Investigation into Battery Recycling in Ireland

by

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ABSTRACT

At present, battery recycling in Ireland is operated on a very small scale in comparison to other recycling projects such as glass and paper. Collection rates are no where near satisfactory with some counties as low as 20% collection rate. The disposal route for non-recycled batteries are dubious with the main non-reported routes being scrap metal merchants and the travelling community.

The main reasons for the poor collection rate are a combination of poor recycling facilities, lack of public awareness, lack of enforcement by the relevant authorities and the cost involved in recycling if ventured into on a commercial basis.

Experiences from other countries demonstrate that there are more efficient methods of battery recycling. The lack of a national cohesive strategy on battery recycling has made the system reliant on one company for nearly all battery recycling in Ireland. This leaves Ireland very vulnerable to the fortunes of one company and their ability to cope with the capacity. Should this company cease trading there would be virtually no legitimate battery collection in Ireland.

Ireland is also vulnerable from the fact that all waste batteries are exported and relies on other countries to recycle this waste commodity. If these markets were closed there would be a serious crisis with the disposal of batteries.

Ireland would benefit from diversification within the industry, a taxation system on the use of batteries, increased awareness campaigns, less reliance on other countries for waste disposal and enforcement of the current legislation by the relevant authorities.

A tax or deposit/refund scheme on imported batteries would provide the necessary funds for battery recycling. This money would fund collection, recycling and information programmes.

ACKNOWLEDGEMENTS

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I would also like to thank my partner John and daughter Phidelma for their support and patience during the year, without their constant encouragement this project would not have been possible.

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INTRODUCTION

The Author, as the Environmental Manager for Returnbatt Ltd, became aware of the need for an examination of the current status of battery recycling in Ireland. From the many reported incidents of batteries being disposed of in an unlawful manner, it was apparent that the current *status quo* was not acceptable and research was needed. On further research it appeared that the capture rate for batteries in general was poor and there was room for improvement.

Batteries come in all shapes and sizes but generally fall into three main groups, lead acid (hazardous), primary or alkaline (non–hazardous) and nickel cadmium (hazardous). Batteries are found in a wide variety of appliances and emergency equipment from walkmans to back up power supplier for hospital equipment. All of these batteries must be disposed of and it is the disposal routes and the consequences of disposal that is of interest to the Author.

The purpose of this project is to research the current position of battery recycling in Ireland, using capture rates and disposal routes as the indicators. The experiences of other countries within the EU are used to form opinions as to the best practical methods to increase the capture rate for batteries in Ireland.

Section 1

Literature Review

1.1 Batteries and how they work

The first battery was demonstrated in 1800 by count Allessandro Volta. He found from different experiments that different metals in contact with each other created electricity. He built a stack of alternating zinc and silver discs and blotting paper soaked in saltwater. When he attached a wire to the top and bottom discs, a voltage and current was detected. He found that the pile could be made as high as practicable and each extra layer increased the voltage. This device became known as the voltaic pile.

Electrons produced during a chemical reaction inside the battery accumulate at the negative terminal. The speed of this chemical reaction controls how many electrons can flow between the terminals. Electrons flow from the battery into a wire and must travel from the negative (-ve) to the positive (+ve) terminal for the chemical reaction to take place.

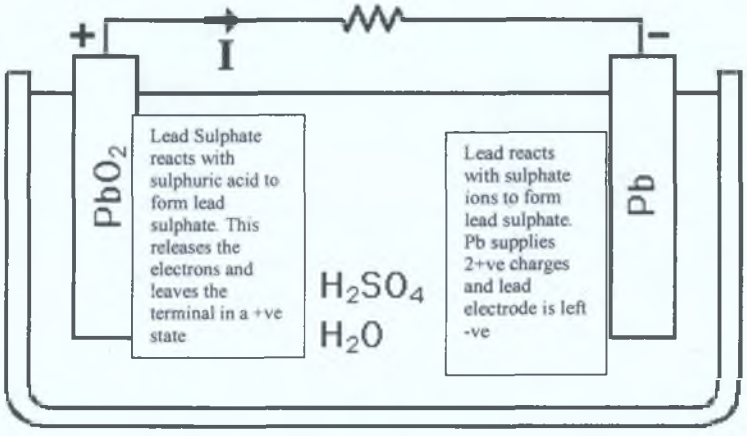
The lead Acid Battery

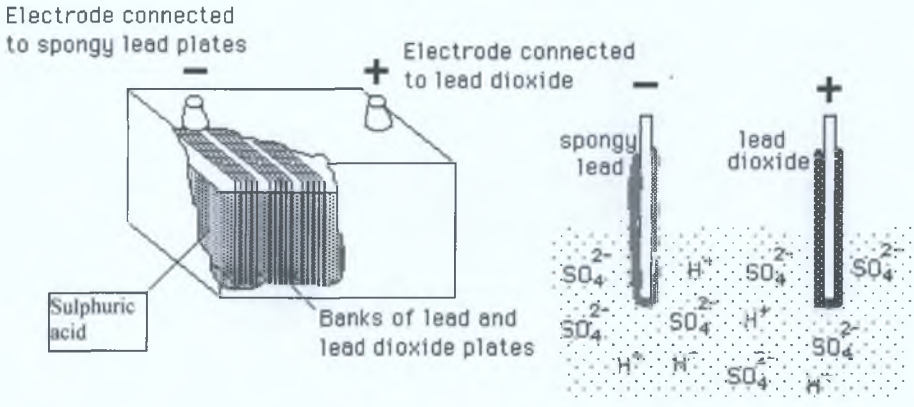
In a lead acid battery there are many cells and each one operates in the following way:

- The cell has one plate made of lead and another plate made of lead dioxide (PbO_2) which are immersed in an electrolyte solution of strong sulphuric acid (H_2SO_4).
- Lead combines with sulphate to create lead sulphate plus one electron.
- Lead dioxide, hydrogen ions ($H+$) and SO_4 ions, plus electrons from the lead plate create lead sulphate ($PbSO_4$) and water on the lead dioxide plate.
- As the battery discharges, both plates build up $PbSO_4$ (lead sulphate), and water

builds up in the acid. The characteristic voltage is about 2 volts per cell so by combining six cells a 12-volt battery is obtained.

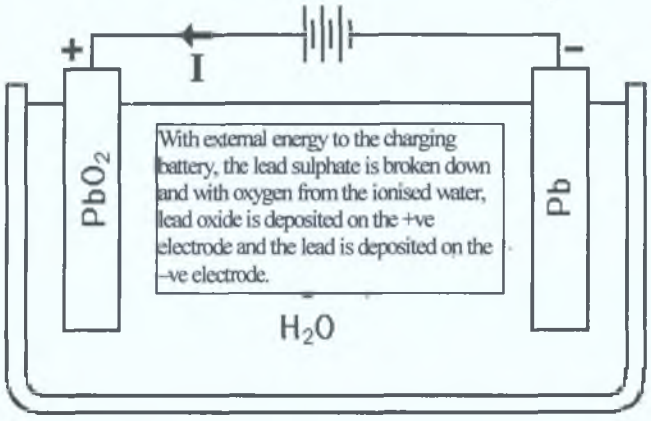
Figure 1 The Operation of the Lead Acid Battery





This process is reversible if a current at the right voltage is applied. Lead and lead dioxide form again on the plates so they can be reused again.

Figure 2 The Re-Charging Operation of the Lead Acid Battery



Carbon-Zinc Battery

The carbon-zinc cell or Lechlanche cell was invented in 1866 and was the most common small battery throughout most of the 20th century until replaced by alkaline cells. The oxidation at the zinc electrode (the anode) is straightforward and similar to that in other cells. The other reactions involve manganese dioxide (MnO_2) which is contained near the carbon centre rod and the ammonium chloride (NH_4Cl) and zinc chloride ($ZnCl_2$) make up the bulk of the electrolyte paste between the cathode and anode.

The chemical reaction is as follows:

$$Zn(s) \rightarrow Zn^{2}(aq) + 2e^{-} \qquad \textbf{Anode}$$

$$2NH_4(aq) + 2MnO_2(s) + 2e \rightarrow Mn2O_3(s) + H_2O(l) + 2NH_3(aq) \qquad \textbf{Cathode}$$

The reduction of the ammonium ion produces two gaseous products, which must be absorbed to prevent the build up of gas pressure.

$$2NH_4(aq) + 2e \rightarrow 2NH_3(g) + H_2(g) \text{ Evolved}$$

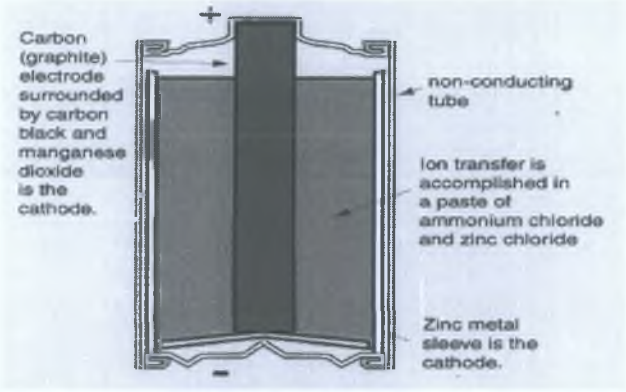
The absorption is accomplished by two further reactions in the paste electrolyte. Zinc chloride reacts with ammonia to form solid zinc ammonium chloride and manganese dioxide reacts with hydrogen to form solid dimanganese trioxide plus water.

$$ZnCl_2(aq) + 2NH_3(g) \rightarrow Zn(NH_3)_2Cl_2(s)$$

$$2MnO_2(s) + H_2(g) \rightarrow Mn_2O_3(s) + H_2O(l)$$

The voltage of this cell is initially about 1.5 volts, but decreases as energy is taken from the cell. It also has a short shelf life and deteriorates rapidly in the cold. Oxidation of the

Figure 3 Operation of the Carbon-Zinc Battery



zinc wall eventually causes the contents to leak out and damage the appliance. They have been mostly replaced by alkaline batteries, which do not suffer the above problems.

Alkaline Dry Cells

Alkaline dry cells overcome some of the problems with carbon zinc batteries by using potassium hydroxide in place of ammonium chloride as the electrolyte. Potassium hydroxide is an alkaline material and gives the battery its name.

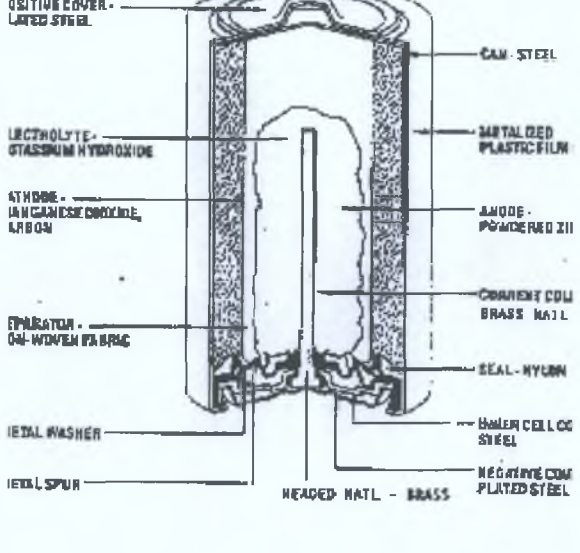
The half reactions are as follows:

$$Zn(s) + 2OH^-(aq) \rightarrow Zn(OH)_2(s) + 2e \qquad \textbf{Anode}$$

$$2MnO_2(s) + H_2O(l) + 2e \rightarrow Mn_2O_3(s) + 2OH^-(aq) \quad \textbf{Cathode}$$

These cells have a much longer shelf life and perform better when discharging in cold weather. These batteries avoid the use of ammonium ions which corrode zinc and do not produce any gaseous products.

Figure 4 Operation of the Alkaline Dry Cell Battery



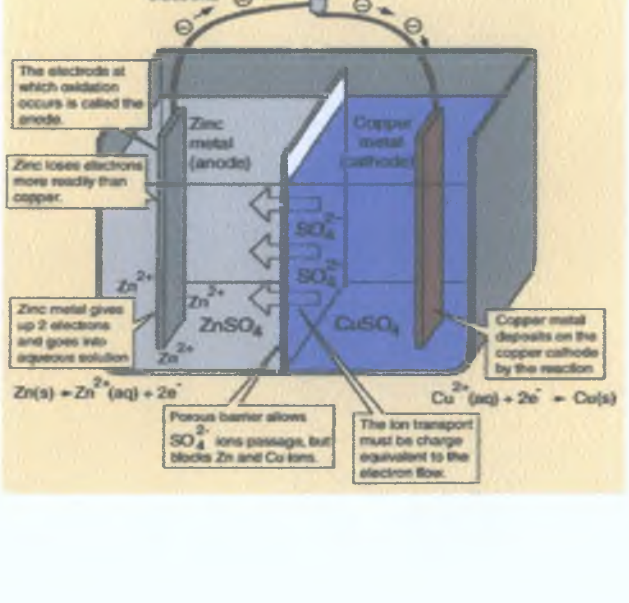
Electrochemical Cells

An extremely important class of oxidation and reduction reactions are used to provide useful electrical energy in batteries. A simple electrochemical cell can be made from copper and zinc metals with solutions of their sulphates. Electrons can be transferred

from the zinc to the copper through an electrically conducting path as a useful electric current.

An electrochemical cell can be created by placing metallic electrodes into an electrolyte where a chemical reaction either uses or generates an electrical current. Electrochemical cells which generate an electric current are called voltaic cells or galvanic cells and common batteries consist of one or more cells. In other electrochemical cells an externally applied electric current is used to drive a chemical reaction which would not spontaneously occur. These are called electrolytic cells

Figure 5 Operation of the Electrochemical Cell



1.2 Types and uses of batteries

Batteries are generally split into two types, primary and secondary. Primary battery is a general description of batteries that are used in household and domestic appliances. Secondary batteries are heavy-duty lead acid industrial and car batteries.

Typical battery chemistries include:

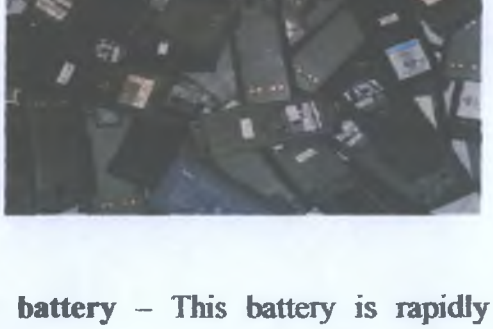
Zinc-Carbon battery- Also known as a standard carbon battery, zinc-carbon chemistry is used in all inexpensive AA, C and D dry-cell batteries. The electrodes are zinc and carbon, with an acidic paste between them that serves as an electrolyte.

Alkaline battery – Used in common 'Duracell' and 'Energiser' batteries, the electrodes are zinc and manganese-oxide with an alkaline electrolyte.

Lithium photo battery- Lithium, lithium-iodide and lead iodide is used in cameras because of their ability to supply power surges.

Lead-acid battery – Used in automobiles and made of lead and lead-oxide with a strong acidic electrolyte. This type of battery is rechargeable.

Nickel-cadmium battery – The electrodes are nickel-hydroxide and cadmium, with potassium hydroxide as the electrolyte. This battery is used in heavy-duty power tools. This type of battery is rechargeable.



Nickel-metal hydride battery – This battery is rapidly replacing nickel-cadmium because it does not suffer from the memory effect (repeated recharging when the battery is not fully discharged) leading to the battery not recharging fully. This battery is used in mobile phones and power tools. This type of battery is rechargeable.

Lithium-ion battery – This battery has a very good power to weight ratio and is found in the more up to date mobile phones and laptop computers.

Zinc-air battery – This battery is lightweight and rechargeable and used in airmotive and other applications in which weight is an important consideration.

Zinc-mercury oxide battery – This is often used in hearing aids.

Silver-zinc battery – This is used in aeronautical applications for its good power to weight ratio.

1.3 Battery use in Ireland

Manufacturers and Importers

At present there are no battery manufacturers in Ireland. The major importer of lead acid batteries is 'Exide' Batteries who import over 95,000 batteries per year. Other importers include 'Oldham', 'Varta' and 'Lucas'. These batteries are mainly for the automotive, airmotive, traction and uninterrupted power supply industries (UPS). The numbers of batteries imported into Ireland for use in industry and transportation are shown in Table1.

