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GLOBAL WATCH MISSION REPORT

WEEE recovery: the European story

JUNE 2006

Global Watch Missions

DTI Global Watch Missions enable small groups of UK experts to visit leading overseas technology organisations to learn vital lessons about innovation and its implementation, of benefit to entire industries and individual organisations.

By stimulating debate and informing industrial thinking and action, missions offer unique opportunities for fast-tracking technology transfer, sharing deployment know-how, explaining new industry infrastructures and policies, and developing relationships and collaborations. Around 30 missions take place annually, with the coordinating organisation receiving guidance and financial support from the DTI Global Watch Missions team.

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WEEE recovery:
the European story

REPORT OF A DTI GLOBAL WATCH MISSION
JUNE 2006

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Resource Efficiency
Knowledge Transfer Network

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EXECUTIVE SUMMARY

S.1 Introduction

Led and coordinated by the Resource Efficiency Knowledge Transfer Network, a DTI Global Watch Mission visited a number of European countries in June 2006 and, unsurprisingly, found a number of different solutions to the common dilemma of meeting the requirements of the European Commission's (EC) Waste Electrical and Electronic Equipment (WEEE) directive (2002/96/EC).

Unlike the Restriction of Hazardous Substances (RoHS) legislation, the WEEE directive is a series of *guidelines*, and as a result has been interpreted in different ways by different European Union (EU) member states. This was found to cause a number of anomalies across the countries visited and this is expected to be the case across the EU.

The stakeholders in the debate are wide and varied, not least in the UK which has recently come out for another round of consultation. This has generated some country-specific solutions which rely on the strength of these stakeholder groups. Another factor is the obvious national characteristics of the consumers, industry and legislature/enforcement bodies in each member state. Sometimes the practices of neighbouring states assisted this process, in other examples it hindered it.

S.2 Common themes

One common theme strongly driven by the multiplicity of stakeholders is the problem of the directive viewed in terms of a supply chain. The key areas of this supply chain are picked out and discussed in the report. It is commonly perceived as involving collection, transport and logistics, sorting and separation, depollution, treatment and processing, then finally material recovery. However, a number of other related issues repeatedly came up, such as:

- Reuse of recovered material
- Definition of 'waste' material (after treatment particularly)
- Counterproductive legislation in other areas such as landfill regulations (or lack of them)
- Environmental enforcement
- Education of industry and the consumer
- Eco-design or design for disassembly
- Method of financing
- Tax burden standardisation across the various groups of categories

A key finding of the mission was that while best practice can be found in all areas of the supply chain from collection to reuse, each supply chain has to be viewed in its entirety as each link depends on the preceding and subsequent steps. For example, it is unlikely that the UK would be able to pick a best-in-class idea from the Swedish collection system and combine it with the most innovative recovery technology available in Germany.

However, it was also apparent that the message of ‘keep it simple and rely on common sense’ was recommended by all the places the mission visited. Depending on the national character, this worked better in some areas than others: common sense, for example, was apparently not always that common!

Another mantra heard, which will be singularly difficult for the UK, was to segregate material as early as possible in the supply chain. Many of the countries visited had tackled this, admittedly with varying degrees of success but it always paid downstream benefits.

A major debate was also being carried out in some countries on how to define ‘waste’, and more importantly how to define when recovered material was ‘not waste’ or fit for purpose in reuse.

The consensus amongst virtually all experts visited was that the easy part of the directive, collection targets, was already being achieved. Most member states were easily achieving the 4 kg per person target, some such as Sweden achieving a significantly higher figure (14 kg).

S.3 Recovery a challenge

However, the material recovery targets were proving more challenging. Simple separation and recovery of the metal fraction, no matter how advanced the technology and processing equipment being used, was unlikely to meet the 80% requirement. In some categories of the directive this was more difficult than others. For example, all countries recognised small WEEE items, Category Two, as particularly troublesome. To achieve the agreed recovery rate it was recognised that clean separation, and more importantly final recovery, of the plastic fraction was paramount. This was always much more difficult and, by implication, more expensive than first envisaged and was where most research was being applied.

