	0.41	0	-	0	-	480	3.43
SKC	5250	4.04	0	-	1350	6.34	547	5.58	180	0.82	1020	7.03	1200	8.57
STC	0	-	0	-	0	-	180	1.84	20	0.09	200	1.38	0	-
SUC	5250	4.04	0	-	1440	6.76	767	7.83	200	0.91	1220	8.41	1680	12.00
CC	4329	3.33	0	-	958	4.50	326	3.33	293	1.33	482	3.32	606	4.33
SM	0	-	0	-	0	-	0	-	0	-	0	-	576	4.11
SKM	0	-	5	0.04	0	-	50	0.51	20	0.09	120	0.83	75	0.53
KA	0	-	0	-	0	-	0	-	100	0.45	0	-	0	-
PUB	0	-	330	2.54	494	2.32	142	1.45	150	0.68	504	3.47	280	2.00
BTR	0	-	0	-	1065	5.00	637	6.50	1540	7.00	175	1.21	0	0.00
OPC	4329	3.33	335	2.58	2517	11.82	1155	11.78	2103	9.56	1281	8.83	1537	10.98
TOTAL COSTS	9579	7.37	335	2.58	3957	18.57	1922	19.62	2303	10.47	2501	17.24	3217	22.98
INCOME														
TRA	24050	18.50	2405	18.50	3940	20.98	1813	18.50	4070	18.50	3022	20.80	2590	18.50
SRD1	2418	1.86	241	1.86	396	1.86	182	1.86	409	1.86	269	1.86	260	1.86
SRD2	7644	5.88	764	5.88	852	4.00	588	6.00	1760	8.00	807	5.57	1680	12.00
SCC	24700	19.00	2470	19.00	4047	19.00	3136	32.00	2200	10.00	2850	19.00	2520	18.00
VIABILITY PPT	+14471	+11.13	+2070	+15.92	-17	-0.08	-109	-1.12	+1767	+8.03	+521	+3.59	-627	-4.47
SST1	+16889	+12.99	+2311	+17.78	+379	+1.78	+72.7	0.74	+2176	+9.89	+791	+5.45	-367	-2.62
SST2	+22115	+17.01	+2834	+21.80	+835	+3.92	+479	+4.89	+3527	+9.44	+1329	+9.16	+1053	+7.52
TST	+46815	+36.00	+5304	+40.80	+4882	+22.92	+3615	+36.88	+5727	+19.44	+4179	+27.86	+3373	+25.52

TABLE 9.3 (Cont.) ASSESSMENT OF LOCAL AUTHORITY SCHEMES BASED ON THE STIRLING GLASS RECYCLING MODEL

FACTOR	STRATHCLYDE: CUMNOCK £	£/t	GLASGOW £	£/t	HAMILTON £	£/t	INVERCLYDE £	£/t	E KILBRIDE £	£/t	MONKLANDS £	£/t	RENFREW £	£/t	STRTKKLVN £	£/t
SIC	20	1.17	-	-	0	-	0	-	300	2.27	60	3.0	0	-	90	0.98
SKC	0	-	1664	3.13	568	3.15	1428	13.60	1260	9.54	330	16.50	1470	7.00	210	2.28
STC	0	-	0	-	0	-	0	-	0	-	0	-	400	1.90	0	-
SUC	20	1.17	1664	3.13	594	3.30	1428	13.60	1560	11.82	390	19.50	1870	8.90	300	3.26
CC	0	-	0	-	0	-	350	3.34	880	6.67	66	3.50	321	1.53	766	8.33
SM	0	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
SKM	0	-	0	-	0	-	0	-	100	0.76	0	-	0	-	50	0.54
KA	0	-	0	-	0	-	0	-	0	-	0	-	0	-	15	0.16
PUB	162	9.53	2970	5.59	360	2.00	370	3.52	283	2.14	369	18.45	700	3.33	290	3.15
BTR	0	-	2124	4.00	540	3.00	1019	9.71	396	3.00	80	4.00	602	2.87	230	2.50
OPC	162	9.53	5094	9.59	1494	8.30	1740	16.57	1659	12.57	515	25.75	1624	7.73	1351	14.69
TOTAL COSTS	182	10.70	6758	12.72	2062	11.45	3168	30.17	3219	24.38	905	45.25	3494	16.64	1651	17.95
INCOME																
TRA	0	-	4994	9.40	3330	18.50	5272	18.50	2442	18.50	370	18.50	4241	20.19	1702	18.50
SRD1	31	1.86	987	1.86	334	1.86	195	1.86	245	1.86	37	1.86	390	1.86	171	1.86
SRD2	27	1.63	3122	5.88	1058	5.88	1050	10.00	776	5.88	40	2.00	1234	5.88	368	4.00
SCC	268	15.75	10108	19.00	3145		960	9.14	2492	19.00	377	19.00	4500	21.67	2208	24.00
VIABILITY PPT	-148	-8.70	-1764	-3.32	+1268	+7.04	-1225	-11.60	-777	-5.88	-535	-26.75	+747	+3.56	+50	+0.55
SST1	-117	-6.80	-777	-1.46	+1602	+8.90	-1030	-9.81	-531	-4.03	-497	-24.89	+1138	+5.42	+221	+2.40
SST2	-90	-5.30	+1358	+2.56	+2326	+12.92	+20	+0.19	-1.28	-0.01	-495	-24.75	+1982	+9.44	+418	+4.55
TST	+178	+10.54	+11466	+21.55			+980	+9.33	+2490	+18.80	-118	-5.90	+6482	+30.86	+2626	+28.54

On a private viability basis (PPT), that is where costs are offset against revenue received from the sale of cullet, 11 of the Local Authorities make a surplus, with 13 making a loss. The cost component is split into Set Up Costs and Operating Costs. For most schemes it is the operating costs that have the greater impact.

Under Set Up Costs the main cost is Bank Costs, which can account for 100% of the costs. The impact of bank costs depends on whether banks are modified, bought new, and if there is any sponsorship. As Bank Costs make such a contribution to the costs they need to be clearly assessed, being discounted at market rates. The influence of the other Set Up Costs, depend on whether storage sites have to be built and the extent of any investment in site costs. The Set Up Costs are fixed, so after a scheme has been established any improvements will need to be sought in operating costs.

The main Operating Costs are collection costs, bulk transport costs and publicity costs. The effect of variations in these cost components is examined in Chapter 10.4.8 for the Hypothetical Local Authority.

Some of the surveyed Councils viewed the figure for Publicity Costs (PUB) as being too high, and did not incur them. The figure used in this assessment is based on Ho's Model (Chapter 10.3.2.e) and can be adjusted to meet the level of costs the Local Authorities actually incur. If publicity costs are zero, four of the Councils - Cumnock, Glasgow, W Lothian and Ettrick - would come into surplus. In the case of Cumnock the scheme was operated by a Private Company, so it is unlikely that publicity costs would be met by the Council. For the other Authorities, the removal of publicity costs would improve the viability of their operations.

Collection Costs (CC) are influenced by the quantity of material uplifted and whether uplift is undertaken by a Private Contractor or Council vehicle. The quantity uplifted can be influenced by the separation of the colours as compartments might not fill at the same rate. In Scotland most Authorities did not separate colours as they thought it would not be cost effective. To keep collection costs down Councils should monitor banks and uplift when they are full.

Bulk transport is incorporated at a fixed rate per tonne. The costs will be influenced by the quantity of glass transported, whether transport is undertaken by the Council or a Private Contractor, and whether the use of back haul rates can be adopted.

Operating costs are influenced by the quantity of materials recovered. If the amount of glass recovered is increased this can reduce the impact of operating costs, particularly publicity, administration and skip maintenance costs. It will have less impact on uplift and bulk transport costs.

Revenue received from the sale of cullet is based on a price of £18.50 for mixed cullet and £ 22.00 per tonne for clear cullet. An increase in the amount paid can improve the returns to the scheme. Operators should also look at the segregation of the different colours to increase revenue. Increased tonnages will lead to increased revenue which can improve the overall economics of the scheme.

Cumnock receives £ 2.00 per tonne from the private company that operated the scheme. This covered the site costs that the Council paid. If the Council operated the scheme themselves they would have to meet set up and operating costs. Glasgow also received a

return of £2.00 per tonne, as some of the glass collected in its area was by a private company. This reduces overall revenue, as well as saving on operating costs.

The assessment looks at the inclusion of savings in disposal costs. Their impact will depend on the disposal option used, and whether savings are passed on. Two figures are used for disposal cost savings (Section 8.2.3). The first (SST1) is based on work by RUSHBROOK (1984) used to produce an average disposal cost figure. The inclusion of this figure (£1.42) increases to 14 the number of Local Authorities in a position of surplus. It also reduces the losses incurred by the other 18 Authorities.

The second disposal cost figure (SST2) comes from the Local Authority Survey (Section 7.5.20). Either the actual figure given by the Council is used or an average figure based on the results of the survey. This figure was generally higher and when incorporated into the assessment 18 Authorities made a surplus with only 6 in deficit.

In the long term there could be savings in collection costs, from the reorganisation of collection activities. These savings could be assigned to the reclamation project. In this case only one authority would make a loss. This loss is due to the low tonnages of glass the scheme at present collects.

The inclusion of disposal and collection cost savings treats recycling as an integral part of the waste management system. These terms are separately assessed as disposal costs are not always passed on, and it is difficult to put a value on savings in collection costs. This allows the operator to review their schemes under their own terms and conditions.

The Stirling Model provides a standardised system of appraisal for Local Authority schemes. It takes a comprehensive view of the costs that are likely to be incurred, treating capital costs on their own merits at market rates. Revenue includes an evaluation for the sale of the different colours and the possibility of accounting for disposal cost savings and collection cost savings. The Model can be used to assess the viability of existing schemes, as a management tool to improve operations, and as a basis for comparing schemes on a like basis.

9.5 NPV Appraisal On The Stirling Costing System

9.5.1 Introduction

A shortcoming of the above three assessments is that they do not take into account the value of cash flows that occur over different time periods. Once a project has been established cash flows will occur in the future, which will need to be considered when evaluating glass recovery projects.

This shortcoming is overcome by the Discounted Cash Flow (DCF) Technique. This approach finds the present value of the expected net cash flows of an investment, discounted at the cost of capital and subtracts from it the initial cost outlay of the project.

The discount rate adopted under the DCF technique acts with the same purpose as the inclusion of interest charges on the estimated expenditures. Discount and interest rates adjust future cash flows both positive and negative, to bring them to a comparable basis. Interest rates achieve this by compensating the lender for any loss arising from having his purchase power pushed forward to a future time period. The discounting process seeks to convert future cash flows into their present value equivalent.

In general, waste management projects will have a negative NPV, as returns are likely to be small, with costs dominating any assessment. The DCF technique enables managers to assess the alternative waste management options - landfill, incineration, and reclamation projects - and rank them in order of their Net Present Value (NPV). The project with the better NPV (highest positive NPV, or lowest negative NPV) would normally be ranked first.

Once a reclamation scheme has been established the capital

investment has been committed, with the operator being faced with loan repayments as well as the operating costs that the scheme incurs. Thus at the outset the operator of a reclamation scheme as with any capital project should consider whether the benefits from the scheme over its operational life will justify the capital expenditure that is necessarily incurred.

WESTON & BRIGHAM (1978) use the following equation to establish a projects NPV:

$$NPV = \sum_{t=1}^{N} \frac{F_t}{(1 + k)^t} - I$$

where: F = Net Cash Flows
k = Marginal Cost Of Capital
I = Initial Cost Of Project
N = Project's Expected Life

The DCF technique involves the discounting of future cash flows, F; for each year of the project, N; to a current or base year by using a discount rate, k; to give a present value for that investment.

The DCF technique allows the decision maker to make an informed choice in conditions where cash flows of different sizes occuring in different time periods need to be considered. Any investment assessment has to be flexible in predicting cash flows. Cash flows are based on perceptions of future changes in relative costs and prices where there may be large amounts of uncertainty about their magnitude. To reduce the uncertainty of estimates used in investment appraisal, sensitivity analysis should be carried out to assess the influence on the NPV of changes in some of the key factors. It is important to assess a recovery scheme under a range of foreseeable alternatives.

Changes in the general level of prices over time will affect the

financial viability of proposed recovery schemes, as it is unlikely to affect all expenditure and revenue flows in the same way. These movements in prices will also affect the choice of discount rate used.

Problems with price fluctuations in the future can be minimised by evaluating a recovery scheme in terms of constant prices. Thus rather than make changes in the current money prices which incorporate the inflation rate, only relative price changes need to be included into the assessment. In general the costs associated with the recovery scheme are assumed to rise in line with general price levels so that their relative prices will remain constant. Thus if labour costs have risen faster than general price levels over the investment period, then allowance for this change will be made by increasing labour figures annually, in the NPV appraisal. A 'real' discount rate can be used to account for changes in price levels.

Capital expenditure is assessed in the year that it is incurred. This is counter to the other assessments where capital payments are treated as an annuity over the projects life time. Depreciation is ignored in an investment appraisal as it is not a cash flow, as the aim of the DCF technique is to relate all cash flows to a single point in time.

9.5.2 NPV Appraisal Of Operating Councils

The Local Authorities have been reappraised to produce a NPV figure for their recovery projects. The information and data used are drawn from the results of the Local Authority Survey (Chapter 7). The Local Authorities have been assessed using the Investment Appraisal model described in Appendix H.

With glass recycling schemes, the capital expenditure is relatively small, limited to: new Bottle Banks, storage bays, skip vehicles and glass crushers. Recycling schemes costs and revenue flows are based on direct cost and revenue components, and indirect costs and savings discused in terms of the viability model (Chapter 10). These cash flows have to be estimated for each year of the projects expected life.

The length of time chosen for an investment is generally based on the working life for the highest value asset. Most of the DOE's evaluation of waste management projects are based on a 10 year investment period. WMAC (1979) used a 5% discount rate following the publication of the Government's White Paper on Nationalised Industries (Cmnd 7131).

The same elements from the viability model (Chapter 10) are read to give the cash flows over the projects lifetime. From these net costs are produced for each year and are discounted at 5% to give the present value. These are summed to give the Net Present Value (NPV). A NPV can be calculated for a scheme on the basis of private costs, disposal costs and the total systems costs including collection costs. This permits the decision maker to make allowances to meet his own operating conditions.

The results of the NPV appraisal for operating Local Authorities are shown in Table 9.4.

Under conditions of NPV appraisal 18 Local Authorities have a positive NPV. These results need to be reviewed in terms of alternative methods of handling waste glass. If other options have a lower NPV than glass recycling projects, then glass recycling may prove to be the best option.

TABLE 9.4 NPV Appraisal Of Local Authority Glass Recovery Schemes

COUNCIL	ABERDEEN	BANFF	GORDON	KINCARDINE	DUNDEE	PERTH	DUNFERMLINE	N.E.FIFE	NITHSDALE	EDINBURGH	E.LOTHIAN	W.LOTHIAN
Set Up Costs:												
Site	- 600.0	- 228.0	- 285.0	- 285.0	- 324.0	- 140.0	- 120.0	- 240.0	- 160.0	- 1760.0	- 320.0	- 90.0
Skip	- 8000.0	- 7000.0	- 3250.0	- 1510.0	- 1200.0	- 2800.0	- 4200.0	- 4000.0	- 1290.0	-15400.0	- 4750.0	- 4500.0
Storage	- 600.0	- 600.0	- 1900.0	- 300.0	0.0	0.0	0.0	- 750.0	- 500.0	0.0	0.0	0.0
Crusher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Investment	- 9200.0	- 7828.0	- 5435.0	- 2095.0	- 1542.0	- 2940.0	- 4320.0	- 4990.0	- 1950.0	-17160.0	- 5070.0	- 4590.0
Operating Costs:												
CC	- 1203.3	- 440.0	- 500.0	- 463.3	- 1283.3	- 370.0	- 1426.7	- 1400.7	- 755.0	- 4333.3	- 433.3	- 958.5
SM	0.0	0.0	0.0	0.0	- 17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKM	- 300.0	0.0	0.0	0.0	- 360.0	- 160.0	0.0	0.0	- 200.0	0.0	0.0	- 30.0
A	0.0	0.0	0.0	0.0	- 200.0	0.0	0.0	- 100.0	0.0	0.0	0.0	0.0
PUB	- 845.4	- 320.0	- 261.2	- 176.0	- 746.0	- 503.0	- 479.7	- 273.8	- 220.0	0.0	- 330.0	- 494.4
BT	- 2996.3	- 825.0	- 700.0	- 1042.5	- 1960.0	- 785.5	- 856.0	- 764.0	- 1286.5	0.0	0.0	- 1065.0
STM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Op. Costs	- 5345.1	- 1585.0	- 1461.2	- 1681.8	- 4567.4	- 1791.5	- 2762.4	- 2538.5	- 2461.5	- 4333.3	- 763.3	- 2547.9
Income:												
Sales	+ 6678.5	+ 2035.0	+ 2098.0	+ 2571.5	+ 6475.0	+ 3422.5	+ 1979.5	+ 3533.5	+ 2793.5	+24050.0	+ 2405.0	+ 3940.5
Disposal	+ 1083.0	+ 646.8	+ 1100.0	+ 817.3	+ 2058.0	+ 462.5	+ 629.2	+ 1123.1	+ 887.9	+ 7044.0	+ 764.4	+ 852.0
Colln.	+ 6555.8	+ 2090.0	+ 3400.0	+ 2641.0	+ 6779.5	+ 555.0	+ 2033.0	+ 3629.0	+ 2869.0	+24700.0	+ 2470.0	+ 4047.0
Private Surplus:												
Net Cash	+ 1333.4	+ 450.0	+ 636.8	+ 889.7	+ 1907.6	+ 1631.0	- 782.9	+ 995.0	+ 332.0	+19617.7	+ 1641.7	+ 1392.6
NPV (5%)	+ 1096.5	- 4353.2	- 517.8	+ 4774.7	+13188.0	+ 9653.9	-10365.3	+ 2693.1	+ 613.5	+135086.9	+ 7607.5	+ 6163.1
Disposal Surplus:												
Net Cash	+ 2416.4	+ 1096.8	+ 1736.8	+ 1707.0	+ 3965.6	+ 2093.5	- 153.7	+ 2118.1	+ 1219.9	+27360.7	+ 2406.1	+ 2244.6
NPV (5%)	+ 9459.2	+ 641.2	+ 7976.1	+11085.9	+29079.4	+13225.2	- 5507.1	+11365.2	+ 7469.4	+194111.9	+13509.2	+12741.9
Total Surplus:												
Net Cash	+ 8972.2	+ 3186.8	+ 5136.8	+ 4348.0	+10745.1	+ 2648.5	+ 1879.3	+ 5747.1	+ 4088.9	+52060.7	+ 4876.1	+ 6291.6
NPV (5%)	+60081.0	+16779.6	+34230.0	+31479.0	+81428.9	+17510.8	+10191.2	+39387.4	+29623.1	+384838.8	+32581.7	+43991.8

TABLE 9.4 (Cont.) NPV Appraisal Of Local Authority Glass Recovery Schemes

COUNCIL	ETTRICK	ROXBURGH	FALKIRK	STIRLING	CUMNOCK	GLASGOW	HAMILTON	INVERCLYDE	E.KILBRIDE	MONKLANDS	RENFREW	STRATHKELVIN
Set Up Costs:												
Site	- 30.0	- 30.0	- 232.0	- 70.0	- 20.0	- 80.0	- 30.0	- 60.0	- 300.0	- 60.0	- 210.0	- 90.0
Skip	- 1500.0	- 900.0	- 3400.0	- 4000.0	0.0	0.0	- 1800.0	- 4098.0	- 4200.0	- 1100.0	- 3500.0	- 1400.0
Storage	- 900.0	- 100.0	- 1000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- 2000.0	- 2000.0
Crusher	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Investment	- 2430.0	- 1030.0	- 4632.0	- 4070.0	- 20.0	- 80.0	- 1830.0	- 4158.0	- 4500.0	- 1160.0	- 5710.0	- 3490.0
Operating Costs:												
CC	- 325.7	- 293.3	- 483.3	- 606.7	0.0	- 1770.0	- 202.0	- 353.5	- 873.3	- 66.7	- 322.0	- 766.7
SM	0.0	0.0	0.0	- 280.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SKM	- 45.0	- 60.0	- 80.0	- 150.0	0.0	0.0	0.0	0.0	- 90.0	0.0	0.0	- 50.0
A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- 15.0
PUB	- 143.0	- 150.0	- 504.0	- 280.0	- 162.3	- 2970.0	- 360.0	- 370.0	- 330.0	- 369.1	- 700.0	- 290.0
BT	- 686.0	- 880.0	- 271.2	- 560.0	0.0	- 2124.0	- 180.0	- 1019.5	- 393.0	- 80.0	- 724.5	- 230.0
STM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Op. Cost	- 1200.6	- 1383.3	- 1338.9	- 1876.7	- 162.3	- 6864.0	- 742.0	- 1743.1	- 1686.3	- 515.8	- 1746.5	- 1351.7
Income:												
Sales	+ 1813.0	+ 4070.0	+ 2931.9	+ 2590.0	+ 314.5	+ 9823.5	+ 1110.0	+ 1942.5	+ 2423.5	+ 370.0	+ 4095.0	+ 1702.0
Disposal	+ 588.0	+ 1760.0	+ 807.7	+ 1680.0	+ 27.7	+ 3122.3	+ 352.8	+ 1050.0	+ 770.3	+ 40.0	+ 1234.8	+ 368.0
Colln.	+ 3136.0	+ 2200.0	+ 2755.0	+ 2520.0	+ 267.8	+10089.0	+ 1140.0	+ 959.7	+ 2489.0	+ 380.0	+ 4550.7	+ 2208.0
Private Surplus:												
Net Cash	+ 612.4	+ 2686.7	+ 1593.0	+ 713.3	+ 152.2	+ 2959.5	+ 368.0	+ 199.4	+ 737.2	- 145.8	+ 2348.5	+ 350.3
NPV (5%)	+ 2298.6	+19715.7	+ 7668.6	+ 1438.2	+ 1155.3	+22772.5	+ 1011.6	- 2617.9	+ 1192.2	- 2285.5	+12424.5	- 784.8
Disposal Surplus:												
Net Cash	+ 1200.4	+ 4446.7	+ 2400.6	+ 2393.3	+ 179.9	+ 6081.8	+ 720.8	+ 1249.4	+ 1507.4	- 105.8	+ 3583.3	+ 718.3
NPV (5%)	+ 6838.9	+33305.9	+13905.1	+14410.7	+ 1369.2	+46881.9	+ 3735.8	+ 5489.9	+ 7140.1	- 1976.6	+21959.3	+ 2056.8
Total Surplus:												
Net Cash	+ 4336.4	+ 6646.7	+ 5155.6	+ 4913.3	+ 447.7	+16170.8	+ 1860.8	+ 2209.1	+ 3996.4	+ 274.2	+ 8134.0	+ 2926.3
NPV (5%)	+31054.3	+50293.8	+35178.5	+33869.5	+ 3436.7	+124786.5	+12538.6	+12900.5	+26359.5	+ 957.6	+57098.6	+19106.4

If disposal cost savings are included, 22 Local Authorities would have positive NPVs. The inclusion of collection savings would give all of the Local Authorities a positive NPV.

The negative NPVs of some Local Authorities result from high initial skip and storage costs that have been incurred. These high costs are not offset by revenue received from the sale of cullet. In these cases low recovery tonnages or high costs of collection and bulk transport costs mean that revenues are not high enough to overcome costs incurred, and thus cover the initial investment costs.

Dunfermline has high initial skip costs, due to the size of skip adopted. This choice resulted in higher collection costs, which the low tonnages of glass recovered are unable to offset through revenue received. It is with the inclusion of disposal cost savings that the Dunfermline project has a positive NPV.

Banff, Gordon, Inverclyde and Monklands also have high initial skip costs. Although capital cpsts are relatively small in year zero, if in subsequent years revenue does not exceed operating costs, then the project will inevitably have a negative NPV.

The decision maker should reappraise the NPV projects under differing conditions to see what effects they might have on the results. This can be done utilising the computer based model in Appendix H, where the key factors can be altered.

If participation rates and waste generation levels are altered, this will affect the NPV value achieved and needs to be examined. In addition different discount rates should be examined, as they will influence the discounted value of the cash flows that are summed up. Also, effects of changes in some of the key costs -

site collection and bulk transported - should be considered.

The NPV appraisal can be used to evaluate glass reclamation projects over the lifetime of the project. As capital costs are relatively small in year zero, the life of the project beyond a certain point has little effect provided revenue exceeds operating costs. If a project has already been established, the capital costs would be treated as sunk costs and ignored. In this case, as long as revenue covers operating costs, the NPV will be positive. The NPV technique will be of value in assessing the possibility of expansion with new capital invested in Banks, Storage and vehicles. The project could then be reassessed to take account of the new investment decision.

9.6 Comparisons Of The Assessment Models

The financial viability of glass recovery schemes depends on assessing the costs in relation to the revenue earned. The costs for the different Local Authorities for the various factors will be influenced by: distance from the market, size and density of the area, the level of public participation, and the collection system adopted.

Table 9.5 shows the results of the four assessments. The Oxford results are in tonnes, the actual tonnage collected minus the calculated breakeven tonnage. The Cleveland and Stirling results are in £s per tonne. The NPV figure is in £s, and is an assessment over the project's life. A positive figure means that the scheme is viable given the constraints of the costing system it is calculated under. The results vary, illustrating the importance of having a standard cost framework to assess reclamation schemes. This is important at a time when there are strict financial controls on Local Authorities imposed by Central Government, where all operations need to be justified.

The first three assessments, review glass recovery schemes over a specific year, taking a short term view of operating conditions. Whereas the NPV technique appraises recovery schemes over the projects expected life.

The GMF/Oxford Assessment indicates the breakeven tonnage required by a Local Authority run glass recovery scheme. These tonnage figures are influenced by the capital costs of bottle banks and storage facilities that a recovery scheme meets. When bulk transport costs are included this adversely affects the viability of the Local Authority schemes; increasing the tonnage of glass

TABLE 9.5 A Comparison Of The Results From The Assessments

COMPARISONS

COUNCIL / APPRAISAL	GRAMPIAN: ABERDEEN	BANFF	GORDON	KINCARDINE	TAYSIDE: DUNDEE	PERTH	FIFE: DUNFERMLINE	N.E.FIFE	DUMFRIES: NITHSDALE	LOTHIAN: EDINBURGH	E.LOTHIAN	W.LOTHIAN
Oxford ($AT-t_1$)	+ 256	+ 15	+ 14.1	+ 115	+ 334	+ 153	+ 18	+ 142	+ 124	+ 1076	+ 83	+ 148
($AT-t_2$)	+ 136	- 107	- 78.5	+ 93	+ 323	+ 143	- 421	+ 114	+ 79	-	+ 73	+ 113
Cleveland (£/tonne)	+ 4.22	- 1.35	+ 6.62	+ 10.49	+ 13.65	+ 12.0	- 4.07	+ 8.9	+ 8.28	+ 18.48	-	+ 8.9
Stirling												
Private Costs PPT(£/t)	- 4.53	- 11.65	- 9.13	+ 9.30	+ 5.28	+ 3.67	- 19.12	- 3.53	+ 0.49	+ 11.13	+ 15.92	- 0.08
Disposal Surplus SST1(£/t)	- 2.67	- 10.87	+ 1.86	+ 11.16	+ 7.14	+ 5.53	- 17.26	- 1.67	+ 2.35	+ 12.99	+ 17.78	+ 1.78
SST2(£/t)	- 1.53	- 6.85	+ 11.00	+ 15.18	+ 11.16	+ 6.17	- 13.34	+ 2.35	+ 6.37	+ 17.01	+ 21.80	+ 3.92
Total Surplus TST(£/t)	+ 16.60	+ 12.15	+ 30.00	+ 34.18	+ 30.52	+ 9.17	+ 5.17	+ 21.35	+ 25.33	+ 36.00	+ 44.00	+ 22.92
NPV (5%) Private Surplus	+ 1096.5	- 4353.2	- 517.8	+ 4774.7	+13188.0	+ 9653.9	-10365.3	+ 2693.1	+ 613	+135086.9	+ 7607.5	+ 6163.1
Disposal Surplus	+ 9459.2	+ 641.2	+ 7976.1	+11085.9	+29079.4	+13225.2	-5507.1	+11365.2	+ 7469.4	+194111.9	+13509.2	+12741.9
Total Surplus	+60081.0	+16779.6	+34230.0	+31479.0	+81428.9	+17510.8	+10191.2	+39387.4	+29623.1	+384838.8	+32581.7	+43991.8

TABLE 9.5 (Cont.) A Comparison Of The Results From The Assessments

COMPARISONS

COUNCIL / APPRAISAL	ETTRICK	ROXBURGH	FALKIRK	STIRLING	CUMNOCK	GLASGOW	HAMILTON	INVERCLYDE	E.KILBRIDE	MONKLANDS	RENFREW	STRATHKELVIN
Oxford ($AT-t_1$)	+ 59	+ 212	+ 92	+ 84	+ 9	+ 224	+ 44	+ 42	+ 61	+ 5.5	+ 145	+ 78.24
($AT-t_2$)	+ 12	+ 205	- 20	-	-	-	+ 40	- 71	- 97	0.0	+ 129	+ 73.75
Cleveland (£/tonne)	+ 8.16	+ 18.15	+ 11.52	+ 20.11	-	-	+ 16.72	- 7.47	+ 7.84	- 3.83	+ 14.23	+ 10.52
Stirling PrivaTE Costs PPT(£/t)	- 1.12	+ 8.03	+ 3.59	- 4.47	- 8.7	- 3.32	+ 7.04	- 11.60	- 5.88	- 26.75	+ 3.56	+ 0.55
Disposal Surplus SST1(£/t)	+ 0.74	+ 9.89	+ 5.45	- 2.62	- 6.8	- 1.46	+ 8.90	- 9.81	- 4.03	- 24.89	+ 5.42	+ 2.40
SST2(£/t)	+ 4.89	+ 9.44	+ 9.16	+ 7.52	- 5.3	+ 2.56	+ 12.92	+ 0.19	- 0.01	- 24.75	+ 9.44	+ 4.55
Total Surplus TST(£/t)	+ 36.88	+ 19.44	+ 27.86	+ 25.52	+ 10.54	+ 21.55		+ 9.33	+ 18.80	- 5.90	+ 30.86	+ 28.54
NPV (5%) Private Surplus	+ 2298.6	+19715.7	+ 7668.6	+ 1438.2	+ 1155.3	+22772.5	+ 1011.6	- 2617.9	+ 1192.2	- 2285.5	+12424.5	- 784.5
Disposal Surplus	+ 6838.9	+33305.9	+12905.1	+14410.7	+ 1369.2	+46881.9	+ 3735.8	+ 5489.9	+ 7140.1	- 1976.6	+21959.3	+ 2056.8
Total Surplus	+31054.3	+50293.8	+35178.5	+33869.5	+ 3436.7	+124786.5	+12538.6	+12900.5	+26359.5	+ 957.6	+57098.6	+19106.4

that is required for a scheme to breakeven. To improve operating conditions managers need to closely control costs and maximise tonnage uplifted from sites.

The Cleveland assessment adopts a more realistic approach to the cost factors it incorporates. In general, the schemes making a loss under Oxford, t_2, make a loss under the Cleveland Assessment.