Table 1. Number of industrial batteries imported into Ireland for the period January to December 2000 (Central Statistics Office)

Type	Kg	Number
Lead Acid Accumulators used for Starting piston engine for Civil Aircraft	69,544	602,549
Lead Acid Accumulators less than 5Kg with non-liquid electrolyte	71,459	933,437
Lead acid accumulators greater than 5Kg with liquid electrolyte	2,218,748	3,961,210
Lead acid accumulators greater than 5Kg with non-liquid electrolyte	1,724,887	4,295,539
Lead acid batteries for vehicle traction with liquid electrolyte	1,423,690	3,135,249
Lead acid accumulators for vehicle traction with non-liquid electrolyte	129,576	579,293
Nickel-cadmium accumulators for civil aircraft	2,510	1,828,12
Hermetically sealed nickel cadmium in accumulators	149,000	6,651,752
Nickel cadmium accumulators, not sealed	195,584	3,172,687
Nickel hydride accumulators	150,045	11862,749
Total	**6,135,043**	**35,377,277**

The major importers of primary batteries are 'Duracell' and 'Eveready-Energiser'.

A large proportion of smaller primary batteries are imported as part of a larger piece of electrical equipment. These should be easily removable from the equipment for disposal. Table 2 displays the number and type of primary batteries imported into Ireland for the year 2000.

Table 2. Number of (Household Type) Batteries Imported into Ireland for the Period January to December 2000 (Central Statistics Office)

Type	Kg	Number
Primary cells	93,879	3,373,652
Zinc carbon	46,587	348,409
Cylindrical Primary	10,660	124
Lithium cells	150,646	11,380,199
Air Zinc	10,002	181,324
Silver oxide	6,944	561,907
Manganese dioxide	1,378,585	14,025,867
Mercuric oxide	5,569	85,567
Total	**1,702,872**	**29,957,049**

Number of batteries sold in cars

The number of batteries sold in the Republic of Ireland in new cars is increasing steadily each year as new car sales increase with growing economic prosperity. Table 3 shows that new car sales in Ireland have doubled in the period between 1996 and 2000 and the number of second hand cars imported has halved in the same period.

Table 3. Motor Vehicles Licensed for the First Time in Ireland between 1996 - 2000 (Central Statistics Office)

Type of Vehicle	**1996**	**1997**	**1998**	**1999**	**2000**
New Vehicles					
Private Cars	109,333	125,818	138,538	170,322	225,269
Goods Vehicles	16,445	18,895	23,811	30,066	33,606
Tractors	2,233	1,848	2,318	2,762	2,817
Motor Cycles	2,412	2,717	3,117	4,955	6,871
Vehicles Exempt from Duty	1,887	2,042	2,481	2,664	3,321
Other New Vehicles	1,654	1,766	2,259	2,831	3,107
Imported Second Hand Vehicles					
Private Cars	44,500	41,554	39,565	36,878	24,003
Goods Vehicles	4,927	4,888	5,388	9,285	6,983
Tractors	3,627	3,065	3,040	3,332	2,785
Others	4,138	4,263	4,643	5,524	5,530
Totals	**191,156**	**206,856**	**225,158**	**268,619**	**314,292**

1.4 Legislation pertaining to batteries

The Waste Management Act, 1996, redefined waste in Ireland and introduced many new principals regarding waste into Irish Law. The act defined waste and hazardous waste and laid the foundation for the introduction of future regulations for hazardous and non-hazardous waste. The act provides a framework for waste management in Ireland through the requirement of permits and licenses for the collection and disposal of waste.

The act defines waste as:

"Any substance or object belonging to a category of waste specified in the first schedule or for the time being included in the European Waste Catalogue which the holder discards or intends to discard, and anything which is discarded or otherwise dealt with as if it were waste shall be presumed to be waste until the contrary is proved"

Hazardous waste is defined as:

(i) Hazardous waste for the time being mentioned in the list prepared pursuant to Article 1 (4) of the Council Directive 91/689/EEC of 12 December, 1991, being either-

(I) *Category I waste that has any of the properties specified in part III of the second schedule, or*

(II) *Category II waste that-*

(A) contains any of the constituents specified in Part II of the Second Schedule, and

(B) has any of the properties specified in Part III of the said Schedule,

(ii) such other waste, having any of the properties specified in Part III of the Second Schedule, as may be prescribed for the purposes of this definition.

e.g. lead acid battery is a category II waste and contains lead and acid, which render it hazardous.

The following are the European Waste Catalogue (EWC) codes for batteries as waste. As waste they must be shipped by Transfrontier Shipment (TFS) using the appropriate documentation.

Primary Batteries	NiCad	Lead Acid
EWC Code 160604	EWC Code 160602	EWC Code 161601

Local authority waste plans are included in the **Waste Management (Planning) Regulations, 1997.** This legislation provides for the preparation of Waste Management Plans by Local Authorities and that hazardous waste be quantified and assessed within the plan.

Section 26 of the Waste Management Act, 1996 requires the Environmental Protection Agency (EPA) to prepare a National Hazardous Waste Management Plan. The main areas covered are, hazardous waste statistics, waste prevention and minimization, hazardous waste disposal sites, policies, priorities, infrastructure, the polluter pays principle and the precautionary principle. Batteries both lead acid and primary are dealt with individually under Sectoral Waste Issues in the Plan and the most recent plan (2001) describes the current status of batteries as follows:

Waste type	Lead Acid Batteries
Main recovery or disposal route	Lead recovered Plastic recoverable
Residues	Acid to neutralisation and disposal
Capacity in Ireland	Adequate Significant quantities of whole units are exported to the UK for recovery. The lead fraction (at least) must be exported for recovery.
Bottlenecks or difficulties	Collection rates have significant scope for improvement.

Waste Type	Other batteries including small consumer batteries (non-lead acid batteries)
Main recovery or disposal route	Landfill-batteries are generally unsegregated Scope for metal and other material recovery.
Residues	----
Capacity in Ireland	None. A limited collection network exists. No processing capacity. Recovery facilities exist in other countries.
Bottlenecks or difficulties	Collection rates are currently negligible – significant scope for improvement.

The **Waste Management (Register) Regulations, 1997.** These regulations require the EPA to keep a register of all applications and grants of waste licenses and guides local authorities on keeping of all applications to the local authority for permits.

Waste Management (Licensing) Regulations, 1997 provides for detailed guidance on IPC and Waste Licences issued by the EPA. The establishment of EPA was provided for by **The Environmental Protection Agency Act, 1992** and introduced Integrated Pollution Control (IPC) Licensing into Irish Law.

A total of 28 classes of significant waste disposal and recovery activities now have dates prescribed for licensing by the EPA. **The Waste Management (Licensing) (Amendment) Regulations, 1998**, set out classes of waste activity prescribed for licensing by the Agency under the Third and Fourth Schedules of the Waste Management Act, 1996. If a particular operation falls within the list of prescribed activities an application must be made for a waste license.

An EPA waste license is required to act as a transfer station for hazardous waste under Licensed waste disposal activities, in accordance with the Third Schedule of the Waste Management Act, 1996

Class 13: Storage prior to submission to any activity referred to in a preceding paragraph of this Schedule, other than temporary storage, pending collection, on the premises where the waste concerned is produced.

Waste Permits are included by the **Waste management (Permit) Regulations, 1998.** These regulations detail the procedure for applying for a waste permit and the activities which require a waste permit. These activities include hazardous waste facilities.

The Waste Management (Hazardous Waste) Regulations, 1998 implements a number of provisions relating to batteries, in particular the marking of batteries to clearly show that they must not be placed in the bin and the prohibition of certain types of battery. This implements **Council Directive 91/157/EEC** on batteries and accumulators.

Part III of the regulations refers specifically to batteries and defines a battery as:

"An apparatus or device designed to act as a source of electrical energy generated by direct conversion of chemical energy and consisting of one or more primary (non-rechargeable) battery cells or secondary (rechargeable) battery cells (also called accumulators)"

The regulations also cover the prohibition of the following types of batteries and appliances, which contain non-removable batteries:

- Alkaline manganese batteries containing more than 0.05% mercury by weight but does not apply to button cells.
- Appliances which contain the above batteries
- Batteries other than alkaline manganese which contain more than 25mg of mercury per cell
- Batteries containing more than 0.025% of cadmium by weight or
- Batteries containing more than 0.4% lead by weight

The regulations also require that the markings on batteries and appliances should include:

a) The heavy metal content of the batteries

b) That the batteries should be collected separately from other waste for the purpose of recovery or disposal, and

c) Where appropriate, that the batteries are suitable for recovery

These regulations do not apply to household batteries sold separately.

The **Waste Management (Movement of Hazardous Waste) Regulations, 1998,** requires that Consignment Notes (C1 Forms) be used for the transportation of hazardous waste within Ireland. This requires that all movements of waste batteries be accompanied by a C1 form obtained from the consignors local authority.

Transfrontier shipments of waste are controlled by the **Waste Management (Transfrontier Shipment of Waste) Regulations, 1998.** These regulations require Transfrontier Shipment (TFS) documentation to be in place prior to a shipment of waste into or out of Ireland. As batteries are classed as amber waste, competent authorities in the relevant countries must authorise the movement and approve the facilities.

The **Waste Management (Hazardous Waste) (Amendment) Regulations, 2000,** reduced the maximum permitted mercury levels from 0.05% by weight to 0.0005% by weight for batteries sold individually.

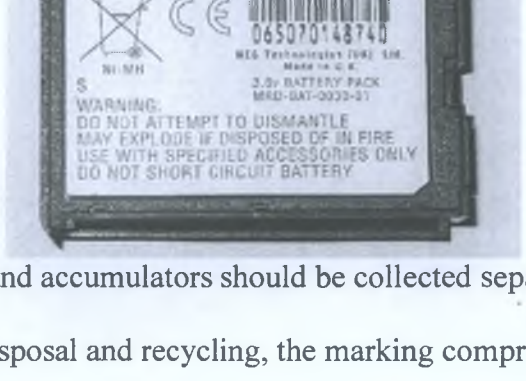
The Waste Management (Collection Permit) Regulations, 2001, require any person collecting waste, including hazardous waste to obtain a permit from the relevant authority. Ten authorities have been designated and a permit is required for each area in which waste is collected. Any company collecting any type of waste battery must apply for a waste collection permit for the area in which they are collecting.

The European Communities (Dangerous Substances and Preparations) (Marketing and Use) Regulations 1998 provides a comprehensive list of substances which may not be marketed or used or which may be marketed and used with restrictions. All batteries containing more than 0.025% mercury excluding button cells are banned under this directive.

The European Communities (Batteries and Accumulators) Regulations), 1994, implemented Council Directive 91/157/EEC on batteries and accumulators. These regulations require that batteries and accumulators in appliances can be easily removed from the appliances, they also require the marking of batteries and accumulators in appliances and where appropriate the appliances in which they are fitted.

The manufacturer or the manufacturer's representative in Ireland shall ensure that batteries, accumulators and appliances are marked with:

a) The heavy metal content of the battery and accumulator. The marking should denote the type of metal e.g. Hg, Cd or Pb. Very small batteries may have the symbol printed on the packaging.



b) That such batteries and accumulators should be collected separately from other wastes for the purpose of disposal and recycling, the marking comprises of a bin with a cross over it to denote that the particular battery should not be placed in the bin.

c) Where appropriate, that they are suitable for recycling.

These regulations were revoked by the Waste Management Act, 1996 and incorporated into the Waste Management (Hazardous Waste) Regulations, 1998.

Legislation relating directly to motor vehicles includes the **Directive 2000/53/EC** of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles-Commission Statements. This directive is aimed at reducing the impact of end of life vehicles by:

1. reducing the amount of hazardous materials contained and
2. harmonising the material contained to help post use recovery.

These changes would mean that manufactures must design and build the vehicle with post use recycling in mind. By 2006, 80% of the vehicle must be reused or recycled and increased to 95% by 2015.

The directive states that all vehicles put on the market after 2003 must not contain lead or cadmium. Batteries containing lead and cadmium will be exempt for the present time while the Commission carry out a an evaluation of alternatives available.

The directive also states that member states should ensure that the last holder or owner of the vehicle can deliver it to an authorised treatment facility without any cost.

Proposed Legislation

The proposed EC Waste Electrical and Electronic Equipment (WEEE) Directive sets out measures that aim to:

- Prevent waste from electrical and electronic equipment by reducing the quantity and harmfulness to the environment of end of life electrical and electronic equipment.
- Encourage reuse, recycling and other forms of recovery of electrical and electronic waste for reuse for their original purpose or other use except as a fuel or as a means of generating energy.
- Minimise the risks and impacts to the environment associated with the treatment and disposal of end of life electrical and electronic equipment.

The proposed directive is aimed very much at the producer of the electronic and electrical equipment. The term "producer" as used here refers to the manufacturer of the equipment.

It is envisaged that the producer of the waste will set up a collection system to enable the last holders and distributors of the waste to return the end of life equipment. A distributor means anyone who provides product on a commercial basis. The distributor must offer to take back free of charge a similar end of life electrical and electronic equipment from private households. The Department of Environment and Local Government envisages a system similar to the Repak system operating for packaging waste. This would involve the collection of the waste at central collection points and the disassembly of the equipment and the recycling of the appropriate parts.

Article 6 of the proposed draft requires that producers set up a system to remove any harmful components such as lead, cadmium etc., from electronic and electrical waste that

is intended for landfill. In the case of built in batteries it would require their removal prior to disposal.

1.5 Fate of Batteries

Batteries are responsible for about 85 % of all cadmium and 11% of mercury in household waste. In the absence of a proper collection system there are four different fates for waste batteries, landfill, incineration, composting and recycling. (It is envisaged that incineration will become a reality in Ireland within the next few years as Indavar has been given planning permission for an municipal waste incinerator in Co Meath).

Incineration

Batteries are responsible for hazardous residues when household waste is incinerated. These residues must be properly disposed. When waste is burned in an incineration plant, mercury evaporates. In the past 50 to 70 per cent of the mercury was emitted to the air and the rest was bound in the slag and residue by the electronic precipitator. Today wet filters reduce the emitted mercury and cadmium trapped in the fly ash filters. Table 4 details the atmospheric emissions per 1000 tonnes of waste per year and as a percentage of the total emissions from waste.

Heavy metals such as arsenic and cadmium contained in incinerated household waste are toxic to humans and are related to carcinogenicity.

Table 4. World-wide atmospheric emissions of trace metals from waste incineration (Stanners & Bourdeau, 1995)

Metal	Atmospheric Emissions from waste Incineration	
	1000 tonnes / year	As % of total waste
Antimony	0.67	19.0
Arsenic	0.31	3.0
Cadmium	0.75	9.0
Chromium	0.84	2.0
Copper	1.58	4.0
Lead	2.37	20.7
Manganese	8.26	21.0
Mercury	1.16	32.0
Nickel	0.35	0.6
Selenium	0.11	11.0
Tin	0.81	15.0
Vanadium	1.15	1.0
Zinc	5.9	4.0

Landfill Disposal

When waste is placed in a landfill, aerobic microorganisms initially break down organic waste using oxygen (O_2) and producing carbon dioxide (CO_2) and volatile fatty acids (VFA's). When all the O_2 has been used in the deeper parts of the landfill or when the landfill has been covered, anaerobic microorganisms use CO_2 to produce methane.

As rainwater permeates into the landfill, the VFA's mix with the rainwater and reduce the pH. This low pH corrodes any batteries contained in landfill and the acid conditions aid the mobilisation of metals contained within.

In modern landfills the methane is collected and used in heat and energy production. Metals found in batteries such as iron, cadmium, nickel, lead and zinc are potentially toxic. Cadmium will evaporate in the landfill and will be emitted with the landfill gas.

Gas from the landfill containing cadmium is burned in thermal recovery plants and eventually emitted to the atmosphere. In older landfills the gas is flared off without any treatment directly to the atmosphere. Volatile heavy metals from the emission of landfill gasses include mercury, cadmium and lead, these cause human and ecological toxicity and are important because of transboundary movement of contaminants.

In well managed modern landfills the leachate is collected and diverted to wastewater treatment plant for biological treatment. Heavy metals contained in the leachate pose problems in the treatment plant, as microorganisms will have different tolerances to individual metals. The metals are only partially soluble in water and are absorbed by the sludge. The excess sludge is de-watered and is either land-spread onto agricultural or non agricultural land or landfilled. If spread on agricultural land, residual metals in the sludge may find their way into plants and thus into the food chain.