Collection of redundant equipment was seen as a vital component of the problem, so the mission visited a number of collection sites in various countries to look at this in detail. Then, having collected the items, clearly new technologies are required to depollute, dismantle and recover materials from the remaining fractions. Particularly critical to efficient recycling is the separation and subsequent recovery of the plastic element, with no suitable economically viable disposal route other than incineration currently identified (except from a very clean segregated fraction, which MBA Polymers Austria claims to recycle at better than 80%). This plastic recovery problem was clearly identified as a major research imperative, and the mission visited three establishments exploring true ‘blue-skies’ solutions (Gaiker in Spain, Fraunhofer IVV and Hamos in Germany).

The connection between government and industrial collaboration was explored in all visits, with funding mechanisms for ‘technology leaps’ being of particular interest. Germany, for example, had a central clearing house system but diluted its effectiveness by insisting on two competing schemes to avoid a cartel situation. Germany has been investing in technological solutions for materials recovery for some years, such developments including a novel solvation method CreaSolv, and Hamos seeking to license technology for producing biodiesel from a coarse plastic fraction. Sweden has an easier route to disposal via its significant metallurgical complexes, and claims the logistics and transport miles make energy recovery, as a hydrocarbon substitute, a more efficient use of resource.

Cross-border ‘trading’ between partners also represents an opportunity and appears to be a growing trend, only hampered by the legal definition of waste material in each country and how waste legislation impacts on that.

S.4 Comparison with Japan

A major objective for the mission was to compare and contrast how the Japanese solution, seen on the previous mission in 2005,[1] fitted into the picture. This had found that Japan had a much simpler legislative structure, for example only tackling four major appliances (TVs, air conditioners, washing machines and fridges), and surprisingly was using very simple recovery technologies. The similarities were that best-practice European technologies, involving segregated collection, good separation (still mainly hand picking), manual depollution and advanced bulk plastic separation were the norm and not very different.

Perhaps surprisingly, not much Japanese separation equipment was seen at any of the facilities visited in Europe. However, unlike Japan, equipment from neighbouring countries was used almost interchangeably in the European recycling facilities visited. Loyalty to brand or country of origin was not as evident in Europe as in Japan.

Critical research is being carried out in both Japan and Europe into recovering plastics from the fines fraction of the shredding processes. As in Japan, in Europe the final route for this difficult fraction tends to be incineration, albeit through a pyrometallurgical route in some countries. As expected, the Japanese model has higher efficiencies mainly due to the effort they have put into assembly-line type dedicated 'demanufacturing' centres.

Japan also benefits from a much closer relationship between the manufacturers and the recyclers which is not evident in Europe. Obviously this is complicated in Europe by the open-market policy for goods supply, and consumer choice on price, not brand or even country of origin. This difference is recognised as being even more pronounced in the UK than many other European countries visited, and poses particular problems for the UK market. Again, as with Japan, national characteristics also give some countries, such as Sweden, a perceived advantage over the UK.

1 *Waste electrical and electronic equipment (WEEE): innovating novel recovery and recycling technologies in Japan, September 2005,* DTI Global Watch Mission Report, URN 06/510, 112 pages, published January 2006: www.globalwatchservice.com/missions

1 INTRODUCTION

1.1 Background: the WEEE directive

The Waste Electrical and Electronic Equipment (WEEE) directive is European environmental legislation and is one of a small number of directives which implement the principle of 'extended producer responsibility'. Under this principle, producers are required to take responsibility for the environmental impact of their products, especially when they reach the end of their useful life. The WEEE directive applies this in relation to electrical and electronic equipment (EEE).