Both schemes spread capital costs over a fixed period in equal instalments. In addition Cleveland incorporates an interest charge on the debt. Although capital costs are relatively low it is important that they should be assessed at market rates conforming to Local Authority policy on waste management decisions. With storage and banks there are two different life expectancies which should be considered when assessing costs. This occurs with the Stirling Model, where storage has a life of 10 years and banks 5 years. Under NPV capital costs are accounted for in the year that they occur, in most cases this is year zero. Component life is considered as this will influence the time scale adopted for the NPV appraisal. The DOE use 10 years in their assessment of waste management projects.

When assessing capital costs and operating costs the Cleveland and Stirling models assess them against the tonnage of glass recovered. To improve the viability of a scheme the operator should seek to maximise the tonnage of material handled, to reduce the influence of the costs on the overall assessment.

The Stirling Model adopts a comprehensive approach to the cost factors. The Stirling Model separates costs into two groups: Set Up Costs and Operating Costs. This division reflects the different factors in establishing a scheme and those in operating a scheme

on a daily basis. This division will assist the Manager in identifying where improvements might be made. Capital costs are spread over the life of the component at market rates of interest. The revenue received is based on the return from the sale of the different colours of glass.

The NPV appraisal takes account of the time value of cash flows, assessing projects over their expected life. Projected cash flows are discounted to the present to give the NPV value for the glass recovery project. This NPV figure can be used as part of the decision making process on whether to pursue and develop glass recycling projects.

The NPV technique assigns capital costs to the year that they incur, whereas the other schemes spread costs over the units expected life as an annuity. This different approach to capital costs will influence the results of any appraisal.

Assessing cash flows over the life of the project allows the operator to assimilate disposal cost savings on a sounder basis. Disposal cost savings in the short term are likely to be marginal, with possibly more significant savings in the long term from reorganisation of waste management services. The inclusion of disposal and collection cost savings depend on long term reorganisation (Chapter 8.2). These savings can be better included in an evaluation over the projects expected life.

When comparing the NPV appraisal with the Stirling assessment there are several differences in the final results. Where the NPV was positive under a private surplus assessesment, it was negative on the financial appraisal. This reflects the different ways of treating capital, either depreciating it over its expected life,

or accounting for it in the year that it occurs. Also under the financial assessment capital costs had a 10% interest rate. Whereas under NPV capital costs are incorporated in year zero at their full value, and it is subsequent cash flows that are discounted, in this case by 5%. In addition, the different lives of Banks (5 years) and Storage facilities (10 years) need to be reviewed. These differences need to be accounted for when examining the results of the appraisals.

Once a scheme has been established, the NPV appraisal is of limited value. In such cases capital costs are treated as sunk costs, and are ignored. Then if the projected revenues cover the operating costs the scheme will have a positive NPV. This situation is examined for the Stirling Model in Chapter 10.

The NPV technique can be used to examine the effects of expansion of recovery projects, with the introduction of new Bottle Banks. Also the effects of changes in key factors can be considered at the outset. Any assessment is dependant on a clear assessment of future operating costs and revenue, and as such will need to be examined under varying conditions.

Glass recovery can be treated as a marginal activity, that is carried out as an adjunct to the Local Authorities duties on waste collection and disposal. When evaluating a recovery scheme it is important to establish the extent to which capital costs can be offset by sponsorship, and operating costs to existing expenditure headings.

In any assessment it is important that Local Authorities include those externalities that will have a financial consequence for their waste management activities. In this case a Council should

consider likely savings in disposal costs, and long term collection costs. The GMF assessment does not account for either of these benefits. Cleveland included the possibility of disposal savings in their analysis. The Stirling Model made allowance for the possibility of both disposal and collection savings being evaluated in the viability assessment. The NPV appraisal with its wider time horizon can clearly more justify the inclusion of disposal and collection savings.

This does not mean that other externalities discussed in Chapter 8 should be ignored. They should be reviewed as part of wider policy initiatives developed by Local Authorities and Central Government.

If the costing system shows a positive contribution for the glass recovery operation it should be pursued. If the assessment shows a net loss when disposal savings are included it is up to decision makers to judge whether the external benefits not included in the costing system are worth the cost. Such judgements will need to be made in light of alternative disposal options and National policy on recycling and waste management.

It is essential when assessing schemes to take account of all relevant factors. It is necessary to view reclamation as part of the whole waste management system accounting for effects on disposal and collection operations. The Stirling Model offers a comprehensive framework for assessing the viability of recovery schemes. Its use of computer techniques allows the operator to assess the system under varying conditions to see what improvements might be made. This is complemented by the NPV appraisal, which takes a long term view. NPV allows recovery schemes to be assessed over a number of years, and include disposal and collection savings on a sounder basis.

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RUSHBROOK P E (1984) The Technological Economics Of
Collection And Landfill Disposal Of
Municipal Waste In The United Kingdom
PhD Thesis University Of Stirling

Chapter 10

The Stirling Glass Recycling Model

10.1 Introduction

The Stirling Model described below has been developed to be used by any Local Authority, or other operator of a glass recovery scheme based on the Bottle Bank system. The Stirling Model provides a consistent basis for evaluating recovery schemes, and a means of assessing ways of improving operating conditions.

The necessary data can be gathered using the Summary Cost Tables (Appendix F.1). These Tables breakdown the glass recovery system into three elements: Set Up Costs, Operating Costs and Income. By using the Summary Tables the operator can immediately assess the net viability of their scheme. This synopsis provides the Base Case, which can be used to undertake sensitivity analysis of the cost factors.

The data gathered is in a form that can be inputed into the computer model (Appendix F.3). The results from this model include: profit figures, tonnage figures, and breakeven prices; given the Local Authorities operating conditions. These results can be used to give the operator an insight into the effect of changes in participation rates, recovery rates, and tonnage on the viability measures.

From this base case the operator can evaluate the effect of changes in the key cost factors to see what improvements might be made.

To assist operators, a separate User Manual is to be developed to help in their use of the Stirling Model.

The advantage of the Stirling Model is that it allows the operator to make a clear assessment of their glass recovery scheme, and justify operational decisions taken. The Stirling Model can be used to assess how well the scheme is doing, and then evaluate the effect of possible changes in operating conditions on the viability measures.

The Stirling Model provides a standardised framework for assessing the viability of glass recovery schemes. Costs have been built up in a series of stages to produce a final bottom line figure. The model aims to provide a simplified and generalised view of the important characteristics of the recycling system. The use of the computer model will allow managers to assess the key factors in their recycling operations under varying conditions.

10.2 Components Of The Model

The components of the Stirling Model are:

1. Waste Generation
2. Costs - Set Up Costs
   - Operating Costs
3. Revenue

There are three sources of waste glass: households, commercial and industrial (Section 3.2). Local Authority glass recovery schemes are primarily concerned with wastes from households and certain

trade sources. This Chapter looks at collection from housholds, with collection from trade sources in Chapter 11.

HO (1982) defined the following model to establish the generation of waste from domestic premises (Section 3.2.1):

$$GRT = 0.052 * M * W * ID$$

Where:

GRT = Gross Recovered Tonnage Of Glass (Tonnes)

ID = Number of Domestic Premises

W = Average weight (Kg) of glass generated per premises per week

M = Participation ratio of households: M = 1 represents 100% participation.

Both Trade and Domestic glass recovery schemes lay emphasis on the participation rates achieved, and the level of generation of glass from the different premises. The domestic model is based on data derived from the local authority survey (Chapter 7), and has been developed on the large bank system. The models can be used to assess the profitability of existing operations. This enables local authorities to identify key cost factors and focus resources on the most critical areas. The trade and domestic models can overlap sharing key resources, although they can be assessed separately. Initially, the domestic system is examined, with the trade system as an adjunct. The model also allows the operators to work out the minimum glass prices needed for the scheme to breakeven.

The substantiation of the cost and revenue factors considered in the Model are outlined below.

10.3 The Stirling Glass Recycling Model

This is based on a scheme using large banks operated by the Local Authority, with glass primarily coming from domestic sources. The viability of a scheme is based on the assessment of the following criteria:

1. Setting Up Costs
2. Operating Costs
3. Income

10.3.1 Setting Up Costs (SUC)

This includes:	Site Costs	(SIC)
	Skip Costs	(SKC)
	Storage Costs	(STC)
	Upfront Publicity Costs	(UPC)
	Crusher Costs	(CRC)

Total Setting Up Costs will be denoted by:

$$SUC = SIC + SKC + STC + UPC + CRC$$

10.3.1.a Site Costs (SIC)

Site costs are dependant on the site chosen. In the first instance prime supermarket car parks will be adopted. This will help to minimise costs.

$$\text{SITE COSTS, } SIC = ((SKA + TAR + RAI + KL)/T) + CPR$$

where: SIC = Site Costs

SKA = Administration Costs
TAR = Tarmac Base
RAI = Railings
KL = Cost of Litter bin
L = Number of litter bins
T = Amortisation Period (Years)
CPR = Loss In Car Park Revenue

Administration costs (SKA) on the final choice of sites, agreements with land owners, the need for planning permission and the final choice of the operation system. This to some extent develops from the Feasibility Study (FST) already undertaken. As

it is part of an Officers job to establish an optimum waste management system, no extra cost will be incurred, and thus can be treated as zero.

Dependant on the site chosen additional infrastructure might be necessary, such as: Tarmac Base (TAR) to reduce site maintenance problems, railings (RAI) to keep vehicles away from the banks, litter bins (KL) to take empty boxes. Supermarket car parks are already tarmaced, and laid out for cars. If they get too close to the banks old kerb stones can be sited to keep vehicles at a distance, and thus ease pick-up problems. These costs are likely to be zero.

The only extra cost may be the siting of a litter bin (KL), but this might be avoided by resiting an existing litter bin. The value of Litter Bins (KL) in reducing problems has been challenged by some authorities. Those people responsible enough to bring bottles, will usually be responsible enough to take any boxes and bags away with them.

Dependant on the site, there might be a loss of car park revenue (CPR) for the period of use. This will depend on there being a charge for use of the car park, ie the type of site: supermarket, council or private. Usually supermarkets see it as a benefit and do not charge for the use of their site.

In the majority of cases these costs will be zero. In the beginning the council will start with a small scheme using prime sites. As the scheme becomes more established, sites can be made more elaborate with painted decals on the ground to mark the site, notice boards explaining the benefits of the scheme and what it has achieved.

Site Costs (SIC) should be amortised over a period of operation (5 years) rather than be accounted for in the first year.

10.3.1.b Skip Costs (SKC)

Skip Costs (SKC) are treated as capital costs, discounted over a period of time (Private Companies use 5 years). Costs are dependant on the size of the bank bought, whether able to modify existing skips, and whether these can be offset by local sponsorship.

SKIP COSTS, SKC = BKC + (MOD) - SPN

where: BKC = ((N * BKC)/IYC) * ((1 + (PWLB * IYC)/100))

N = Number of Banks
BKC = Cost of Banks

IYC = Time Period
PWLB = Interest Rate

MOD = Modified Skips
= ((NMD * CMD)/IYC) * ((1 + (PWLB * IYC)/100)

NMD = Number of skips modified
CMD = Cost of Modification

SPN = (NSP * CSP)
SPN = Sponsorship
NSP = Number sponsored
CSP = Cost of sponsorship.

The least costly method to the council would be sponsorship, followed by modification of existing skips and finally the purchase of new skips.

10.3.1.c Storage Costs (STC)

Storage is important to spread out transport costs over a greater quantity. Should store a minimum of 20 tonnes for a bulk load. Also a Council needs to decide whether they will store the colours separately. This will influence collection costs, which along with

storage costs need to be offset against improved revenue received from the glass collected. Options for storage include:

1. Existing unused storage bays on Council's land.
2. Council land that can have bays built on.
3. Private Company storage.
4. Use of Demountable Body.

If have existing bays that are not being used the cost to the scheme will be zero. May need to consider the opportunity costs of the land if the land can be used for another purpose or sold. If need to build new bays, this will be treated as a capital cost to be spread over a set time period. There is a need to establish costs of constructing bays to keep glass colours separate and hold 20 tonnes.

STORAGE COSTS, STC = KT + RV

where: KT = (KS/IYS) * (1 + (PWLB * IYS)/100)

KS = Storage Costs
IYS = Time Period
PWLB = Interest Rate

RV = Rateable value of land

In construction the Council should seek to minimise costs by making use of existing materials - railway sleepers, breeze blocks surrounding a concrete base.

If storage facilities are provided by Private firms there may be a specific charge, or a reduction in the purchase price received for the cullet. The charge could be per tonne of material stored, or more likely at a rate per year for a set area of a company's depot. One private company pays the Councils less per tonne as it incurs the costs of bulk transport to the processor.

If a Council has a bulk vehicle it may have 'spare' demountable

bodies that could be used to store glass. With demountable bodies there is a need to look for a two tier structure, so banks can be unloaded direct into the body without necessitating the use of mechanical shovels. The cost will either be the purchase of a demountable body, or the use of an under used one that the council already owns. There may be an opportunity cost if it can be used for something else.

10.3.1.d Upfront Publicity

The Glass Manufacturers Federation normally help in the initial publicity and promotion of any new bottle bank scheme. This will take up the Administrators time, but most of the material will come from the local representative of the Glass Maunfacturers, as well as from the National office of the GMF.

10.3.1.e Crusher Costs

CRUSHER COSTS, CRC = (CAP/IYC)*(1+(PWLB*IYC)/100)

where: CAP = Crusher Capital Cost
IYC = Life Of Crusher
PWLB = Interest Rate

Some Councils have installed crushers to reduce the volume of material for bulk transport and can increase the quantity of material transported. Most Councils feel that the operation of pick-up and emptying at storage sites breaks up bottles enough and the use of a crusher is not justified.

A number of companies produce bottle crushers of varying specifications. Rankinco Ltd produce a hand operated crushing machine, at a price of £550 plus VAT complete with stand. The same unit with an electric motor costs £600 plus VAT. This unit can handle all sizes of bottle up to a champagne bottle size.

10.3.2 Operating Costs (OPC)

This includes:

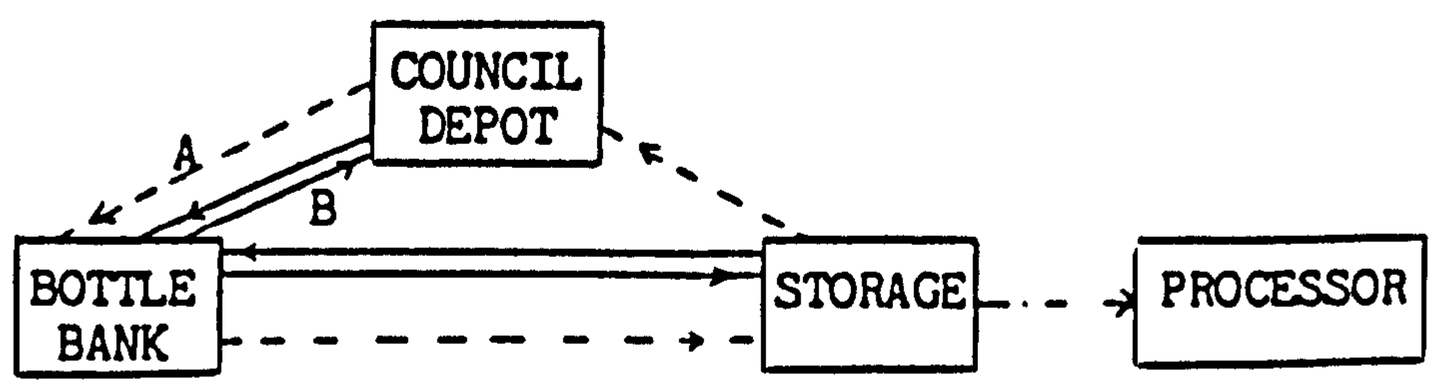
1. Collection Costs (CC)
2. Site Maintenance (SM)
3. Skip Maintenance (SKM)
4. Administration (KA)
5. Publicity (PUB)
6. Bulk Transport (BTR)
7. Storage Maintenance (STM)
8. Crusher Costs (COC)

Thus operating costs can be described by the formula:

$$OPC = CC + SM + SKM + KA + PUB + BTR + STM + COC$$

10.3.2.a Collection Costs (CC)

Large Bank Council Operated:



There are three collection options:

A. Local Authority can take empty skips to site and exchange for full skip; maintaining service to the site.

B. Local Authority can pick up 'full' skip; take to processor/storage; and then return emptied skip to site.

C. Use of private contractors.

Collection costs will be sensitive to distance and the quantity of material collected, and will reflect whether an empty skip is taken to the site to replace the full one or whether the skip is taken away from the site leaving it empty for a period. The 'spare' or 'float' skip can be sited on a Civic Amenity site to collect glass while not in use for collection.

Ease of site access will dictate the time of pick-up and necessity of overtime payments. With car park sites access may be blocked or difficult during certain times of the day, resulting in the need

for an early morning or evening pick-up. This can cause a noise nuisance to nearby residents.

Cleveland (1980) established the following equation to assess average costs of skip uplift:

a. This is dependant on the taking of an empty skip to the site, to replace the full one which is brought back to the storage/process site.

$$\text{COLLECTION COSTS, } CC = \frac{1}{n} \sum_{i=1}^{n} \frac{(2xi + h)}{s} * c$$

where:

CC = Average Cost per skip movement.

n = Number of skip sites.
s = Average speed of skip vehicles (21 mph)
xi = Distance between each of sites and central storage/processor, total distance (miles).
h = Handling time per cycle for mechanical operation (20 minutes).
c = Cost of vehicle per hour.

This is based on delivery of empty skip to site being swapped for the full skip which is then delivered to storage site. For pick-up of the full skip and then return emptied to the site, the above formula can be adapted to:

b. This is dependant on picking up the full skip from the site, taking it to be emptied at the storage/process site, and then returning the empty skip to the site, with the vehicle returning to the depot.

$$\text{COLLECTION COSTS, } CC = \frac{1}{n} \sum_{i=1}^{n} \frac{(4xi + h)}{s} * c$$

Most Council's cleansing departments 'hire' vehicles from Transport Department at a fixed rate and do not have the breakdown of actual cost factors. They are charged a notional rate per hour. A more detailed examination of vehicle costings is given in Appendix F.2. The model relies on a figure per uplift (CC), which is then divided by the banks capacity (V) to give a per tonne figure. This is a generous figure for filling and the model has

been tested for different filling rates. Being simply a rate per uplift this can incorporate pick-up by either council or private contractor.

The problem of using a contractor is that he may wish to operate on a fixed schedule, which might not suit site needs. Council vehicles can operate a flexible collection system operating when needed, thus dictated to maximising the tonnage uplifted.

If councils already have a vehicle, collection costs will be marginal. They will need 1 driver, whose cost will be wage rate (DW per hour) times the time taken (TH, hours). This will depend on the distance and whether swap skips. Cost per tonne will be dependant on tonnage collected. As fixed costs will have to be paid anyway, collection costs can be treated as marginal costs, ascribing a proportion of running costs plus drivers wages. When the vehicle is fully utilised by the scheme then all fixed and operating costs would be assigned.

The need for additional specialised vehicles will depend on the number of sites, the collection time, and other demands on Council vehicles.

Also may need to assess weighbridge costs, if before delivering to the storage/processor site the vehicle is weighed. This will add to the time taken for collection, and can increase the costs.

The emptying schedule will depend on filling rate (r) achieved, which needs to be monitored through a 'pilot study', or the routine activities of the street cleansing teams. This is the area where costs can be controlled, by uplifting only when skips are full. Should aim for the skips to have 2.5+ tonnes to minimise average costs per tonne for each skip movement.

The quantity collected in a bank will be influenced by the size of compartments if the bank is segregated to collect the different colours. Once one compartment is full arrangements for uplift will have to be made even if the other compartments are partly filled. Care needs to be taken in deciding the compartment sizes, which will be influenced by the production and consumption breakdowns: Clear (75%), Green (20%), Amber (5%). A lot of councils have split banks into two: clear and mixed. This reduces the potential revenue slightly, with a reduced price for green glass, but means banks will be fuller when uplifted. Other Councils have decided just to collect mixed glass, reducing the revenue potential. As a scheme becomes established, the Council could expand through siting a smaller or modular bank to collect green or mixed glass.

In the long term cost savings lie here through maximising containers contents before uplift, and taking advantage of Council vehicle infrastructure.

10.3.2.c Site Maintenance (SM)

These can be separately accounted for, or incorporated in the Council's general street cleansing costs. If the Bank is withdrawn the street will still need cleaning - although maybe to a lesser extent - can view as a marginal cost.

Incorporate site maintenance costs as the wage rate (WR) times the number of hours the work takes (TM).

SITE MAINTENANCE, SM = (WR * TM) * n

where: WR = Wage Rate
TM = Number of Man-Hours worked
n = Number Of Sites

The 'cleaner' could always be asked to monitor the rate of filling (r), to help minimise the costs of uplift per tonne.

10.3.2.d Skip Maintenance (SKM)

This is an important element as the maintenance of a good public image may help participation rates. Skip maintenance counters problems of graffiti and vandalism. There is a chemical available to remove graffiti. Vandalism is part of a wider social problem that requires a more defined approach and is not part of the remit of this work.

Some problems can occur, in the handling of banks during uplift and transport. Loose chains on skip vehicles knocking against banks can cause damage. This can be overcome by keeping chains under tension. The drivers need to kept aware of the problem, and be encouraged to take care in container handling.

Costs are dependant on the bank material type. Some maintenance will be met by the Private Companies that operate the schemes. For some Councils a proportion of these costs has been offset by a one off grant from the British Soft Drinks Council (BSDC).

SKIP MAINTENANCE, SKM = (MC + LAB) * n - G

where: MC = Materials Cost
LAB = Labour Costs
n = Number Of Banks
G = Grants

The GMF provide the following figures on estimated costs:

Skips -	Clean-up	£50 - 80 per annum.
	Re-furbish	£80 -100 per 18 months
Bins -	clean-up	£25 - 40 per annum
		2% of Capital Costs.

If banks have been sponsored, these costs would be met by the sponsors. Although Glass companies are reluctant to refurbish banks its worthwhile to contact them in the first instance for advice. Companies do have stencils to lend, which can be used to spray on logos within 10 minutes.

10.3.2.e Administration

If recovery scheme is terminated, administration overheads will remain, so can treat as a marginal cost. Unless Council employs a person specifically for the job - Recycling Co-ordinator.

Can specifically cost: Number of hours (TA) times the wage rate (WA) plus a proportion of the overheads.

ADMINISTRATION, KA = (WA * TA) + Proportion of Overheads

where: WA = Wage Rate (Rate per Hour)
TA = Time Taken (Hours)

10.3.2.e Publicity (PUB)

Publicity campaigns are required to stimulate and maintain the recycling consciousness amongst the general public. Such campaigns should be aimed at the identified 'marginal' recyclers who either currently participate but would not continue to do so unless their interest is sustained, or who do not participate.

Publicity is split between Council, and local GMF representative. Costs are totally dependant on what level of publicity operators want to achieve. It is best to approach the local glass recycling company to see what they recommend. The current view is to try and increase the number of sites, as people seeing them is the best form of advertisement for the scheme. The repeated sighting of banks brings them, and keeps them in the public consciousness.

TURNER (1978) for paper recovery felt that a publicity drive is needed every 3 to 4 months to maintain levels of public interest and support. For glass the best time is after the public has faced a lot of problems, ie when they have a lot of glass waste - after Xmas, and during summer when more beverages are consumed in glass

packaging. After the public has faced a problem of a lot of glass waste, can get the recycling message home a lot quicker.

There are several possibilities:

1. National Publicity Drives - these are put forward and met by funds through the Glass Manufacturers' Federation.
   E.g. Glass Recycling Year, 1982 (Ali Jamja)
   National Bottle Bank Bonanza, 1984.
   National Advertising Campaign, 1986.

2. Feature articles in Local Papers - costs time of officer to inform papers. Use to publish milestones of the scheme E.g. First 100 tonnes, 500 tonnes, 1000 tonnes etc. Also can use to inform where revenue is going - to charities, or to rates fund.

3. Posters

4. Adverts in Local Papers, on sides of collection vehicles.

5. Items in Departments' Publicity brochures.

6. Schools - Information Weeks, usually promoted by GMF.

Publicity requires continuous prodding, and can be seen to have two phases:

A. Educational - to inform the public about the scheme; how they can participate; and what the benefits are.

B. Reinforcement - this will be continuous, to keep the scheme in the public eye; through publicising milestones achieved.

The simpler the message the better. Councils can use competition between areas in one town to encourage rivalry and public support. This was successfully done in Reading. Links with charities have been successful in boosting participation, particularly the more emotive areas of: cancer research, handicapped, kidney dialysis, and other local charities. Look at positive re-inforcements - monetary awards.

HO (1982) produced the following equation to assess publicity

costs. For a town of 45,000 domestic premises publication and the distribution of leaflets and posters will cost £500 per annum. Thus:

$$\text{ANNUAL PUBLICITY, PUB} = \frac{ID}{45{,}000} * 500$$

$$= 0.01 * ID$$

where: ID = Number of Domestic Premises

Some Councils feel that this cost might be high, although FOE Resourcesaver found they were spending £250 per month, about £1000 per 45,000 domestic premises. This cost will vary significantly between local authorities.

10.3.2.f Bulk Transport (BTR)

This will involve loading (TL) and transport (TR) activities, and can be carried out by Council or Contract vehicles. These costs will be marginal if Council has existing vehicles and loaders to carry out the activity. Normally, the Transport Department charges the 'Cleansing Department' a fixed sum per vehicle used.

Bulk loading will necessitate use of a mechanical shovel - 20 minutes for 20 tonnes. This would be a marginal cost using existing equipment and labour, with the extra cost being the extra fuel used, the additional wear and tear on the vehicle, and the opportunity costs of the labour and machinery if it could have been used for other tasks.

BULK TRANSPORT, BTR = (TR+TL)

where: TR = Transport Costs (£'s per tonne)
TL = Loading Costs

If the Council needs an extra vehicle then will have to amortise the costs over the appropriate period. Although as vehicle will

only be used for part of the time, should use a proportion of the costs allocating the extra costs of usage incurred to the operation of the scheme.

10.3.2.g Storage Maintenance

These can be incorporated in normal depot activity if storage is part of an existing Council unit. If a special storage site has been built away from normal Council activities then they can be costed separately as wage rate (WS) times time taken (TS). This is needed to contain glass in the compounds provided and prevent it becoming a hazard.

STORAGE MAINTENANCE, STM = (WS * TS)

where:
WS = Wage Rate
TS = Time Taken (Man-hours)

This activity could be part of the mechanical loaders activities, after the vehicle has been loaded.

10.3.2.h Crusher Usage Costs

Use of a crusher will reduce the volume of glass to be transported and may bringdown transport costs. This activity would be done prior to loading at storage site. Costs will primarily be labour. Additional costs for maintenance and electricity dependant on machine used.

CRUSHER USAGE COSTS, CUC = LC + Mn + Pr

where:
LC = Labour Costs
Mn = Maintenance
Pr = Fuel Costs

10.3.2.i Summary

OPERATING COSTS, OPC = CC + SM + SKM + KA + PUB + BTR + STM + CUC

10.3.3 Income

This consists of 3 elements:

1. Revenue (TRA)
2. Disposal Cost Savings (SRD)
3. Savings in Collection Costs (SCC)

10.3.3.b Revenue (TRA)

From the sale of collected cullet the Council will receive a revenue, the amount dependant on quantity and whether glass colours segregated. Thus:

$$\begin{aligned} \text{REVENUE, TRA} = {} & P1 * PCG * 0.052(M * W * ID) \\ & + P2 * PGG * 0.052 * (M * W * ID) \\ & + P3 * PMG * 0.052 * (M * W * ID) \\ & + P4 * PAG * 0.052 * (M * W * ID) \end{aligned}$$

where:
P1 = Price of Clear Glass (CG)
P2 = Price of Green Glass (GG)
P3 = Price of Mixed Glass (MG)
P4 = Price of Amber Glass (AG)

PCG = Percentage by weight of Clear Glass
PGG = Percentage by weight of Green Glass
PMG = Percentage by weight of Mixed Glass
PAG = Percentage by weight of Amber Glass

M = Participation ratio of households
W = Average weight (kg) of glass per household
ID = Number of Domestic premises

In addition if a Private Company operates in the Council's area, the Council may receive a nominal return on the quantity collected (£2 per tonne), or a similar amount may go to a local charity.

10.3.3.c Disposal Cost Savings (SRD)

Through glass being put into banks it reduces the flow of materials entering the domestic waste stream, which may lead to less materials having to be collected and disposed. Such benefits need to be incorporated in an overall social appraisal of the scheme, and are looked at in more detail in Chapter 8.2.

With every tonne of glass recovered, there will be a reduction in the amount of waste to be disposed, which can lead to savings in refuse disposal costs. Thus:

DISPOSAL COST SAVINGS PER ANNUM, SRD = (Y * 0.052 * (M * W * ID))

where: Y = Disposal Cost Savings per tonne

The level of savings that a Council may achieve will depend on the disposal options adopted - Landfill, Incineration, Etc.

10.3.3.d Savings In Collection Costs (SCC)

Local Authority collection costs are determined primarily by their legal obligations to collect domestic wastes and by the character of the area in which collections are made. The length of collection rounds and thus the number of vehicles and staff is largely fixed by factors such as population density of the area, type of housing development and the location of waste collection facilities. Thus collection costs are unlikely to be responsive to small fluctuations in the volume of waste generated by individual households.

But in the long term with less waste to be collected there maybe improvements in collection efficiency, with the re-organisation of collection rounds and thus a reduction in overall collection costs (Chapter 8.2.4). In more rural areas, where collection distances are long, these savings may be less apparent unless collections could be made on a fortnightly basis rather than weekly.

Thus:

SAVINGS IN COLECTION COSTS, SCC = (R * 0.05 * M * W * ID)

where: R = Collection Cost per tonne

10.3.4 Net Cost Of Operating Glass Recycling Scheme

Costs:

FST - Feasibility Study
SUC - Setting Up Costs
OPC - Operating Costs

Income:

TRA - Revenue from sale of cullet
SRD - Disposal Cost Savings
SCC - Savings in Collection Costs

Net Costs

1. Operating Surplus: TRA - (FST) - (SUC + OPC)

2. Disposal Surplus: (TRA + SRD) - FST - (SUC + OPC)

3. Systems Surplus: (TRA + SRD) - FST - (SUC + OPC) + SCC

A positive result indicates a net surplus by the local authorities from the operation of the glass recovery scheme. If the assessment shows a net loss when disposal savings are included it is up to the Local Authority to decide whether the wider external benefits described in Chapter 8 are worth the loss incurred. Such judgements will be based on treating recycling as an integral part of the waste management system, and in terms of a national policy for recycling.

10.4 Application Of The Stirling Model

10.4.1 Introduction

To illustrate the application of the model, a hypothetical local authority (HLA) has been assessed. The characteristics of this authority have been drawn from the results of the survey of participating local authorities. It is primarily based on Scottish Local Authorities. Restricting it to Scotland has a number of advantages. All the authorities deliver to the same cullet processor, so the price received for the cullet is constant. The examination of local authorities could be transferred to the catchment areas of other processors throughout Britain. Confining it to Scotland avoids the division between collection and disposal authorities that occurs in England, as these responsibilities are combined at District Council level. In Scotland the introduction of reclamation schemes can have a direct influence on the authorities collection and disposal practices.

The viability model is run for the HLA to produce a standard set of results. From this base case a series of sensitivity analyses are undertaken of the key factors to see what affects this have on the standard set of results.