In a review of the composition of landfill leachate from landfills receiving mainly non-hazardous municipal waste in Germany it was found that heavy metals (specifically nickel, zinc and cadmium) are not generally present at significant concentrations. Mean and median levels were well below concentrations routinely found in household sewage. Table 5 details the heavy metal concentrations from both waste water treatment plants and landfill leachate after treatment. This research shows that the levels in treated leachate are generally much lower than in treated municipal waste water.

Table 5. Heavy metal concentrations in leachate from Waste Water Treatment (European Environment Agency, 2000)

Parameter	Municipal Waste Water after water treatment (tonnes per annum)	Municipal Waste Landfill Leachate after water treatment (tonnes per annum	Percentage for Leachate
Cadmium	8.9	0.027	0.30
Nickel	360	0.90	0.25
Zinc	890	1.80	0.20

Heavy metals contained in landfills including cadmium, nickel, copper, lead and mercury are less important as they are thought to be reasonably stable in the landfill body.

Composting

Composting is the partial biological decomposition and stabilisation of organic substrates, under aerobic conditions, and under conditions that allow the development of thermophilic temperatures as a result of biologically produced heat, to produce a material (compost) that is more stable, free of pathogens and plant seeds, that can be beneficially employed in agriculture or horticulture.

If batteries enter the material to be composted, the battery will not degrade as organic matter will. The main body of the battery will be left, as it is made of plastic and metal. In the case of cadmium batteries the heat generated by the degradation of the waste will cause some of the cadmium to be liberated. Other heavy metals will be leached into the compost. Shredding will increase the movement of metals into the compost.

Waste for composting from municipal sources may contain trace metals such as zinc and copper which are required for plant growth in small amounts. Other metals such as lead, cadmium and mercury are toxic.

It has been found that compost derived from mixed non-segregated wastes has a higher concentration of metals than source separated wastes (see Table 6). Elements such as mercury and cadmium will accumulate in animal and human tissue and lead to chronic toxicity.

Table 6. Example analyses of composts from source separated, mechanically separated, and unseparated MSW. (Environment Agency UK)

Element (mg/kg/dm)	**Source separated household waste and green waste composts***	**Mechanically separated household waste compost****	**Unseparated household waste*****
Cd	0.4-2.1	6.2	1.1
Cr	14-75	135	27
Cu	37-277	269	230
Ni	12-40	267	27
Mg	82-196.6	539	290

* Shanks &McEwan, Devon County Council, Wyvern Waste, Dundee City Council
** Byker plant, Newcastle
*** COWS project, Department of Trade and Industry
Note: The results used in this table have been collated from information provided by the producers. There is likely to be some variation in the analytical methods used. The results may be based on a small number of samples.

Recycling

The most favorable alternative to incineration and landfilling is recycling. This not only eliminates the problems associated with landfilling and incineration but reuses the metals needed for more batteries such as cadmium, lead, mercury, silver, iron, nickel and copper. Batteries must be segregated prior to recycling as it is almost impossible to recycle a mixture of batteries due to the high energy used and waste produced.

Lead Acid Batteries

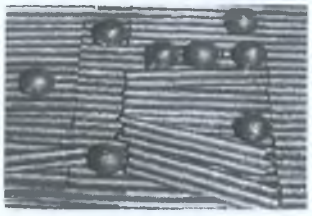
Large tractor units crush lead acid batteries and separate the three main components, plastic, lead and sulphuric acid. The plastic parts are broken apart, washed, dried and melted down. The molten plastic is moulded into pellets, which are sent to battery case manufacturers to be made into new battery cases. The lead is melted into moulds called pigs or hogs depending on their size. The pigs or hogs are sent to battery manufacturers where they are made into new plates. The sulphuric acid can be either neutralised or converted to sodium sulphate for use in the making of laundry detergent or glass. Ninety eight per cent of the battery is recycled.

Nickel Cadmium Batteries

The batteries are chopped into small pieces and heated until they become liquid in a vacuum distillation furnace. The waste material is separated leaving a black residue on top called slag, which is then scraped off.

The different metals settle in different layers and are skimmed off from the top of the liquid. These metals are solidified and reused to make new batteries. Cadmium is very light and vaporises at high temperatures. The batteries are melted and the cadmium vapour is blown by fans where it is cooled with water mist and condenses into solid cadmium in ball and bar moulds. These are sent for further processing and returned to the battery manufacturers to make new batteries. Eighty five per cent of the NiCad battery is recycled.

Cadmium Balls and Bars



Primary Batteries

Primary batteries are separated into batches according to the type of metal used. Once separated the batteries are fed into a vacuum distillation furnace, where under great pressure the zinc is evaporated and separated from the other materials, which include carbon and manganese oxide.

The evaporated gas is cooled and the zinc is set into ingots. These ingots are sent to battery manufacturers to be used again. These batteries are sixty five per cent recyclable.

Battery Recycling in Ireland

In Ireland it is illegal to dispose of lead acid batteries in the domestic waste stream as provided by the Waste Management Act, 1996. Most local authorities provide collection points at civic amenity and landfill sites. These are for domestic users only and commercial users are not allowed to deposit waste there.

The Waste Management (Hazardous Waste) Regulations, 1998 implements a number of provisions relating to batteries but primary batteries are excluded from these regulations as they are not classed as hazardous waste.

Commercial users must pay for a battery disposal service themselves. This service is provided by only one company on a nation-wide basis, Returnbatt Ltd.

Role of Returnbatt Ltd

Returnbatt is a wholly Irish owned company, established in 1996. Returnbatt is involved in the collection, storage, processing and transfer of lead acid batteries and the collection and transfer of nickel-cadmium rechargeable, lithium, and primary batteries. Lead acid batteries are sent to England for processing. Non-lead acid batteries are sent to France and Germany for recycling. Returnbatt presently employs 10 people.

Returnbat was granted a Waste Permit by Kildare County Council in December 1996 and was granted a waste licence by the EPA in November 2000 (Licence No. 105-1)

Returnbatt provides battery boxes to customers (mainly garages) for the storage of lead acid batteries. This box acts as a bunded area to prevent any leakage. When the box is full the customer telephones or e-mails Returnbatt Ltd and requests a collection. The container is normaly collected within one week. When the container is collected a clean, empty one is left in its place. Under the Waste Management (movement of Hazardous Waste) Regulations a C1 form must be completed and a certificate of disposal is given to the customer.

On return to Returnbatt the bins are unloaded and inspected. Any unacceptable material is quarantined and reports issued. The batteries are then transferred into transport containers. These transport containers are shipped to England where the batteries are

processed. This transfrontier shipment must comply with the provisions of the Waste Management (Transfrontier Shipment of Waste) Regulations, 1998.

Primary batteries are collected from a number of sources including schools, industry and local authority amenity sites. Like the lead acid batteries the customer requests a collection and on return to Returnbatt the batteries are sorted and transferred to barrels for transportation. The batteries are transported by transfrontier shipment to Germany.

At present Returnbatt does not have any competitors that provide the same service. This is most probably due to the difficulty introducing the service on a nation-wide basis and providing the collection service.

Some scrap/metal merchants will accept batteries and export transfrontier shipment, Cunnigham Metals in Dublin do provide a localised service.

The Travelling Community have traditionally collected metals for recycling. Lead in lead acid batteries has an intrinsic value of its own and as a result the batteries are often collected by travellers and the lead removed. The batteries are often transported to Northern Ireland and sold to metal merchants for approximately £1 Sterling each. This unregulated removal of batteries has caused problems around the country as illustrated overleaf.

Batteries Outside Cashel Co Tipperary.

Table 7 details the quantities of batteries recycled by Returnbatt Ltd between 1999 and 20001. These figures shows a steady increase in battery recycling.

Table 7. Quantity recycled by Returnbatt Ltd in 2001 (in tonnes per annum) (Returnbatt Ltd)

Battery Type	1999	2000	2001
Lead Acid	1785	2426	3101
NiCad	8	15	256
Primary	4	8	13

As part of the recycling service Returnbatt Ltd organised a take back of the Eircell 088 mobile phone. This entailed collecting the phones and removing the battery. The battery was sent for recycling and the phone and charger sent to the UK for recycling. This project was successful with 3519 telephones sent to Returnbatt for recycling. This project was funded by Eircell.

This project has led Eircell/Vodafone to install recycling points, serviced by Returnbatt, in their shops throughout the country.

Primary batteries are collected separately at landfill and civic amenity sites. Some local authorities sponsor a Schools Battery Recycling Programme run by Returnbatt Ltd. There are over 500 primary battery recycling points in schools throughout Ireland at the moment.

Cara Waste Management Ltd operate a Chemcar, which visits towns throughout the country and collects hazardous waste including batteries. The individual local authority sponsors this service and individuals bring their waste to a specific location.

Table 8 displays the amount of primary and lead acid batteries that are disposed of in a unreported manner in the years 1996 and 1998. The table shows a dramatic increase in the unreported disposal of lead acid batteries.

Table 8. Breakdown of Unreported Waste (EPA Hazardous Waste Management Plan 2001)

Year	Lead Acid (Tonnes per annum)	Primary (Tonnes per annum)
1996	2575	2378
1998	9038	2914

Battery Recycling in Europe

In the UK the system for battery collection both primary and secondary is similar to Ireland, with collection points throughout the country at civic amenity sites. Individual companies must pay for the service themselves for primary and secondary batteries.

Almost 870 million disposable and rechargeable batteries are sold in Germany per year. From the 1st October 1998 in Germany consumers must return used disposable and storage batteries to the retailer or to drop-off points provided by the government.

Retailers are obliged to accept used batteries without making any charge to consumers. A container for collection must be placed at every point of sale. A deposit system has come into place for lead acid batteries. The customer must now pay a deposit when buying a battery for their car, unless they return a used car battery at the same time.

Manufactures must recycle returned batteries or assume responsibility for the disposal of those that cannot be recycled. Under the Batteries Ordinance, these requirements to recycle and dispose are to be met by manufacturers through a jointly run return system.

Belgium is a federal state divided into three regions and these regions are further sub-divided into provinces, which are further divided into municipalities. These municipalities enter into voluntary agreements on the environment called covenants.

- A fund is maintained by the importers, which pays for an organisation called BEBAT. This organisation collects and recycles the batteries.
- A charge of 5 BEF is put on each battery or electrical item containing a battery.
- The capture rate is approximately 55%.
- There are penalties against BEBAT of 50 BEF per battery that is not recycled.
- Drop-off systems where the householders take the materials to container parks.

Take-back obligations placed on the producer exist for used consumer goods including batteries.

In Sweden in June 1997 a battery ordinance was issued. This stated that:

- Spent batteries may not be included in or stored with other waste.
- The government shall collect spent batteries and make available a suitable collection system.

- The government sorts and transports spent batteries for disposal.
- Spent batteries collected by those selling or commercially transferring batteries must be delivered to the municipal collection system.
- Anyone selling batteries must inform the consumer of places where they can return spent batteries.
- Anyone commercially manufacturing or importing batteries into Sweden is under a duty to accept spent batteries and transport them to a facility for disposal or recovery.
- Discarded goods containing built in batteries must be delivered to a designated disposal site by the waste transportor.
- Charges are levied on the manufacturers and importers of batteries to fund the disposal sites.

Manufacturers and importers of batteries in the Netherlands must ensure that batteries of the brand marketed by them are collected and processed with a view to reuse. The collection rates are independently monitored and manufacturers and importers can set up joint collection systems to facilitate the recycling objectives. The manufacturers and importers can impose a charge on each battery sold to facilitate the collection and recycling.

In Finland batteries are collected in special bins in buses, booths and waste collection points. The funding for the collection of batteries is included in the general waste charge. The collection rate is nearly 100% and fines are imposed for breaches of the waste act.

In Norway it is the responsibility of the manufacturer and importer of batteries to ensure that they are collected and recycled. This is achieved through a non-profit organisation

called As Batteriretur. There are over 10,000 collection points for batteries throughout Norway in comparison to just over 600 in Ireland (this includes 500 schools).

Section 2

Potential for Battery Recycling in Ireland

Table 9 shows the number of lead acid batteries collected by Returnbatt Ltd from 1996 to 2001. Many counties show no collection or very low collection rates in the early years of the service. This was mainly due to the company not opening up these markets in the early years. Counties with very high collection rates are usually in areas with large scrap metal merchants who act as collection centres for batteries from end of life vehicles.

The totals for each year show a steady increase in battery collection with a slight decrease in 1999. This drop may be explained by the introduction of charges for the provision of the service and a number of customers withdrawing. Figure 7 displays the growth in lead acid battery collection since Returnbatt Ltd was established in 1996. The growth rate for each county is displayed in Appendix 1.

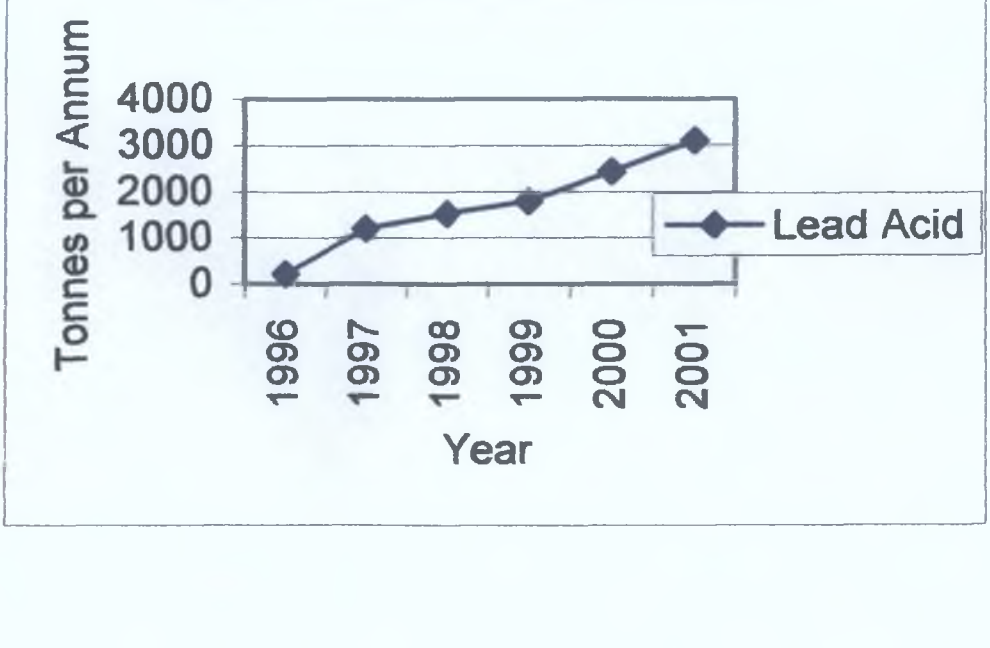


Table 9. Quantity of Lead Acid Batteries Collected by County in Tonnes per Annum (Returnbatt Ltd)

County	1996	1997	1998	1999	2000	2001
Carlow	4.82	8.30	6.26	4.56	7.23	7.35
Cavan	0.00	9.26	7.56	3.15	14.85	11.33
Clare	38.49	35.96	41.85	41.07	53.24	62.39
Cork	10.74	110.31	99.27	119.87	145.61	433.22
Donegal	0.00	0.00	5.73	2.33	6.17	12.09
Dublin	58.51	220.49	327.31	465.8	993.02	1072.35
Galway	8.60	184.43	322.73	250.34	355.41	368.27
Kerry	0.00	2.25	8.93	18.99	30.75	45.56
Kildare	9.42	28.50	51.38	79.05	144.00	104.58
Kilkenny	8.55	7.14	9.84	14.40	16.56	26.48
Laois	25.32	127.34	148.35	217.95	16.56	26.48
Leitrim	1.28	2.94	2.76	3.38	7.35	13.43
Limerick	0.00	164.70	143.30	171.98	214.35	311.61
Longford	0.00	5.33	3.80	11.69	13.19	20.48
Louth	0.87	3.78	4.91	13.22	26.06	30.90
Mayo	0.00	0.00	20.33	13.76	22.74	28.50
Meath	5.96	14.69	9.06	25.94	30.35	93.71
Monaghan	0.00	0.00	3.15	3.39	4.59	22.28
Offaly	4.88	88.07	30.95	35.73	33.29	53.72
Roscommon	0.90	1.89	8.55	2.28	8.03	13.07
Sligo	2.70	2.16	7.34	3.45	10.74	21.90
Tipperary	9.15	28.86	42.14	31.64	49.65	79.50
Waterford	6.20	16.80	34.11	45.74	39.89	48.29
Westmeath	4.74	108.95	151.16	164.01	140.91	137.63
Wexford	13.77	13.92	16.34	22.38	31.46	54.98
Wicklow	4.17	18.93	21.29	23.51	17.81	55.26
Total	**219.07**	**1,236**	**2,276.84**	**1,780.61**	**2,433.81**	**3,155.56**

Tables 10 and 11 illustrate the difference between the number of batteries collected and new cars sold. When a new car is sold the old one is generally traded in or scrapped, during both of these processes the battery is either replaced as part of a service or scrapped. It is a good indication of the collection rates for lead acid batteries.