The broad aim of the directive is to address the environmental impacts of WEEE and to encourage its separate collection and subsequent treatment, reuse, recovery, recycling and environmentally sound disposal. It also seeks to improve the environmental performance of all operators involved in the life cycle of EEE, especially those dealing with WEEE. Accordingly it sets certain requirements relating to the separate collection of WEEE, standards for its treatment at permitted facilities, and sets targets for its recycling and recovery. Under the directive:

- Retailers have an obligation to give consumers the opportunity to return WEEE, free of charge, on the sale of a new item
- Producers are responsible for funding the collection, treatment, recovery and recycling of separately collected WEEE in proportion to their EEE market share (ie the amount of EEE they place on the UK market in any compliance period)

This mission was undertaken with the objective of comparing and contrasting the Japanese solution to WEEE recovery and reuse with that of best practice in Europe, with a view to informing the debate in the UK.

Details of the Global Watch Mission to Japan can be found in footnote 1, page 5

The Japanese solution is based around their Home Appliance Recycling Law (HARL) which is described in the earlier Global Watch Mission report. After the Japan mission, alternative European solutions became significant. The UK, along with the rest of Europe, is subject to the WEEE directive which sets recycling and recovery targets for various categories of WEEE.

The WEEE directive was to be enacted throughout Europe by June 2006. However, the actual mechanics of how it is enforced vary from country to country, and the UK has been slow to implement the directive. On 14 December 2005 the Minister for Energy announced yet another review of the implications of the WEEE directive in the UK. The UK is now one of only two countries still to apply the directive through national legislation (the other being Malta) and implementation is not likely before early 2007. As all other EU member states have applied the directive, policy decisions in member states have been widely explored and broadly understood or agreed.

The mission focused on the actual implementation strategies and technologies being used to address the policy, whilst recognising that the scale of the problem, and hence the solution, will vary from one EU member to another. For example, supply chain collection logistics are significant in some member states while the physical technologies required to depollute and recover materials may be more significant in others.

1.2 Specific mission objectives

Following the issue of the WEEE directive, global manufacturing companies are keen to see recycling sites established in Europe to address the producer responsibilities obligation. In Germany there is a national collection system similar to the National Clearing House system considered for the UK. However, some areas of particular difficulty were identified relating to:

- Collection and segregation of wastes – innovative solutions are being developed to address this
- Plastics recycling and recovery (shredding and subsequent separation technologies) – Sweden for example is prepared to accept cruder separation as it recovers energy and material via its integrated pyrometallurgical plants

The European mission objectives sought to evaluate:

High level

- The mechanisms put in place by the EU members visited (specifically Sweden, Germany, the Netherlands, Spain and Austria) to achieve their targets for electronic recycling
- Government support for development projects in this technology sector
- Strategies to meet WEEE legislation in a global context
- Current investment profiles (industrial and government)
- Best practice for collection and segregation of WEEE
- Recycling capability (particularly from small-scale collection sites to large processing units)
- Current level of uptake of collection logistics
- Level of plastic revalorisation efficiencies (if any)

Technological

- Technological approaches taken by industry to achieve their targets
- Perceived needs for improved separation techniques (eg advanced shredding and mechanical separation), including depollution processes
- Integration of novel technologies for plastics and metal separation within the traditional mechanical separation and incineration routes
- Performing of novel leaching and electrochemical reactions to recover metals
- Improvement of metal revalorisation efficiencies
- Novel processes to recover plastics

Technology transfer and skills

- Integration of academia with industry to transfer research and development (R&D) expertise into industrial processes
- Multidisciplinary collaboration to bring about step changes in technology
- Training capabilities and method of implementation for the overall recycling targets
- Complementary strengths of European partners and the UK manufacturing base to identify potential new alliances

The mission visited five member states over 10 days, taking in technology centres, civic collection centres, recycling facilities and equipment manufacturers. The team was led by the Resource Efficiency Knowledge Transfer Network (a government-funded academic/industry technology-transfer network)[2]. A full list of establishments and visit reports can be found in Appendix C. The team members and their company profiles can be found in Appendix B.

The information gathered from this mission will be exploited in several ways:

- Comparisons will be made with the approach adopted within mainland Europe to introduce new technologies, specifically in the field of plastics and metals recovery, and more generally in recycling technologies. Examples of best practice will be translated for potential adoption within the UK context.