10.4.2 Characteristics Of Hypothetical Local Authority

The hypothetical local authority has the following characteristics:

Population (IP)	=	126,978
Number Of Domestic Premises (ID)	=	48,837
Number Of Commercial Premises (IC)	=	4,204
Area Served By The Authority	=	79,358 Hectares
Population Density	=	1.6 persons per hectare

This would represent one of the more urban areas of Scotland.

10.4.3 Characteristics Of Glass Recycling Scheme

The authority operates a glass recycling scheme based on the use of 8 large banks. These were bought for the purpose at £746 each through the Council's own resources, with no assistance from sponsors. These are the standard banks with a capacity of 3 tonnes. The costs of the banks are spread over a period of 5 years at an interest rate of 10% per annum. They have been sited at local supermarkets where there is sufficient car park space, thus keeping the site costs down. The only extra costs are for litter bins which are purchased at a cost of £35 each.

Storage needs are met by a purpose built facility that has been constructed on existing Council land. Two bays are provided to keep clear and mixed glass apart. The bays were built at a cost of £1040 for the two bays. Each bay can hold 20 tonnes. The use of storage ensures that their is sufficient cullet for bulk transport, enabling costs to be spread over the maximum load. Storage costs are treated as a capital investment that is spread over 10 years at an interest rate of 10% per annum.

It is felt that publicity to promote the glass recycling scheme will be provided by the GMF through their local representative. In addition the Council Officer would be involved with the preparation of press releases to the local media. These are treated as marginal costs, in this case zero.

To reduce the volume of the collected glass a crusher can be employed. However, with the sequence of handling of the glass it is felt that the glass would be broken up to a sufficient extent to make the use of a crusher unnecessary.

Table 10.1 Characteristics Of Hypothetical Local Authority (HLA) - Bottle Bank Scheme

Population	: 126,978
Number Of Domestic Premises	: 48,837

Set Up Costs

	£	
Site Costs:		
Administration Costs:	0	
Costs Of Tarmac:	0	
Costs Of Railings:	0	
Costs Of Litter Bins:	35	
Number Of Litter Bins:	8	
Loss Of Car Park Revenue:	0	
Skip Costs:		
Number Of Bottle Banks:	8	Life of Banks: 5 years
Cost Of Bottle Banks:	£746	
Number Of Bottle Bins:	0	
Cost Of Bottle Bins:	£300	
Number Of Modified Banks:	0	
Cost Of Modified Banks:	0	
Number Of Sponsored Banks:	0	
Revenue From Sponsors:	0	
Cost Of Storage Bays:	£1040	Life of Storage: 10 years
Rateable Value	0	
		Interest Rate: 10%

Operating Costs

Collection Costs:	£9.47	per uplift
Site Maintenance:	£0.15	per uplift
Skip Maintenance:	£80.00	per skip
Administration:	£100.00	per year
Publicity:	0.01	* ID
Bulk Transport:	£4.0	per tonne
Bulk Loading:	£0.5	per tonne

Income:

Revenue:		
Sale Of Clear Glass:	£22.00	per tonne
Sale Of Mixed Glass:	£18.00	per tonne
Percentage Of Clear Glass:	0.6	
Percentage Of Mixed Glass:	0.4	
Other Benefits:		
Disposal Costs	£1.42	per tonne
Collection Costs:	£19.00	per tonne

10.4.4 Operating System

The banks will be serviced by Council skip vehicles, being uplifted when they are full. After operating for a period a data set will be built up so that the Council Officer can predict when uplift would be necessary. The filling rate can be monitored by street cleansing teams or the supervisory staff. An empty bank is taken to the site and swapped for the full bank, which is then taken to the storage site to be emptied. The vehicle is hired internally at a fixed rate per uplift. Dividing by tonnage uplifted gives the cost per tonne.

The banks are split into two compartments to keep clear glass separate from the rest of the material. The split is dependant on the amount of glass that can be picked up in an area. After several uplifts a clearer picture of the split can be found, and compartment sizes can be adjusted to maximise the loads uplifted in each compartment. In this case the division is in favour of clear glass, with 60% of the bank set aside for clear glass and 40% for mixed. Glass is segregated to try and maximise the revenue acheived from the recycling scheme.

Maintenance costs are split into site and skip costs. Site maintenance costs are marginal being incorporated into the general street cleansing costs, and a notional sum is assigned to the bottle bank scheme, in this case £0.15 per uplift. The only extra costs may be in the provision of litter bins, which have been incorporated into site costs. Skip maintenance costs are dependant on the skips chosen. Provided care is taken in handling during uplift these costs can be restricted to combating problems of vandalism and graffiti. These will be up to £80 per skip per annum, giving a total cost of £640. There is no sponsorship to

offset these costs.

Administration costs are felt to be marginal, as even if the scheme is terminated these costs will still be incurred. In this case the administration costs are assiged a notional sum, incorporated as £100 per annum. If the scheme is successful the employment of a recycling co-ordinator could lead to some administration costs being assigned to the scheme.

Publicity and promotional activities are necessary to maintain the public's interest. These will be through the use of posters, leaflets, and the use of press releases to mark targets the scheme has reached. Costs will be in the order of £500 per 45,000 premises; and will vary between Councils, and the support provided through the GMF with their National campaigns.

The bulk transport of the collected cullet is handled by a private haulier at a fixed rate. The contractor is hired when a 20 tonne load is ready to be delivered. This is at a fixed rate per tonne, in this case £4.00 per tonne. In addition there is the cost of bulk loading at £0.50 per tonne.

The final cost of storage maintenance is felt to be a marginal cost, which can be incorporated into the normal activities of the depot staff, or as part of the duties of the bulk loader. This is treated as zero for this authority.

10.4.5 Income

These costs of operating the recycling scheme are offset by the revenue obtained from the sale of glass. In addition the Council may achieve benefits through savings in disposal costs, and in long term collection cost savings.

10.4.5.a Revenue

Revenue is from the sale of cullet to the processor at a price of £22 per tonne for clear glass and £18 per tonne for mixed glass. The revenue is dependant on the cullet being accepted under their quality restrictions and on the split between clear and mixed glass, and the total tonnage recovered.

10.4.5.b Savings In Waste Disposal Costs

Waste is disposed of predominantly by means of landfill (Table 10.2). RUSHBROOK (1984) estimated that for a landfill site handling between 10 to 500 tonnes per day, the annual operating cost (Y) is related to the daily disposal tonnage (X_D) by the relation $Y = 3586X_D^{0.51}$. This formula can be used to compute an average waste disposal cost by landfill for the hypothetical local authority, giving an average value of £1.42 per tonne (Table 10.3). This is less than the costs noted in the survey of the local authorities, which on average were £5.88 per tonne.

10.4.5.c Savings In Collection Costs

In the long term the recovery of glass could lead to savings in collection costs incurred by the authority. From the survey of Local Authorities an average collection cost of £19.00 per tonne was given, and was adopted for the hypothetical authority.

TABLE 10.2 Methods And Disposal Of Waste In England And Wales (CIPFA 1981)

METHOD	1974/5 %	1975/6 %	1976/7 %	1977/8 %	1978/9 %	1979/80 %
LANDFILL - Untreated	84	75	73	71	71	71
LANDFILL - After Shredding	4	4	4	3	3	2
DIRECT INCINERATION	6	8	9	9	9	8
SEPARATION & INCINERATION	2	2	1	1	1	1
CONTRACTOR & OTHER WDA's	3	10	12	15	15	17
COMPOSTING & OTHERS	1	1	1	1	1	1
TOTAL	100	100	100	100	100	100

Source: CIPFA Statistics (1981)

TABLE 10.3 Average Waste Disposal Cost Of Hypothetical Local Authority

Average Waste Generated per premise per week = 11.03 kg

Number of Domestic Premises = 48,837

Domestic Waste Generated Per Annum = 28,011 tonnes

Average Tonnage Disposed Per Day (250 Days Per Annum) = 112 tonnes

Annual Operating Cost $Y = 3586X_0^{0.51}$

$= 3586 * 112^{0.51}$

$= 39784$

Average Waste Disposal Cost Y = £1.42 per tonne

Source: Rushbrook P (1984)

10.4.6 Computer Runs

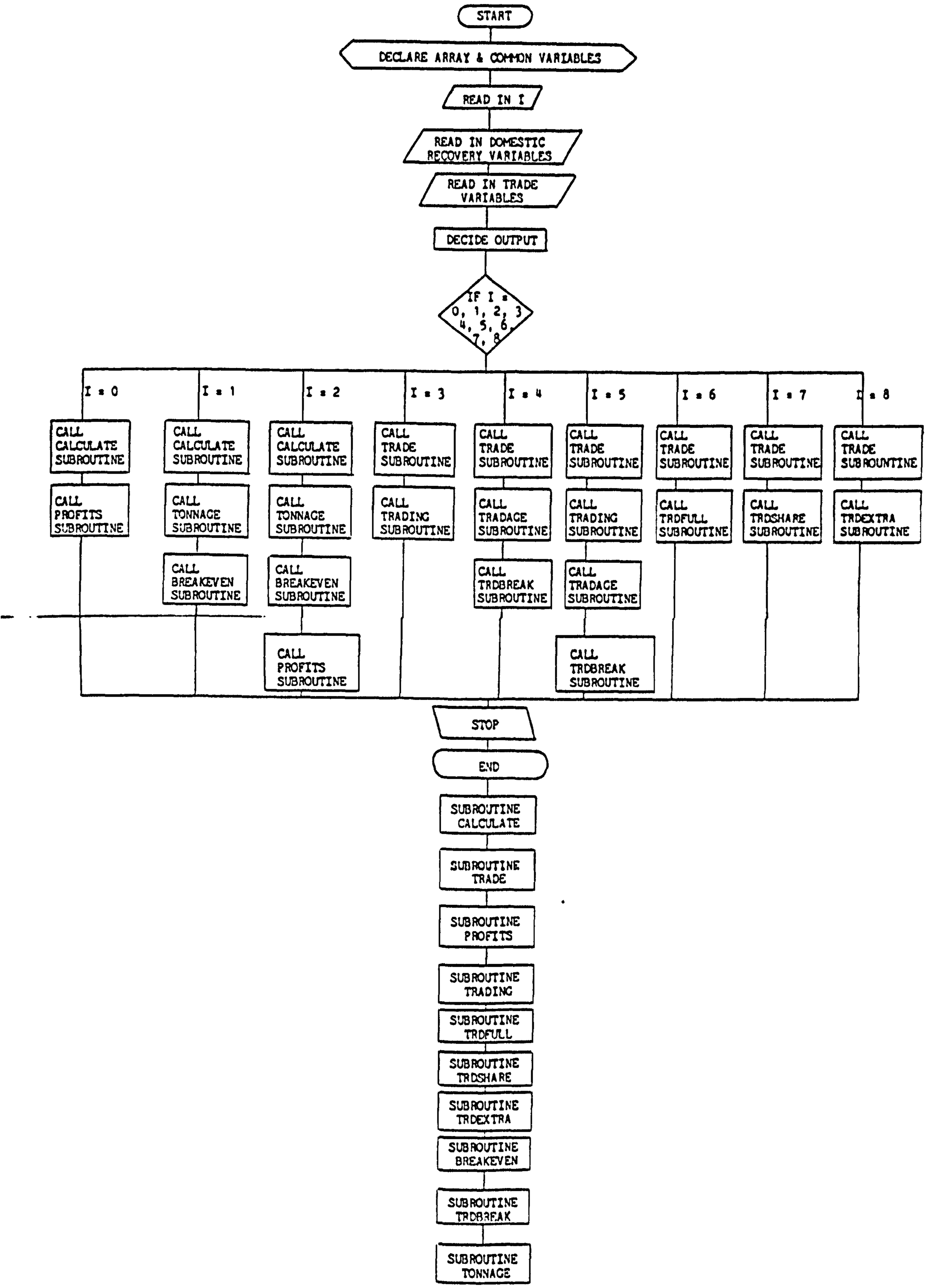
Figure 10.A shows the program algorithim for the viability model. The program consists of a series of sub-routines: Calculate, Profit, Tonnage, Breakeven, Trade and Trading. The sub-routines called depend on the output required. Domestic collection schemes and trade collection schemes are treated separately. Details of the FORTRAN program listing is provided in Appendix F.3.

The first run is based on the conditions provided by the Hypothetical Local Authority (HLA). It is confined to glass from the domestic waste stream, with household participation rates ranged from 1 to 100%. The generation of glass from households ranges from 0.1 kilogrammes to 1.1 kilogrammes per week, in steps of 0.1 kilogrammes. It is a combination of these two factors - participation and waste generation - that produce the total tonnage figures. Prices paid by the processor are £22 per tonne for clear glass and £18 per tonne for mixed glass. For the HLA a sample of the results from the first run are shown in Appendix F.5.

10.4.7 Results Of The Computer Run

The program covers both Household and Trade glass collection schemes, with the route followed through the program dependant on the control variable I. Routes 1,2, and 3 refer to collection through the Bottle Bank scheme, and routes 4 to 8 refer to a Trade Collection scheme (Chapter 11). For the Bottle Bank System, the control variable I decides output options required. For I = 0, only the profits are printed out. For I = 1, the tonnages achieved and break-even prices are printed out. For I = 2 profits, tonnages and breakeven prices are printed out.

FIGURE [illegible] — Algorithim of Class Recycling Viability Model



The print out of tonnage shows the total tonnage of glass waste that can be produced under varying participation rates and glass generation levels from domestic households. It is on the basis of these tonnage figures that the operating costs are calculated on a per tonne basis, and that the total revenue figures are derived. As expected the tonnages increase as participation rates increase and generation levels increase.

The tonnage achieved will ascertain the breakeven price that will be required to cover the operating costs. The breakeven price print out gives the average breakeven price for the various participation rates and generation levels achieved. The breakeven price will be influenced by the operating system adopted. As operating costs are spread over a greater tonnage the breakeven price will fall, and the scheme will become more profitable.

The profits print out provides three sets of figures reflecting the strict financial costs of the operating system, and the more contentious issues of disposal cost and collection cost savings. These three net costs - private viability, disposal system surplus and the total systems surplus - are printed out separately under the profits subroutine. It is felt that these three viability assessments should be kept separate, as it reflects the varying approaches of different Councils. Some Councils assess schemes strictly in terms of financial costs and benefits. Others mention the potential disposal cost savings that are available which should be incorporated into the assessment. Then in the long term collection costs savings may be achieved and should be associated with the Bottle Bank scheme. By keeping these three measures separate it allows Council's to assess schemes under their own terms. In England and Wales there is a demarcation between WCAs

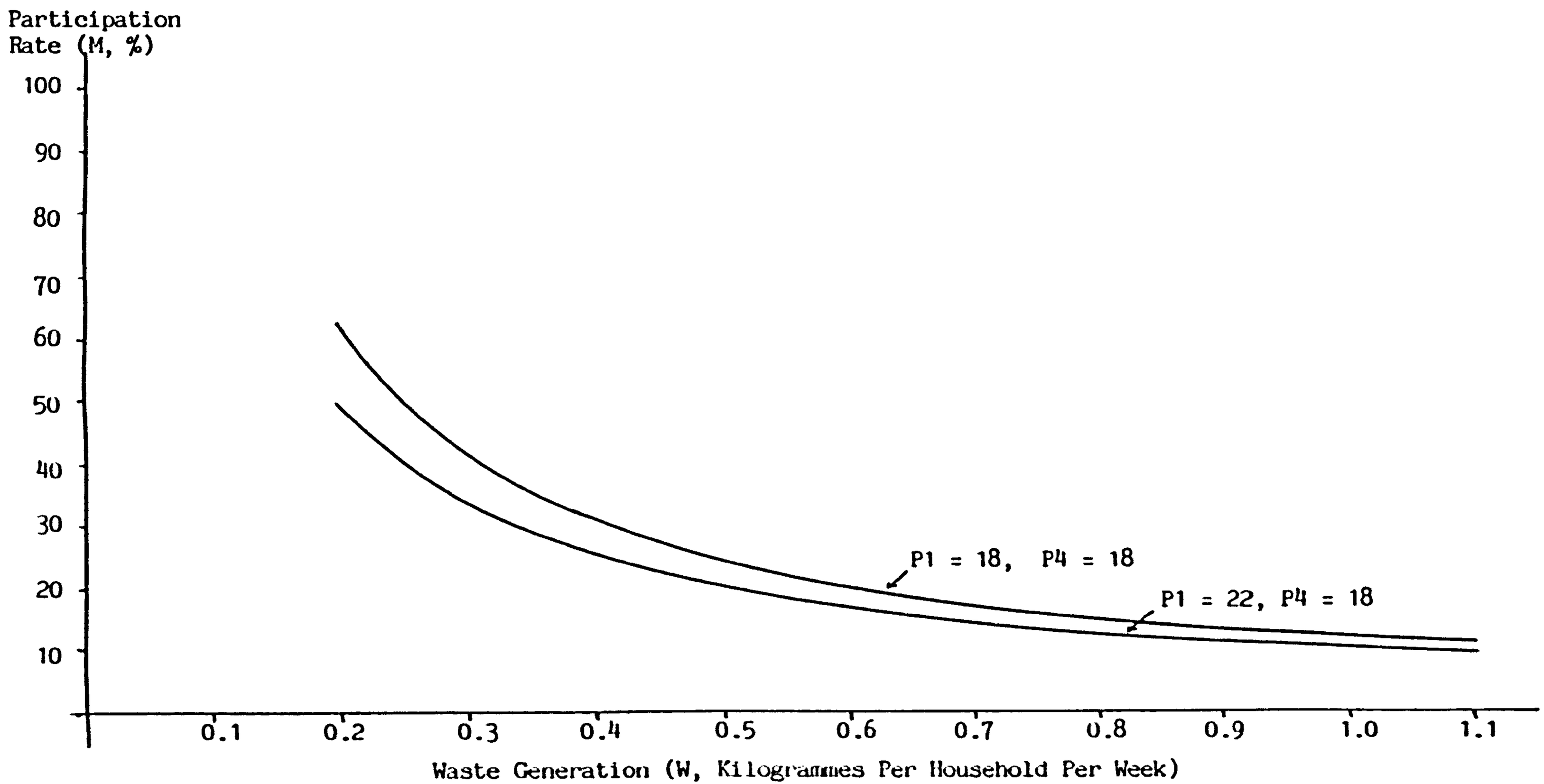
and WDAs which is reflected in the construction of this model through keeping these measures separate.

The profits tables lists the profit possible for each participation rate, and waste generation level from households. A negative figure means a loss has been incurred. These profits tables show that the more waste glass that is collected the more likely the scheme is to be profitable. Economies of scale can be achieved with the collection of waste glass.

By comparing the actual tonnage of glass collected, with the output tables from the computer model the operator will be able to compare their operations with those predicted by the model. From this they will be able to see what improvements they need to make in their operations to achieve a breakeven target. Using this model the operator will be able to monitor the viability of their recycling schemes, over a period of time. As most local authorities will have a number of population centres, the possible generation of waste will vary across the district. The operator can use the tables to guide its actions, by concentrating on the higher population centres with its resources.

Figure 10.B shows some breakeven boundaries for the glass recycling model. This is based on the private financial viability only and looks at the model under a series of price conditions. The operator can use these boundaries to ascertain what participation rate and generation level is needed for the scheme to breakeven, at varying price levels. Based on the minimum price of £18 per tonne received for mixed glass and a glass generation rate of 0.2 kg per week, a participation rate of 63% will be required for the scheme to breakeven. If an average glass generation level is taken of 0.6 kg per week, a participation rate

FIGURE 10.B Profit/Loss Breakeven Boundaries Under Varying Prices
(Based on PPT - Private Financial Appraisal)



of 20% is needed for the scheme to breakeven. As a households glass generation will vary from 0.1 to 1.1 kg per week, with only a proportion of this being recycled; participation levels will be the key factor in influencing the conditions for breakeven. To enhance the operating conditions the operators need to maintain and improve participation levels and to maximise the proportion of glass that is recovered from each household. A good response of 25% of an area's household will need to recover 0.4 kg of glass from each household to break-even at the price received of £18 per tonne.

If the possible disposal cost savings and collection cost savings are incorporated into the assessments, this will push the profit/loss boundaries to the left increasing the area where operations will be profitable. At £18 per tonne for mixed glass and a glass generation of 0.2 kg per week, the participation rate needed to breakeven will be reduced to 56% if disposal cost savings are included (Figure 10.C). And a participation rate of 20% if collection cost savings are included as well (Figure 10.D). This stresses the importance of examining the waste management system as a whole.

From the breakeven boundaries it is possible to refer back to the tonnage tables to see what tonnage is necessary for the scheme to breakeven. On a private financial appraisal (PPT) the scheme needs to recover between 254 and 259 tonnes of glass. This can be achieved at different participation rates and waste generation levels. These tonnage breakeven boundaries are shown in Figure 10.E. This figure shows that the recovery scheme can breakeven at a participation rate of 17% and a waste generation level of 0.6 kg per week; or alternatively at a participation rate of 12% and a

FIGURE 10.C Profit/Loss Break-Even Boundaries
- Based On Disposal Surplus (STS) - includes Disposal Cost Savings

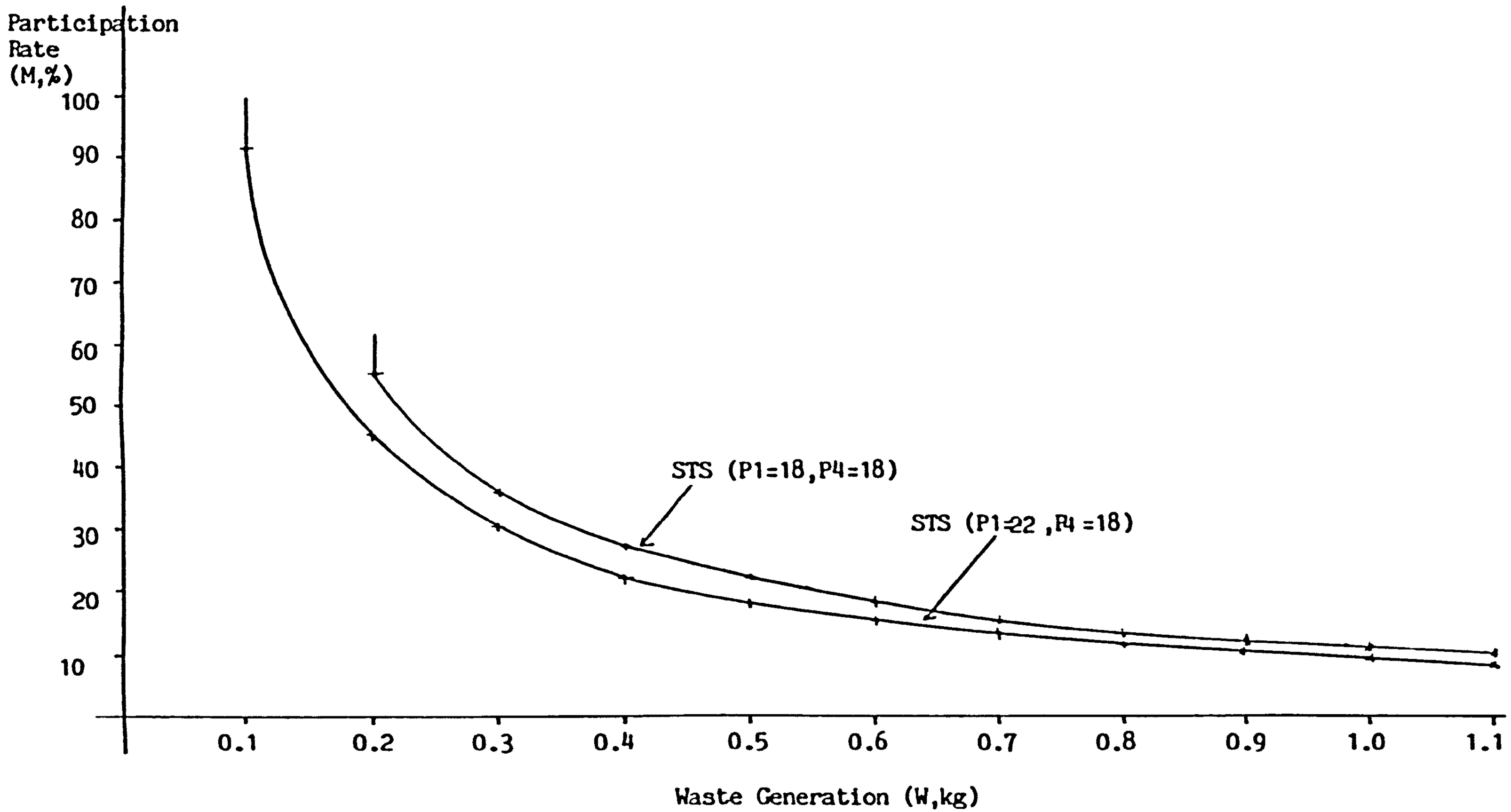
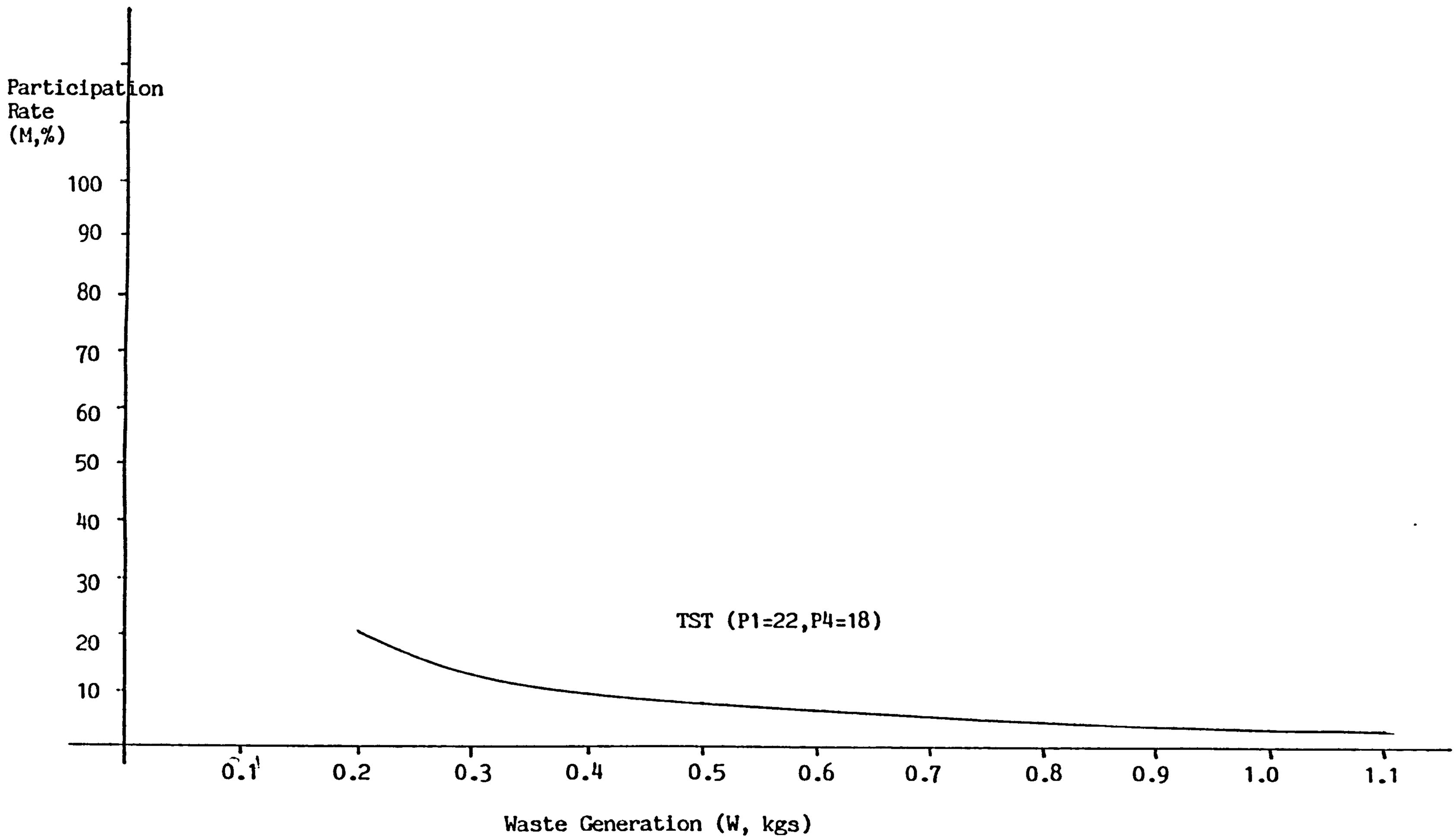


FIGURE 10.D Profit/Loss Break-Even Boundaries
- Based On Total Systems Surplus (TST) - Includes Disposal and Collection Costs Savings



waste generation level of 0.9 kg per household per week.

If disposal cost savings and collection cost savings are included in the assessment this will reduce the amount of glass that needs to be collected for the recovery scheme to breakeven. With just disposal cost savings included (SST) the tonnage of glass required for the scheme to breakeven lies between 231 and 233 tonnes per annum. Whereas if collection cost savings are included as well as disposal cost savings the breakeven tonnage boundary is pushed to the left in Figure 10.E and lies between 96 and 99 tonnes per year. In both cases these breakeven tonnages can be achieved under varying participation and waste generation rates.

10.4.8 Varying Conditions

Four scenarios are examined under varying conditions. Each scenario is based on different participation rates and glass waste generation levels and thus on different tonnages of glass recovered. These have been taken from the results of running the viability model on the HLA. A breakdown of the operating costs, revenues and resultant net effects for each scenario is shown in Table 10.4.

The four scenarios chosen represent a cross section of the possible operating conditions. They are confined to participation rates at or below 20% as this reflects what operating authorities have achieved. They straddle the breakeven boundaries, so any changes in operating conditions may have a marked effect.

In examining the different conditions, any changes are noted with reference to the private financial viability measure (PPT) only. From this measure the effect on the other terms (SST, TST) can be perceived.