Table 10. Comparison of number of cars sold to number of lead acid batteries collected by county (Returnbatt Ltd and SIMI)

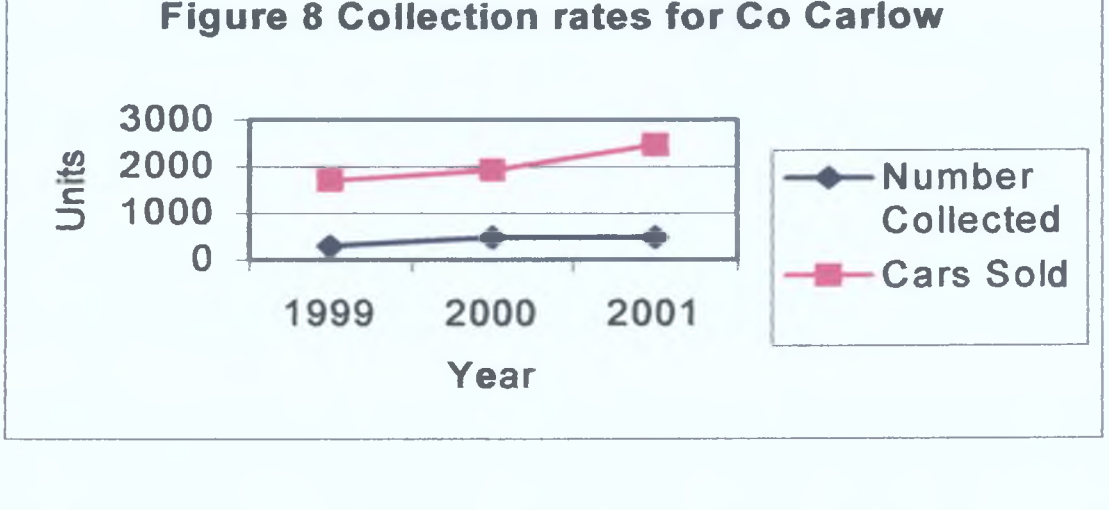
County	Collected 1999	Sold 1999	Collected 2000	Sold 2000	Collected 2001	Sold 2001
Carlow	304	1,701	482	1,916	490	2,465
Cavan	210	1,815	990	1,758	755	2,721
Clare	2,738	3,573	3,549	3,967	4,159	5,244
Cork	7,991	18,535	9,707	21,346	28,881	27,835
Donegal	155	3,558	411	3,830	806	5,036
Dublin	31,053	66,778	66,201	64,090	71,490	83,918
Galway	16,689	6,541	23,694	7,217	24,551	9,492
Kerry	1,266	3,296	2,050	3,676	3,037	5,214
Kildare	5,270	7,048	9,600	7,360	6,972	10,017
Kilkenny	960	2,663	1,104	3,181	1,765	4,137
Laois	14,530	1,834	1,104	2,085	1,765	2,839
Leitrim	225	672	490	688	895	1,002
Limerick	11,465	6,213	14,290	7,338	20,774	9,896
Longford	779	937	879	971	1,365	1,267
Louth	881	3,967	1,737	4,298	2,060	5,666
Mayo	917	3,056	1,516	3,402	1,900	4,784
Meath	1,729	5,485	2,023	5,485	6,247	7,477
Monaghan	226	1,466	306	1,725	1,485	2,306
Offaly	2,382	2,178	2,219	2,447	3,581	3,508
Roscommon	152	1,635	535	1,856	871	2,490
Sligo	230	1,975	716	2,408	1,460	3,107
Tipperary	2,109	4,656	3,310	5,617	5,300	7,593
Waterford	3,049	4,334	2,659	5,173	3,219	6,467
Westmeath	10,934	2,548	9,394	2,896	9,175	3,726
Wexford	1,492	4,133	2,097	4,717	3,665	6,112
Wicklow	1,567	4,321	1,187	4,818	3,684	6,476
Total	**121,302**	**166,917**	**164,250**	**176,265**	**212,353**	**230,420**

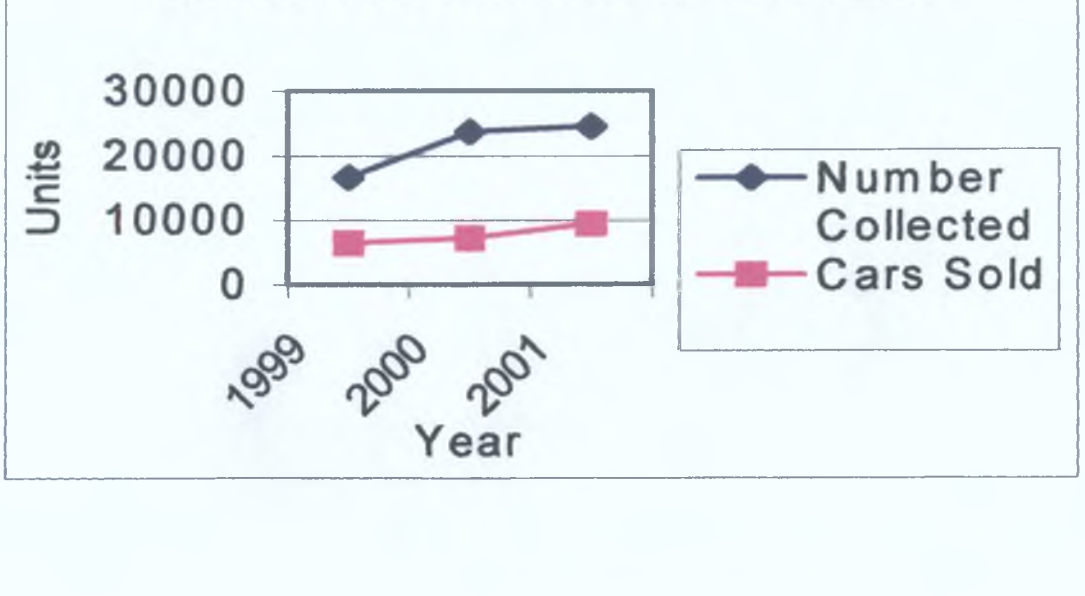
Table 11. Collection rate of lead acid batteries based on no. of Cars Sold to batteries collected, (Returnbatt Ltd and SIMI)

County	% 1999	% 2000	% 2001
Carlow	17.9	25.2	19.9
Cavan	11.6	56.3	27.7
Clare	76.6	89.5	79.3
Cork	43.1	45.5	103.8
Donegal	4.4	10.7	16.0
Dublin	46.5	103.3	85.2
Galway	255.1	328.3	258.6
Kerry	38.4	55.8	58.2
Kildare	74.8	130.4	69.6
Kilkenny	36.0	34.7	42.7
Laois	792.3	52.9	62.2
Leitrim	33.5	71.2	89.3
Limerick	184.5	194.7	209.9
Longford	83.1	90.5	107.7
Louth	22.2	40.4	36.4
Mayo	30.0	44.6	39.7
Meath	31.5	36.9	83.5
Monaghan	15.4	17.7	64.4
Offaly	109.4	90.7	102.1
Roscommon	9.3	28.8	35.0
Sligo	11.6	29.7	47.0
Tipperary	45.3	58.9	69.8
Waterford	70.4	51.4	49.8
Westmeath	429.1	324.4	246.2
Wexford	36.1	44.5	60.0
Wicklow	36.3	24.6	56.9
Total	**97.86**	**80.61**	**81.57**

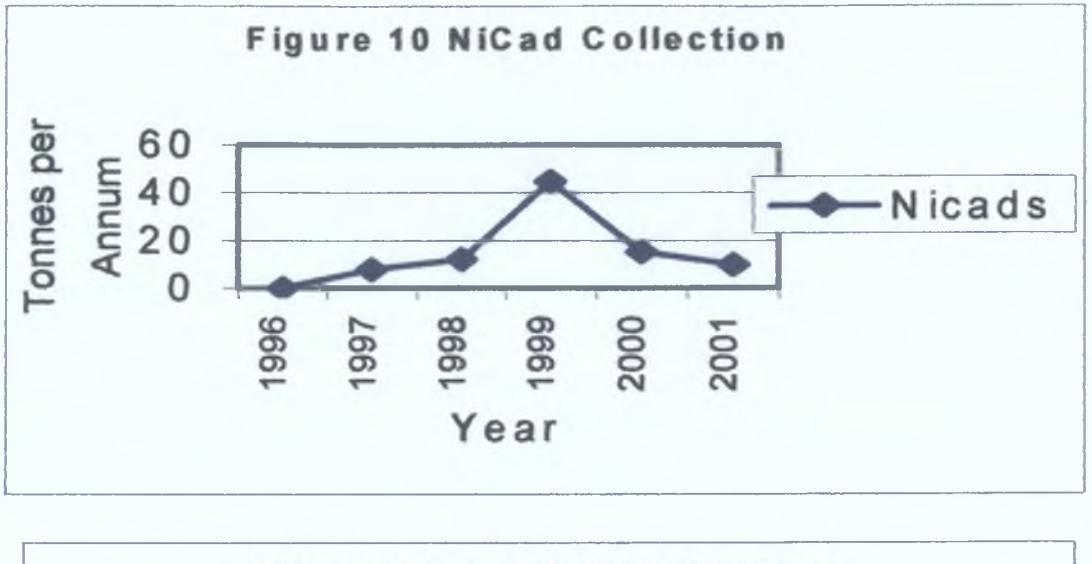
Counties such as Galway and Limerick that have large scrap merchants generally have the high collection rates of over 200%. This is displayed in figures 13, 14, 15 and 16. The counties with large scrap merchants generally act as a collection centre for the province.

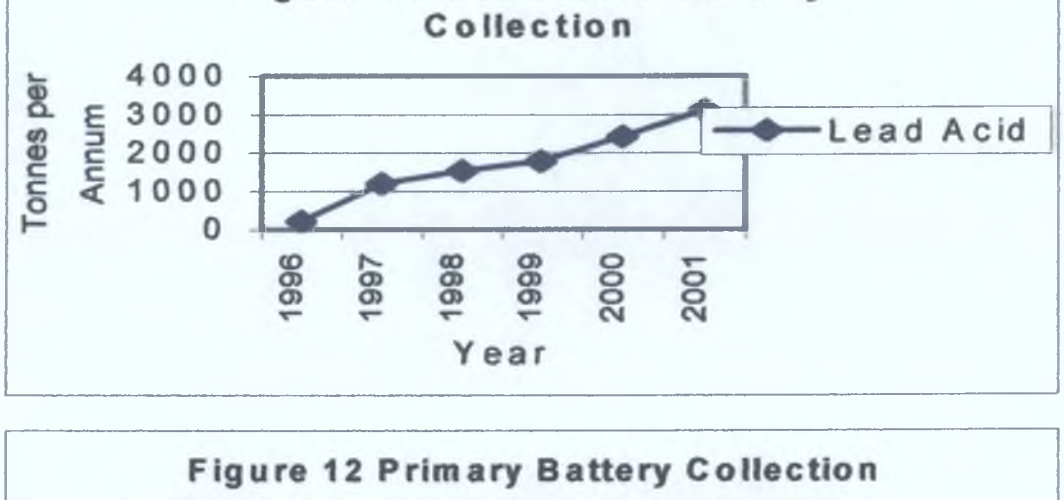
Figures 8 and 9 show the difference between counties with large scrap metal merchants such as Galway with a collection rate of 258% in 2001 and Carlow with no large scrap metal merchant with a collection rate of 19% in 2001.





Figures 10, 11 and 12 show battery collection in Ireland with a general trend of increasing collection for all types of batteries.