- Collaboration between the UK and other member states will be explored to develop improved de- and remanufacturing principles. Potential economic benefits from a better understanding of the European market are a key outcome of this mission, and any technologies developed or licensed as a result could contribute significant inward investment into the UK from global manufacturers looking to meet their producer liability responsibilities in Europe, thereby potentially increasing trade. Integration of a European 'holistic approach' and future targets/methods of achieving these targets are considered crucial to a UK solution.

- A better understanding of the current technologies will be communicated to the UK industry and legislature in this area, possibly allowing some 'leap-frogging' or at least cost-avoidance.

2 www.resource-efficiency.org

2 LEGISLATION

2.1 EU legislation

The EU enacted the WEEE directive (2002/96/EC) on 13 February 2003. Being a directive, rather than a regulation, each member state must introduce national legislation to meet the objectives set down in the directive. This allows each country to tailor legislation to its specific circumstances but can also lead to inconsistencies and differences in interpretation.

These differences in national legislation influence the whole supply chain as can be seen throughout this report. The influence of collection schemes on all the subsequent steps is particularly marked.

2.2 Outline of the WEEE directive

- **Objectives** – Prevention of waste, promotion of reuse and recycling, improved environmental performance of all organisations involved
- **Scope** – electrical and electronic equipment (see Exhibit 2.1)
- Product design – legislates against designs that preclude reuse or recovery
- **Separate collection** – free and accessible collection of WEEE from end users
- **Treatment** – sets storage standards and depollution requirements to prevent environmental contamination
- **Recovery** – sets minimum targets for recovery (Exhibit 2.1)

Category	Examples	Targets for recovery	Targets for recycling and reuse
1 Large household appliances	Washing machines, microwaves, air conditioners	>80%	>75%
2 Small household appliances	Vacuum cleaners, toasters, coffee machines	>70%	>50%
3 IT and telecoms equipment	PCs, printers, cellular phones	>75%	>65%
4 Consumer equipment	Radios, TVs, VCRs, DVD players	>75%	>65%
5 Lighting equipment	Fluorescent lamps, discharge lamps (not filament lamps)	>70%	>50%
6 Electrical and electronic tools	Saws, drills, sewing machines	>70%	>50%
7 Toys, leisure and sports equipment	Electric trains, video games	>70%	>50%
8 Medical equipment	Cardiology equipment, dialysis machines	Not defined	
9 Monitoring and control instruments	Smoke detectors, heating regulators	>70%	>50%
10 Automatic dispensers	Vending machines	>80%	>75%

Exhibit 2.1 WEEE recovery targets by category

2.3 Timings

- 13/2/03 – European directive enacted
- 13/8/04 – Directive to be transposed into national law
- 13/8/05 – Systems to be in place for the free segregated collection of domestic WEEE
- 31/12/05 – >4 kg of WEEE to be collected per person per year
- 31/12/08 – New target (to be defined) for collection to be met

2.4 National laws

The legislation, date enacted and registration requirements in each of the countries visited by the mission are summarised in Exhibit 2.2.

Country	Legislation	Date enacted	Registration requirements
Austria	Federal Law Gazette II No 121/2005	29/4/05	Companies with offices in Austria to register with Umwelt Bundesamt. No requirement for producers with no office in Austria to register (eg direct customer sales from outside EU)
Germany	ElektroG (Combined RoHS and WEEE)	23/2/05	All producers must register with EAR (Elektro-Altgeräte Register)
Spain	Royal decree 208/2005	25/2/05	All producers must register with the national register of industrial establishments (Spanish legal entity or representative required). Producers also need to register with regional bodies for each region in Spain
Sweden	Swedish Code of Statutes 2005:204	14/4/05	Only producers with offices in Sweden must register with the Swedish Environment Protection Agency
Netherlands	SAS\2004072357	19/7/04	No registration requirements, importers responsible for meeting obligations. Enforcement by the Ministry of Housing, Spatial Planning and Environment

Exhibit 2.2 WEEE legislation by country

3 COLLECTION, TRANSPORT AND COMPLIANCE SCHEMES

3.1 Sweden

The WEEE compliance scheme in Sweden is called El-Kretsen. Established in 2001 it was created in response to national producer responsibility legislation for end-of-life electronics, which was revised in 2005 in order to comply with the additional provisions introduced by the WEEE directive. Some of the changes included the introduction of new product groups, stricter requirements for collection, and the requirement for at least one collection facility to be provided in each municipality.