FIGURE 10.E Tonnage Breakeven Boundaries
(Shown for Private Costs (PPT), Disposal Surplus (SST), Total Surplus (TST))

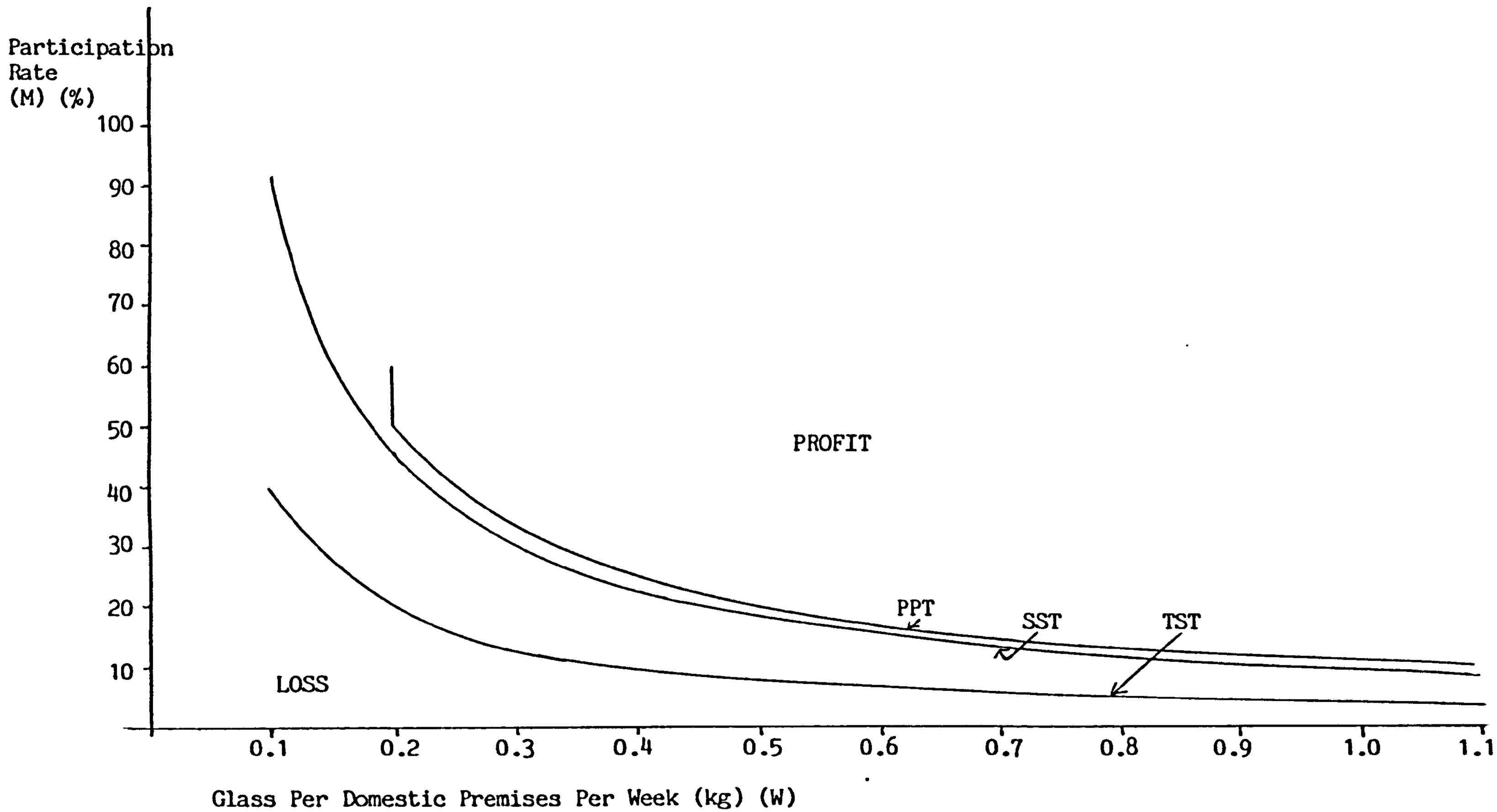


TABLE 10.4 Summary Of Bottle Bank Costs Under A Selection Of Participation And Generation Rates

Participation	10	10	20	20
Waste Generation	10	4	4	10
Tonnage Generated	254	101.6	203.2	507.9
SET UP COSTS				
Site Costs	56.0	56.0	56.0	56.0
Bank Costs	1790.4	1790.4	1790.4	1790.4
Storage Costs	208.0	208.0	208.0	208.0
Publicity Costs	0.0	0.0	0.0	0.0
Crusher Costs	0.0	0.0	0.0	0.0
TOTAL	2054.4	2054.4	2054.4	2054.4
SUCPT = SUC/GRT	8.1	20.2	10.1	4.04
OPERATING COSTS (£/tonne)				
Collection Costs	3.16	3.16	3.16	3.16
Site Maintenance	0.05	0.05	0.05	0.05
Skip Maintenance	2.52	6.23	3.15	1.26
Administration	0.39	0.98	0.49	0.19
Publicity	1.92	4.83	2.40	0.96
Bulk Transport	4.50	4.50	4.50	4.50
Storage Maintenance	0.0	0.0	0.0	0.0
Crusher Usage	0.0	0.0	0.0	0.0
TOTAL	12.54	19.75	13.75	10.12
GROSS OPERATING COSTS				
GOPC = OPC * GRT	3185.16	2006.60	2794.00	5140.70
INCOME				
REVENUE				
TRS1 = Clear Glass	3352.80	1341.12	2682.24	6695.04
TRS2 = Green Glass				
TRS3 = Amber Glass				
TRS4 = Mixed Glass	1828.80	731.52	1463.04	3651.84
TOTAL	5181.60	2072.64	4145.28	10346.88
SAVINGS IN DISPOSAL COSTS				
SRD = Y * GRT	360.68	144.27	288.54	721.22
COLLECTION COST SAVINGS				
SRC = R * GRT	4826.00	1930.40	3860.80	9650.10
NET EFFECTS				
A. PRIVATE VIABILITY				
PPT (M,W)	= - £0.23	- £19.56	- £3.46	£6.21
B. DISPOSAL SURPLUS				
SST (M,W)	= + £1.19	- £18.15	- £2.04	+ £7.64
C. TOTAL SYSTEMS SURPLUS				
TST (M,W)	= + £20.19	+ £0.85	+ £16.96	+ £27.63

From Table 10.4 it is possible to identify the key cost factors that will affect the viability of the recovery scheme. The operator having identified these can seek ways to improve the conditions and thus improve the viability of the scheme. The table is broken up into three sections: set up costs, operating costs, and revenue. These are looked at in turn. Changes in set up costs will largely be cosmetic accounting practices, as once a system is established these costs will be 'fixed'; but they are important in identifying changes that can be made before starting up new shemes or expanding the existing scheme. The main area where changes will have immediate effects will be with alterations in the operating conditions, and in the revenue received.

10.4.8.1 Set Up Costs

Table 10.4 shows that the Set Up Costs (SUC) are consistent across the four scenarios. To reduce the impact of these costs the operator needs to maximise the tonnage of glass that is recovered. The greater the tonnage the less influence set up costs will have on the overall assessment of a recovery scheme. With 500 tonnes recovered set up costs are £4.04 per tonne, whereas with only 100 tonnes recovered they are £20.2 per tonne. To improve the viability the scheme needs to maximise the tonnage of glass that is recovered.

From Table 10.4 the key element can be identified as the Bank Costs which account for 87% of the total set up costs. This is followed by storage costs (10%) and then by site costs (3%). In looking for improvements in the viability of the recovery scheme attention should be focused on reducing the influence of Bottle Bank costs on total set up costs.

The viability model is based on using new banks that cost £746 amortised over 5 years. In the first instance the bank capital charges could be reduced by spreading them over a longer life period. Bank lives of 5, 7, 10 and 20 years are shown in Table 10.5. An adjustment in capital charges can be justified as it is not yet clear how long the glass banks will last. Some Authorities have predicted lives of 10 years. If the operator is looking to expand the scheme he may wish to show that the costs can be recovered quickly and thus chose a short life. As bank life is increased, this will reduce total bank costs per year; but they still remain a significant proportion of set up costs.

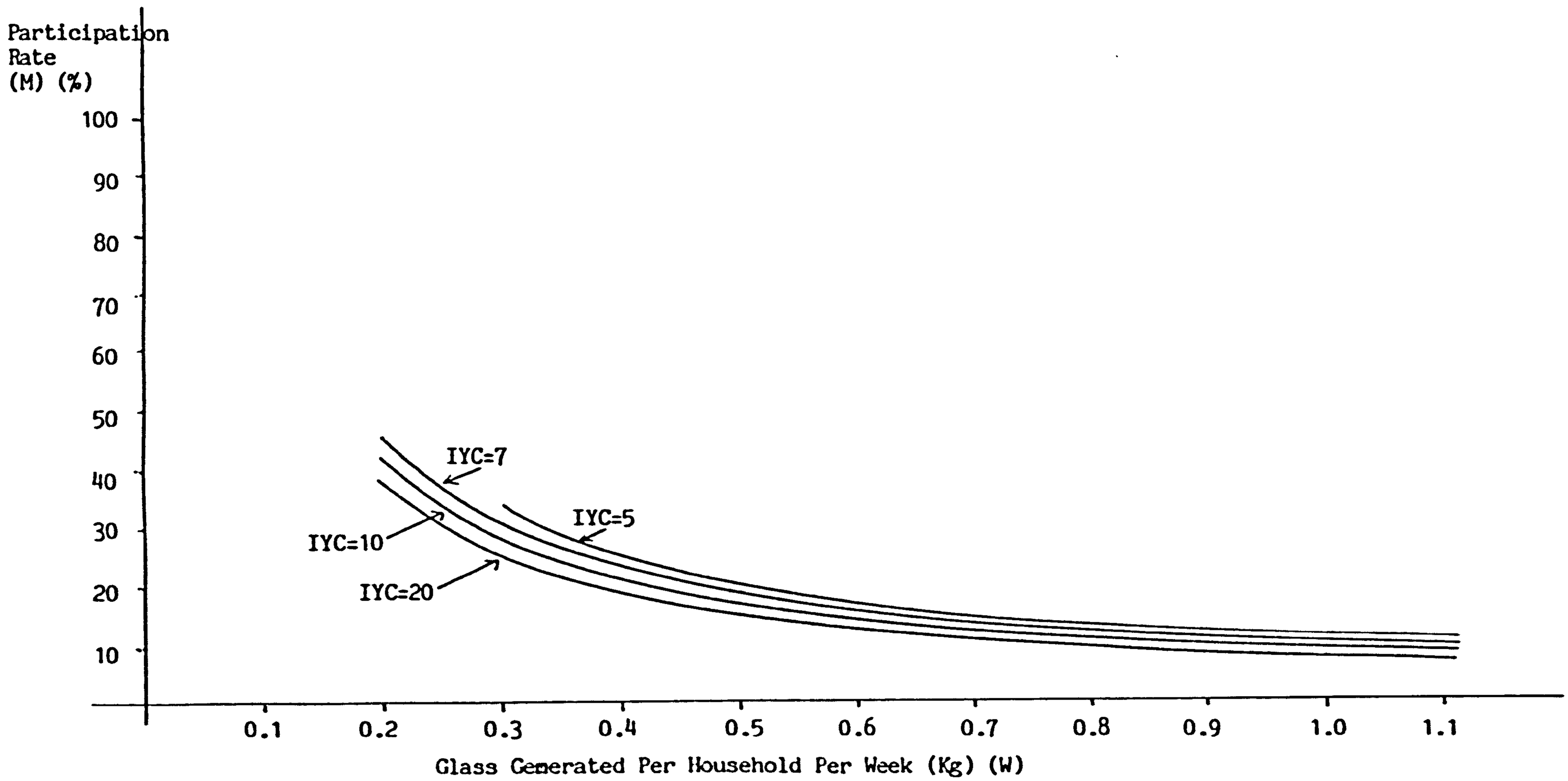
There effects on the viability measures are shown in Appendix F.6.1. As Bank Life is increased this in effect pushes the profit/loss boundary to the left (Figure 10.F), reducing the loss area under the curve and thus increasing the circumstances where a profit is likely to occur.

TABLE 10.5 Effect Of Changes In Bank Life On Set Up Costs

BANK LIFE (IYC) (Years)	BANK COSTS (BC) (£)	TOTAL BANK COSTS (£)	TOTAL SET UP COSTS (£)	BANK COSTS AS A PERCENTAGE OF SET UP COSTS
5	746	1790.4	2054.4	87%
7	746	1449.4	1713.3	84%
10	746	1193.6	1457.6	82%
20	746	895.2	1159.2	77%

A more significant way of reducing initial bank costs is to reduce the actual purchase price of the banks. This can be achieved in a number of different ways - using modified skips or sponsorship. Skips that have served their useful life in other Council activities can be modified to serve the purposes of a Bottle Bank. Or the Council can buy second hand skips in to be converted in the Council's own depot. Alternatively, the Council can seek sponsorship of banks to offset the costs of skips.

FIGURE 10.F Profit/Loss Boundary (PPT)
- Changes In Bottle Bank Life: 5, 7, 10, 20 years



Sponsorship could even be sought for existing skips. Sponsors can meet all or part of the capital costs and payments towards maintenance costs.

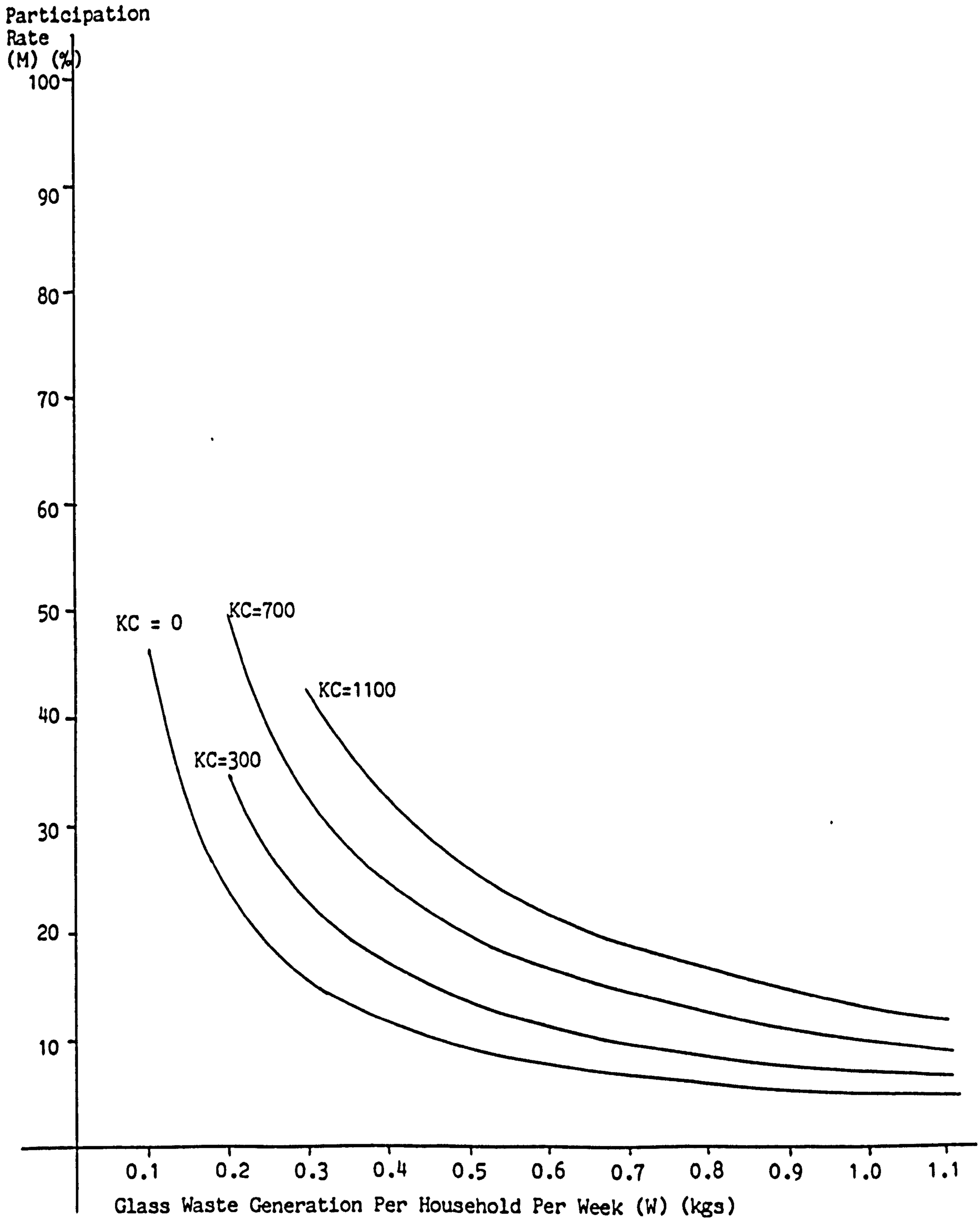
TABLE 10.6 Effects Of Changes In Bottle Bank Costs (BKC) On Total Set Up Costs (SUC)

BANK COSTS (BKC) (£)	TOTAL SKIP COSTS (SKC) (£)	TOTAL SET UP COSTS (SUC) (£)	SKIP COSTS AS A PERCENTAGE OF SET UP COSTS (%)
0	0	264	-
100	240	474	50.63
200	480	744	64.52
300	720	984	73.17
400	960	1224	78.43
500	1200	1464	81.97
600	1440	1704	84.51
700	1680	1944	86.42
746	1790.4	2054.4	87.15
800	1920	2184	87.91
900	2160	2424	89.11
1000	2400	2664	90.10

TABLE 10.6 shows the effect of a range of bank costs on total set up costs. The influence on all three viability measures are shown in Appendix F.6.2. A reduction in Bank Costs pulls the private profit/loss boundary to the left increasing the area where a recovery scheme can make a profit (Figure 10.G).

This needs to be looked at when setting up a scheme or thinking of expanding. The other elements of set up costs - storage costs, site costs, and initial promotion costs - should not be ignored, but should be examined to see what improvements can be made to improve the viability of the recovery operations. Site costs can be minimised by resiting existing litter bins, and by siting skips on supermarket car parks. Costs of promotion can be offset through the use of press articles and by seeking the material support of the local GMF representative. Storage costs could be shared with other opera ors or Council's, and other activities. If a Trade Glass collection scheme operates then it could share storage costs

FIGURE 10.G Effects On Profit/Loss Boundary (PPT) Of Changes On Bottle Bank Costs (KC)



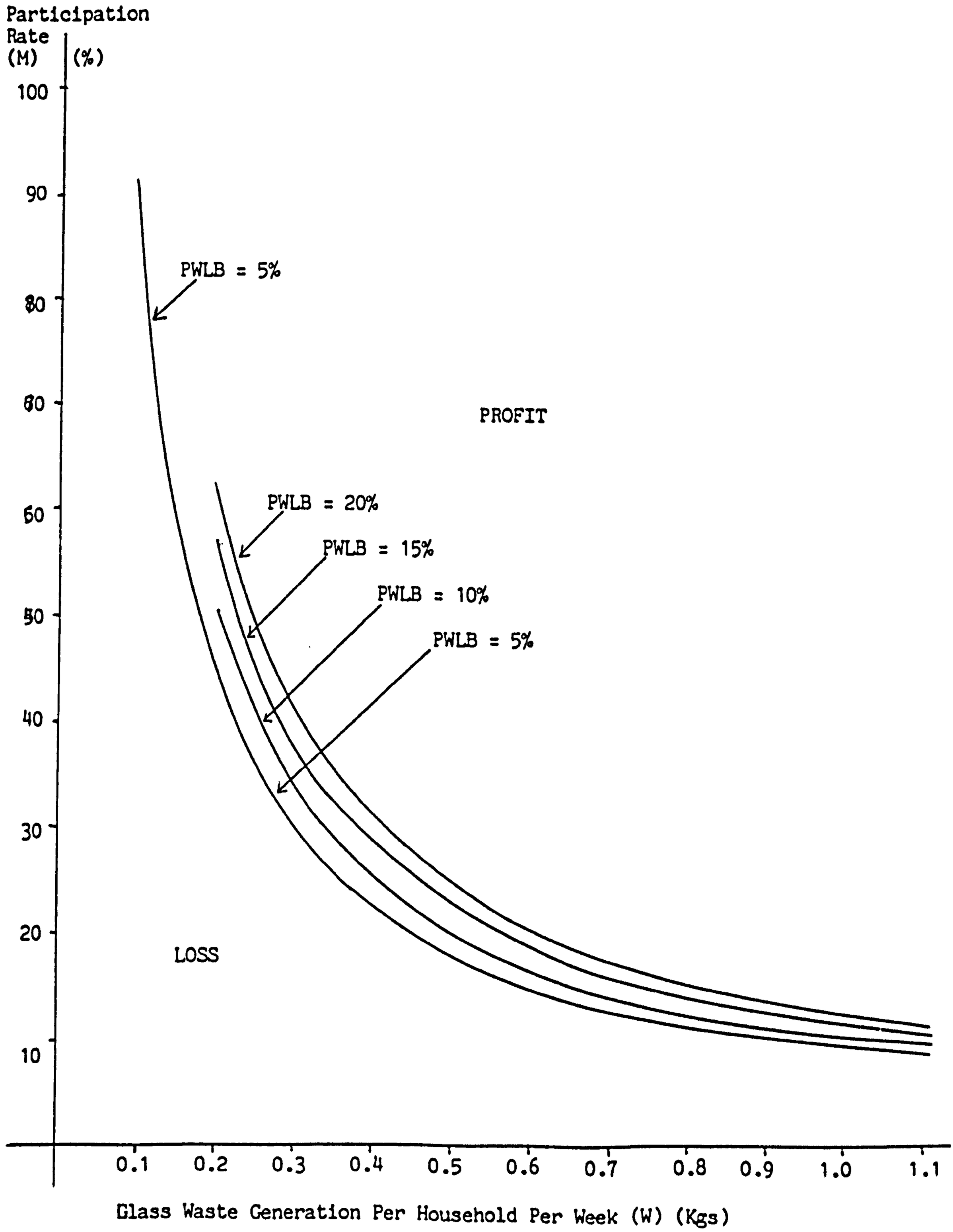
and crusher costs with the glass recovery schemes. Also Councils could share a neighbouring operators storage facilities. This will offset savings in capital costs with the need to pay a fee to use storage facilities.

Another area of influence on set up costs will be the interest rate used to assess capital costs. This largely lies outwith a Council's influence being dictated by market conditions and Government policy. A range of interest rates have been been examined to see what influence they have on the viability of the recovery scheme. Appendix F.6.4 shows the influence on the viability measures of these changes in interest rate. This shows that as the interest rate falls the influence of set up costs falls and leads to improvements in the viability measures.

Figure 10.H shows the effect of changes in interest rate on the private profit/loss breakeven boundary. This shows that as interest rate increases it pushes the profit/loss boundary outwards reducing the profitable area.

Changes in these elements of set up costs can improve the viability of recovery schemes. There assessment will largely be determined at the outset of the scheme and need to be considered then. They should also be reviewed if the scheme is being expanded, or if some of the fixed resources can be shared. For instance if a trade scheme is established this could share the costs of storage. The operator then might revise the way storage costs are assessed and can influence the viability of both recovery schemes. Appendix F.6.6 shows the effects of reducing storage costs on the viability measures. As it only makes a small proportion of set up costs, these changes are small, but could be significant on the borderline cases.

FIGURE 10.H Effects Of Changes In Interest Rates (PWLB) On Profit/Loss Breakeven Boundary (PPT)



10.4.8.2 Operating Costs

In a recovery system that is already running the set up costs will be fixed and thus it is the operating costs that will be of more importance in seeking improvements in the viability of the operation. TABLE 10.4 shows that the main operating costs are: skip collection costs, bulk transport costs, skip maintenance and publicity costs. Each of these costs need to be assessed to see what affects they will have on the viability of the scheme. The effects of any changes are looked at in terms of the private financial cost measure (PPT), although changes on all three measures are shown in Appendix F.6. In this section attention is confined to scenario 1 with a participation rate M = 10% and waste generation W = 10 (1.0 kg) giving a glass recovery tonnage of 254 tonnes per annum. This scenario lies on the boundary of profit and loss, thus any changes will be clearly seen.

Collection costs (CC) at £3.16 per tonne make up 25% of the operating costs. This cost is influenced by the tonnage uplifted (D) on each trip taken. In the initial case the banks have been assumed to hold 3.0 tonnes per uplift. If uplift is made when the bank is less full it will increase the costs of uplift per tonne. TABLE 10.7 shows how collection costs will vary if banks are not full when they are uplifted. It shows that at 3.0 tonnes collection costs comprise 25% of the operating costs, but if only 1.5 tonnes is uplifted this will increase collection costs to 40% of total operating costs. An increase from £3.16 per tonne to £6.31 per tonne. The quantity uplifted can have a significant influence on the operational viability of the recovery scheme.

Appendix F.6.8 shows the influence of changes on uplift quantity on the three viability measures (PPT, SST, TST). They show that

TABLE 10.7 Effect Of Changes In Uplift Capacity On Operating Costs

COLLECTION COST (H) (£/uplift)	CAPACITY OF BIN (V) (tonnes)	QUANTITY UPLIFTED (D) (tonnes)	COST PER TONNE (£/tonne)	TOTAL OPERTNG COSTS (£)	COLLECTION COST AS PERCENTAGE OF OPERATING COSTS
9.47	3.5	3.5	2.7	12.08	22.35
		3.0	3.16	12.54	25
		2.5	3.78	13.17	28.7
		2.0	4.73	14.12	33.5
		1.5	6.31	15.69	40.2
		1.0	9.47	18.85	50.2
		0.5	18.94	28.32	66.8

TABLE 10.8 Influence Of Changes In Collection Costs (H) On Total Operating Costs

COLLECTION COSTS (H) (£/uplift)	COLLECTION COSTS PER TONNE (H/3)	TOTAL OPERATING COSTS (£)	COLLECTION COSTS PER TONNE AS A PERCENTAGE OF OPERATING COSTS (%)
1.00	0.33	9.71	3.40
2.00	0.67	10.05	6.67
3.00	1.00	10.38	9.63
4.00	1.33	10.71	12.42
5.00	1.67	11.05	15.11
6.00	2.00	11.38	17.57
7.00	2.33	11.71	19.89
8.00	2.67	12.05	22.16
9.00	3.00	12.38	24.23
9.47	3.16	12.54	25.19
10.00	3.33	12.71	26.20
11.00	3.67	13.05	28.12
12.00	4.00	13.38	29.89
13.00	4.33	13.71	31.58
14.00	4.67	14.05	33.24
15.00	5.00	14.38	34.77

the lower the tonnages uplifted of 0.5 and 1.0 has the greater influence on the viability measures. As quantity uplifted increases this will improve the viability of the recovery schemes. To minimise costs operators need to ensure that uplift will only be made when the bank is nearly full. This will be influenced if the bank is sectioned for colour collection which may fill at different rates. This will be done by experience of filling rate, and bank compartments may need to be adjusted over a time period.

Figure 10.I shows the influences of changes on filling rate on the private profit/loss boundary (PPT). As the uplift tonnage increases it pushes the boundaries to the left it increases the area in which a profit may be made. It shows that uplift tonnage can have a marked influence on the viability of recovery schemes.

The initial collection (CC) cost of £9.47 per uplift is based on the full skip being swapped for an empty one and thus minimises the number of trips a skip vehicle makes to a site. This figure needs to be monitored against charges made by outside skip hire companies to establish the cheapest rate. Also the scheme is dependant on a flexible service with skips being uplifted when required and not necessarily at fixed time periods.

TABLE 10.8 shows how variations in collection costs will affect total operating costs. As collection costs are reduced, it reduces the total operating costs and the proportion that collection costs make of the total operating costs. As collection costs increase this will reduce the viability of the recovery scheme. Figure 10.J shows that as collection costs increase from £5 per uplift to £15 per uplift it forces the private profit/loss boundary outwards, reducing the area in which profits can be made.

FIGURE 10.I Effect Of Changes In Uplift Tonnage (D) Per Bank On Profit/Loss Breakeven Boundary (PPT)

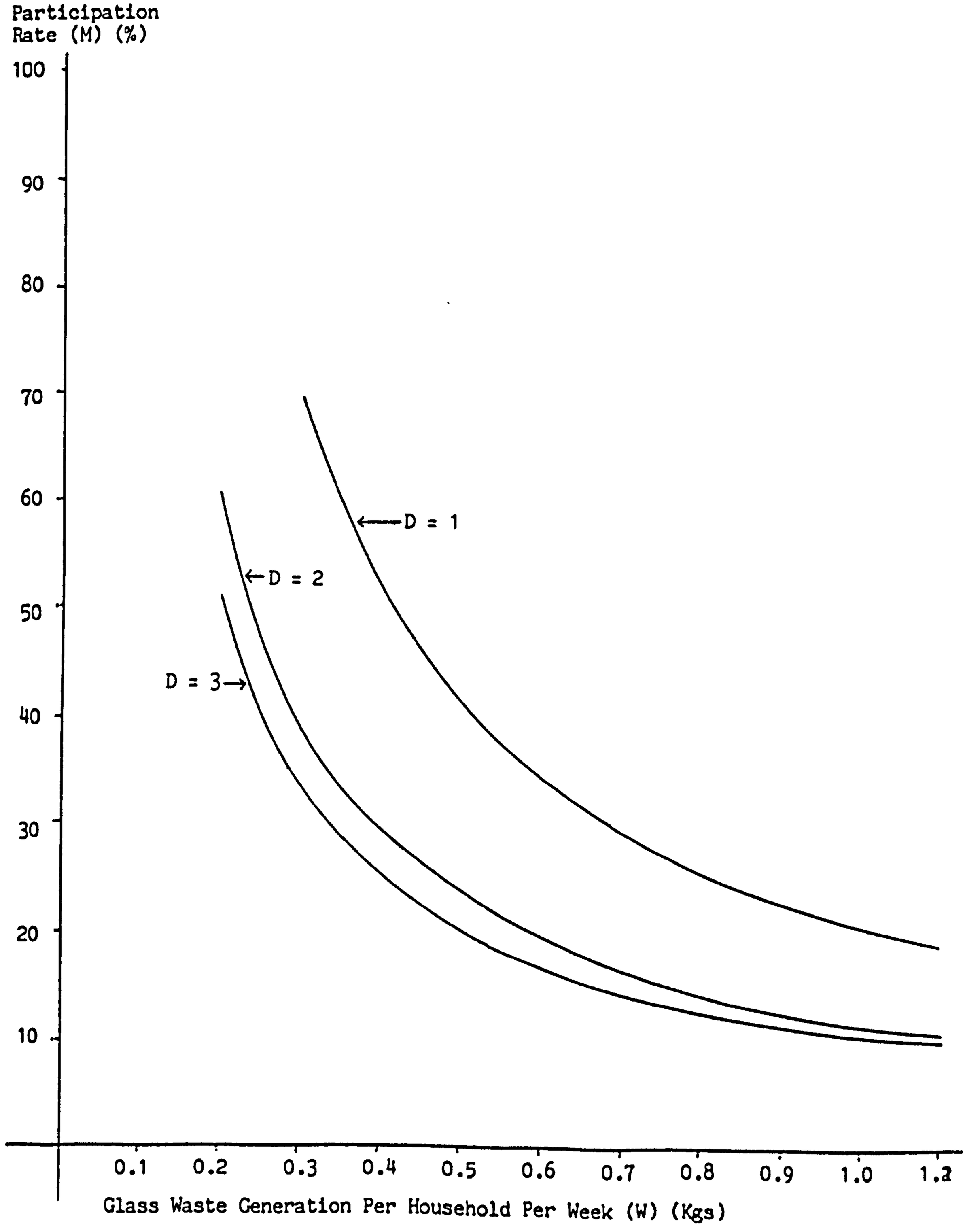
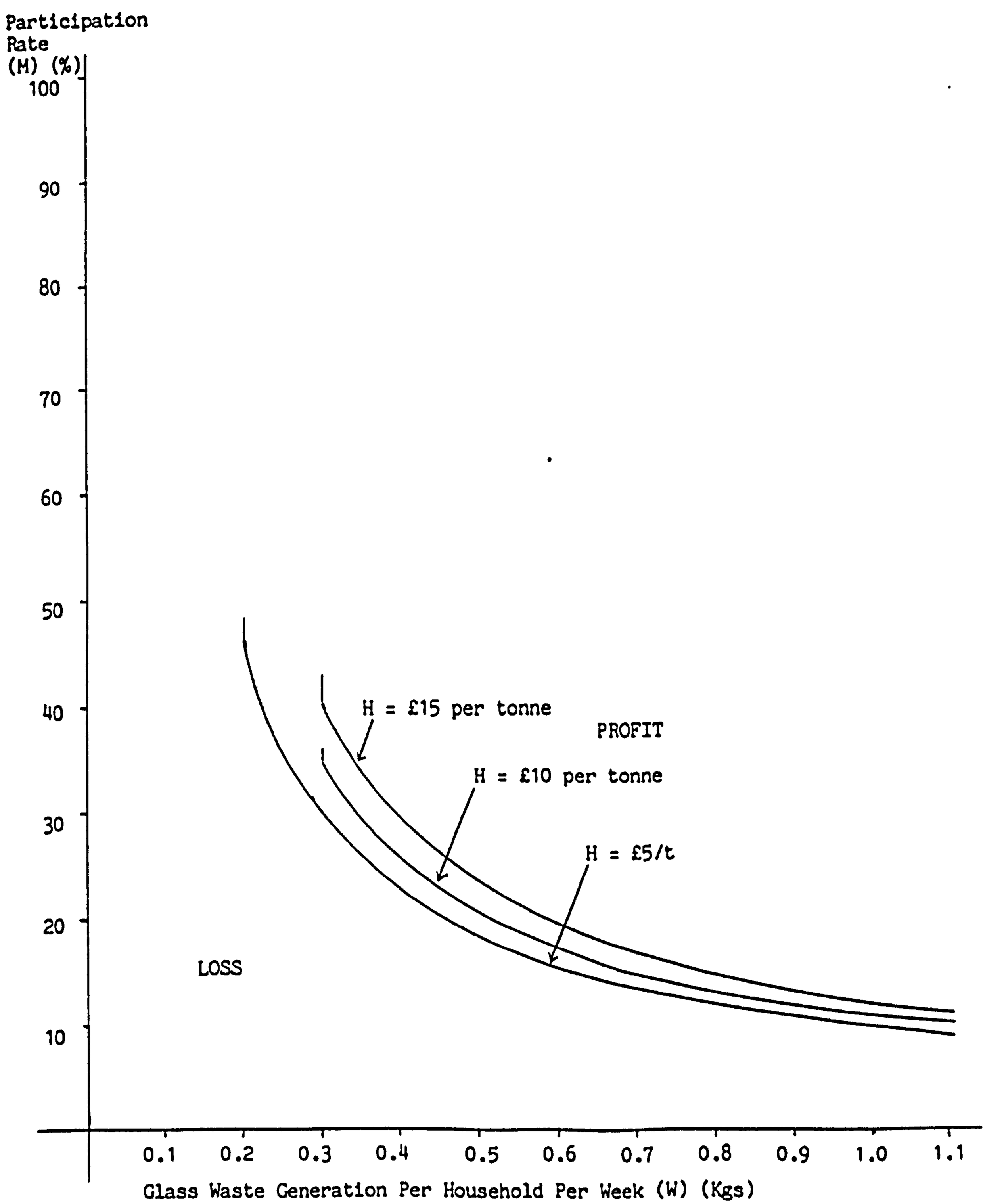


FIGURE 10.J Effects Of Changes In Collection Costs (H) In Profit/Loss BreakEven Boundary (PPT)



For the base case bulk transport costs are the main component of the operating costs. In this instance they make up 36% of total operating costs. To minimise costs the operator should look at competing private hauliers rates to find the best rate. They should examine the possibility of back-haul rates. This is when an operator delivering to an area who would normally return empty could charge a favourable rate to transship the glass to the processor. But the main influence on costs will be the tonnage carried. Operators should maximise the load carried and so spread costs over a greater tonnage. This will be dependant on having suitable storage facilities and maybe the use of a crusher to reduce the volume of material carried.