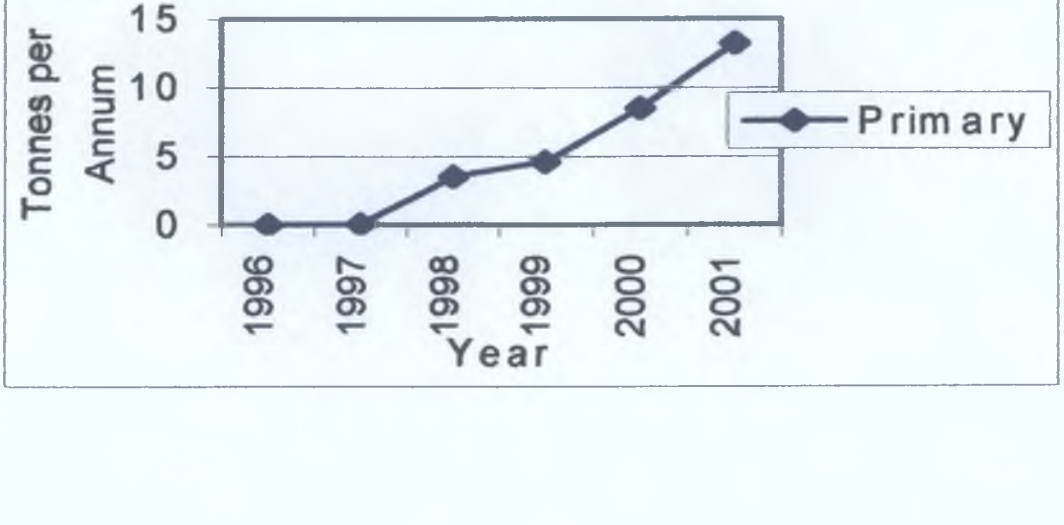


Figure 13 Collection Rates for Ulster

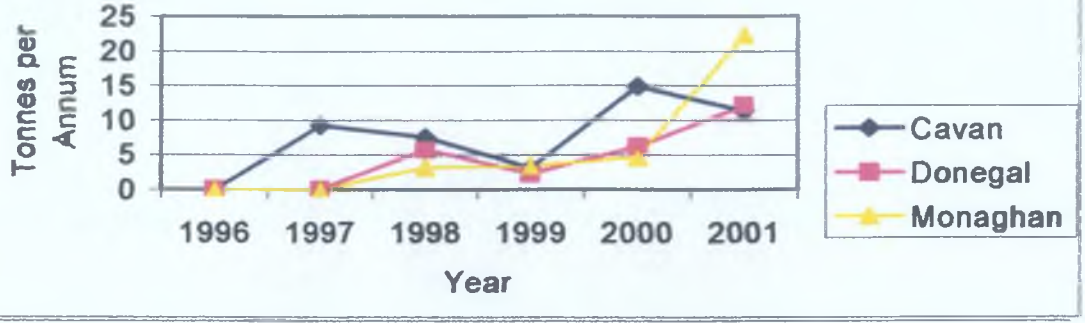


Figure 14 Collection Rates for Munster

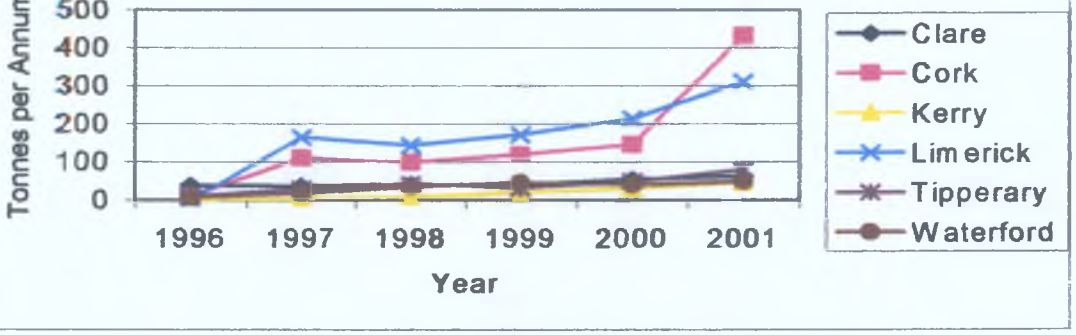


Figure 15 Collection Rates for Connaught

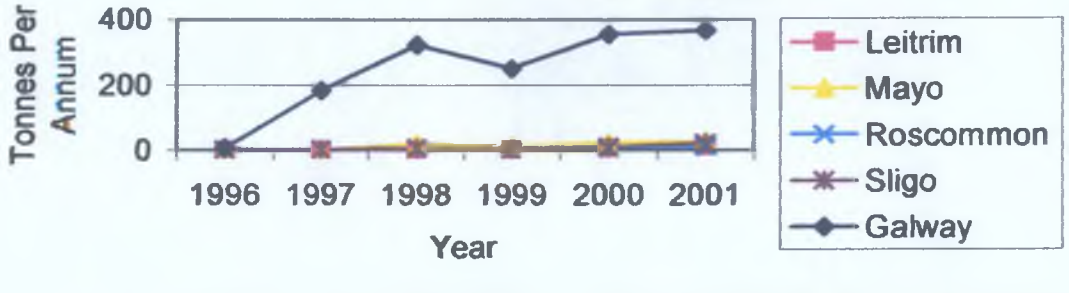
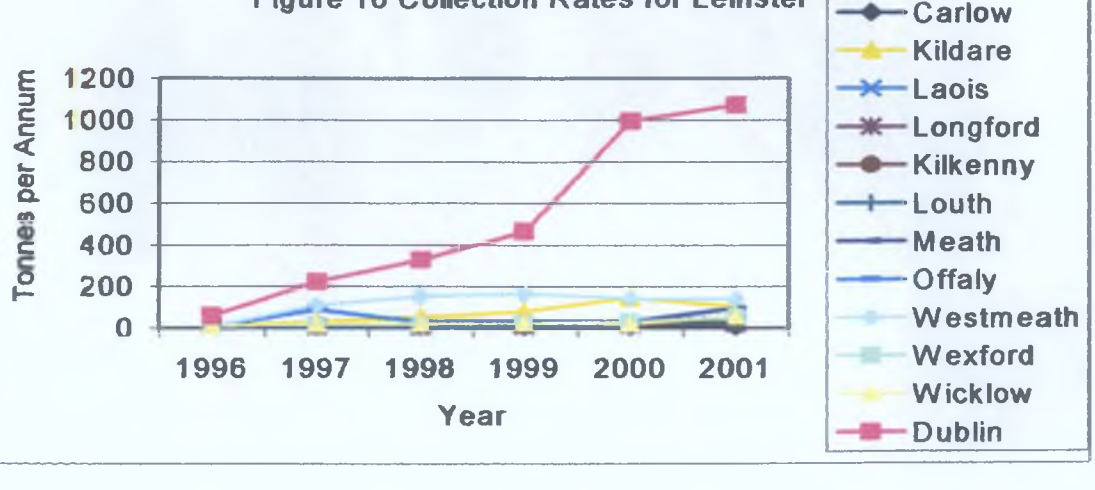


Figure 16 Collection Rates for Leinster



Survey

Two simple surveys were carried out for the purpose of ascertaining attitudes towards battery disposal in Ireland from a commercial and a local government point of view.

A survey was carried out (with the assistance of the Sales Executive in Returnbatt Ltd.) on all new clients for the lead acid recovery service (see appendix 2). The survey was completed when the contract was signed by the customer. This questionnaire sheet was entirely confidential and no names or identifying information was used.

A second survey was carried out on Local Authorities and was in relation to general battery recycling in their area (see appendix 3). A questionnaire was posted to the environment section of each local authority. A second questionnaire was posted three months after the first to those local authorities, which did not reply to the first.

RESULTS

Table 13. County Council Survey Results

Local Authority	Facilities	Procecutions for breeches of the Waste Management Act, 1996. In relation to Batteries	Future Battery Collection Plans
Cork Corporation	2 Sites	None	1 More Civic Site
Dublin Corporation	Bring centres	None	Looking at the schools
Dunlaoghaire-Rathdown	5 Primary Collection Points	None	Extend as budget allows
Galway CoCo	2 Civic amenity sites	None	2 new civic amenity sites
Galway Corp	1 civic amenity site	None	None
Kerry	4 transfer stations, chemcar 4 times per year and county offices	None	3 to 6 monthly collection of all household hazardous waste
Kildare	120 schools, 1 landfill, and county offices	None	2 new recycling centres, libraries and other county buildings
Leitrim	2 collection points for lead acid batteries	None	4 civic amenity sites
Limerick	1 Landfill site and collection by the council of primary batteries from schools	None	Libraries
Limerick Corp	45 Schools and 2 civic amenity sites	None	new civic amenity site
Longford	3 Schools 3 CoCo Offices	None	None
Mayo	1 civic amenity site and mobile collection	None	Mobile collection twice in 2002 and may start schools
Monaghan	1 bring centre	None	2 new civic amenity sites
Offaly	1 Landfill site and primary batteries collected in schools programme	None	Three civic amenity sites will collect batteries
Roscommon Co Co	Chemcar system quarterly	None	None
Sligo	None	None	12 Green schools and hazardous waste collection 2002
South Dublin	1 Civic amenity	None	No
Tipperary NR	1 recycling centre and 1 landfill	None	In-house collection system at Council offices
Waterford Co Co	None	None	Plan to make arrangements in the near future
Waterford Corp	1 civic amenity site and mobile collection	None	Possibly schools battery recycling programme in the future.
Westmeath	2 collection points at landfill sites	None	Noone
Wexford	103 schools 2 civic amenity sites and 2 local authority buildings	None	None
Wicklow	5 area offices, 4 household hazardous waste collections per year, 2 landfill sites	None	New civic amenity sites and special services for farmers

Garage Disposal Route Survey Results

Response to the question: Before Returnbatt, how did you dispose of your batteries?

Table 14 Number of Respondents to Survey

Did not have batteries	Rubbish Bin	Taken away by Travellers	Scrap merchant
1	3	22	43

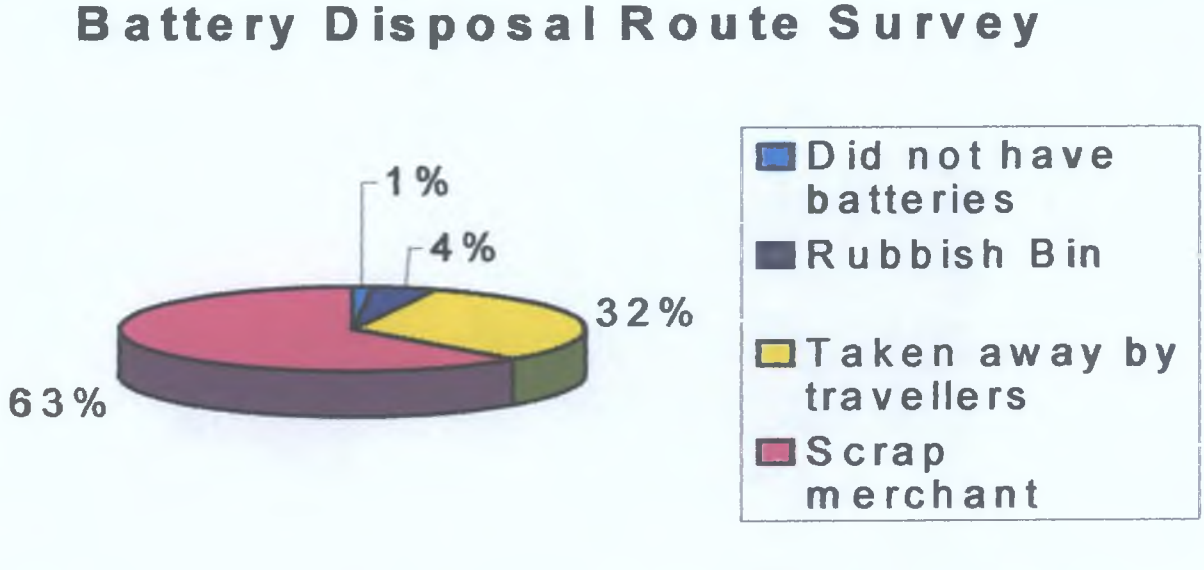


Figure 17 Battery Disposal Route Survey

Garage Legislation Awareness Survey

Response to the question: Before Returnbatt, did you know the legislation relating to used batteries?

Table 15 Number of Respondents to Survey

Response to Legislation Question	
Yes	No
40	29

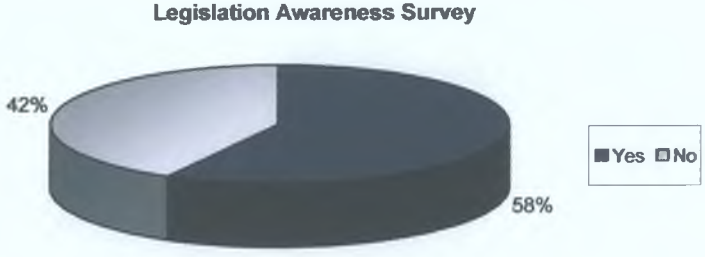


Figure 18 Legislation Awareness Survey

SECTION 3

DISCUSSION

General

Battery recycling in Ireland appears from the figures to be very arbitrary and solely dependent on the uptake of commercial ventures. From the Central Statistics Office figures, 10,700 tonnes of batteries were available for collection in 2000. This was composed of 6000 tonnes of individual batteries (nicad and lead acid) and 4700 tonnes of batteries in new and imported cars. Returnbatt Ltd collected 3000 tonnes. This gives a collection rate of 28% and leaves a large proportion of batteries being disposed of illegally. In 2000, 1700 tonnes of primary batteries were imported. Returnbatt Ltd collected 8 tonnes, this is a collection rate of 0.47%. This is a particularly poor rate of collection.

From the survey results, the primary route for disposal of batteries prior to the uptake of the Returnbatt service is scrap merchants. Most of these scrap merchants are not licensed to collect and dispose of lead acid batteries. The second most popular route of disposal are the travelling community. This is particularly worrying as there is no traceablity of this waste and there is a risk of primary processing of the waste taking place. Disposal of lead acid batteries into the general waste is low at 4%, but if this is carried out on a national basis it would be approximately 420 tonnes of batteries per year.

There is a general awareness of the law relating to the recycling of lead acid batteries, with 58% of the people surveyed having some knowledge of the laws.

Primary batteries had a collection rate of 0.4% in 2000. This figure is particularly bad considering the ease at which these batteries can be collected due to their status as non-hazardous waste. This figure is primarily due to the lack of any cohesive infrastructure within Ireland for the promotion and collection of these batteries.

The collection rate for NiCad batteries in 2000 was 17%. This figure is particularly worrying due to the hazardous nature of cadmium. Cadmium is a volatile toxic metal and has serious consequences when landfilled.

There is a cost involved in the disposal of these batteries. The cost acts as a deterrent to recycling and promotes the illegal disposal of batteries. With little enforcement of the law relating to this particular waste it is very unlikely that battery collection rates will improve.

There appears to be very little policing of the laws in relation to the disposal of lead acid batteries. From the replies to the survey of all local authorities in the country, none have ever prosecuted for breaches of the Waste Management Act in relation to batteries. This is particularly surprising as batteries are in such plentiful supply and tracing culprits is relatively easy in that most garages supply and change batteries.

On the positive side, most local authorities have some form of battery recycling in place and those that do not have positive plans for the future. The provision of more civic amenity sites is particularly important as more people will recycle if it is convenient.

Primary batteries are mostly collected through the Schools Battery Recycling Programme, the Chemcar system and through civic amenity sites. As yet there is no

impetus for businesses to recycle batteries and only larger companies with environmental programmes tend to recycle primary batteries.

If Ireland is to meet its obligations for battery recycling there are different methods that can be used to promote it. Firstly it is important to examine the reasons for the low recycling rate. There are three main reasons for not recycling batteries:

Cost

Primary and NiCad batteries cost money to recycle. If people have a large amount of batteries to recycle, it is expensive and can prove prohibitive. This is a deterrent to recycling and can lead to batteries being disposed of to landfill. If companies wish to have a battery recycling point on their premises they must pay an annual charge of €320 for the box and a further cost of €3.81 per kilo for the batteries.

Sites that have a lead acid battery box must also pay €385 per year for the collection service, but not by weight for the batteries. Lead acid batteries have an intrinsic value because of the lead. The viability of battery recycling depends on the price of lead on the open market. If the price of lead falls dramatically a charge would have to be imposed per battery, on companies for this service.

Availability

In many counties in Ireland the distance to civic amenity sites is prohibitive. Unlike bottle and can banks which can be placed in car parks, battery recycling points must be kept in secure locations. Primary battery points can be placed in schools and county council premises. Schools are ideal location as children are a high user group of batteries. Lead acid batteries are a hazardous waste and must be stored in supervised locations. This is

particularly important from a security point as this battery has an intrinsic value and is susceptible to theft. In some instances there is a distance of 40 miles to the nearest civic amenity site, this acts as a deterrent to recycling.

Enforcement

Unless there is greater enforcement of the laws in relation to the disposal of batteries in particular, lead acid batteries, there will always be a reluctance to dispose of waste properly. Not one of the local authorities that responded to the survey had ever prosecuted anyone in relation to the unlawful disposal of batteries.

It is estimated that Returnbatt Ltd has approximately 15% of the garages in the country participating in their battery collection service. This leaves a large number of garages not participating in battery recycling. It is very easy for local authorities to investigate businesses that do not dispose of waste in a legal manner; many local authorities do not police this area of waste management. Local authorities have not participated in awareness campaigns regarding batteries. Under funding and lack of personnel may be a large contributory factor in this situation.

The Waste Management (Movement of Hazardous Waste) Regulations, 1998, requires that Consignment Notes (C1 Forms) be used for the transportation of hazardous waste within Ireland. This requires that all movements of waste lead acid batteries be accompanied by a C1 form obtained from the consignor's (the initial holder of the waste) local authority. The form is comprised of five copies and is divided into three sections, A, B and C. The carrier keeps the white copy, the local authority (consignor's area) receives the green copy, the local authority (consignee's area) receives the blue copy, the consignee receives the yellow copy and the consignor receives the pink copy.

The C1 form is a useful tool in the tracking and control of hazardous waste, which is being moved within the country. Each local authority knows exactly what hazardous waste is being moved through their area.

There is very little policing of the regulations particularly in relation to batteries. This leaves companies such as Returnbatt Ltd as the only ones using C1 Forms.

Each local authority has their own C1 forms, even the city councils within the larger areas have their own C1 forms. There are thirty-four different local authorities within the Republic of Ireland. Even though these forms are identical in format the individual serial numbers are different. This makes it very difficult to acquire C1 forms, as there is no central source for them. Different local authorities designate different sections within the authority to supply the forms, some use the Environment, others Sanitary Services. This poses a problem when supplying C1 forms to the general public as confusion sometimes ensues.

Wicklow County Council applies a fee of €12.70 for each C1 form they supply. This acts as a deterrent to recycling as it targets the people who are already operating within the law. Returnbatt Ltd customers within the Wicklow area have suggested that they will not use the service in future because of this extra charge on top of the annual service fee charged by Returnbatt.

The Waste Management (Collection Permit) Regulations, 2001 require any person collecting waste, including hazardous waste to obtain a permit from the relevant authority. Ten authorities have been designated and a permit is required for each area in

which waste is collected at a cost of €1143 per area. Each area has different application forms and different criteria for acceptance. This system is confusing and prohibitive and puts a strain on any company working in more than one area. There is no consistency in the application process or the requirements for issuing of the permit.

Some regions have deferred decisions on these permits until December 2002. This poses problems with responsible customers who are aware of the legislation and require proof from their waste service providers of their permit status. If some permits are issued in a timely fashion and others are not this leaves those without permits at a disadvantage and this can pose problems with competition.

Recycling companies in the Republic of Ireland cannot collect waste in Northern Ireland as it is within a separate state. With a population of approximately 1.5 million a large number of batteries is unavailable to the southern recycling market. A company operating in the Republic cannot bring waste from the North without transfontier documentation. If this market was opened up it would make processing of batteries more viable as the volume would be economical. This would equally apply to other waste markets such as the waste tyre market.

Taxation

Taxation offers a solution to the above problems if they are carefully designed and they are part a package of green tax reforms. It the taxes are gradually implemented after a period of consultation, improvements will be seen in innovation, competitiveness, employment and the tax system.