Owned by 21 electrical and electronic trade associations, El-Kretsen is a not-for-profit company with over 800 member companies that offers a nationwide WEEE recycling system for all categories of products affected by the WEEE directive. The service that El-Kretsen provides meets all legal producer responsibility obligations, and includes undertaking the arrangements with the local authorities for the collected WEEE to be taken to authorised recycling facilities, and the organisation of the financial and reporting aspects as defined by the directive. However, there are still questions about how to deal with products bought over the Internet or from a non-registered foreign producer.

The El-Kretsen compliance scheme may be divided into two parts:

- WEEE from municipal collection sites
- WEEE generated by organisations such as private companies, offices and hospitals

The municipal WEEE collection scheme, called 'Elretur', is conducted in collaboration with the Swedish municipal authorities and is underpinned by a contract for cooperation that remains valid until 2010, a move that supports future investment and development. The municipal authorities are responsible for the collection of WEEE from households within their respective municipalities, and El-Kretsen is responsible for the transportation of the collected electronic scrap from the municipal collection facilities to authorised recyclers.

There are approximately 650 collection facilities in Sweden where householders can drop off WEEE free of charge. Additionally there are several other collection schemes available to householders, such as the collection of WEEE together with large bulky household items, and the collection of fire detectors from households which is undertaken in collaboration with the business association for fire detectors.

The waste electronics are sorted into six categories at the collection facilities to include:

- Large white goods
- Fridges and freezers
- Small and medium sized WEEE
- Fluorescent tubes (straight tubes, 60 cm in length)
- Compact fluorescent tubes and other discharge lamps
- Light bulbs (incandescent)

The separation of WEEE was seen to be very important.

All the collection facilities are manned and their availability to the public is viewed as very good. Typically, the collection sites are open five days a week, with many municipalities offering weekend and late night opening. Malmö has one collection point on site for WEEE (Sysav) and 15 sites around Malmö. The Sysav site is closed on Fridays for collection into the main depot. Material is brought in from 14 local authorities – covering 620,000 inhabitants – with four collection depots for the outlying areas.

The convenience and accessibility of the collection sites combined with high-profile advertising campaigns in the media are thought to be responsible for the very high WEEE collection rates achieved. Sweden has the highest WEEE collection and treatment rates in the world with over 112,000 tonnes of WEEE collected by El-Kretsen in 2005, equating to 14 kg per person, with 20% increase in information technology (IT) material collected – 22,700 t – in 2005.

Business-to-business (B2B) WEEE is also handled by El-Kretsen and is organised either in collaboration with some of the municipalities or through third-party logistics companies. In 2005, El-Kretsen provided almost 300 collection facilities across Sweden enabling businesses and other organisations to drop off discarded equipment free of charge. By volume, one of the most important services has been direct return through so-called ‘returnee certificates’ at one of the recyclers under contract to El-Kretsen. The system involves the handing over of a certificate which the business uses as a guarantee that the number of units returned for recycling equals the number of new units purchased by the business user.

El-Kretsen employs 21 third-party transport companies to collect WEEE from the 950 or so collection facilities in Sweden. In 2005, 112,000 t of WEEE were transported to the 28 authorised recycling plants that operate in conjunction with the compliance scheme. The collection and transport scheme is operated on a nationwide level using large-capacity vehicles to ensure the efficient and cost-effective collection of WEEE. From the sites the waste is collected in roll-on/offs for ease of placement and movement. The transport is divided into five categories with each logistics company specialising in collecting specific WEEE categories in specific regions. Since some of the WEEE is viewed as hazardous, all the logistics companies must have obtained the correct permits in order to be employed by El-Kretsen. At the Sysav site it was noted that Kemi was used for the transport of hazardous waste; however, third-party transportation companies bore the Sysav logo on the truck.