Appendix F.2 on bulk transport costs shows that costs vary from £1.20 to £9.71 per tonne. This range is examined in TABLE 10.9 to see what effect this will have on total operating costs. Figure 10.K shows the effects of changes in bulk transport costs on the private profit/loss boundary. As transport costs increase from £2.0 per tonne to £10.0 per tonne it pushes the profit/loss boundary outwards reducing the profitable area. Bulk transport costs need to be looked at closely, as they can have a major influence on the operating costs and thus on the viability of recovery schemes.

Skip Maintenance costs (SKM) are a high cost element in the base case. These may be artificially high, as the model has adopted the figures from the top end of the range suggested by the GMF. The initial survey found the costs lower than this, as they had not identified the expenses necessary. Initially, some costs had been met by a one off grant.

TABLE 10.10 looks at changes in skip maintenance costs per skip as

FIGURE 10.K Effects Of Changes In Bulk Transport Costs (TR) On Profit/Loss Breakeven Boundary (PPT)

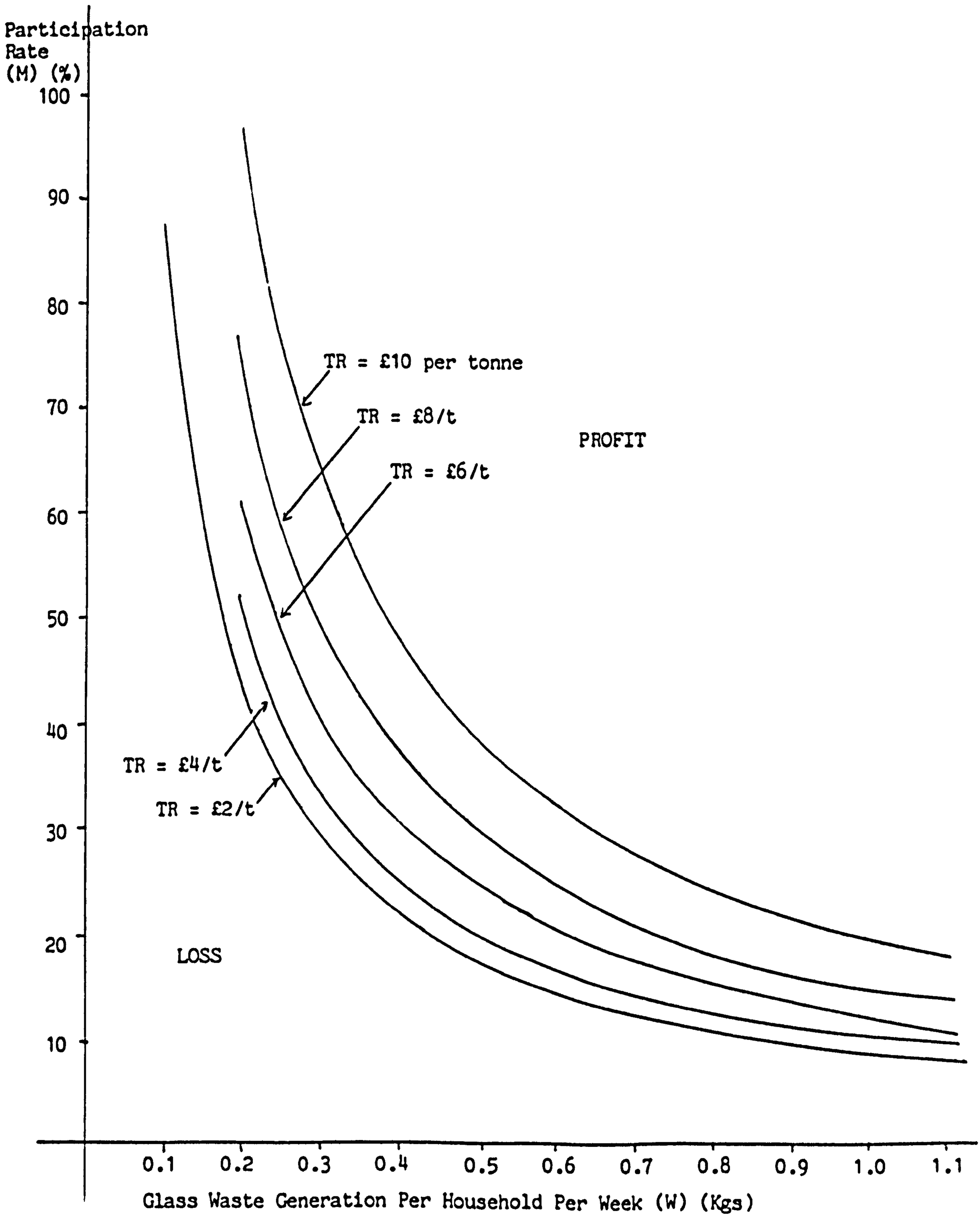


TABLE 10.9 Effects Of Changes In Bulk Transport Costs (BTR) On Total Operating Costs

BULK TRANSPORT COSTS (£/tonne)	TOTAL OPERATING COSTS (£/tonne)	BULK TRANSPORT COSTS AS A PERCENTAGE OF OPERATING COSTS (%)
1.00	9.04	11.1
2.00	10.04	19.9
3.00	11.04	27.2
4.00	12.04	33.2
4.50	12.54	35.8
5.00	13.04	38.3
6.00	14.04	42.7
7.00	15.04	46.5
8.00	16.04	49.8
9.00	17.04	52.8
10.00	18.04	55.4

TABLE 10.10 Effects Of Changes In Skip Maintenance (SKM) On Total Operating Costs

SKIP MAINTENANCE COSTS (SKM) (£/skip/yr)	TOTAL SKIP COSTS (£)	SKIP COSTS PER TONNE (£/tonne)	TOTAL OPERATING COSTS (£)	SKIP COSTS PER TONNE AS A PERCENTAGE OF OPERATING COSTS (%)
100	800	3.15	13.17	23.9
80	640	2.52	12.54	20.1
60	480	1.89	11.91	15.9
40	320	1.26	11.28	11.2
20	160	0.63	10.65	5.9
0	0	0.00	10.02	-

TABLE 10.11 Effects Of Changes In Publicity Costs (PUB) On Total Operating Costs

PUBLICITY COSTS PER YEAR (£)	PUBLICITY COST PER TONNE (£/tonne)	TOTAL OPERATING COSTS (£/tonne)	PUBLICITY COSTS PER TONNE AS PERCENTAGE OF OPERATING COSTS (%)
600	2.36	12.98	18.18
500	1.96	12.58	15.58
488	1.92	12.54	15.31
400	1.57	12.19	12.87
300	1.18	11.80	10.00
200	0.79	11.41	6.92
100	0.39	11.01	3.50
0	0.00	10.62	-

they affect total operating costs. Again, as costs are reduced, total skip will fall as does the proportion of total operating costs they make up. As skip maintenance costs are increased it will reduce the profits of any scheme. This is made clear in Figure 10.L which shows the effects on the private profit/loss boundary. As costs rise it pushes the boundaries outwards, reducing the area where operations are profitable. Skip maintenance costs can be offset by sponsorship, or by advertisers; who will contribute to the banks up keep. Costs can be reduced by encouraging operators to be carefull when they uplift skips to minimise damage.

The fourth element is on-going publicity, through use of promotional brochures, leaflets and posters. A number of Councils thought that these costs were high, although they were in line with those faced by Avon Resourcesaver in their recycling operations. Costs can be minimised by making use of feature articles in local newspapers which mark landmarks achieved, and by use of the GMF representatives resources. Also the Bottle Bank itself acts as a promotional tool.

A lot of operators do not assign a budget to publicity. Publicity costs are ranged from £0 to £600 per annum, and there effects on operating costs are shown in Table 10.11. As publicity costs fall this will reduce the overall operating costs and improve the chances of a scheme becoming viable. Although a fall off in promotion activities might result in a fall off in the level of participation. Figure 10.M shows the influence of changes in publicity costs on the private profit/loss breakeven boundary. As publicity costs rise it pushes the boundaries outwards, reducing the area in which a scheme will be profitable.

FIGURE 10.L Effects Of Changes Of Skip Maintenance Costs (SKM) On Profit/Loss Breakeven Boundary (PPT)

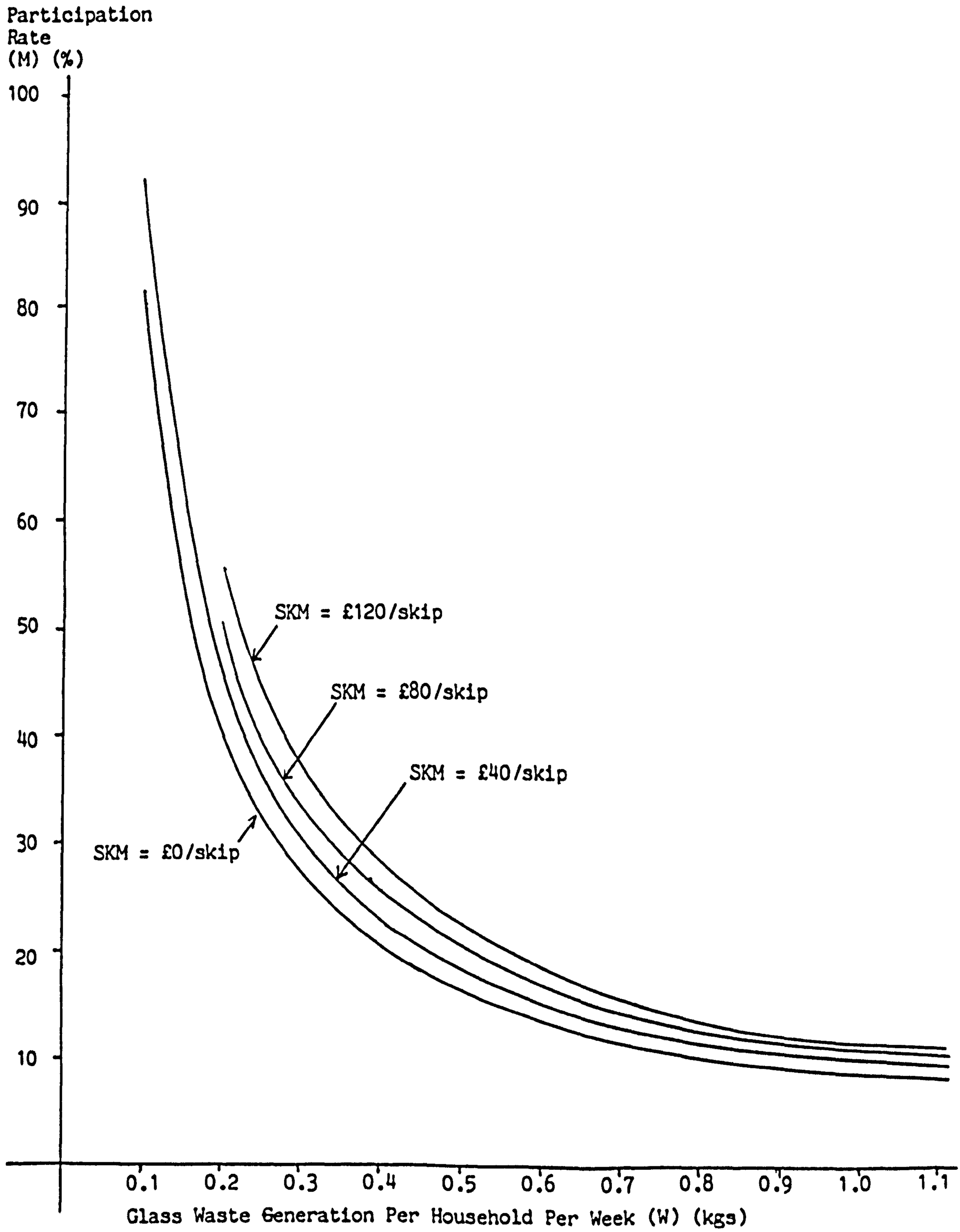
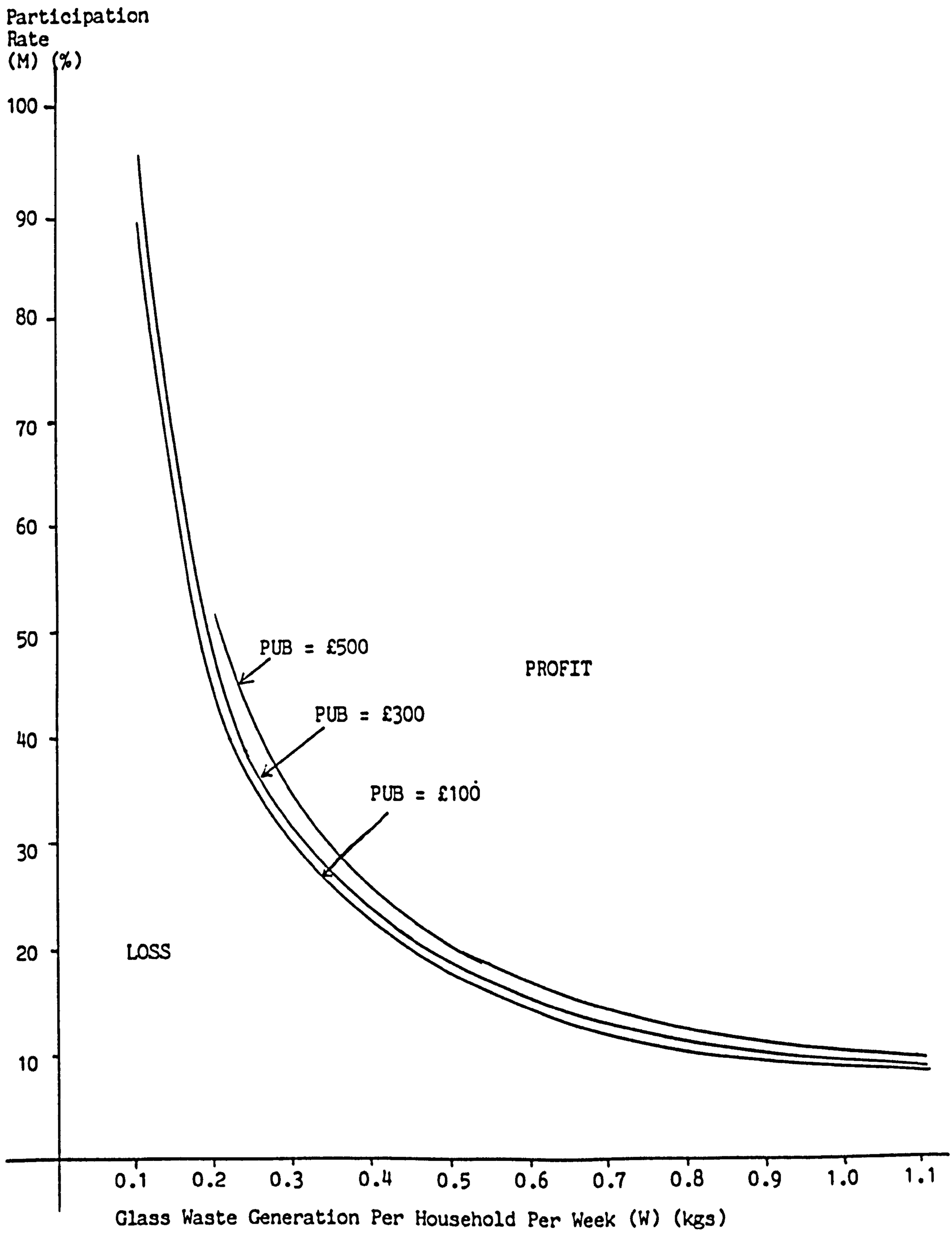


FIGURE 10.M Effects Of Changes In Publicity Costs (PUB) On Profit/Loss Breakeven Boundary (PPT)



Together these four elements - collection costs, bulk transport costs, skip maintenance costs and publicity costs - make up 96% of the total operating costs. Of these - publicity and skip maintenance costs can be minimised. An operator can reduce publicity to press articles and remove this cost from the assessment. Skip maintenance costs can be minimal. If these costs are removed it will reduce operation costs by £4.44 per tonne in the case of scenario 1, and increase the chances of a scheme becoming viable. This leaves collection and bulk transport costs as the key costs. In both cases costs can be improved by maximising the tonnage moved. It is in this area that attention should be focused when looking for improvements in the viability of an operational scheme.

In both areas - set up costs and operating costs - changes can be made to influence the viability of a recovery operations. With set up costs improvements need to be done at the outset. If set up costs can be reduced this can improve the viability of the recycling scheme. If the scheme is in existence and already operating set up costs can be treated as sunk costs when assessing the viability. Any decision on the need to terminate a recycling operation will depend on whether the scheme can cover its operating costs. In the four scenarios examined operating costs per tonne are: £12.54, £19.75, £13.75, and £10.12, which a revenue of £20 per tonne will meet. Any excess will be used to offset the set up costs.

Any improvements in the schemes costs will improve a recovery schemes chances of being viable. In each case changes in profit/loss boundaries are more sensitive at lower waste generation levels, with household participation rates being the

key element in a scheme being successful.

10.4.8.3 Income

The third area in assessing the viability of a recovery scheme is the income levels achieved. This is made up of revenue from the sale of the glass, savings in disposal costs, and savings in collection costs. Changes in any of these will influence the viability of a recycling scheme.

The revenue received is dependant on quality and whether the glass is colour separated. If glass is segregated this will improve the revenue received, but may be offset by increased storage costs and uplift costs. The price of cullet has increased steadily since the Bottle Banks were first introduced in 1977, in line with changes in raw material prices. Improvements in prices paid, will improve the chances of a recovery scheme becoming viable.

For each tonne of glass recovered there will be disposal savings which can be linked to the scheme, and increase the conditions under which a scheme will be viable. Some WDA pay authorities for each tonne of glass they recover. This factor needs to be examined when assessing a schemes viability.

Changes in collection costs are more difficult to assess and attribute to a recovery scheme. In the long term if sufficient quantities of materials are diverted from the collection system there will be possibilities for amalgamating routes, reducing the number of collection vehicles which will lead to savings in collection costs. They need to be assessed if a full picture of a waste management option is to be produced.

10.4.9 Variations From The Hypothetical Local Authority (HLA)

There are a number of variations that can be examined from the initial base case: the development of a trade scheme, an assessment of a more rural area and a more urban area, and the possible effects of expansion and contraction of schemes. These are examined below with more details provided in Appendix F.7.

10.4.9.1 Trade Scheme

If a trade glass collection scheme is established it may share some of the fixed costs of the recovery operation. The main costs that can be shared are in the area of set up costs. A Trade System is likely to be able to share storage and crusher costs. Although, storage costs are only a small proportion of set up costs, sharing them can improve the glass recovery scheme.

It is felt that savings in operating costs are unlikely, as they operate under two different collection systems. With Banks, collections are from a central site, whereas trade glass collections follow a 'door to door' system. However, if the trade system is operated in conjunction with a modular system, then they could share some of the operating costs. This is expanded under the trade system in Chapter 11.

10.4.9.2 Rural Area

A recovery scheme being set up in a more rural area is faced with similar problems to the base case. The main differences is in the more widespread and smaller population centres. Thus the quantity of waste glass available for collection will be smaller. The characteristics of a Rural area are shown in Appendix F.7 (Table F7.1). The area has three population centres, which will support

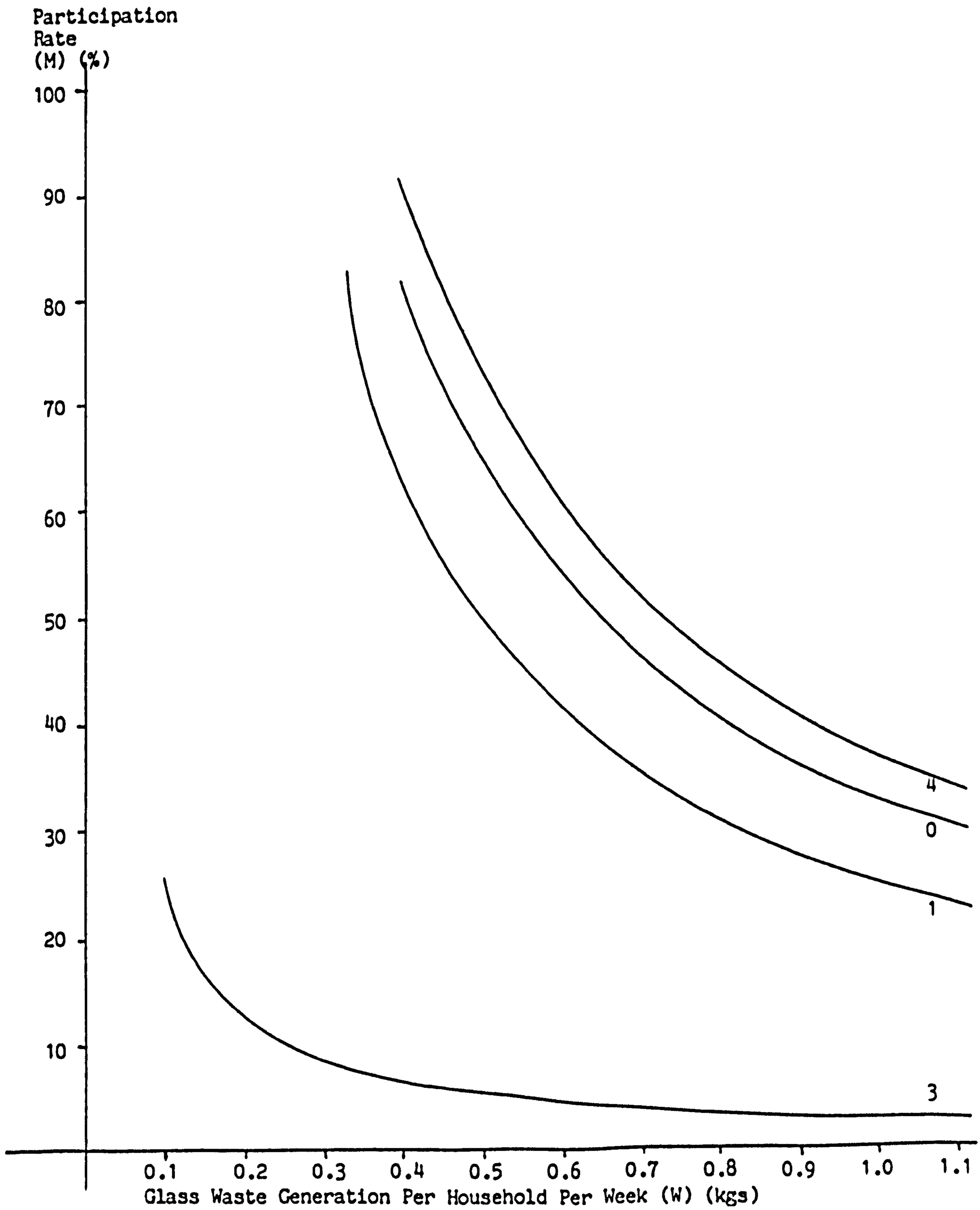
one bottle bank each. Banks are uplifted by an existing council vehicle delivering to a central storage site; then bulk transported to the processor by a private haulier. As highlighted earlier it is these two costs of uplift and bulk transport are the key to establishing a successful operation. In a rural area the extra distances involved may increase the costs incurred. In the first instance these costs are kept the same as in the original base case. With the only change being a reduction in the number of banks to three, and a reduction in overall bank costs.

Income will be based on similar lines to the base case, but with less glass the returns will be lower. Collection costs in a rural area might be less susceptible to changes, due to the extra distances involved. Any benefits may result from reducing the number of collections made, and thus the number of vehicles that a council will need to operate a collection system.

A summary of costs is shown in Table F7.2 (Appendix F.7). The main costs are set up costs which dominate the whole recovery operation. These can be reduced with the costs being spread over greater tonnages. At the outset, the viability of a rural recovery scheme is marginal; with a scheme needing a high participation rate to cover its costs. They need to recover about 102 tonnes per annum to breakeven; from a maximum available of 345 tonnes of glass per annum. The scheme can breakeven at various participation and generation rates which are shown as line zero in Figure 10.N. At a household contribution rate of 1.0 kilogrammes, 41% of all households will need to participate.

If the area is far from the processor, bulk transport costs could be at the high end of the scale, unless Council can transship to a neighbouring Council. If the cost is increased from £4.00 per

FIGURE 10.N The Private Viability Profit/Loss Boundary (PPT) For A Rural Scenario Under Varying Conditions



tonne to £8.00 per tonne this will push the profit/loss boundary outwards reducing the profitable area (Line 4 Figure 10.N).

The Council could use existing storage facilities or a demountable body to minimise storage costs. Site costs can be minimised by resiting bins and using existing tarmaced sites. Bottle bank costs can be reduced by modification of existing skips or through sponsorship. The effects of changes in these costs have been illustrated for the base case in Section 10.5.8.1. If in this case set up costs were treated as zero this has a dramatic effect on the profit/loss boundary. Figure 10.N shows the improvements with zero set up costs represented by line 4. A scheme would only need to recover 8 tonnes of glass per year to breakeven.

This shows the need to look at all the cost factors at the outset, so that ways can be sought to minimise them. In particular looking at sponsorship, existing storage facilities, and ways of minimising operating costs.

10.4.9.3 Urban Area

In a more urban area the factors to be considered when assessing the viability are very similar. The population levels will be higher, and population densities will be higher. With more waste material available an urban area would be able to support more bottle banks. However, with the importance of the capital costs in any assessment, there establishment would need to be considered carefully. It is more likely an urban area would build up a recovery scheme in a series of stages. Initially, the operator would indentify the prime sites for bottle banks and establish those first. Once a scheme has been established the Council could look at the opportunities of expansion (Section 10.4.9.4).

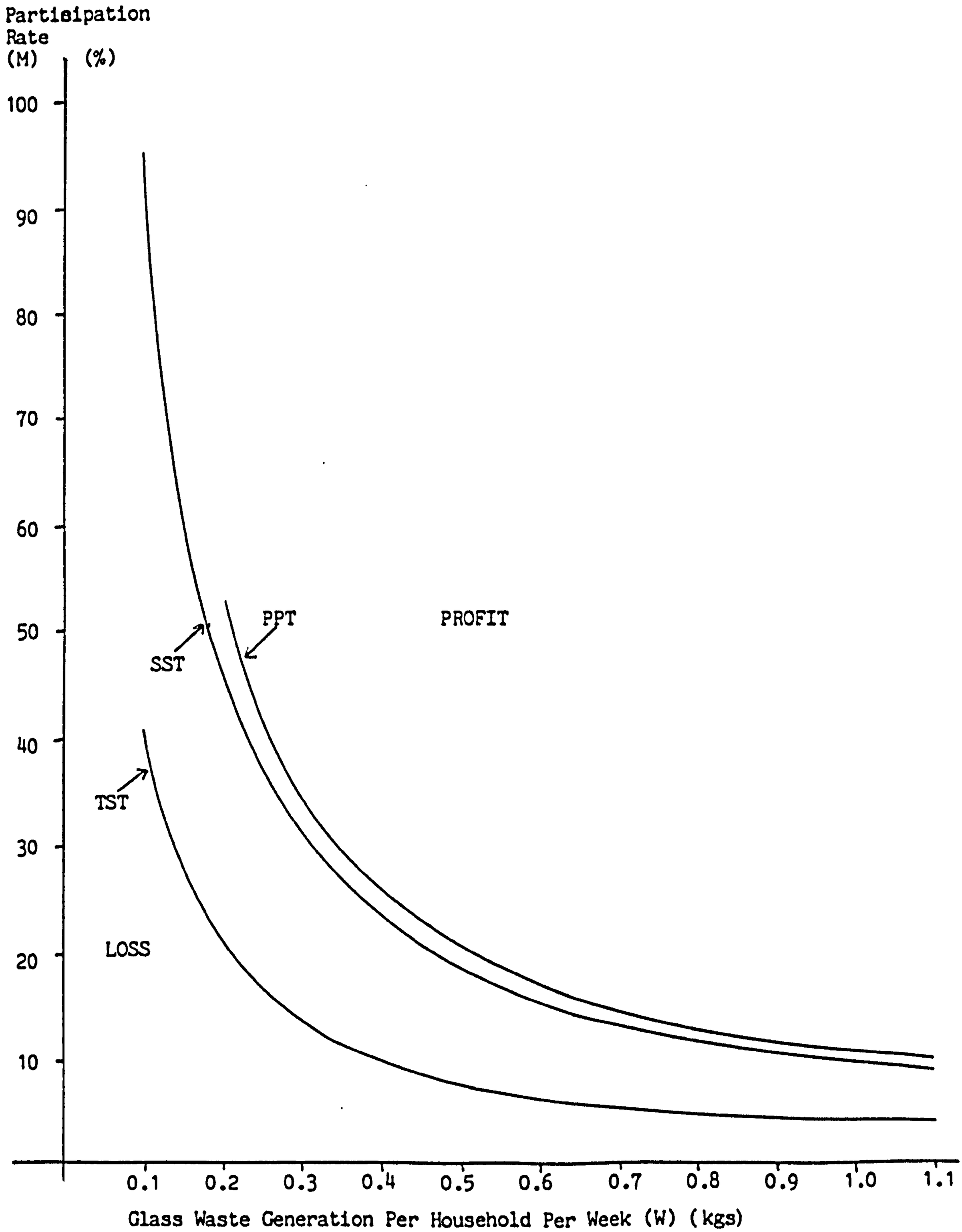
A larger populated area would be able to support more banks. An examination of a system with 20 banks is looked at, this provides 1 bank per 6000 people (Table F7.4, Appendix F.7). Set up costs are significant with the larger number of banks if all are set up at once. With more glass waste available to be recovered it is the operating costs that contribute the most to the assessment of the viability of a recovery system. Collection costs and bulk transport costs are the most important elements, which will need carefull control by the operator of the system.