If batteries are taxed at source, a central pool of money is available to fund:

a) Collection systems: At present anyone wishing to recycle batteries (other than at a civic amenity site) must pay for the service. If collection rates are to be anywhere close to bottle recycling, there must be the same availability throughout the country.

b) Information programmes: At present there are no national information programmes for battery recycling that are funded by the government. Programmes such as those promoted by Repak are funded by the packaging industry and this industry passes on the cost of these contributions to its customers. This is an indirect form of taxation which the government does not have the responsibility to manage.

c) Research programmes: Smaller recycling businesses are often on a tight budget and there is often very little money available to research new and innovative techniques. This leads to a lack of investment and forward planning and ultimately a lack of competitiveness. Research programmes which forge links between industry and Universities and Institutes of Technology can be particularly successful with a mixing of technology and practical experience.

d) Recycling facilities: Ireland does not at present have sufficient capacity to feed recycling facilities within this country. This is not in line with government policy on recycling. It is the expressed wish of both the government and the EPA that waste should not be shipped outside Ireland if possible. The transfrontier shipment of waste consumes a large amount of natural resources and multiple handling of hazardous waste increases the risk of accidents and incidents. If an environmental tax was used to directly fund a recycling facility, the responsibility of waste would be kept within the country of origin. Where there is a shortfall in capacity, recycling facilities could be subsidised by a tax on batteries.

If the price of lead acid batteries was increased through taxation, there would be an added impetus to find other, less hazardous metals to use in batteries. This was apparent in Sweden when a tax was imposed on diesel, this helped the development of new less polluting fuels.

If a tax were imposed on non-rechargeable primary batteries it would make the use of these batteries less attractive and encourage people to use rechargeable batteries in preference.

Taxing items at source is a cost-effective method of tax collection. The retailer acts as the tax collector and the consumer cannot avoid paying tax. It works in the same way as Value Added Tax.

The recent tax on plastic bags was a marked success with the Department of the Environment placing the reduction in the use of bags at 94%.

Table 16 displays the possible advantages and disadvantages of recycling schemes available to the government. The levy or eco tax is the most preferable option as it is the easiest to administer and enforce.

Table 16. . Schemes available for battery recycling.

SCHEME	POSITIVES	NEGATIVES
Levy/Eco Tax	• Applies to imports • Relatively easy to administer • Source of income for other uses if fund is not drawn on • Meets polluter pays principal	• Needs legislation • Needs third party (e.g. EPA) to administer • Needs enforcing
Deposit/Return Scheme	• Encourages Recycling • Onus on customers • Easy concept • Easy to introduce • Meets polluter pays principal	• Needs legislation • Difficult to administer • Complex scheme
Voluntary Agreement/Approved Battery recycling scheme	• Meets polluter pays principal • Similar schemes already established	• Needs legislation • Needs agreement of interested parties • Not effective as legislation

SECTION 4

Conclusions

Waste disposal is an important national issue and the country faces a time of self-awareness and responsibility in relation to waste. Battery recycling in Ireland is at present:

- Underdeveloped
- Reliant on one company
- Reliant on other countries for disposal
- Not enforced by local and national government
- Under funded
- Undirected
- Not prominent as part of national waste awareness campaigns

The most appropriate direction for battery recycling will include:

- Diversification of the industry with the inclusion of more companies operating waste disposal facilities
- A taxation system run by the government or government appointed body
- Increased awareness campaigns
- Less reliance on other countries for waste disposal
- Enforcement by the relevant authorities in relation to battery recycling

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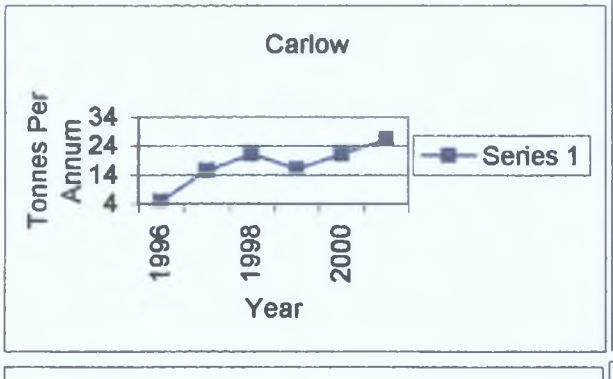
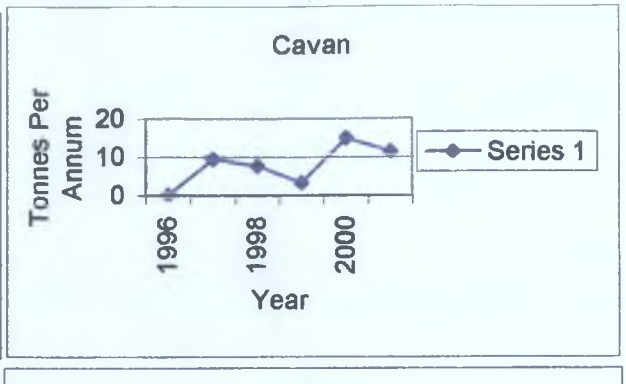
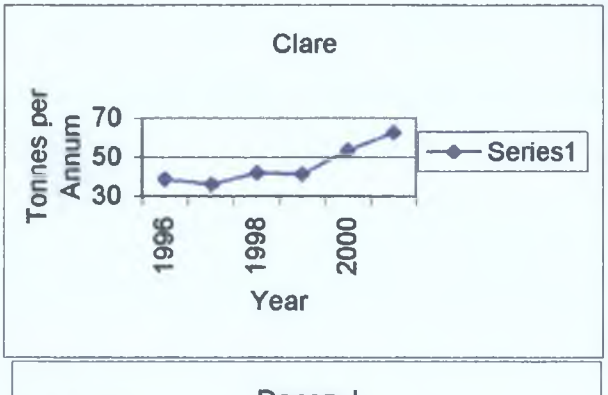
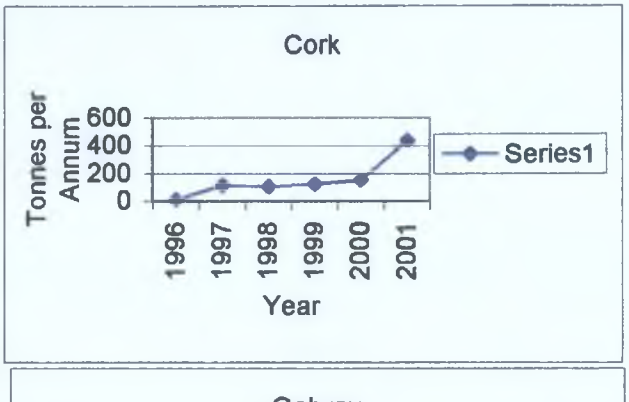
Appendix 1

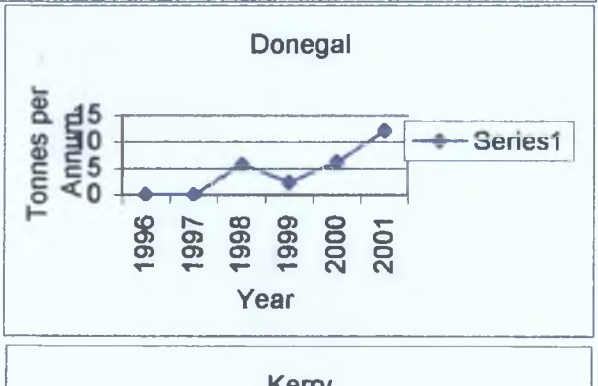
Individual County Collection Rates of Lead Acid Batteries