Large white goods and refrigeration equipment are transported as loose cargo and loaded with cranes; small and medium sized WEEE are transported in netted pallet boxes with a capacity of 400 kg. Fluorescent tubes and light bulbs are transported using specialised boxes to prevent implosion and breakage. Cathode ray tube (CRT)-containing material is specifically collected in stillages. The boxes used for WEEE transport are circulated between the various collection and recycling facilities. The collected WEEE from the municipalities and B2B WEEE is then transported to one of the 28 recycling plants affiliated to El-Kretsen, including Sysav, for treatment.

All the transport and recycling service contracts are procured through competitive bidding.

El-Kretsen is financed through the fees its members pay. The fees are calculated from the volumes of new sales declared by the membership. As of 1 January 2006, the basic annual membership fee is 500 SEK (~£37) exclusive of VAT. In addition, each member pays a variable fee with the amount depending upon category of product and the amount of product sold.

At the end of each month a producer will complete a form notifying El-Kretsen of the previous month's sales. Based on this information, El-Kretsen generates an invoice for payment the following month. However, the Swedish IT industry has developed its own system for payment. Each month El-Kretsen calculates the actual costs of recycling information and communication technology (ICT) products. These costs are then divided among the producers in proportion to each producer's market share, defined as sales volume from the previous quarter expressed in tonnes.

Product type	Fee
Washing machines	45.00 SEK (~£3.33)
Microwaves	25.00 SEK (~£1.85)
Dishwashers	45.00 SEK (~£3.33)
Refrigerators, cabinet and chest freezers	300.00 SEK (~£22.22)
Vacuum cleaners	15.00 SEK (~£1.11)
Mobile phones	0.20 SEK (~£0.01)
TV sets – 32 inches and larger	180.00 SEK (~£13.33)
TV sets – 22-31 inches	120.00 SEK (~£8.88)
Cameras, video recorders, film	1.00 SEK (~£0.07)
Straight fluorescent tubes	1.90 SEK (~£0.14)
Electric hand tools	2.00 SEK (~£0.15)
Small electrical appliances under 100 g (not containing built-in batteries)	1.00 SEK (~£0.07)
Fire detector (optical)	12.50 SEK (~£0.93)
Fire detector (radioactive)	37.50 SEK (~£2.78)

Exhibit 3.1 Product types and fees in Sweden (El-Kretsen)[3]

Some product types and fees are given in Exhibit 3.1.

3.2 Spain

The Ministry of Environment transposed the WEEE directive on 25 February 2005. EEE producers (manufacturers, importers and distributors) may fulfil their obligations under the WEEE directive individually or via a compliance scheme. All producers are obliged to register with the National Register of Industrial Establishments with a concurrent obligation to register with the regional authorities where producers are established or have a legal entity present. There are no charges associated with the registration process. However, the various WEEE compliance schemes can undertake registration on behalf of member companies.

Spain is organised into 17 autonomies, each with its own environmental regulations. Under the Spanish WEEE take-back system, local authorities in the municipalities with a population greater than 5,000 inhabitants are responsible for collecting WEEE from households and storing it until collected by producers or compliance schemes. Additionally, consumers can return end-of-life equipment to retailers/distributors from whom they are purchasing an equivalent or replacement product, or where necessary WEEE can be collected directly from householders. Discarded products may also be brought to authorised collection points which are financed and managed by private waste-management companies.

There are currently very few collection points in Spain, with the exception of Catalonia (250 collection points) and the Basque Country (45 collection points). Whilst the current collection infrastructure is viewed as inadequate, to prevent delays in

3 www.tinyurl.com/enuvy

the implementation of the directive the actors involved in operating the take-back schemes agreed to proceed with WEEE collection and treatment. There are future plans for investment to develop and expand the existing network of collection points. Since 13 August 2005 the local government has not been paying for recycling – it is already producer responsibility. At the moment, recycling of brown/grey goods (not including fridges or lamps) achieves 1 kg per person per year.