Figure 10.0 shows the profit/loss boundaries for a more urban scheme. It shows that a recovery scheme can make a positive return provided the contribution and participation levels are right. At a contribution of 0.7 kilogrammes per household per week, 14% of households need to participate for the scheme to breakeven. On a private viability level the scheme would need to recover 600 tonnes of glass to breakeven, which is about 10% of the glass waste that is available. A lower participation rate is needed, as there are more households in the area. If disposal savings are included the scheme would need to recover 520 tonnes to breakeven, and with collection costs only 230 tonnes.

10.4.9.4 Expansion Of A Recovery Scheme

After a scheme has proved to be successful the operator may look at the possibilities for expansion of the recovery scheme, with the introduction of more banks. This would lead to an increase in the capital costs which need to be offset by an increase in the tonnage of glass recovered. The introduction of new banks in new areas may reduce collections from other banks, as the public may use banks closer to them.

FIGURE 10.0 Profit/Loss Boundaries (PPT,SST,TST)
For A More Urban Area



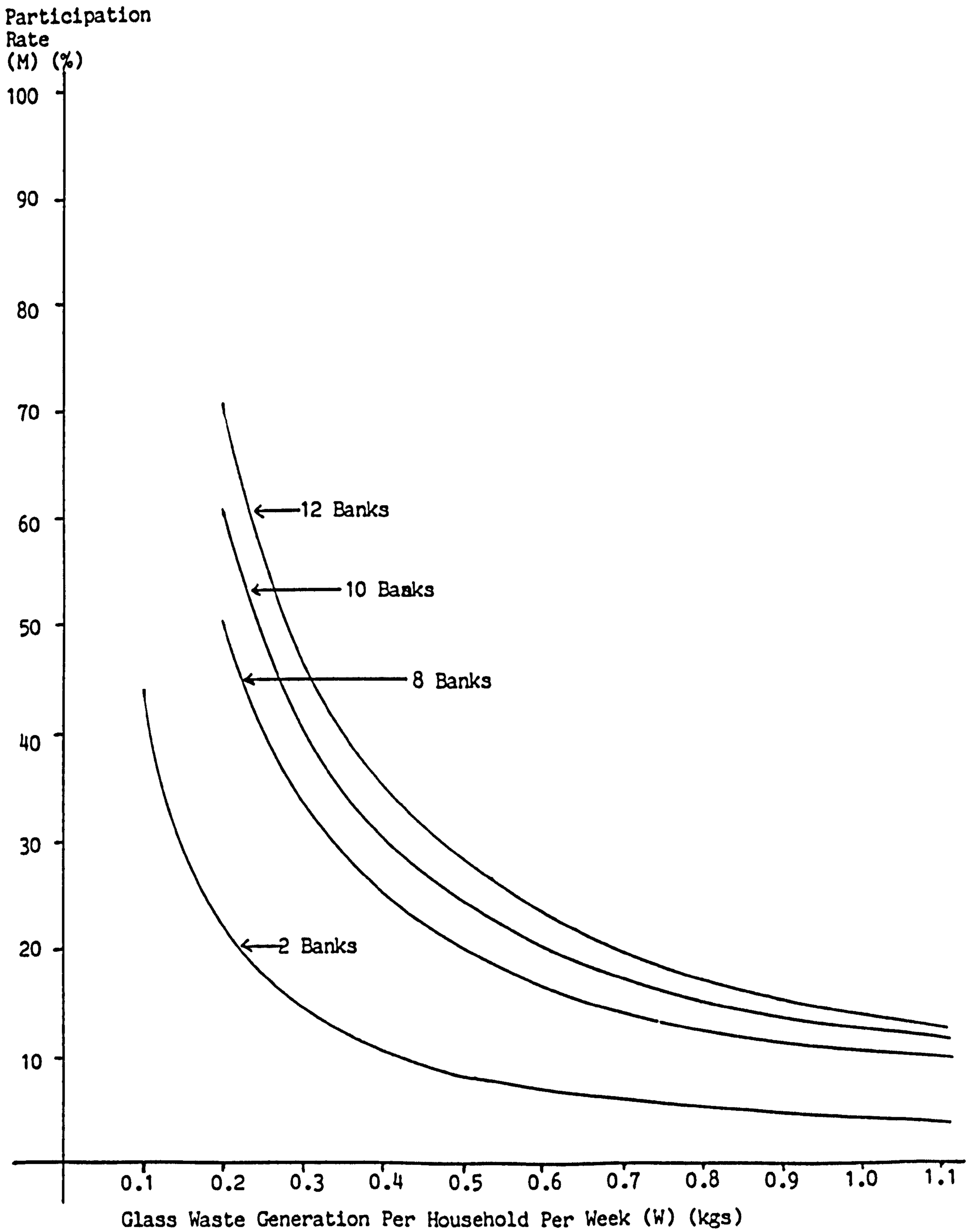
A scheme should be viewed as an on-going service that is provided to the public. As capital costs are paid off, the recovery scheme's viability will improve, if they can continue using the paid off banks. Then the recovery scheme will just have to look at financing replacement banks, and expansion through the introduction of new banks.

Figure 10.P looks at the system with varying numbers of Banks. It shows the base case with 8 banks, which needs to recover 254 tonnes to be viable. With the introduction of two extra banks, a scheme would need to recover 308 tonnes per annum. That is an extra 54 tonnes of glass per annum. It would raise recovery from 9% to 11% of the glass available. However, if the skip costs for the first 8 banks have already been met, then the capital costs for only two extra banks will have to be met. In that case it would breakeven if it recovered 110 tonnes per annum. So if they maintained the previous collection figures the scheme would improve its viability. If the 8 banks are increased by four to 12, then the scheme would need to recover 358 tonnes to breakeven, 13% of the waste glass available.

10.4.9.5 Contraction Of The Recovery System

If a scheme is not operating very successfully, the operator may look to reduce the extent of the scheme. First the operator should look at possible improvements they can make in their operating costs. Once a scheme is established set up costs are sunk costs so there will not be any savings if the scheme is terminated. If they are treated as sunk costs then revenue only needs to cover its operating costs with any surplus being offset against set up costs. Also would need to look at alternative uses for banks and storage sights.

FIGURE 10.P Effect Of Expansion On Profit/Loss Boundary (PPT)



10.5 Summary Of The Stirling Glass Recycling Model

The Stirling Model provides a comprehensive and logical framework for the assessment of glass recovery schemes. The Model's division into three sections - Set Up Costs, Operating Costs and Income - reflects the way glass recovery schemes have been established, and where attention can be focused in the search for improvements in operating conditions. The Stirling Model can be used to evaluate and compare existing glass recovery operations. A separate investment appraisal for new glass recovery projects is shown in Appendix H. The use of the computer model provides managers with an anayltical tool to assess recovery schemes under varying conditions.

The Model was used to assess the viability of a Hypothetical Local Authority. This showed the importance of waste generation and participation levels in assessing the viability of recovery schemes. The Model was used to highlight the key costs and establish the effects of any changes in these factors. Set Up Costs are influenced by the tonnage of glass recovered. The key cost are the investment in new Banks. To reduce the influence of Bank costs the operator can look to sponsorship, and the possibility of modifying existing skips.

When looking to improve the scheme set up costs can be treated as sunk costs, with attention focused on operating costs. The main operating costs are bank collection and subsequent bulk transport. These are influenced by the tonnage recovered. Uplift costs are affected by the filling rate which in turn can be affected by colour segregation of the Bank. This might reduce the amount of glass picked up unless compartments accurately reflect the collection of the different colours. In bulk transport, a maximum

load should be moved, and the examination of back-haul rates undertaken. In both cases competitive private haulier rates should be examined.

The Model was used to appraise the surveyed Local Authorities (Section 9.4). This gave a truer reflection of their operating situation, than the comparable assessments. The results showed the importance of treating recycling as part of the wider waste management system with possible savings in disposal and collection costs. In most schemes disposal cost savings are attainable, although not always assigned. Savings in collection costs are a long term goal. The Model distinguishes between three viability measures: private surplus, disposal surplus and total systems surplus. These measures are kept separate to reflect different Council policies, and the wider demarcation between collection and disposal functions in England.

The Stirling Model has been constructed to be used by any Local Authority operating a glass recovery scheme. The required data can be gathered using the Summary Tables (Appendix F.1) that were drawn up from the Model. This information would be inputed into the computer model to provide the base case. The model produces profit, tonnage, and breakeven price results in table form. These can be used to assess how well their recovery scheme is doing. The tables provide an insight into the effects of different participation and waste generation rates. From this base case the Local Authority can evaluate the effects of changes in the key factors to see where improvements might be made. The Model can initially be used to assess how well the existing scheme is doing, and then evaluate the effect of possible changes in operating conditions on the viability measures.

The Model was based on the Large Bank system, which dominates glass recovery systems in Britain. It is possible to incorporate a system that uses sponsorship, modified banks and modular banks. For modular banks uplift costs would be evaluated on the whole collection round rather than a single bank pick-up. By using plug in cost figures it can assess a scheme whether it makes use of Council or Privately operated systems. The Stirling Model offers a flexible approach to the analysis of recovery schemes, that are still being developed.

Glass recycling can be viewed as a marginal activity to the Councils present collection and disposal activities. In such a case the assessment of glass recovery schemes would only assess the extra costs that are incurred. It is only when vehicle and labour become fully utilised in the recovery scheme, then all the costs would be assigned to the scheme. In its initial stages schemes should seek to share costs where possible between Council Departments, and between Authorities.

The Stirling Model provides a basic framework for the assessment of glass recovery schemes using local data. From the base case comparisons can be made for different operating conditions. Allowances are made for the wider effects on disposal and collection operations, treating recycling as an integral part of the waste management system.

10.6 References

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Journal Of Environmental Management Vol 6 (3)

Chapter 11

Separate Trade Glass Collection System

11.1 Introduction

Trade glass waste remains a largely untapped source of glass. The survey of Local Authorities (Chapter 7) showed that several Councils were already involved in the recovery of glass from trade sources. The tonnage recovered from trade sources contributed the larger proportion of total glass recovered by these Councils.

Trade glass recovery schemes were examined with the aim of establishing a 'Trade Viability Model'. A series of interviews was carried out of those Councils running Trade recovery schemes, which are summarised in Appendix G.1. It is on the basis of this information that the Trade Model was developed.

11.2 Trade Glass Collection Model

Trade glass collection systems have to overcome similar problems that the more established Bottle Bank schemes have dealt with. These include:

Waste Generation

Operating System - Set Up Costs
- Operating Costs

Markets for cullet - revenue

Other Benefits - Disposal Savings
- Collection Savings

Net Surplus

In addition, a further problem is to decide whether some of the costs already met by the Bottle Bank system should be shared with

the Trade system, or whether each scheme should be separately assessed. This can influence the viability of both schemes.

11.3 Waste Generation

There is a need to relate the quantity and the composition of trade waste to the number and type of premises in an area. The quantity of glass from trade premises can be found by:

$$TRT = 0.01 * Z * (0.05 * X * IC)$$

where: TRT = Trade Premises Waste Generation (tonnes)

X = Average kilogrammes of waste generated per catering premises
Z = Participation of traders, where Z = 1 represents 100% participation
IC = Number of catering premises

This equation was developed from Section 3.2.2. The problem is identifying the trade premises that are likely to produce large quantities of glass.

11.4 Operating System

Collection is based on a 'milk round' with the lorry uplifting glass from a series of premises. Each premises stores glass for up to a week before it is uplifted on a previously specified day. Bins are emptied into the truck, which then delivers glass to a storage site. Site costs are met by the caterer.

11.4.1 Set Up Costs

This includes:
- Skip Costs
- Storage Costs
- Initial Promotion Costs
- Crusher Costs
- Vehicle Costs

11.4.1.a Skip Costs (TSK)

Container costs will be influenced by the site storage capability, the collection method adopted and whether the Council has any suitable bins available and their need for modification. The number and type of container adopted will depend on the quantity produced by trade premises, and whether the colours are segregated.

Thus Skip Costs, TSK = TC * TQ

where: TC = Cost of bins
TQ = Quantity of bins

If treated as a capital cost, these costs can be spread over a period of years using the following equation.

$$\text{Skip Costs,} \quad TSK = \left(\frac{TC * TQ}{IYT}\right) * \left(1 + \left(\frac{PWLB * IYT}{100}\right)\right)$$

where: TC = Cost of Bins
TQ = Quantity of Bins
IYT = Expected Life of Bins
PWLB = Interest Rate

11.4.1.b Storage Costs

If collection area is far from the processor it will be necessary to store cullet until their is sufficient to bulk transport to processor.

Options

1. Use Bottle Bank storage facilities and treat as zero for trade cullet. Storage Costs: KTS = 0

2. Use Bottle Bank storage facilities, but share costs. This can be dependant on trade glass as a proportion of glass handled. (Bank Storage Costs: STC = KS + RV)
Trade Storage Costs: TSTC = 0.6 * STC

3. Trade scheme can meet full costs of storage (Sn 10.4.2.c).
Trade Storage Costs: TSTF = KS + RV

11.4.1.c Initial Promotion Costs

Costs will be through letters informing caterers of the scheme to ellicit their support and outline the benefits. This could be followed up with visits and the issue of leaflets outlining the collection dates, the type of glass wanted and the storage bins handled. This will be primarily be administrative costs (Section 11.4.2.d) and are treated as zero.

11.4.1.d Crusher Costs

Crushers are used to reduce the volume of the glass material to maximise payloads. A possible more important use is to improve the quality of the glass by removing contraries. Such a unit should be sited at the storage site, so that material can be crushed, checked for contraries and transported to storage bay in a minimum of space. If one is not available, have to purchase one at £U, or manufacture one at £M. Such a unit needs to be housed near the storage area probably in a building to protect workers and machinery from the elements. This can be an existing building or a new cost £FU. If it has an economic life of IYU and an interest rate of PWLB; the loan charge per annum for crushing system will amount to:

$$CUC = \left(\frac{U + FU}{IYU}\right) * \left(1 + \left(\frac{PWLB * IYB}{100}\right)\right)$$

Options

1. Use Bottle Bank crusher facilities and treat as zero for trade cullet. Crusher Costs, CTC = 0

2. Use Bottle Bank crusher facilities, share costs (Falkirk's trade glass makes up 60% of glass handled).
   Bottle Bank Crusher Costs, $CUC = \left(\frac{U+FU}{IYU}\right) * \left(1+\left(\frac{PWLB*IYB}{100}\right)\right)$
   Trade Crusher Costs, TCUC = 0.6 * CUC

3. Trade scheme can meet the full costs of crusher.
   Trade Crusher Costs TCUF = CUC

11.4.1.e Vehicle Investment And Loan Charges

As vehicles have to be used for collecting waste glass there should be a renewal fund contribution to reflect utilisation of the vehicle. If the capital investment is £V, and interest rate is PWLB, depreciated over IYV years, a loan charge or renewal fund contribution per annum for NV vehicles will come to:

$$VI = \left(\frac{NV * V}{IYV}\right) * \left(1 + \left(\frac{PWLB * IYV}{100}\right)\right)$$

However, at the moment trade collection operations only utilise a part of a vehicles availability, so only a proportion of these costs can be assigned to trade operation. Aberdeen operates 1 day a week, thus can attribute 20% of the costs to the trade system; thus attribution to the renewal fund is:

$$TVI = 0.2 * VI$$

where: TVI = Trade Vehicle Investment
VI = Vehicle Investment

11.4.1.f Number Of Vehicles, NV

If Vehicle has x tonnes of carrying capacity and Trade Premises produce z kgs of glass per day/week; then vehicle can cover x/z = y premises per day/week. If serves premises once every week, the vehicle can cover 5y premises per week.

For example:

Vehicle (V) has a capacity(x) of 3 tonnes
Premises produce 5.2 kg per day; 26 kg per week of glass.
Thus x = 3 tonnes
z = 26 kgs
No Of Premises Can Be Served is x/z = 3000/26
= 115 premises.

It is unlikely that there will be 115 suitable premises in one concentrated area that can be served in one round. A lorry can

serve several routes, or the quantities of glass might be higher. Can split into central business area and outlying suburban area.

Thus Number of vehicles required will be dependant on the quantity of glass generated (TRT), the number of premises a vehicle can serve (y), and the quantity each premise generates (z). This can be found by:

$$NV = \frac{TRT}{(z * y)}$$

11.4.1.g Summary Of Trade Set Up Costs

	Separate	Shared	Marginal
Skip Costs (TSK)	TSK	TSK	TSK
Storage Costs (TST)	TSTF	TSTC	TKS
Initial Promotion (IPC)	IPC	IPC	IPC
Crusher Costs (TCUC)	TCUF	TCUC	CTC
Vehicle Costs (TVI)	TVIF	TVI	TVIM

1. Trade System Meets All Costs

$$TFSUC = TSK + TSTF + IPC + TCUF + TVIF$$

2. Trade System Shares Bottle Bank Costs

$$TTSUC = TSK + TSTC + IPC + TCUC + TVI$$

3. Trade System Only Meets New Costs

$$TMSUC = TSK + TKS + IPC + CTC + TVIM$$

11.4.2 Trade Operating Costs

This includes:

- Collection Costs - Labour Costs
  - Vehicle Costs
- Skip Maintenance
- Administration
- Publicity
- Crusher Operating Costs
- Storage Maintenance
- Bulk Transport

11.4.2.a Labour Costs

The cost of labour is made up of: Basic Wage, Bonus (33%), and Add On Costs (National Insurance, Holiday Pay, Superannuation). If use 1 driver his basic wage and bonus can be determined as DW, with AC as the percentage figure for add on costs. In addition if a bin system of collection is operated at least one loader (LW) will be needed. Thus costs can be calculated as:

Driver Costs, = 50 * (DW * (1 + 0.01 * AC))
Loader Costs, = 50 * (LC * (1 + 0.01 * AC))

Total Labour Costs, TLAB = 50 * (DW+NL*LC) * (1+0.01*AC)

where: TLAB = Total Labour Costs

DW = Drivers basic wage plus bonus
NL = Number of loaders
LC = Loaders basic wage plus bonus
AC = Add on Costs

Labour costs will be influenced by the number of vehicles used, thus total costs will equal the number of vehicles times the labour costs (NV * TLAB).

Total Labour Cost = NV *(50*(DW+NL*LC) * (1+0.01*AC)

However, labour will be involved in the collection of trade on a part time basis only can assign a proportion of costs dependant on the time taken.

Trade Labour Costs (TTLB) = PL * TLAB (PL=% usage)

11.4.2.b Vehicle Cost For Collection Round

Information held by Councils is limited on the operating costs of vehicles, distance covered and fuel used per collection round. In most cases the Transport Department charges user department a fixed sum per vehicle per day for use of any vehicle. This cost (T) will comprise a share of - Running Costs: Fuel, Lubricants, Tyres, Maintenance and Wages.

Standing costs are incorporated in the loan charges as part of the set up costs of the trade scheme. This area of transport costing has been dealt with in more detail in Appendix F.2. For the model vehicle costs have been incorporated as T, based on the charge per day Councils make between departments.

For 1 day collection per week, over 50 weeks, total transport cost per annum for NV vehicles is:

$$TV = NV * G * 50 * T$$

where: TV = Total vehicle costs

NV = Number of Vehicles
G = Number of days collections made per week
(G = 0.2 = 1 day)
50 = Number of weeks collection made
T = Transport costs per day.

11.4.2.c Skip Maintenance

Skip maintenance will depend on the type of bins and the method of collection. It is advised that they be marked with the operators name and their purpose, which may need to be redone periodically. As bins will be stored internally or outside in secure areas, vandalism and graffiti should not be a problem. The costs are as yet unknown, as the schemes are still being established. In the model skip maintenance costs are put as zero (TSKM = TQ*SKM).

11.4.2.d Administration Overheads

Glass recovery should be seen as part of normal collection activities of a Local Authority. If a recycling scheme is stopped, officers within the Department will not get proportionally less salary than before; nor if overheads had been assigned to the scheme would they be saved. In fact the administrative burden will tend to remain the same. At present as glass recovery is only a marginal administrative activity, administration overheads can be assessed as zero (TA=TH*TW).

11.4.2.e On-Going Promotion

Publicity to Traders is going to be limited, as it is a specialist section of the community. They will need to be informed of the weekly collection day and the type of containers that will be handled. This can be part of information provided on the general trade collection system and the existence and scale of charges. It should be in the Traders interests to keep glass separate. If they do not penalties can be imposed through the levy of trade charges and/or action by Environmental Health Officers. Costs will be part of administrative burden (TPUB=0).

11.4.2.f Crusher Operating Costs

If you have two people, operating crusher and monitoring conveyor, costs will be made up of:

Total Costs, CLAB = 50 * (CLC+CNL) * (1+0.01*AC)

where: CLC = Crusher Labour Costs
CNL = Conveyor Labour Costs
AC = Labour Add On Costs
50 = Number of weeks operated

It is likely that, crusher duties will only be a small part of workers activities and only that proportion should be assigned to

the Trade system:

TCLB = PR * CLAB

PR = Proportion OF Time Taken (%)

11.4.2.g Storage Maintenance

This is likely to be marginal being incorporated into the normal activities of storage depot workers. (TSTM = 0)

11.4.2.h Bulk Transport

This will involve loading (TL) and transport (TR) activities and are similar to the costs faced by Bottle Bank operations. Costs are simply a rate per tonne.

Bulk Transport, BTR = (TR + TL)
where: TR = Transport Costs (£'s per tonne)
TL = Loading Costs (£'s per tonne)

Bulk transport can be either by Council or Private Contractors.

11.4.2.i Summary Of Trade Operating Costs

Factor	Use Bottle Bank Resources	Share Resources	Separate Trade System
Collection: Labour	TMLB	TTLB	TLAB
Vehicle	TMTV	TTV	TV
Skip Maintenance	TSKM	TSKM	TSKM
Administration	TA	TA	TA
On-going Promotion	TPUB	TPUB	TPUB
Crusher Operating Costs	TCMB	TCLB	CLAB
Storage Maintenance	TSTM	TSTM	TSTM
Bulk Transport	TBTR	TBTR	TBTR

Total Trade Operating Costs Sharing Resources (Shares Costs)

TTOPC =TTLB + TTV + TSKM + TA + TPUB + TCLB +TSTM+ TBTR

Total Trade Operating Costs Separate System (Meets Full Costs)

TFOPC =TLAB + TV + TSKM + TA + TPUB + CLAB + TSTM + TBTR

Total Trade Operating Costs (Meets Extra Costs)

TMOPC =TMLB + TMTV + TSKM + TA + TPUB + TCMB + TSTM+ TBTR

11.4.3 Income

As with the Bottle Bank scheme income will consist of three elements:

1. Revenue (TRA)
2. Disposal Cost Savings (SRD)
3. Changes in Trade Collection Costs (SCC)

11.4.3.a Revenue (TRA)

From the sale of collected cullet the Council will receive a revenue, the amount dependant on quantity and whether glass colours are segregated. Thus:

```
REVENUE, TRA = P1 * PCG * 50 * (0.01*Z*(0.05*X*IC))
               + P2 * PGG * 50 * (0.01*Z*(0.05*X*IC))
                  + P3 * PMG * 50 * (0.01*Z*(0.05*X*IC))
                     + P4 * PAG * 50 * (0.01*Z*(0.05*X*IC))
```

where:
P1 = Price of Clear Glass (CG)
P2 = Price of Green Glass (GG)
P3 = Price of Mixed Glass (MG)
P4 = Price of Amber Glass (AG)

PCG = Percentage by weight of Clear Glass
PGG = Percentage by weight of Green Glass
PMG = Percentage by weight of Mixed Glass
PAG = Percentage by weight of Amber Glass

X = Participation ratio of catering premises (X = 1, equivalent to 100%)
Z = Average weight (kg) of glass per premises per week
IC = Number of Catering premises

In the main Traders will split glass into clear and mixed at most, as storage space and quantity of glass is unlikely to justify further segregation.

11.4.3.b Disposal Cost Savings (SRD)

Through glass being put into banks it reduces the flow of materials entering the waste stream, which may lead to less materials having to be collected and disposed. Such benefits need

to be incorporated in an overall social appraisal of the scheme. With every tonne of glass recovered, there will be a reduction in the amount of waste to be disposed which can lead to savings in refuse disposal costs. Thus:

DISPOSAL COST SAVINGS PER ANNUM, SRD = Y * TRT

where: Y = Disposal Cost Savings per tonne

TRT = Recovered Tonnage

The level of savings that a Council may achieve will depend on the disposal options adopted - Landfill, Incineration, Etc.

11.4.3.c Changes In Trade Collection Methods

If Councils charge for the collection of trade waste the removal of a proportion of the waste would lead to a loss in revenue to the Council. If TD is the average charge for the collection of commercial waste per tonne then the loss in income from commercial collection will be:

LOSS IN TRADE REVENUE, LTR = TD * TRT

Although trade revenue losses will be offset by the revenue from the sale of cullet and from savings in trade waste collection costs. The introduction of charges might encourage Local Traders to divert their waste from their bins to the cullet collection system. In the long term there may be improvements in collection efficiency, and a reduction in overall collection costs. Thus:

SCT = TB * TRT

where: SCT = Savings In Trade Collection Costs
TB = Collection Cost per tonne

Thus: Change In Trade Collection Costs

TCH = SCT - LTR

11.4.4 Net Cost Of Operating Trade Glass Recycling Scheme

Net costs will be influenced by whether the scheme meets its full costs; is operated in conjunction with other activities and shares costs; or alternatively, utilises spare resource capacity and meets extra costs (eg fuel costs).

Costs: SUC - Set Up Costs (SUC)
OPC - Operating Costs (OPC)

Income: TRA - Revenue from sale of cullet
SRD - Disposal Cost Savings
TCH - Changes In Trade Collection Costs

Net Costs

A. Trade Scheme Meets Full Costs

1. Operating Surplus: TFPT = TTRA - TFOPC - TFSUC

2. Disposal Surplus: TFST = TTRA + TRDS - TFOPC- TFSUC

3. Total Surplus: TFTS = TTRA + TRDS + TCH - TFOPC -TFSUC

B. Trade Scheme Shares Costs

1. Operating Surplus: TTPT = TTRA - TTOPC - TTSUC

2. Disposal Surplus: TTST = TTRA + TRDS - TTOPC- TTSUC

3. Total Surplus: TTTS = TTRA + TRDS + TCH - TTOPC -TTSUC

C. Trade Scheme Meets Extra Costs

1. Operating Surplus: TMPT = TTRA - TMOPC - TMSUC

2. Disposal Surplus: TMST = TTRA + TRDS - TMOPC- TMSUC

3. Total Surplus: TMTS = TTRA + TRDS + TCH - TMOPC -TMSUC

A positive result indicates a net surplus to the local authorities from the operation of a trade glass recovery scheme. If the assessment shows a net loss when disposal savings are included it is up to the Local Authority to decide whether the wider external benefits (Chapter 8) are worth the loss incurred. Such judgements will be based on treating recycling as an integral part of the waste management system.

11.5 Application Of Trade Glass Collection Model

11.5.1 Introduction

To illustrate the effects of the trade model, a hypothetical trade scheme is examined. The characteristics of the trade scheme have been drawn from the Bottle Bank system, and from information provided by established operators of trade schemes. The basic characteristics are given in Table 11.1. The model assesses the system under three different conditions: 1. Meeting all costs of the operation (Full Costs), 2. Sharing costs with other uses of the same facility (Share Costs) and 3. Meets just the extra costs that the scheme incurs (Marginal Costs).

The three cost options reflects how Councils view trade glass recovery schemes. If a total new infrastructure has to be set up then full costs need to be reviewed. If the trade scheme is treated as part of other recycling and collection activities a proportion of the costs incurred can be assigned. Finally, the trade schemes can utilise spare capacity in vehicle and labour resources, and thus meet only the extra costs incurred.

11.5.2 Characteristics Of Trade Recycling Scheme

The Authority operates a trade glass recovery scheme that serves 50% of the catering premises in its area. Collection is made from premises with skips tipped directly into the lorry. Each premises has on average two bins holding up to 25 kilogrammes. Each bin costs £8 and is expected to last 7 years.

Storage needs are met by a purpose built facility that has been constructed on existing Council land. The use of storage facilities ensures that there is sufficient cullet available to

TABLE 11.1 Characteristics Of Trade Operating System

Population: 126,978
Number Of Domestic Premises: 48,837
Number Of Commercial Premises: 4,204

Number Of Catering Premises: 400
- serve 50% of caterers: 200

Trade Glass Waste Available: TRT = 260 tonnes

Operating System
Set Up Costs

Skip Costs
No Of Skips: 400 Life Of Skips: 7 years
Cost Of Skips: £ 8 per skip Interest Rate: 10%

Storage Costs
Capital Cost: £1040 Rateable Value: £0

Crusher Costs: £0

Vehicle Costs
No Of Vehicles 1 Life Of Vehicle: 7 years
Cost Of Vehicle: £35,000

Operating Costs

Uplift: Labour - Driver Costs: £7000 pa (£140 per week)
Loader Costs: £7000 pa (£140 per week)
Number Of Loaders: 2
Add On Costs: 30%
Vehicle Costs: £7000 pa (£ 140 per week)

Skip Maintenance: TQ * SKM = 0

Administration: TH * TW = 0

On-Going Promotion: PB * IC = 0

Crusher: Labour - Loading Crusher: £0 pa
Conveyor: £0 pa

Crusher Supplies - Fuel: £0
Maintenance: £0

Storage Maintenance: WS * TS = 0

Bulk Transport: - Transport: £4.00 per tonne
Loading: £0.50 per tonne

Income

Revenue: Mixed Glass - £18.00 * per tonne

Disposal Savings: Y = £1.42 per tonne

Collection: Savings In Collection - TB = per tonne
Loss In Trade Revenue - TD = per tonne

bulk transport to the processor in economic loads. Storage costs are treated as a capital investment with costs spread over 10 years at an interest rate of 10% per annum.