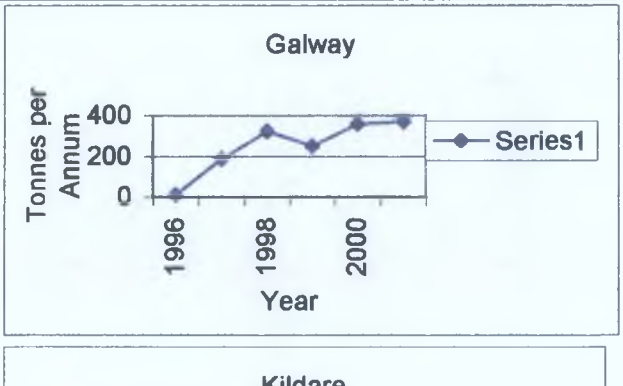


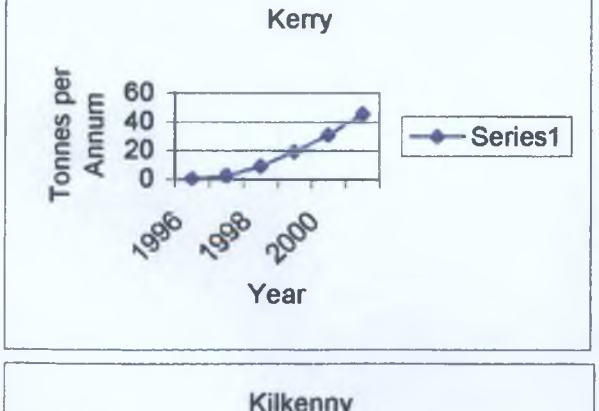


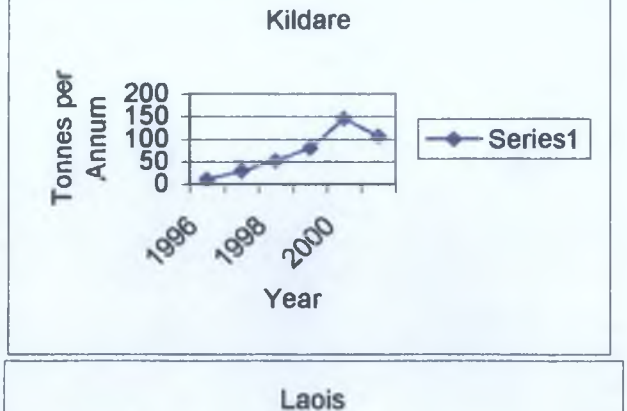


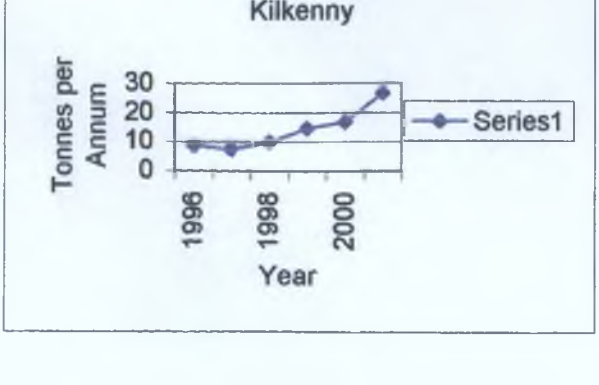


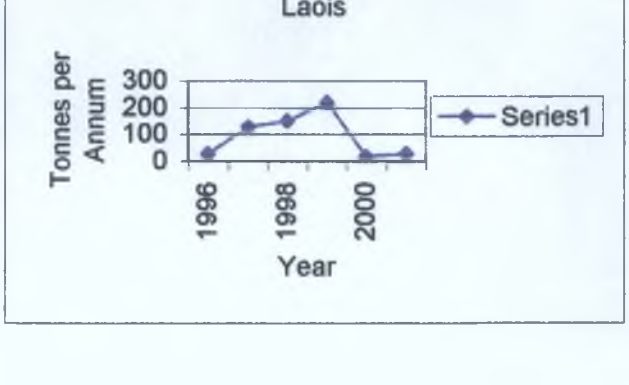












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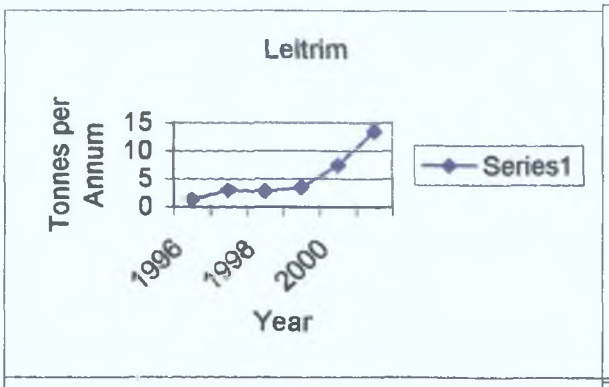
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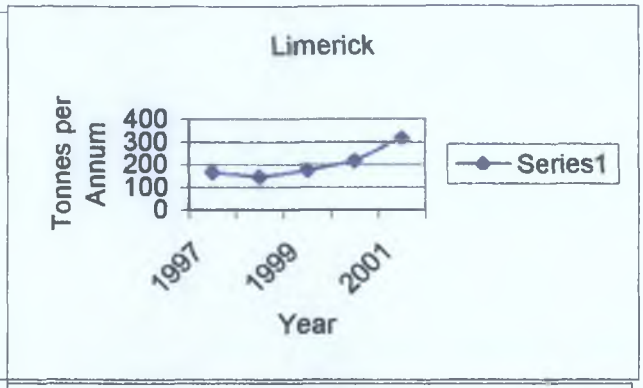
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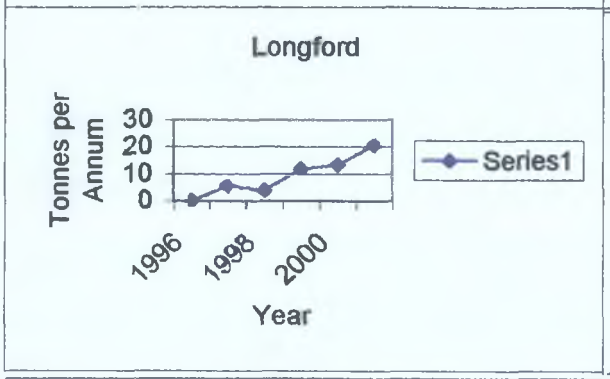
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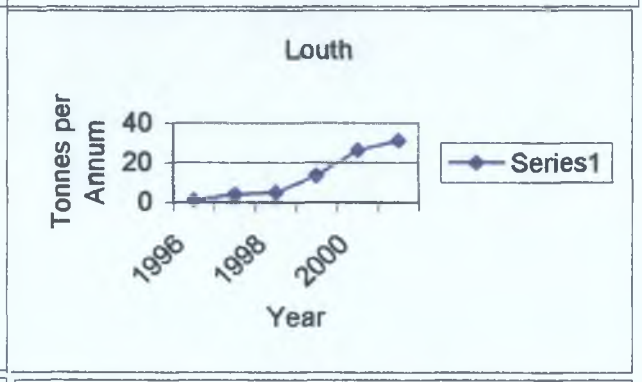
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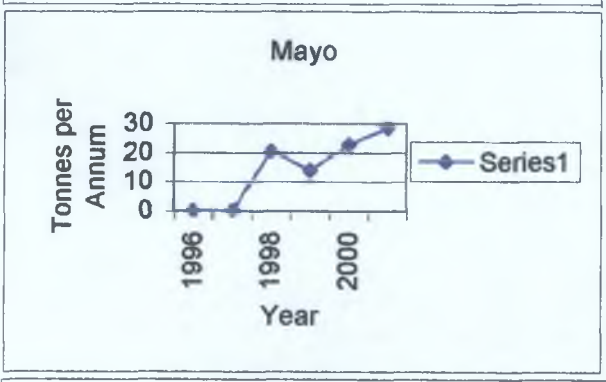
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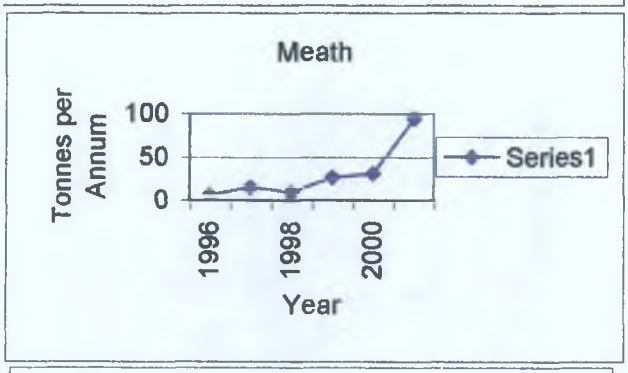
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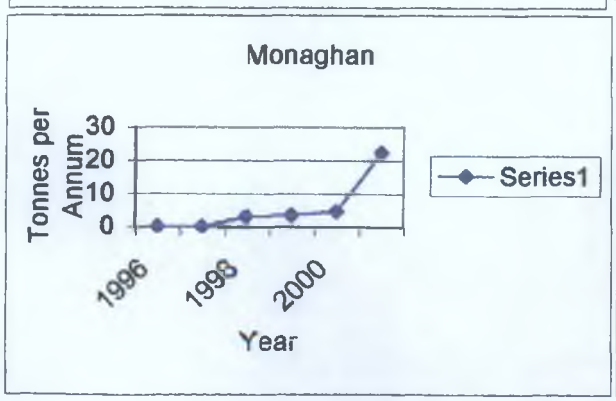
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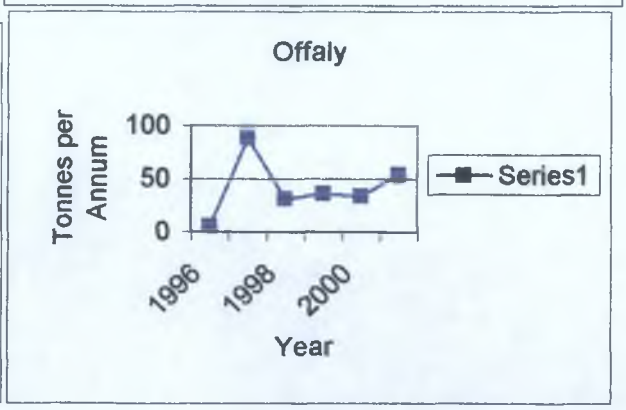
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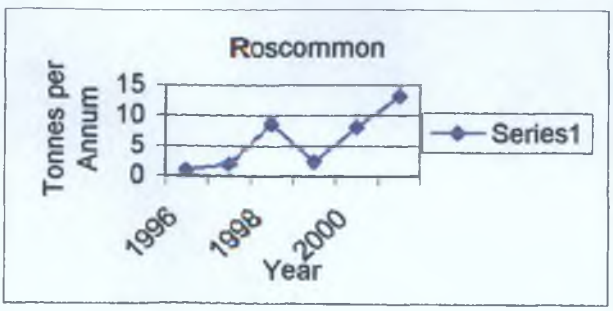
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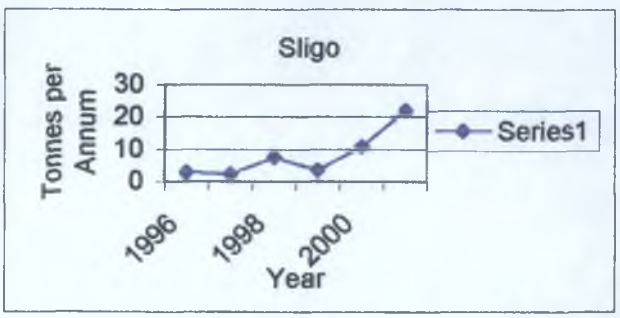
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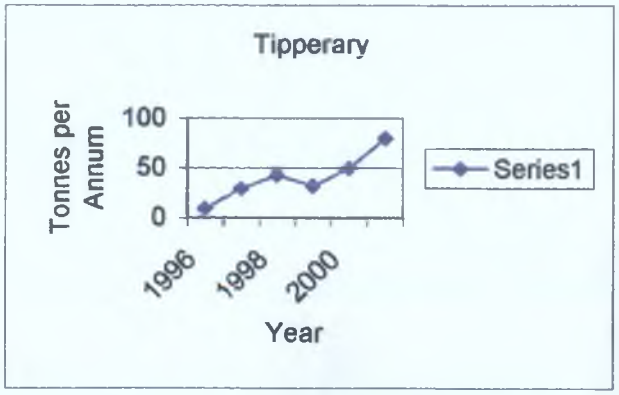
Appendix 1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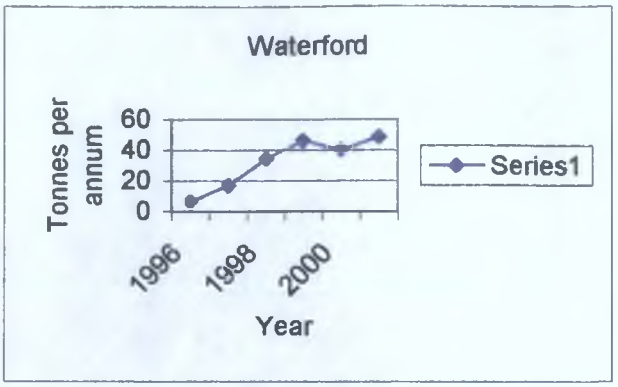
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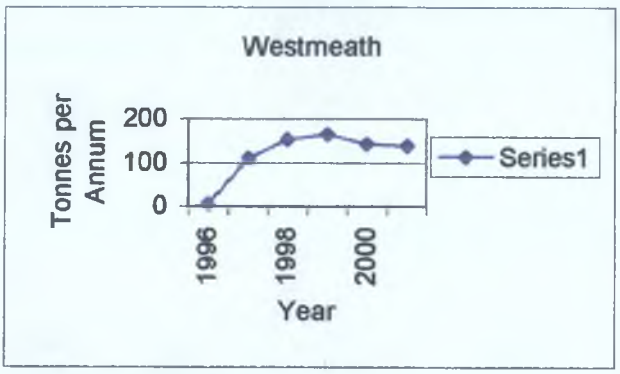
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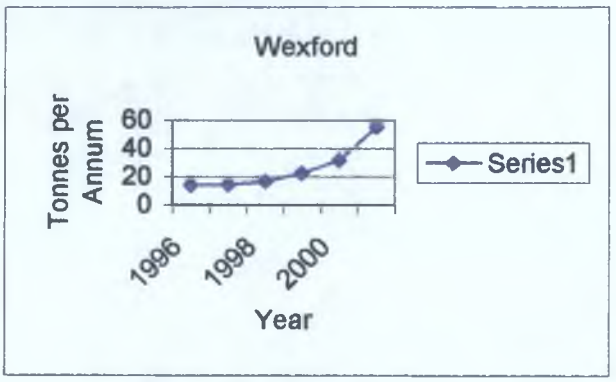
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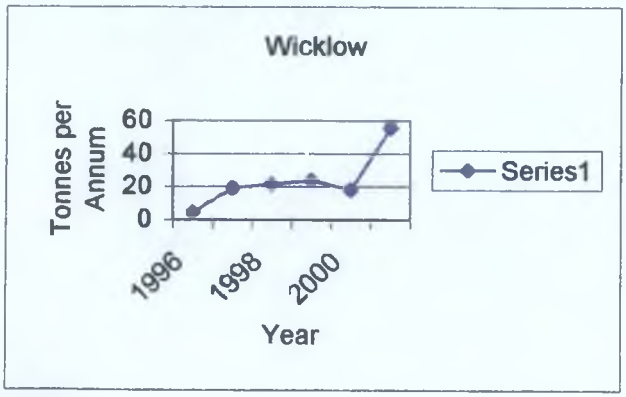
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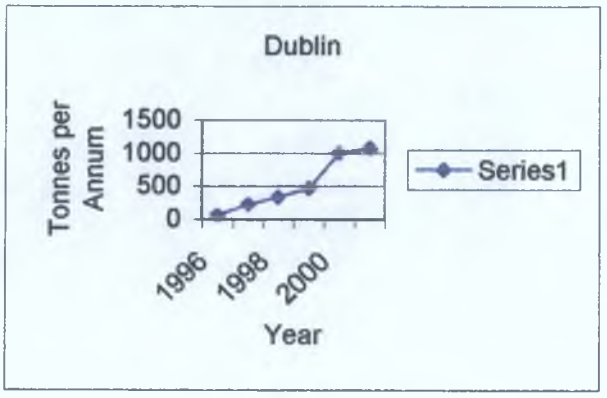
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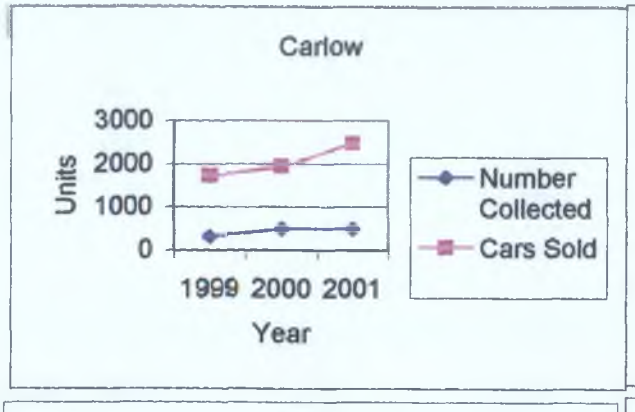
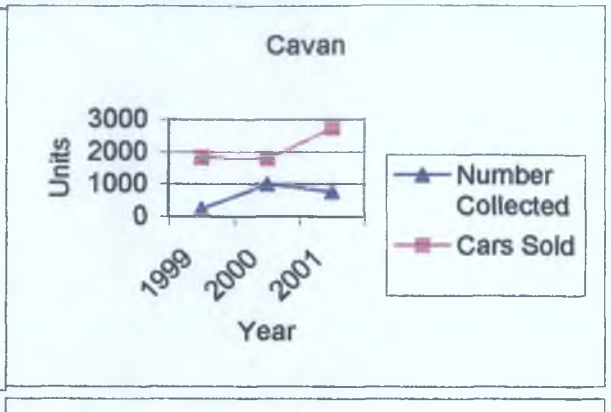
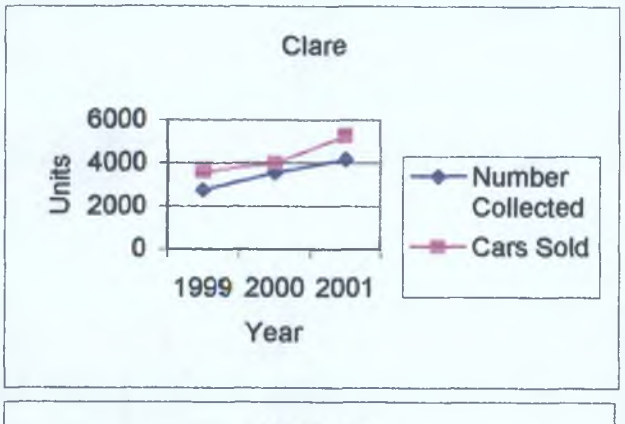
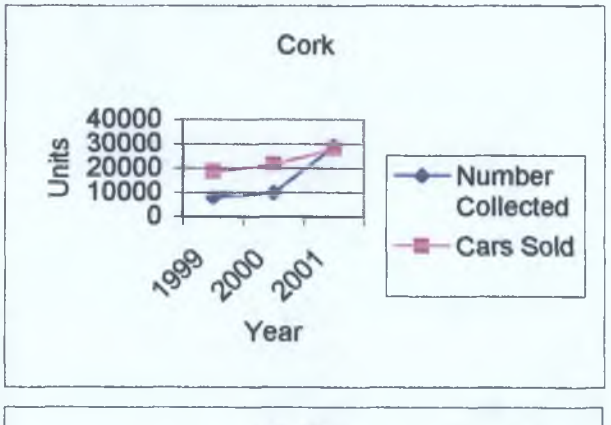
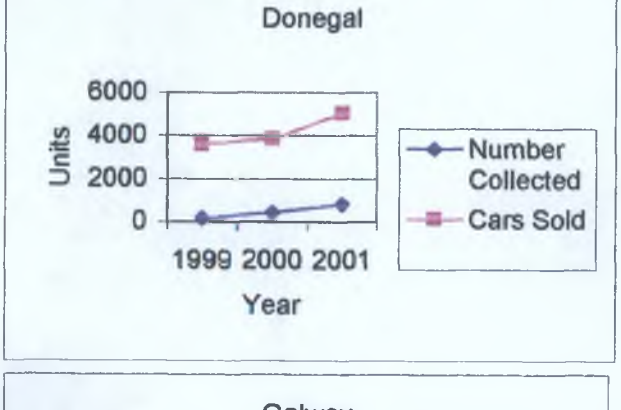
Appendix 1
New Car/Used Battery Capture Rate

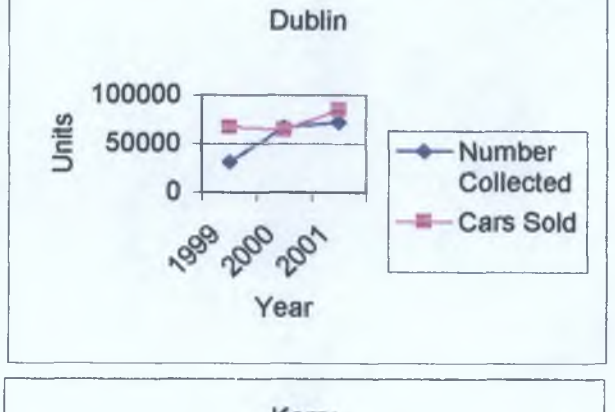


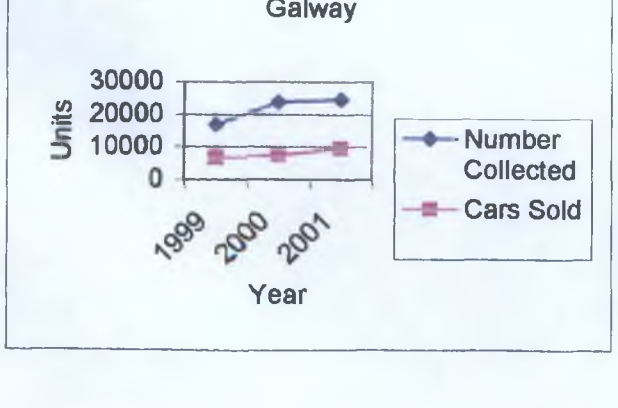


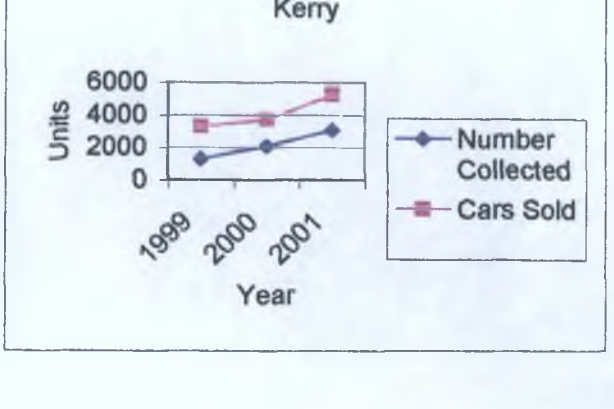




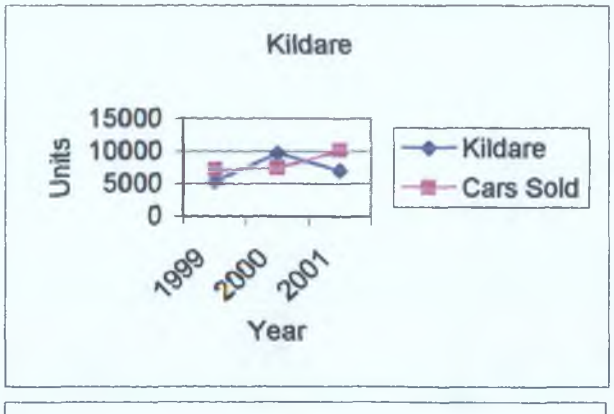


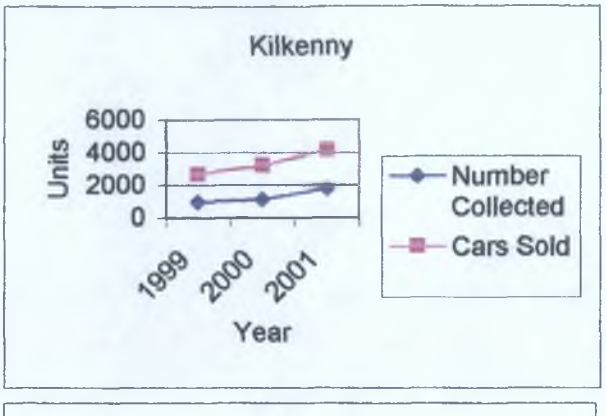


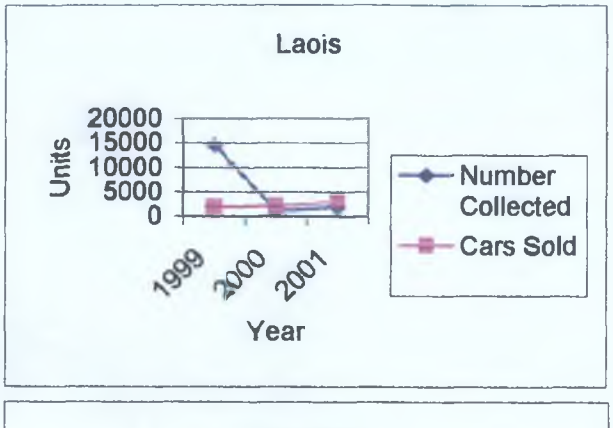


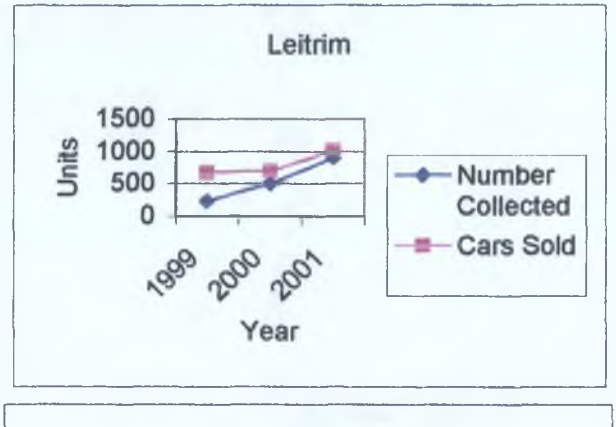


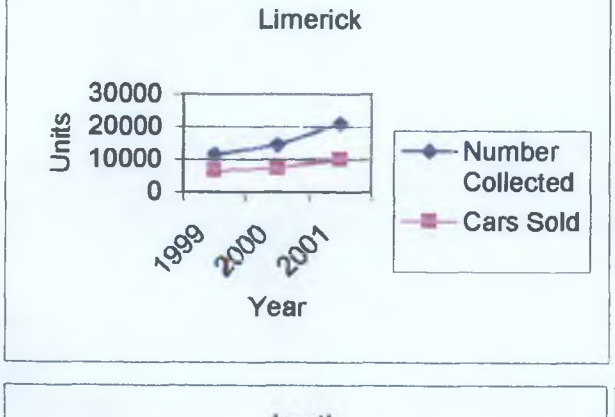
Appendix 1
New Car/Used Battery Capture Rate

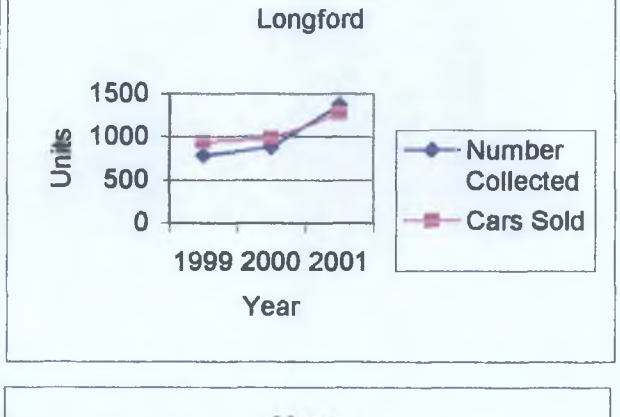


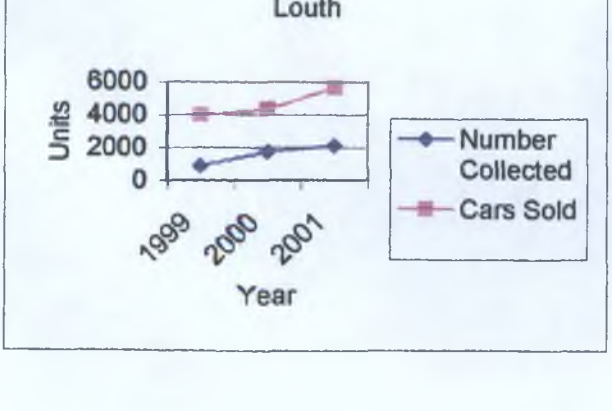


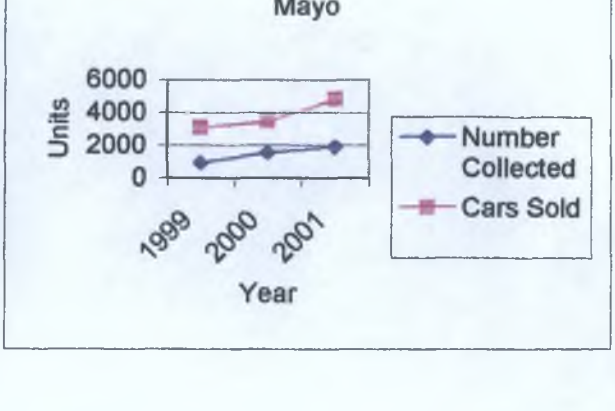




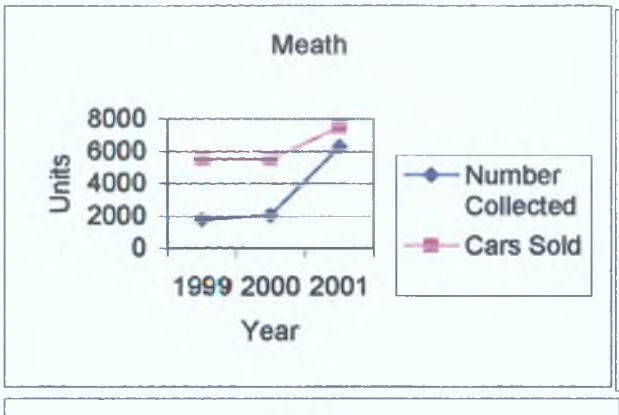


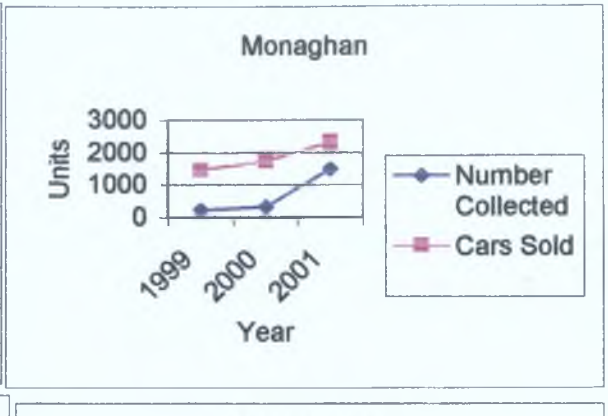


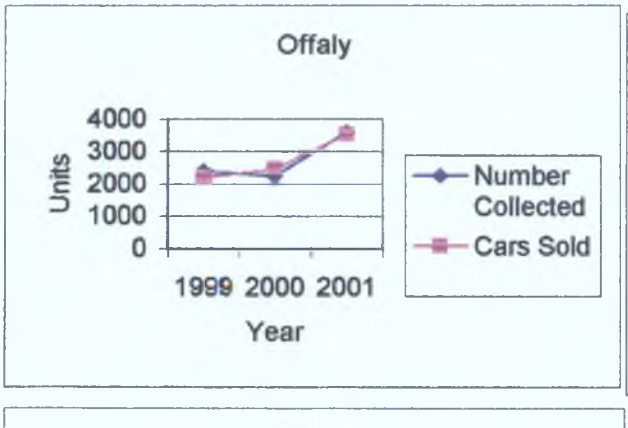


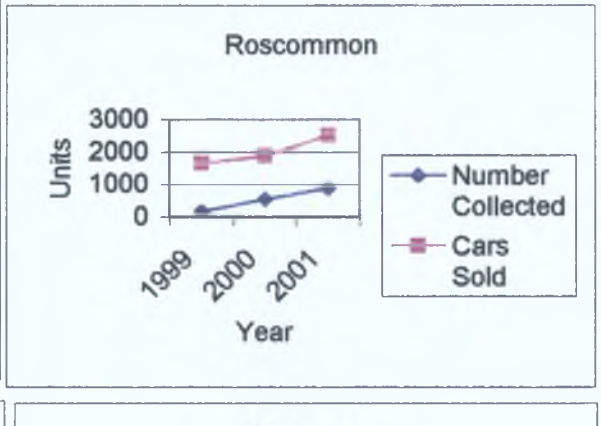


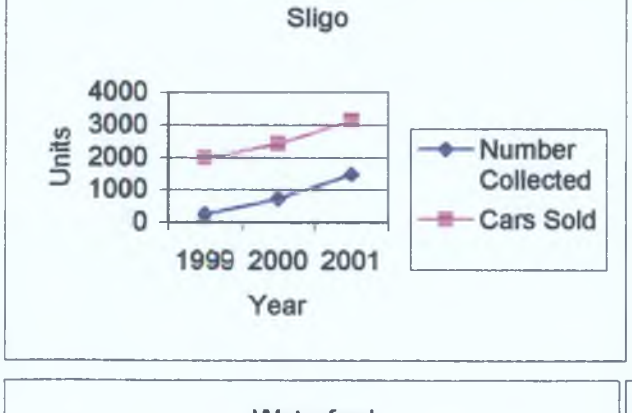
Appendix 1
New Car/Used Battery Capture Rate

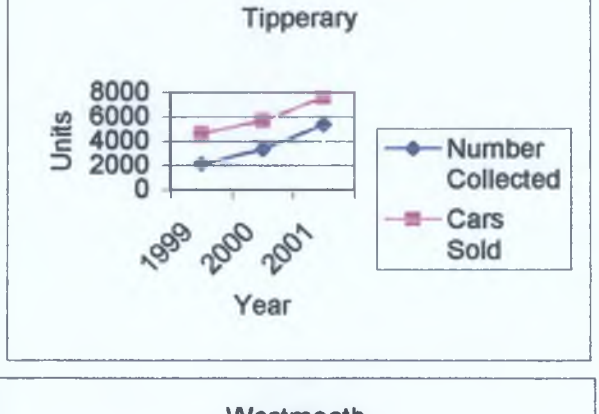


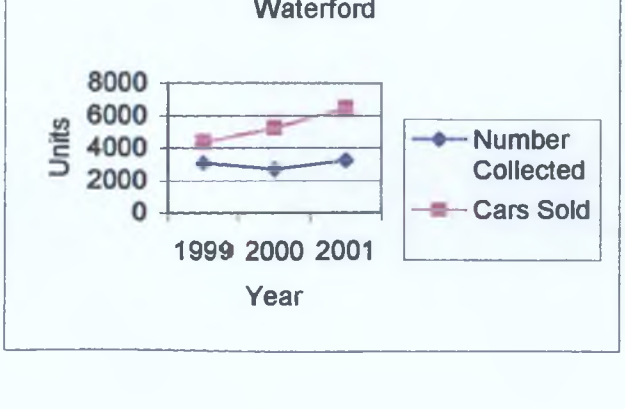


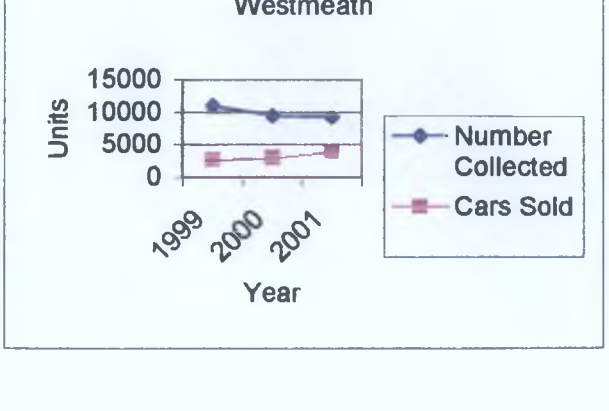




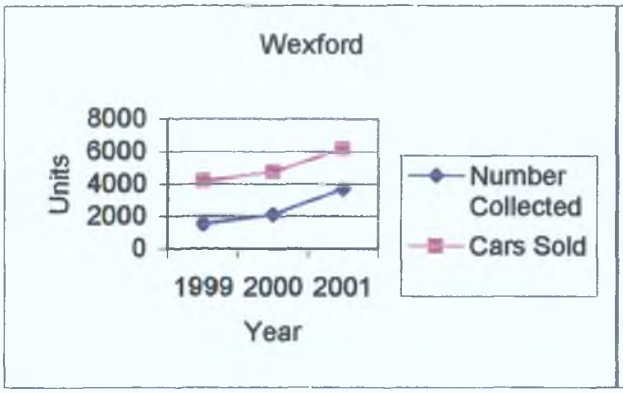


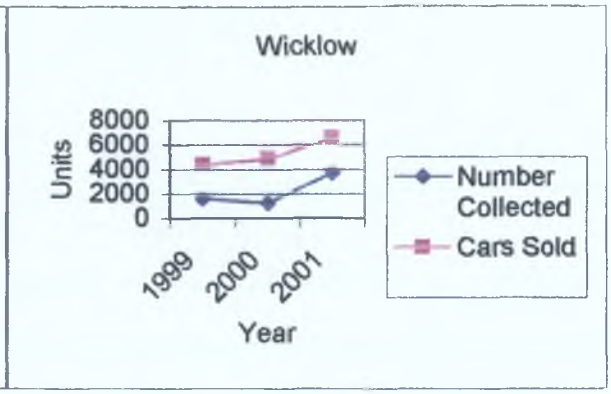


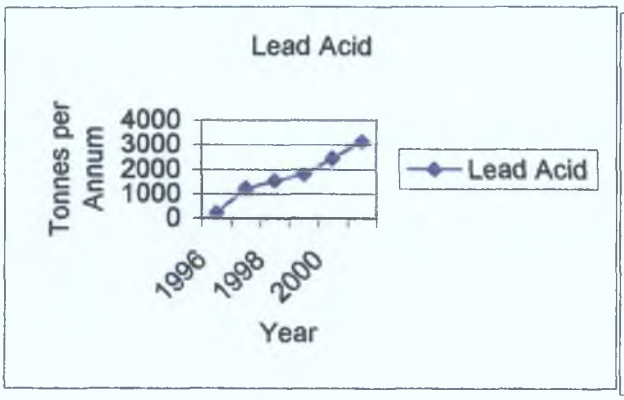


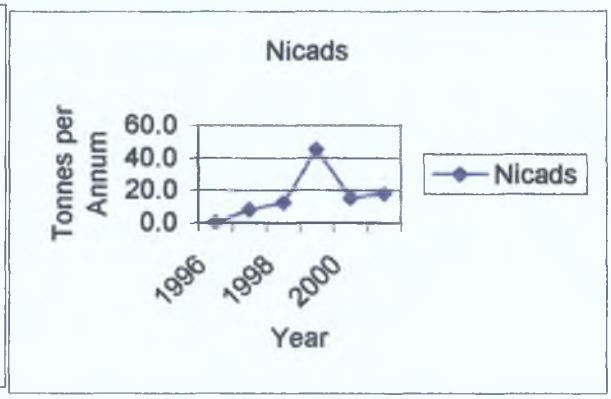


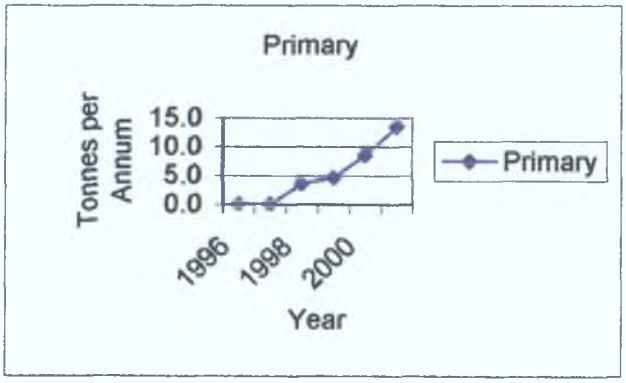
Appendix 1
New Car/Used Battery Capture Rate











Appendix 2

Battery Survey

Before Returnbatt where did you dispose of your batteries?

Did not have batteries ☐ Rubbish bin ☐ Taken away by travellers ☐ Scrap merchant ☐

If none of the above please specify

_____

_____

_____

Before Returnbatt contacted you did you know the law relating to used batteries?

Yes ☐ No ☐

Please note that this survey is entirely confidential and no names are taken or used.

Appendix 3

Environment Section
Donegal County Council
County House
Lifford
Co Donegal

Battery Recycling

Dear Sir or Madam,

I am investigating the availability and take up rate of battery recycling throughout Ireland and Europe and I hope you will answer a few short questions.

What facilities does the Local Authority provide in your area for the collection of batteries?

Has the council ever prosecuted anyone for breaches of the Waste Management Act in relation to batteries (primarily lead acid)?

Does the council have any future plans for collection systems in the future?

Thank you in advance for your help,

Regards,

E. Downey