Promotional costs will be through correspondence, and can be treated as part of the normal administrative costs of the waste management system.

To reduce the volume of the collected glass a crusher can be employed. However, with the sequence of handling glass goes through it is felt that the glass would be broken up to a sufficient extent that the use of a crusher would be unnecessary.

Pick up is made up by a refuse collection vehicle. Initially spare capacity is utilised as the scheme establishes itself. These vehicles can hold 3 tonnes, and cost about £35,000 which are spread over 10 years.

11.5.3 Operating System

The skips will be uplifted and emptied into the lorry on site on a weekly basis making use of available fleet vehicles. Uplift is made over a period of two days with 100 premises served each day. The number of bins each site has depends on the quantity of waste glass that each premises produces, but on average it is two skips per site. The collected glass is then transported to the storage site where it is unloaded into the mixed glass bay. The colours are not separated as this might be too onerous for the participants. Once enough glass is available a private haulier is contacted who then bulk hauls the glass to the processor.

Labour used for uplift is made up of 1 driver and two loaders, whose earnings on average are £7000 per year. Add on costs for

pensions, holidays and national insurance increase this by about 30% to a total salary of £9100 per annum. The labour will come from the collection department and will have other duties to perform. In this case if two days are taken up, then 20% of their costs can be assigned to the trade scheme. Alternatively, there total costs can be assigned to the scheme. Or as there costs have already been accounted for, and there under utilised time is being used this can be treated as a marginal cost. All three options are examined by the model.

Vehicle costs are made up of standing and operating costs. A working estimate of £140 per week for operating costs has been assigned to the scheme.

Skip maintenance costs are unclear, but they should be minimal as skips are kept in secure storage areas away from possible abuse through vandalism. If there is public access to the skips such as the use of modular bins on catering premises these costs could be more significant.

Administration costs are felt to be marginal, as even if the scheme is terminated these costs of handling the material will still be incurred, and are incorporated as zero.

Promotional activities would comprise use of correspondence and leaflets to inform traders of the collection dates, the numbers of bins that will be picked up, and the importance of keeping other materials out of the glass. This will be a marginal cost and will fall within normal administrative duties, and the department's brochures publicising their activities.

Bulk transport of the collected glass is handled by a private haulier at a fixed rate, of £4.00 per tonne. The contractor is

called in when 20 tonnes of glass is available to be transported to the processor. A nominal £0.50 per tonne is assigned for the loading operation, which takes about half an hour.

11.5.4 Income

These costs of operating the recycling scheme are offset by revenue obtained from sale of glass to the processor. In addition there may be benefits through savings in disposal costs, and changes in trade collection costs.

Revenue results from the sale of cullet to the processor at a price of £22.0 per tonne for clear glass and £18.00 per tonne for mixed glass. The revenue is dependant on cullet being accepted under their quality restrictions, on the colour split and on the tonnage recovered. Initially the glass is collected as mixed glass, as it is felt that traders would be unwilling to separate glass into the colours, due to lack of storage space and the number of bins required.

Waste is predominantly disposed of by landfill at an average cost of £5.88 per tonne. With each tonne of glass recovered there may be immediate savings in disposal costs which should be attributed to the scheme.

Changes in collection costs are made up of two elements: A possible loss in revenue, and Savings in Collection Costs. As each tonne of glass diverted there will result in a fall off of revenue from trade charges. This is dependant on amount charged (£0.30p per sack which holds 25 kilogrammes), and the quantity of material that is collected. However, savings in collection costs are likely to be more long term, if the reduction of the volume of glass can lead to a reorganisation in collection operations.

11.5.5 Computer Runs

The trade analysis is based on a set of subroutines that form part of the main glass viability program outlined in Figure 10.A and consist of: Trade, Trading, Tradage, Trdbreak, Trdfull, Trdshare and Trdextra. They are called up dependant on the output required by the operator. Details of the FORTRAN program listing is provided in Appendix F.3.

Subroutine Trade carries out the basic calculations, which the other subroutines output in a number of different forms. Trading provides tables illustrating the net effects of operating the scheme under the three possible costs conditions: meeting full costs, sharing costs or meeting the extra costs. These can be outputed separately using the subroutines Trdfull, Trdshare and Trdextra respectively. These three subroutines also show the effects of including disposal savings and the changes in the collection costs of trade waste. The subroutine Tradage outputs the levels of glass recovered in tonnes per annum under the varying participation and waste generation levels. Trdbreak outputs the breakeven prices that would be necessary for a trade glass recovery scheme to breakeven under the three cost conditions.

The first run is based on the conditions listed in Table 11.1. The run is confined to glass from trade sources, with participation rates ranging from 1 to 100% of the possible traders. The glass generation rate ranges between 20 to 30 kilogrammes per week in steps of 1 kilogramme. It is a combination of the participation rate and generation rates that gives the tonnage of glass available. The Tonnage output shows that at 100% participation and a generation of 30 kilogrammes per week there is the potential of

300 tonnes of glass available. At a price of £18 per tonne this is worth £5400 per year if it is recovered and sold to the glass processor.

11.5.6 Results Of The Computer Run

The program allows the user to get a number of different outputs dependant on the control variable I. The output tables show the profit/loss per tonne that is possible for a combination of participation rates and traders waste generation levels. The tables show that as participation rates and generation levels increase the recovery schemes costs per tonne fall, improving the chances for the trade scheme to become profitable. This shows that schemes can benefit through economies of scale. Some sample outputs for tonnage, breakeven, and the varying cost conditions are shown in Appendix G.9.

The tonnage recovered will influence the breakeven price and thus the likely surplus that the scheme could achieve. The breakeven price print out shows the average price per tonne required for the scheme to breakeven under varying participation and waste generation rates. As greater tonnages are recovered it spreads the costs, reducing the average cost per tonne of the recovery operation. Breakeven price will be influenced by the operating system adopted and whether the scheme meets its full costs, shares costs, or covers extra costs incurred.

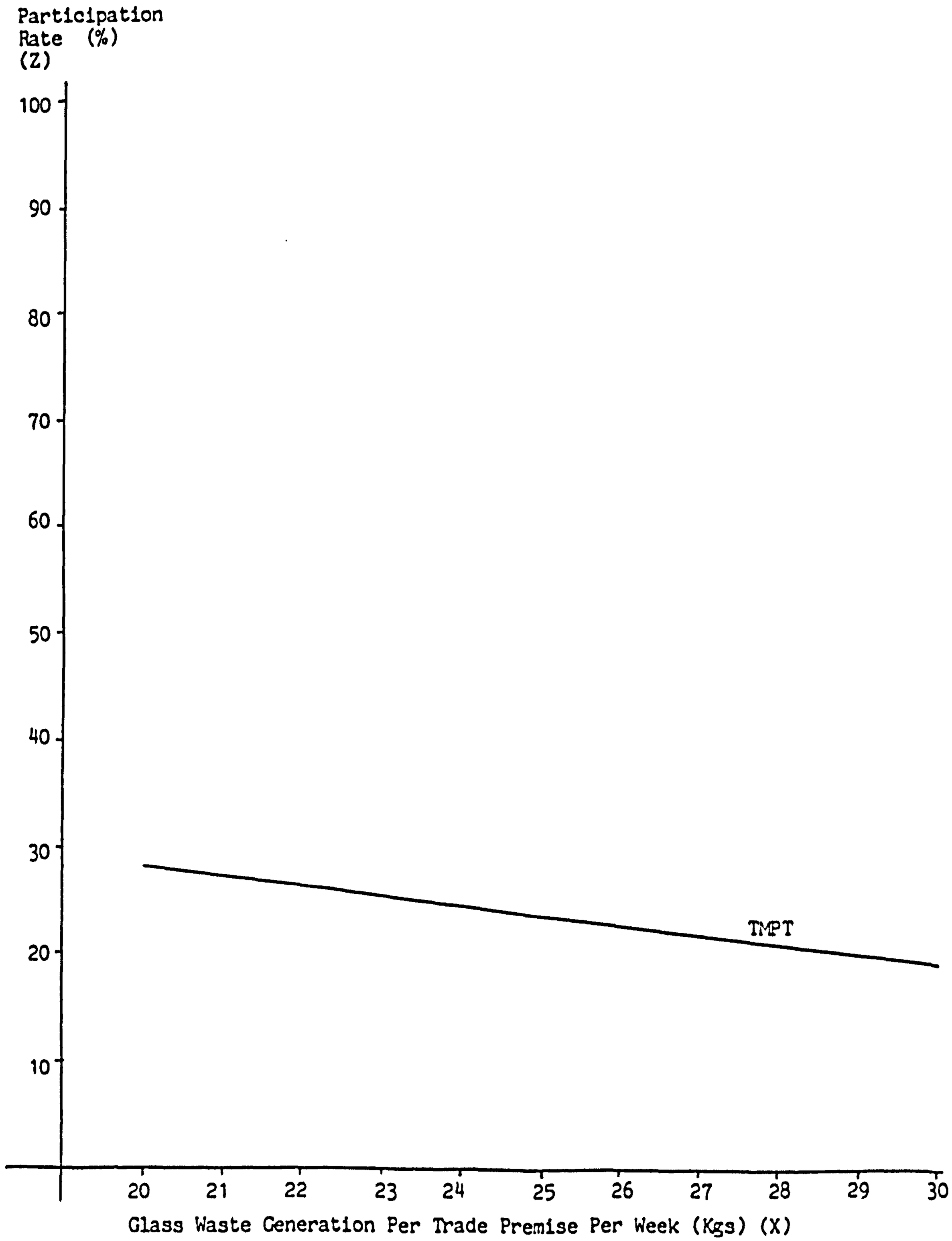
Subroutine Trading prints out three summary assessments for the three cost conditions. In principal the main costs are labour, vehicle and storage costs, with the most important being labour costs. If set up independantly the recovery scheme would have to meet the full costs of labour, vehicle and storage facilities so

it is necessary to consider this option. Alternatively, if it is set up in conjunction with other activities the scheme would be able to share some of the set up and operating costs that it incurs. Finally, if the costs of labour and vehicles used have already been met by other operations, then the recovery scheme might only be assigned the extra costs it incurs, eg additional fuel costs. These three options are expanded in separate subroutines where the influences of disposal savings and changes in trade collection costs are examined. By keeping these three measures separate it allows an operator to assess a scheme under their own terms and conditions.

Figure 11.A shows the breakeven boundaries for the trade recycling model. This is based on the private financial viability assessment only. Under full and shared cost options the scheme would make a loss under the hypothetical trade scheme. If the recovery scheme met the full costs of its operations it would lose £489.78 per tonne at a participation rate of 30% and a waste generation level of 29 kilogrammes per premise per week. If costs are shared the scheme would lose £95.96 per tonne at this combination of participation and waste generation levels. If the scheme meets only the extra costs of operations - primarily new skips and bulk transport costs - the scheme would make a positive return of £4.57 per tonne at a 30% participation rate and a waste generation level of 29 kilogrammes per premise per week. Under these conditions a breakeven boundary is only produced for a scheme that meets the extra costs of its operations.

The operator can use this boundary to ascertain what participation rate and waste generation level is needed for the scheme to breakeven. With price received of £18 per tonne and a scheme just

FIGURE 11.A Profit/Loss Breakeven Boundary For Trade Scheme Meets Extra Costs (TMPT)



meeting the extra costs of operations the scheme would breakeven at a participation rate of 23% and a generation level of 26 kilogrammes per premise per week. From the breakeven boundaries it is possible to refer back to the tonnage tables to see what quantity of glass is required for the scheme to breakeven. On a private financial appraisal (TPT), to cover the extra costs (TMPT) the scheme needs to recover 58.00 tonnes of glass per annum. This is just under 15% of the available glass. As traders generation can vary markedly with only a proportion of glass waste being recycled, it is likely that participation rates will have the greater influence. To improve operations the operator needs to look to maximise the level of glass collected and the participation level of traders and thus maximise the tonnage of glass recovered.

If disposal costs are included in the assessment this will push the profit/loss boundary to the left increasing the profitable area. Changes in collection costs have not been assessed. If trade charges are enforced then there could be an immediate loss in revenue to the Council, which would have an adverse effect on operations. Although it might act to encourage traders to participate in the scheme and thus reduce their costs of operations. Also a reduction in trade revenue might be offset by savings in collection costs, but this is likely to be a long term benefit. This is why they have been kept separate from any general assessment of the recycling scheme.

11.5.7 Varying Conditions

The viability of a trade glass recovery scheme is dependant on the cost option chosen and whether disposal and collection savings are included. Of the three cost options it is only when meeting the extra costs incurred that a trade scheme has been shown to recover its costs. The other two cost systems need to be examined carefully to see if there are any changes that can be made that will lead to an improvement in the operating position of the recovery scheme. A number of the critical costs have been examined to see whether a change in the operating system can be brought about which would result in an improved chance of viability.

11.5.8 Changes In Income

An increase in the price received for the recovered glass would improve the situation. But from the breakeven price tables (TRDBREAK Appendix G.9) it is possible to gain an idea of the price required for the trade scheme to recover its costs. For a scheme meeting full costs and operating with a participation rate of 30% and a generation level of 29 kilogrammes per premise per week, a price of £507.78 per to nne is required for the scheme to breakeven. If costs are shared this falls to £113.26 per tonne and for a system meeting the extra costs of the recovery operation the price required is £13.48 per tonne. If the participation rate is raised to 100% of the traders the price needed falls sigificantly. For full costs it is down to £155.48 per tonne, for shared costs it is £37.13 per tonne and for meeting extra costs it is down to £7.18 per tonne. At a processor price of £18 per tonne for mixed glass, it is only a system that just meets the extra costs that would cover its costs and make a surplus. It is unlikely that

prices will reach such a level as to bring the others into surplus.

The revenue could be improved by separating out the colours of glass. If done at the trader end this would require several bins, ample storage space and the willingness of the traders to cooperate. In addition it would effect the method of uplift; either warranting the need of a compartmentalised lorry, or the uplift of, and replacement of skips which are then emptied at the storage site. The former is likely to lead to increased vehicle costs and a reduced capacity and the latter is likely to lead to the use of a flat-bed lorry which also results in a reduced capacity. This can increase collection costs and adversely affect the viability of the scheme. An alternative method would be to hand sort back at the storage site and make use of a conveyor and possible crusher. This would increase the operating costs of the schemes. As most glass from caterers is likely to be green wine bottles and the tonnage is not that large it is felt that segregatiion is likely to have an adverse affect on costs and discourage traders from participating.

The incorporation of disposal cost savings and collection cost savings would also improve the operational cost position of the scheme. If the most expensive disposal option of incineration is used at £12 per tonne, this would not make a significant impact on the full cost or shared cost position. Changes in collection costs are unclear. If trade charges are made, the recovery of glass is likely to have an immediate adverse affect on the Council's revenue which should be associated with the recovery option. These would be offset in the long term by improvements in the collection system, with a reduction in waste lifted it may be possible to

reorganise collection activities and thus save on collection costs. These changes in collection and disposal costs would have to be large to have a significant effect on the viability of the recovery options.

11.5.9 Changes In Costs

As improvements in the income a recovery scheme generates are unlikely to have a major effect on the viability of a scheme, attention needs to be focused on the schemes costs, and the operating system it has adopted. Tables 11.3 and 11.4 outline the costs for two recovery conditions, one recovering 300 tonnes and the second 58 tonnes. The first represents a participation rate of 100% and a waste generation rate of 30 kilogrammes per premise per week. Under this operating system this is the maximum amount of glass that can be recovered. The second is based on a participation of 20% and a generation rate of 29 kilogrammes per week. This scenario lies on the breakeven profit/loss boundary for a scheme that just assesses the extra costs it incurs. As costs are gross figures, they are the same on both tables. The costs are based on fixed units of capital and time and not per tonne figures. The only difference is in bulk transport costs which is based on a fixed cost per tonne. Also the income figures vary as this reflects the different tonnages of glass recovered. The tables show the cost per tonne figures for set up costs and operating costs. It illustrates the way costs are reduced per tonne as more material is recovered and shows that a given operating system must seek to maximise the tonnage it recovers to minimise its operating costs. It shows that once a scheme has been set up the costs are largely fixed and thus it is up to the operator to optimise the system.

TABLE 11.2 Summary Of Trade System Costs

Participation Rate (Z)	20 %
Waste Generation (X)	29 kilogrammes
Tonnage Recovered (TRT)	58 tonnes

SET UP COSTS	Full Costs		Shares Costs		Extra Costs	
Skip Costs	777.14	(8%)	777.14	(30%)	777.14	(100%)
Storage Costs	208.00	(2%)	124.80	(5%)	0.00	
Promotion Costs	0.00		0.00		0.00	
Crusher Costs	0.00		0.00		0.00	
Vehicle Costs	8500.00	(90%)	1700.00	(65%)	0.00	
TOTAL	9485.14	(100%)	2601.94	(100%)	777.14	(100%)
SUCPT = SUC/TRT	163.54		44.86		13.39	
OPERATING COSTS						
Labour Costs	27300.00		5460.00		0.00	
Vehicle Costs	7000.00		1400.00		0.00	
Skip Maintenance	0.00		0.00		0.00	
Administration	0.00		0.00		0.00	
Promotion	0.00		0.00		0.00	
Crusher Labour	0.00		0.00		0.00	
Crusher Supplies	0.00		0.00		0.00	
Storage Maintenance	0.00		0.00		0.00	
Bulk Transport	261.00		261.00		261.00	
TOTAL	34561.00		7121.00		261.00	
OPCPT = OPC/TRT	595.87		122.77		4.50	
INCOME						
Revenue						
Mixed Glass	1044.00		1044.00		1044.00	
Disposal Savings	82.36		82.36		82.36	
Changes In Collection						
Loss In Revenue	0.00		0.00		0.00	
Collection Savings	0.00		0.00		0.00	
Total	0.00		0.00		0.00	

NET EFFECTS

A. Private Viability
TFPT = - 741.40 TTPT=- 149.64 TMPT=+ 0.10

B. Disposal Systems Surplus
TFST = - 739.99 TTST=- 148.22 TMST=+ 1.52

C. Total Systems Surplus
TFTS = - 741.40 TTTS=- 149.64 TMTS=+ 0.10

TABLE 11.3 Summary Of Trade System Costs

Participation Rate (Z)	30 %
Waste Generation (X)	29 kilogrammes
Tonnage Recovered (TRT)	90 tonnes

SET UP COSTS	Full Costs		Shares Costs		Extra Costs	
Skip Costs	777.14	(8%)	777.14	(30%)	777.14	(100%)
Storage Costs	208.00	(2%)	124.80	(5%)	0.00	
Promotion Costs	0.00		0.00		0.00	
Crusher Costs	0.00		0.00		0.00	
Vehicle Costs	8500.00	(90%)	1700.00	(65%)	0.00	
TOTAL	9485.14	(100%)	2601.94	(100%)	777.14	(100%)
SUCPT = SUC/TRT	105.39		28.91		8.63	
OPERATING COSTS						
Labour Costs	27300.00		5460.00		0.00	
Vehicle Costs	7000.00		1400.00		0.00	
Skip Maintenance	0.00		0.00		0.00	
Administration	0.00		0.00		0.00	
Promotion	0.00		0.00		0.00	
Crusher Labour	0.00		0.00		0.00	
Crusher Supplies	0.00		0.00		0.00	
Storage Maintenance	0.00		0.00		0.00	
Bulk Transport	405.00		405.00		405.00	
TOTAL	34705.00		7265.00		405.00	
OPCPT = OPC/TRT	385.60		80.70		4.50	
INCOME						
Revenue						
Mixed Glass	1620.00		1620.00		1620.00	
Disposal Savings	127.80		127.80		127.80	
Changes In Collection						
Loss In Revenue	0.00		0.00		0.00	
Collection Savings	0.00		0.00		0.00	
Total	0.00		0.00		0.00	

NET EFFECTS

A. Private Viability

TFPT = - 473.00 TTPT= - 96.60 TMPT= + 4.87

B. Disposal Systems Surplus

TFST = - 471.58 TTST= - 90.21 TMST= + 6.28

C. Total Systems Surplus

TFTS= - 471.58 TTTS= - 90.21 TMTS= + 6.28

TABLE 11.4 Summary Of Trade System Costs

Participation Rate (Z) 100 %
Waste Generation (X) 30 kilogrammes
Tonnage Recovered (TRT) 300 tonnes

SET UP COSTS	Full Costs		Shares Costs		Extra Costs	
Skip Costs	777.14	(8%)	777.14	(30%)	777.14	(100%)
Storage Costs	208.00	(2%)	124.80	(5%)	0.00	
Promotion Costs	0.00		0.00		0.00	
Crusher Costs	0.00		0.00		0.00	
Vehicle Costs	8500.00	(90%)	1700.00	(65%)	0.00	
TOTAL	9485.14	(100%)	2601.94	(100%)	777.14	(100%)
SUCPT = SUC/TRT	31.62		8.67		2.59	
OPERATING COSTS						
Labour Costs	27300.00		5460.00		0.00	
Vehicle Costs	7000.00		1400.00		0.00	
Skip Maintenance	0.00		0.00		0.00	
Administration	0.00		0.00		0.00	
Promotion	0.00		0.00		0.00	
Crusher Labour	0.00		0.00		0.00	
Crusher Supplies	0.00		0.00		0.00	
Storage Maintenance	0.00		0.00		0.00	
Bulk Transport	1350.00		1350.00		1350.00	
TOTAL	35650.00		8210.00		1350.00	
OPCPT = OPC/TRT	118.83		27.36		4.50	
INCOME						
Revenue						
Mixed Glass	5400.00		5400.00		5400.00	
Disposal Savings	426.00		426.00		426.00	
Changes In Collection						
Loss In Revenue	0.00		0.00		0.00	
Collection Savings	0.00		0.00		0.00	
Total	0.00		0.00		0.00	

NET EFFECTS

A. Private Viability
TFPT = - 132.45 TTPT= - 18.03 TMPT= + 10.91

B. Disposal Systems Surplus
TFST = - 131.03 TTST= - 16.62 TMST= + 12.33

C. Total Systems Surplus
TFTS = - 131.03 TTTS= - 16.62 TMTS= + 12.33

11.5.10 Changes In Set Up Costs

Set up costs in order of importance are: vehicle costs, skip costs and storage costs. In a scheme meeting full or shared costs the main component is vehicle investment charges, followed by bin investment charges and then storage costs. For a scheme meeting the extra costs only, it is assumed that a vehicle is available and storage facilities exist so the only additional costs to be met are the provision of bins. Attention needs to be focused on vehicle costs and ways of reducing their impact on the operating system.

11.5.10.1 Changes In Vehicle Investment Costs

For full costs vehicle charges account for 90% of the set up costs, for shared costs they account for 65% of the costs. This could be reduced in a number of ways. The vehicle used could be bought second hand and thus reduce the initial capital costs of the vehicle. Instead of using the more specialised refuse collection vehicle a cheaper vehicle could be used. This may result in a change in the actual uplift of the glass and affect the operating costs. A refuse collection vehicle is convenient as it can hold up to 7 tonnes and if necessary crush the glass. It also forms part of the work force that are involved in waste collection and they are used to operating it. Instead of this type of vehicle, a low sided vehicle could be used with skips being emptied directly into it, or being taken away and emptied at the storage sites. For shared costs, as vehicle costs are proportional to the use made of them a reduction in vehicle costs would improve the situation.

As shared costs are charged as a proportion of time they use the

vehicle, measures could be taken to reduce the use of the vehicle. An examination of collection routes and the quantities of glass collected needs to be undertaken. If the routes could be amalgamated so vehicle use is reduced to one whole day or one half day this will reduce the proportion of vehicle costs the scheme has to meet. One method is where quantities of glass do not justify a visit those premises could be withdrawn from the scheme, or possibly put on a two week rota with other premises. This could reduce the vehicles charge from 20% to 10% of its total costs.

Changes in vehicle costs and their influence on the private viability measures are shown in Tables 11.5. For a scheme meeting full costs the effects are shown in Table 11.5, with vehicle costs ranging from zero to £35,000 in steps of £5000. Changes in vehicle capital costs will also influence a system being operated under shared costs, and this is shown in Table 11.6. The effect of reducing the time vehicle is used from 20% of the time to 10% of the time, is shown in Table 11.7 for the different vehicle costs.

TABLE 11.5 Effect Of Change In Vehicle Costs On Set Up Costs And The Private Viability Measure

Scheme Meets Full Costs
Participation Rate = 20 % Generation Level = 29 kilogrammes
Tonnage Recovered = 58 tonnes

VEHICLE CAPITAL COST (V) (£'s)	VEHICLE COSTS (VI) (£'s)	TOTAL SET UP COSTS (SUC) (£'s)	VEHICLE INVESTMENT AS PERCENTAGE OF SET UP COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
35000	8500.00	9485.14	90	- 741.40
30000	7285.71	8270.85	88	- 720.48
25000	6071.43	7056.57	86	- 699.54
20000	4857.14	5842.28	83	- 678.61
15000	3642.86	4627.99	79	- 657.67
10000	2428.53	3413.71	71	- 636.74
5000	1214.28	2199.42	55	- 615.80
0	0.00	985.14	-	- 594.86

The tables show that the vehicle costs can be reduced and the proportion of set up costs they make will also fall. However, the

TABLE 11.6 Effect Of Change In Vehicle Costs On Set Up Costs And The Private Viability Measure

Scheme Shares Costs (TVI = 0.2 * VI)
Participation Rate = 20 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 58 tonnes

VEHICLE CAPITAL COST (V) (£'s)	VEHICLE COSTS (VI) (£'s)	SHARED VEHICLE COSTS (TVI)	TOTAL SET UP COSTS (SUC) (£'s)	VEHICLE INVESTMENT AS PERCENTAGE OF SET UP COSTS (%)	PRIVATE VIABILITY MEASURE(TFPT) (£'s per tonne)
35000	8500.00	1700.00	2601.94	65	- 149.64
30000	7285.71	1457.14	2359.10	62	- 145.45
25000	6071.43	1214.23	2116.17	57	- 141.26
20000	4857.14	971.43	1873.37	52	- 137.01
15000	3642.86	728.57	1630.51	45	- 132.89
10000	2428.53	485.71	1387.65	35	- 128.70
5000	1214.28	242.86	1144.79	21	- 124.51
0	0.00	0.00	901.94	-	- 120.33

TABLE 11.7 Effect Of Change In Vehicle Costs On Set Up Costs And The Private Viability Measure

Scheme Shares Costs (TVI = 0.1 * VI)
Participation Rate = 20 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 58 tonnes

VEHICLE CAPITAL COST (V) (£'s)	VEHICLE COSTS (VI) (£'s)	SHARED VEHICLE COSTS (TVI)	TOTAL SET UP COSTS (SUC) (£'s)	VEHICLE INVESTMENT AS PERCENTAGE OF SET UP COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
35000	8500.00	850.0	1751.94	48	- 134.98
30000	7285.71	728.6	1630.51	45	- 132.88
25000	6071.43	607.1	1509.10	40	- 130.79
20000	4857.14	485.7	1387.64	35	- 128.70
15000	3642.86	364.3	1266.23	29	- 126.61
10000	2428.53	242.8	1144.79	21	- 124.51
5000	1214.28	121.4	1023.37	12	- 122.42
0	0.00	0.0	901.14	-	- 120.33

tables indicate that even if vehicle costs are reduced to zero it still does not bring the recovery options based on full and shared costs into surplus. This does not mean that any improvements should not be made because although by themselves changes produce minor effects, in combination with other cost improvements it could bring these recovery systems into surplus. As shown with the Bottle Bank system improvements can be made with changes in vehicle life and changes in interest rates used. Once a scheme has been established the set up costs are fixed, so any improvements will need to be made in operating costs. Although, when operating under shared conditions and more of a resource is used by the scheme, a case can be made for increasing the proportion of fixed costs that are assigned to the scheme. Set up costs will need to be continually reviewed when assessing trade recovery schemes.

11.5.10.2 Changes In Skip Costs

The second main cost incurred is the capital investment in skips to store glass in before it is collected. This item accounts for 8% of full costs, 30% of shared costs and 100% of extra costs. These costs can be reduced by using available dustbins, abandoned chemical drums, or cardboard boxes, or other available containers. If boxes are used a second system for collecting them might be required. This could be part of a trade collection of cardboard as is the case with the Aberdeen system (Appendix G.3).

Also as participation rates are varied, an operator would only need to supply bins to those traders who participate in the recovery scheme. This would reduce costs in all cases effectively pulling the profit/loss boundary to the left reducing the losses per tonne and in the case of a system meeting extra costs improving the area that is likely to be profitable.

11.5.11 Changes In Operating Costs

For full costs the operating costs per tonne are £595.87 for a scheme recovering 58 tonnes and £122.77 for a scheme meeting shared costs. For scheme meeting extra costs the operating costs are £4.5 which is related to bulk transport costs. A scheme recovering 300 tonnes has operating costs of £118.83 per tonne for full costs, £27.36 per tonne for shared costs and £4.5 per tonne for meeting extra costs. The main operating costs are vehicle costs made up of labour costs and vehicle costs used in uplift from trade premises and bulk transport costs from moving glass from storage sites to the processor. In this assessment the other costs have been treated as zero and it is felt that they would not be significant if separately assessed and included.

11.5.11.a Changes In Labour Costs

Labour costs are the main component accounting for 79% of full costs and 76% of shared costs when the system operates at a participation rate of 20% and recovers 58 tonnes of glass per annum. For a system just meeting the extra costs of its operations it is felt that labour costs would have already been met by existing activities and are treated as zero.

Labour costs are largely fixed by local practices. The system described is based on two loaders and 1 driver. The need for two loaders is dependant of the weight of the bins picked up. At a recovery of 29 kilogrammes per premise, this would be 15 kilogrammes per bin which should be able to be lifted by one man. Labour could be reduced by one loader and where necessary the driver could assist the loader. This might cross areas of demarcation and cause unnecessary problems. This would reduce

costs by a third to £18200 for a scheme meeting full costs and £3640 for shared costs. A reduction in labour costs in both cases will bring down the overall operational costs. The effects of changes in labour costs are shown in Tables 11.8 and 11.9 Labour is reduced from three down to one man to see what affect this have on the viability measure.

The tables show that reductions in labour cost do have a major influence upon the operating costs, although again neither costing system is brought into surplus. At a recovery rate of 300 tonnes with labour down to two men the loss per tonne falls from £18.04 per tonne to £11.97 per tonne. If the need for labour is reduced from 20% to 10% of total costs, this brings the loss down to £5.91 per tonne. At such levels minor changes in the other costs, or an improvement in the prices received could bring the scheme into surplus on a shared cost basis. If disposal cost savings are included this could tip the balance in achieving a surplus.

11.5.11.b Changes In Vehicle Costs

Vehicle costs are the next main component of the operating costs. They are based on a fixed charge of £140 per week. If this can be reduced by using less vehicle time, this would improve the overall operating costs.

11.5.12 Resume

To improve the operating conditions the costs factors needed to be tackled together and not treated separately. Although reductions in one cost factor might not have a significant effect, a reduction in several together could improve the system and bring the recovery scheme into surplus.

TABLE 11.8 Effect Of Changes In Labour Costs On Operating Costs On Private Viability Measures

Scheme Meets Full Costs
Participation Rate = 20 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 58 tonnes

LABOUR NUMBER	TOTAL LABOUR COSTS (£'s)	TOTAL OPERATING COSTS (TSUC) (£ 's)	LABOUR COSTS AS PERCENTAGE OF OPERATING COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
3	27300	34561	79	- 741.4
2	18200	25461	71	- 584.52
1	9100	16361	56	- 427.62

TABLE 11.9 Effect Of Changes In Labour Costs On Operating Costs On Private Viability Measures

Scheme Meets Full Costs
Participation Rate = 100 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 300 tonnes

LABOUR NUMBER	TOTAL LABOUR COSTS (£'s)	TOTAL OPERATING COSTS (TSUC) (£'s)	LABOUR COSTS AS PERCENTAGE OF OPERATING COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
3	27300	35650	77	- 132.45
2	18200	26550	68	- 102.12
1	9100	17450	52	- 71.78

TABLE 11.10 Effect Of Changes In Labour Costs On Operating Costs On Private Viability Measures

Scheme Shares Costs TTLB=0.2*TLAB
Participation Rate = 20 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 58 tonnes

LABOUR NUMBER	SHARED LABOUR COSTS (£'s)	TOTAL OPERATING COSTS (TSUC) (£'s)	LABOUR COSTS AS PERCENTAGE OF OPERATING COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
3	5460	7121	77	- 149.63
2	3640	5281	69	- 135.91
1	1820	3481	52	- 86.88

TABLE 11.11 Effect Of Changes In Labour Costs On Operating Costs On Private Viability Measures

Scheme Shares Costs TTLB=0.2*TLAB
Participation Rate = 100 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 300 tonnes

LABOUR NUMBER	SHARED LABOUR COSTS (£'s)	TOTAL OPERATING COSTS (TSUC) (£'s)	LABOUR COSTS AS PERCENTAGE OF OPERATING COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
3	5460	8210	66	- 18.04
2	3640	6390	57	- 11.97
1	1820	4570	40	- 5.91

TABLE 11.12 Effect Of Changes In Labour Costs On Operating Costs On Private Viability Measures

Scheme Shares Costs TTLB = 0.1 * TLAB
Participation Rate = 20 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 58 tonnes

LABOUR NUMBER	SHARED LABOUR COSTS (£'s)	TOTAL OPERATING COSTS (TSUC) (£ 's)	LABOUR COSTS AS PERCENTAGE OF OPERATING COSTS (%)	PRIVATE VIABILITY MEASURE(TFPT) (£'s / tonne)
3	2730	4391	62	- 102.57
2	1820	3481	53	- 86.88
1	910	2571	35	- 71.18

TABLE 11.13 Effect Of Changes In Labour Costs On Operating Costs On Private Viability Measures

Scheme Shares Costs TTLB = 0.1 * TLAB
Participation Rate = 100 %
Generation Level = 29 kilogrammes
Tonnage Recovered = 300 tonnes

LABOUR NUMBER	SHARED LABOUR COSTS (£'s)	TOTAL OPERATING COSTS (TSUC) (£ 's)	LABOUR COSTS AS PERCENTAGE OF OPERATING COSTS (%)	PRIVATE VIABILITY MEASURE (TFPT) (£'s per tonne)
3	2730	5480	50	- 8.94
2	1820	4570	40	- 5.91
1	910	3660	25	- 2.87

As has been shown increased recovery of glass allows costs to be spread further and reduce the cost per tonne figure. More glass can be collected by bringing in more traders to the scheme and by maximising the glass recovered from each premise. If the number of traders is raised to 400, the potential glass available is doubled to 600 tonnes. However, expansion would increase skip costs to £1554, and may affect operating costs. Although skip costs have been shown not be critical, uplift costs are, so care must be taken not to increase labour or vehicle usage. With 400 premises losses can be reduced if the maximum tonnage of glass is collected to £60.77 per tonne for a scheme meeting full costs, and£3.57 for a scheme meeting shared costs. For a scheme meeting extra costs the revenue per tonne is increased to £10.91 per tonne. If the generation rate per premise is increased to 30-40 kilogrammes this again would increase tonnage available to 400 tonnes for a scheme serving 200 premises.

As tonnage recovered has increased the costs per tonne will fall. In combination with this if some of the cost savings are introduced this will bring the scheme into breakeven. Then if disposal cost savings and changes in collection are added, trade recovery schemes can be a sound method of handling waste glass.

There is a need to maximise participation rates, the amount of glass recovered from each premise and keep costs down. The cost options looked at show that it is best if it can use spare capacity and just meet additional costs. The next option would be making a contribution to the resources it uses. Finally a scheme meeting full costs could not be justified on this operational system.

11.6 Summary Of The Trade Model

The Trade model has been developed from an analysis of existing recovery schemes. It was noted that these recycling projects operate on different 'costing' levels that reflect how close their links are with existing operations. This applied whether the recovery scheme was part of existing Local Authority operations, or whether it was part of a private waste disposal company's operations. To allow for these different situations, trade reclamation schemes can be assessed under three cost conditions.

If the scheme has been set up on a trial basis that makes use of 'spare' capacity then only the extra costs that are incurred in the operation of the scheme should be considered. This will be the additional fuel costs and investment into new skips. When the scheme becomes a full part of the services offered then the scheme should be reassessed in terms of the proportion of resources the scheme uses. Vehicle and labour costs would be apportioned to the operation based on the time they are used. This will provide a more realistic assessment of the trade project's viability.

The third costing system applies when the recovery project is a separate operation and meets the full costs of its operations. This can place an unrealistic burden on a project which makes only limited use of vehicle and labour requirements. This was shown in the results of the hypothetical case where based on full costs, the trade recovery option made heavy losses. It is a more realistic assessment when applied to certain private operators who solely ran a trade recovery option and ran into severe financial problems.

If the trial scheme proves to be successful and starts to share costs, there is the long term possibility that Local Authority schemes will meet full costs. This will occur when the project fully utilises the equipment assigned to it.

The Trade Model can be used by any operator to assess the viability of trade glass recycling schemes. This can be used to assess existing schemes. An assessment of new projects is looked at in Appendix H. The data required for use in the model can be gathered using the Summary Tables (Appendix G.10). This information can be run on the computer model to provide a standard set of results. From this initial appraisal variations can be made of the key factors to see what impact they might have on the results. The Trade Model takes account of the wider effects of glass recycling on disposal and collection costs.

The results showed that it was only when meeting extra costs that a trade scheme was shown to be in surplus. This emphasises the dilemma over which costs should be assigned when assessing recovery projects. There is a need to make a clear assessment at the planning stage of which costs should be included in any viability appraisal. This is important in internal assessments and when making comparisons with other recycling projects and waste management options.

Chapter 12

International Comparisons

12.1 Introduction

This Chapter provides a brief review of some glass recycling projects that operate in other countries. It seeks to highlight the more significant projects and how they compare to the projects adopted in Britain. It also provides a brief insight into the legislation that waste management systems operate under. More detailed reviews can be found in the work of other authors.

HANNEQUART (1983) has prepared a comprehensive review of the legislation that affects waste management policy in European Countries. A study of community projects within the USA has been undertaken by COHEN (1978). An assessment of mechanical separation systems is given by a study by BROWN, VENCE & ASSOCIATES (1983). An extensive analysis of separate collection and recycling schemes was undertaken by R K Turner for the OECD (1983).

Chapter 4 in its review of returnables compares the adoption of deposit legislation in a number of countries. Reference was made to the WMAC (1981) report and an international study undertaken by the OECD (1978). Particular examples of glass recycling were shown in Chapter 5. This covered both source separation and mechanical separation examples.

This Chapter draws on examples of glass recovery in European Countries to see if there are any similarities with the schemes adopted in Britain and if any lessons can be learned from the experience of others. The Chapter concludes with a brief resume of

the role and influence of the European Economic Community.

12.2 Comparison

Table 12.1 provides a brief summary of the glass recovery systems operating in certain European countries, how they developed and what problems they faced. These countries have had varying success rates, with each showing continued growth. Compared to these countries Britain has not been very successful. This can be put down to a number of factors: varying degrees of Government influence, lack of support from Local Authorities, and poor commitment from Industry and the general public. The key to the success of the better schemes appears to be the willingness of Governments to introduce legislative measures to reduce waste and promote recycling options.

12.3 Legislation

In France Industry and Government have signed a 'contract' to reduce the level of waste and levels of energy consumption. This has lead to the development of different recovery schemes, which has lead to the successful reclamation of 25% of glass consumption. Holland has several Acts to control waste production. This allows the Government to introduce regulations to encourage source separation, establish a system of deposit legislation and possible standardisation of containers. Local Authorities are required to install the standard glass collection scheme, with a bank for every 2000 people. West Germany also has legislative means to encourage recycling and control materials reaching the waste stream. Legislation has been used as a stick to encourage the packaging industry to take responsibility for their waste. Whereas in Britain Legislation (CPA 1974 Sn 18) allows

TABLE 12.1: A REVIEW OF GLASS RECOVERY PRACTICES IN EUROPEAN COUNTRIES

COUNTRY	STARTED	GOVERNMENT/L.A. ROLE	COLLECTION SYSTEM	COLOUR SEPARATION/ PROCESSING	TONNES RECOVERED (1984)	% NTNL GLASS CONSUMPTION	PUBLIC AWARENESS	GENERAL POINTS
Austria	1975		Initiated by Glass Manufacturers - taken over by OPG reclaimer.	Colours separate and process to remove contraries.	47,000	30%	Consumer education and information programmes are the key to success.	
Belgium	1978	Difficult to promote with cost controls on Local Authorities.	Initially house-to-house collection scheme (Ghent) with large banks ($10m^3$) - problems - lack of storage - congestion in uplift - poor appearance - overcome by Modular Banks ($2.6m^3$) Antwerp: 200 skips - 1/1100 people.		120,000	36%	Recovery companies promote advantages of recycling.	Started to reduce glass in compost made from household waste. March 1985 Verlipack glass manufacturer bankrupt.
France	1974 (Ind.) 1979 (H'shlds)	'Contract' between Govt. and packaging industry to recycle materials to save energy (50% subsidy of collection costs).	Bordeaux - house-to-house collection (private company) on fortnightly basis. Switching to central skips promoted by manufacturers and private companies - operate 20,000 skips.	Hand sort bottles for re-use (5m/year). Ind. built 15 recycling centres.	540,000	25%	Strong links with charities. National Poster Campaign (1985). Survey-92% knew of them 75% good idea 34% used them	Two tier pricing: < 150 kms get 200F/tonne. > 150 kms = 210F/tonne.
Ireland	1978	Government encourages recycling where it is profitable.	Irish Glass Bottle Co. and Dublin C.C. set up large banks.		6,000	7%		Need a national waste strategy.
Italy	1976	Law No. 915 (September 1984) seeks to promote collection & recycling of containers - encourages L.A. support.	Initiated by Assovetro with Cullet Merchants and Local Authorities. Used $4-6m^3$ skips - problems of uplift and siting. Overcome with $1.5m^3$ Modulars - site 200m apart 1/1000 people.	Cullet Merchants treat and crush glass. Collect as mixed. Keep investment down.	428,000	24%	Banks orange in colour with WWF (Panda) symbol to promote env. health benefits. Publicises through T.V.	Ind. committed to take all glass collected.
Netherlands	1970s	Merchandise Act can regulate use and type of packaging. Waste Substances Act 1977, Article 2 requires L.As to install standard glass collection skips (1/2000 people).	Modular Banks - 7000 skips (1984).		230,000	53%	Promotion through T.V. and retailers.	Decline in glass in waste stream from 14% (1979) to 7% (1984). Disposal savings of F120 million.
Portugal	1983	Departments of Energy and Environment funds T.V. and radio adverts.	Trial started by AIEVE (GMF) in urban areas (>30,000 people). Modular Banks - $1.1m^3$ - coloured $2.6m^3$ - clear Best sites: supermarkets, street markets.	Colour sort.	23,000	10%	Success depends on continuous information programmes.	Revenue funds: Childrens' projects.
Switzerland	1971	Local Authority investment in new skips.	Started by Vetropack on house-to-house basis. Problems - labour intensive, storage, fixed collection date, colours mixed. 1976 changed to centrally sited Modulars $6m^3$ and $9m^3$.	Modulars allow colour separation - increased tonnage recovered (65% mixed, 22% clear).	127,000	45%	Scheme heavily promoted.	3310/3027 L.A. (Population = 6.4m) participate.
West Germany	1974	Waste Management Prog. (1975) encourages recycling. Law for disposal of waste can restrict packaging types, if no suitable disposal/recycling method.	1974 - developed around glassworks, on banks $4-10m^3$. Cities - Modulars empty on site.	Keep colours separate. Recycling centres in most cities. Priority to collect clear glass, as half production is clear but only a fifth of recovered glass.	884,000	11%	Public is the key, best promotion is a well run scheme.	Need to reinforce separation, otherwise production of green may limit glass collection. Promote recycling to keep within legislation requirements.

Councils to recycle if they wish, but does not enforce it as with Holland. The recent appointment of a Minister with responsibility for recycling may lead to more positive steps from Central Government.

12.4 Initiation

In all cases, glass recovery has been promoted by the Glass Manufacturing Industry or their Trade Body in that country. Although once established the general operation has passed to specialist private waste reclamation companies. With the contract in France between Industry and Government it has ensured that there is a ready market for the recovered cullet. They have indexed the price to changes in raw material prices. In France they also operate a two tier pricing structure. Local Authorities further than 150km from the factory are paid F210 per tonne and those nearer than 150km receive F200 per tonne. This price differential is to compensate for extra transport costs. The system in Germany also offers a guaranteed market, with long term contracts between Local Authorities and the Industry to control price and the quality of service. In Britain the scheme was initiated by the GMF, it offers a guaranteed market and a price linked with material costs. The development of recovery schemes can also be seen in light of pressure from environmentalists and the threat of legislation to control packaging waste.

12.5 Collection System

The collection system that has been generally adopted is based on centrally located banks. A number of countries had started with house-to-house collection of glass as this used the existing collection system. This ran into a number of problems and they

have switched to central skips. In Ghent, Belgium house-to-house collection was complemented by the siting of skips in residential areas. In France collection of glass was made on specified days, with the collection costs being subsidised by Government funds. In Switzerland, glass collection started in 1973 with recovery from households. This was advantageous as it involved no extra investment by Local authorities. However, this system had a number of problems. It was labour intensive, there were household storage problems, the constraint of a fixed collection date and the colours were mixed. These problems were overcome in 1976 with the move to permanent collection sites providing for the separation of colours. This lead to new investment in banks, which was countered by the benefits of maximising revenue through keeping colours separate. The banks can also be used at anytime and uplift is linked to filling rates so loads can be maximised thus keeping collection costs down. In Switzerland it has lead to improved viability with associated increase in the amount of glass recovered.

Britain started with a house-to-house collection scheme in York which was run by Redfearn National Glass (Chapter 5.3.1). As with other countries the scheme was costly to run, with low returns and a poor quality of material recovered. This lead to Britain adopting the centrally sited large Bottle Bank.

In West Germany moves are being made back to house-to-house collection with the development of the 'Green Bank' system (Chapter 5.3.4). The aim was to recover recyclables in one bank and other refuse in a separate bank. The additional income from the extra materials would help offset the extra costs that are incurred.

Use of the large Bank has itself met a number of problems. In Belgium with $10m^3$ skips they had problems of siting and their poor appearance. In addition there was the problems of congestion during uplift and return of skip to the site. This lead to the development of the smaller Modular Banks which have been adopted by most European Countries. This allows on-site emptying which has a number of advantages. There is no space required for substitute skips. They are purpose designed and can look attractive on site. With this system it is possible to increase the number of modular banks on site to cater for changes in demand. The Modular system is being developed in Britain, primarily by the glass industry and private waste collection companies. Local Authorities are staying with the large banks, due to the costs of changing the collection system.

Italy aims to site a skip every 200m serving 1000 inhabitants. Italy now has 20,000 skips. The Netherlands requires a skip for every 2000 people and now operates 7000 Banks for 14 million people. Britain has 2070 sites (2070+ Banks) serving 55 million people. This illustrates the different levels of commitment.

Also of importance is siting. Across Europe the better sites have been found to be the large supermarkets with easy public access. In Italy users tended to be on foot so siting was on streets and near residential areas. The patterns of transport adopted by users will influence siting policy.

12.6 Publicity

Public support is also a key area, as it is only through their support that a glass recovery scheme can be successful. All countries have adopted high profile promotional schemes. But the

best promotional tool is a successful recycling scheme. Promotion tends to be two fold: informational, advising on how the scheme works and the targets acheived, and educational, putting recycling into context of the waste management system. Holland's promotional schemes bring cooperation between the Glass Industry, Local Authorities and retailers. In Portugal promotional campaigns are funded through Government Departments and make use of television and radio adverts.

12.7 Charity Links

A successful way of encouraging public support is through passing on some of the revenue to local charities or community projects. This is used in France and Portugal. In Britain Reading has donated £70,000 for kidney dialysis units since they started in 1979. It has proved a very successful way of promoting recycling.

12.8 Summary

Across Europe successful schemes are dependant on a clear stance being taken by National Governments on waste management policy. They provide a back stop from which recycling is encouraged as well as enforced by the potential of the legislative power available.

Important are the links with the public, and information needs to be made available on how the scheme works and why they should support it. Also of importance are the collection and organisational factors.

12.9 The European Community

In the environmental action programme the Nine agreed that the most important problem for the Community in the waste management field, was the elimination of wastes which, because of their toxicity, their bulk, or for other reasons require a solution extending beyond the regional framework and possibly even beyond national frontiers. The programme went onto argue that even if the harmful effects of wastes do not extend beyond the immediate region, Community action may well become necessary if the elimination or re-use of wastes are dependant on economic resources.

The programme specified that work should be carried out involving:

a. the drawing up of an inventory of wastes or residues which are particularly harmful to the environment.

b. the study of the economic and legal aspects of the problems posed by the collection, transport, storage, recycling or final treatment of particular wastes.

c. an examination of the action to be taken at Community level with regard to these wastes.

The Council Directive (75/442) on waste disposal adopted on July 15 1975 established the principle that waste should be disposed of without endangering human health and without harming the environment. This defined Waste as any substance or object which the holder disposes of, or is required to dispose of pursuant to the provisions of national law in force. It views the disposal of waste as: collection, sorting, transport and tipping above or below the ground. It also includes the transformation operations necessary for its reuse, recovery or recycling. This Directive also states that the prevention, recycling and processing of waste, the extraction of raw materials and energy from waste should be encouraged.

This Directive has similar proposals as the Control of Pollution Act 1974. This framework directive was designed to be complemented by specific directives applying to different types of waste. Specific directives applying to treatment of waste oil to oblige recycling wherever practical and another concerned the disposal of PCB's and PCT's have been adopted. To this has been added the Directive on Liquid Beverage Consumption formally adopted in June 1985 (Chapter 4.8.6).

The Commision established within the Environment and Consumers Protection Service a Waste Management Committee. This Committees interests include:

1. To encourage industry to maximise its use of recycled materials, where it is economic.

2. To develop a waste directory for industrial use.

3. Improve the technology of recycling to increase the volume of material used.

4. To persuade users, to accept a higher degree of re-use of recycled materials even by the use of lower quality.

Waste prevention and the best possible use of natural resources is a clear goal of the Community's Waste Management Programme. They looked at household waste because:

1. Disposal costs are rising.

2. Further recovery of the waste can make a substantial contribution to the conservation of resources.

In the packaging area the Commission sought a solution that would minimise packaging manufacture and distribution costs, maximise consumer satisfaction, reduce social costs and safegaurd employment. A common approach in the reduction of waste and the conservation of raw materials and energy is desirable. With beverage containers this common approach points to two complementary courses of action: a. the re-use of containers and b. the recycling of materials. It is felt that the packaging

TABLE 12.2 The Potential For Further Reclamation

MATERIAL - Form in which it arises	AMOUNT AVAILABLE (million tonnes/year)	MOST VALUABLE RECOVERY METHOD	VALUE $ (Million)
FERROUS METALS - Cans & obsolete scrap	10-20	Recycle (high grade)	c. 2500
NON-FERROUS METALS - Packaging & obsolete scrap	1-2	Recycle (high grade)	c. 1000
PAPER - Newsprint, packaging, etc.	20	Recycle (high & low)	2000
GLASS - Containers etc.	6	Recycle (high) Reuse & Recycle	100 500
PLASTICS - Containers etc.	3	Recycle (high & low) & Byproducts	1000
RUBBER - Tyres, etc.	1.5	Recycle (high & low) & Reuse	500
TEXTILES - Clothes, etc.	2	Recycle (high & low) & By-products	1000
CHEMICAL WASTES	5-10	Reuse & By-products	1000
LUBRICATING OILS	1.25	Recycle (high) & Reuse (low)	
PFA & MINING WASTES	200	By-products	500
AGRICULTURAL & FOOD WASTES	40-60	By-products	c. 3000

SOURCE: ERL Economics Of Recycling 1978

industry throughout Europe could make a distinct contribution to environmental issues by designing products for:

1. Re-use or multiple use where possible.
2. Ease of reclamation, recycling and disposal.
3. Using the least energy intensive material, required for the product.
4. Reducing certain polluting effects of the manufacturing and packaging materials.

The Commission are developing research programmes into the retrieval of materials and energy from household waste, retrieval by thermal processing, the utilisation of waste rubbish and the fermentation of waste by hydrolysis.

In 1975 Environmental Resources Limited (ERL) were asked to undertake a study of the potential for recycling within the Community. The aim was to examine reclamation at a general level to establish why materials were discarded and not reclaimed. A high proportion of materials available for reclamation arise in the Community's mixed waste. It is financially advantageous to the Community for materials to be recycled wherever practical rather than used to produce a fuel or compost since their value as a substitute for a primary material is higher than as a by product. Table 12.2 shows the potential for recycling within the Community.

The total reclamation potential value of annual arisings of unrecovered materials in the Community is in excess of $10,000 million (ERL 1978); based on the assumption that the most valuable recovery methods were used. Savings in imports depend upon which materials the reclaimed materials are substituted for and where the virgin and secondary materials are processed whether within the Community or outside its boundary.

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Chapter 13

Discussion And Conclusions

13.1 Overview

This work provides a detailed appraisal of the current status of glass recycling in Britain. Attention has been mainly focused on glass recovery from households by Local Authorities and Private Companies.

The technical problems of glass recycling were briefly examined (Chapter 3). This highlighted the problem of colour mixing, and the need for sufficient quantities of cullet. The different recovery options were looked at from returnables to reuse (Chapters 4 & 5). It showed that a balanced approach was necessary, as not all glass containers can be returnable; a system to collect, process and reuse containers needs to be developed.

Chapter 5 looked at the various recovery options that have been tried. The main method of recovery is centrally located Bottle Banks (Chapter 6). It is this area where attention has been focused. Statistics on glass collection costs and information on recycling operations in Scotland were collected for the first time (Chapter 7). This should provide a useful data base for policy makers.

Information from these surveys provided the basis for the financial viability models, for household (Chapter 10) and trade glass recovery (Chapter 11). This information was used to assess the viability of the surveyed Local Authorities (Chapter 9.4).

Based on the private viability measure (PPT) nearly half of the surveyed Authorities were making a surplus. The division of costs into Set Up and Operating Costs can be used to highlight the main cost components. Under Set Up Costs the main cost is the capital cost of the Bottle Banks. This can be minimised by seeking sponsorship or by modifying existing skips. However, once a scheme has been established the Set Up Costs can be treated as fixed costs, so any improvement in operating conditions will come careful control of the operating costs. The key operating costs are the initial uplift of the banks and the onward bulk transport of the glass. These can be kept to the minimum by maximising the tonnage of glass that is moved. The Model can be used to assess the effect of changes in the costs on the viability measures.

The costs are influenced by the tonnage of cullet recovered. The greater the quantity reduces the impact of set up and operating costs on the viability measures. Increased tonnages of cullet recovered can improve the overall economics of a glass recovery scheme.

The assessment of the surveyed Authorities showed the importance of reviewing the wider benefits of disposal and collection cost savings. When disposal cost figures (SST2) from the survey were included 18 Authorities were in surplus. In the long term if collection savings can be assigned, only one Authority would make a loss.

The inclusion of the wider costs and benefits by this model provides a rational basis for decision making by the managers of recycling schemes.

13.2 Britain's Poor Glass Recycling Performance

Glass recycling has expanded steadily in Britain from 5 Local Authorities in 1977 to 320 in 1984 recovering 162,000 tonnes of glass. This represents 12% of glass consumption. Although, this is encouraging, when compared to other European Countries this performance was poor (Chapter 12). Holland was shown to recover 53% and West Germany 33% of their glass.

From the results of the Local Authority Survey (Chapter 7) and the review of European practices (Chapter 12) it is possible to highlight some of the causes of Britain's relative poor performance.

13.2.a Government Policy

Waste management legislation in Britain allows Councils to recycle, but provides no requirement to do so, nor financial incentives to encourage it. In other European Countries, Governments have taken a more positive approach actively encouraging Industry and Local Authorities to develop recycling schemes. In France the government and the packaging industry signed a 'contract' to reduce levels of waste to save energy. In France subsidies have been made to offset collection costs for those recovery schemes further away from the processor. Holland has legislation that requires a certain level of provision for glass recycling. European Governments offer positive encouragement to recycling schemes, backed by legislation that requires Industry and Local Authorities to take action.

13.2.b Nature And Scope Of Recycling Schemes

Most countries operate variants of the Bottle Bank scheme,

although European countries have exploited the smaller modular banks. Modular banks are easier to site and overcome problems of congestion, noise and the poor appearance of the large banks.

The main difference between Britain and Europe is in the density of the Bottle Banks. In Scotland, Authorities operate on average 8 Banks. Edinburgh one of the larger schemes has 22 sites (1 site per 25,000 people). In contrast Holland requires 1 skip per 2000 people, and Italy aims for 1 Bank per 2,000 people. Holland has 7000 Banks for 14 million people whereas Britain has 2070 sites for 55 million people.

As sites are more dispersed in Britain, participants will have to make a conscious effort to bring their used glass containers to the Banks.

13.2.c Financial Information

Many Local Authorities viewed economic viability to be a very important criterion for judging the success of recycling schemes. However, only six Councils claimed to separately account for their glass recycling schemes; although their approach was questionable. The poor financial information available to Councils makes rational decisions on recycling difficult. The development of a uniform costing system that provided appropriate management information could help glass recycling to expand in Britain.

13.3 Recommendations For Improved Recycling Performance

13.3.a Government Policy

It is in the assessment of the wider social costs and benefits (Chapter 8) that the Government has a role to play in ensuring that the socially optimal decision is made.

A more active approach from Government to recycling is required. This needs to be done through the development of a comprehensive waste management policy, that treats recycling as an integral part of the whole.

The appointment of a Minister with Responsibility for Waste, may show a change in attitude by the Government, although any positive effects are as yet unclear. A clearer approach from the Department of the Environment, through its circulars on 'good' practice, the issue of recycling could be put forward.

This needs to be done in conjunction with a positive approach that allows investment in recycling schemes. This needs to be reviewed in the context of financial controls imposed on Local Authority finances.

Legislative measures can be used to enforce Local Authorities to recycle waste materials. This could be as in Holland, stipulating a standard reclamation scheme. Such moves on recycling need to be done in terms of the development of a sound National Policy on recycling and Waste Management. The EEC Directive on beverages (Section 4.8.6) may lead the Government to take more positive action.

13.3.b Nature And Scope Of Recovery Schemes

Three quarters of Local Authorities operate glass recycling schemes, although their size is limited. This could be due to the nature of the Large Bank, which can be difficult to site. A move to the smaller modular banks, which take up less space and have a better appearance could be considered.

Large Banks are best suited to supermarket car parks, where there

is the space to site them and easier to uplift. To increase their numbers it could be made a condition of planning permission for new supermarkets that space is made available for Bottle Banks and other recycling systems.

A move to modular banks requires investment into new banks, and possibly a new vehicle with crane attachment. The decision needs to be based on a sound financial basis.

Moves need to be made to increase the number of Bottle Bank sites to make them more easily accessible to the general public. The introduction of more banks, will make them more noticeable, advertising the scheme and possibly increase the level of support for the schemes.

13.3.c A Sound Financial Basis

Decisions to operate and to expand glass recovery schemes need to be based on a sound assessment of the financial implications. Two cost models have been developed: The Stirling Glass Recycling Model (Chapter 10), and The Trade Glass Collection Model (Chapter 11).

The Stirling Glass Recycling Model was built up through extensive contacts with Local Authority Officers. It has been built up in three sections: Set Up Costs, Operating Costs and Income. This reflects the key operating areas that need to be considered when establishing and managing recovery schemes.

A uniform and comprehensive costing is provided for managers to use in the assessment of their recycling schemes. The Model is flexible being adaptable to local conditions and using local data. Being computerised the effect of variations on the key costs can

be easily and clearly assessed. It is on the basis of a uniform approach that comparisons can be made with other similar recovery schemes.

In its treatment of income, account is taken of the possible disposal and collection cost savings. These are separately assessed as disposal cost savings may not always be remitted and collection costs are a long term benefit that is difficult to assess. In addition it allows for the division between WCAs and WDAs in England.

The Trade Model is different in that collection is made from specific premises. Although, with fewer premises it is similar to the 'milk round' collection system adopted for modular banks. With Trade, three cost options are reviewed: First, whether the scheme makes use of spare resource capacity and just accounts for the extra costs incurred. Second, whether it shares costs being assigned a proportion of costs related to the level of use. Third, whether the full costs of the resources used are assigned. The assessment of a Trade Scheme showed a surplus only under the extra cost option. This reflects the difficulties encountered by private contractors, who faced the full costs of trade schemes (Appendix G.6). It is only by using spare capacity of an existing transport fleet, available to a WCA or Private Waste Reclaimer that a surplus can be shown.

A close look needs to be made of these cost options. The question arises as to when a scheme using 'spare' capacity becomes a permanent fixture and shares costs. This will be when the service to traders is maintained despite the need for the vehicle in its costed operation. Then there is the boundary between shared costs and full costs. When the vehicle only serves the trade scheme full

costs would be met. In such a case the trade scheme may have spare capacity of its own which could be utilised by other activities. The division between these cost options needs to be looked at more fully.

13.4 General Conclusions

1. Britain's glass recycling performance can be improved by a firm policy stance being taken by Government through incentives and legislative means. This should encourage Industry, Local Authorities and the General Public to recycle materials where practicable.

2. Decisions on the operation of recycling schemes needs to be made on a sound financial basis. The Financial Models produced in this work provide a realistic uniform cost approach to the assessment of recycling schemes.

3. The use of the cost models needs to be based on the availability of sound local cost information.

4. Recycling needs to be treated as part of the waste management system, as it has consequences locally and nationally. The wider environmental and social costs and benefits should be considered in the decision making process.

It is hoped that this work will prove useful for those people operating glass recovery schemes, and those considering establishing glass recovery schemes. It is felt that through the use of the models, glass recovery from household and trade sources can be run effectively, efficiently and successfully.

People Who Have Been Of Help In The Completion Of This Work

The successful completion of this work has been dependant on the help and cooperation of many individuals and organisations who are listed below. I would particularly like to thank Mr George Peggie of Stirling District Council for his advice and help in the initial stages of this work, and his cooperation in answering questions as the work developed. Mr Peter Mansfield, Recycling Officer, Richmond Council has provided much useful guidance and advice throughout this work.

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