There are nine newly established WEEE compliance schemes responsible for managing the systems for the collection, transport, storage and treatment of end-of-life electronics from the collection points and local authorities. The compliance schemes must be authorised by the regional authorities and will join the existing collection system for WEEE (collection points, retailers and large chain stores and household collections). Formed by trade associations or an alliance of trade bodies, the compliance schemes are largely sector specific, reflecting the ten product categories established under the directive. It is envisaged that over time a number of the schemes will merge. The collection schemes established under the directive must be authorised by the regional authorities and will join existing collection schemes.

Compliance schemes and product groups handled by them are listed in Exhibit 3.2.

Collection and treatment of household WEEE in the Basque Country

In 1994 Indumetal, in collaboration with the Basque Government, initiated a pilot scheme for the collection and recycling of WEEE household equipment, excluding large white-line goods. The scheme began in the city of Bilbao, with a population of 400,000, and resulted in the collection of 100 t of WEEE in the first year of operation. Based on this successful pilot programme the scheme was extended to the whole Basque country (2.1 million inhabitants) in 1997. During 2005 almost 2,100 t of WEEE were collected and recycled.

Other WEEE take-back schemes in Spain

Catalonia

With support from the Catalonian Government, refrigeration equipment has been recycled since 1995. Brown and grey-line appliances were added to the scheme in 2002. CRTs are collected in separate boxes from other WEEE. Electrorecycling SA, a subsidiary of Indumetal, offers logistics management for 250 collection points and industrial derived WEEE, working with nine logistics companies, operating eight intermediate warehouses for small quantities before consolidating into trucks with 28 boxes per truck. In 2005 there were 6,744 movements of boxes from collection points in Catalonia with 5,500 t collected.

Association	Product category	Compliance scheme
ANFEL	White line	ECOLEC
ANTIC	Consumer electronics	ECOTIC
ASIMELEC	Photocopiers and printers	ECOFIMATICA
ASIMELEC	Mobile phones	TRAGAMOVIL
ASIMELEC	Categories 5-10	ECOASIMELEC
ANFALUM	Lighting equipment	ECOLUM
ANFALUM	Lamps	AMBILAMP
	Categories 2-4	ERP
	Category 3	ECORAEEs

Exhibit 3.2 *Compliance schemes in Spain*

Andalucía

With a population of 8 million, some provinces in the region have had a grey and brown WEEE recycling scheme operated by Recilec.

3.3 Netherlands

There are two WEEE compliance schemes that have been established by EEE producers and importers that operate in the Netherlands. These are NVMP (Dutch Foundation for the Disposal of Metal and Electrical Products) and ICT Milieu. The latter is responsible for collecting ICT equipment only, which in 2005 totalled 16,500 t, whilst NVMP collects other white and brown electrical goods (OWEB). Both schemes are financed based on market-share calculations.

NVMP was established in 1998 in response to national legislation that has subsequently been repealed with the advent of the WEEE directive; the compliance scheme comprises six different trade bodies:

- VLEHAN – white goods manufacturers
- FIAR – brown goods
- VLA – ventilation industry
- SVEG – electrical tools manufacturers
- Strichting Lightrec – lighting industry
- SMR – metal and electrical equipment

The take-back scheme operated is via a levy on WEEE generated. The fees charged are per appliance although many smaller appliances no longer carry a charge, such as power tools and many small kitchen appliances. Typical costs (exclusive of VAT) are shown in Exhibit 3.3.

ICT Milieu only processes IT, telecoms and office equipment. The approach differs from that used by NVMP in that no visible fee is used and producers only pay for the actual costs of recycling, with recycling companies calculating the cost of recycling based on

Appliance type	Fee (excluding VAT)
Espresso machine	€0.84 (~£0.57)
Washing machine	€4.20 (~£2.86)
Refrigerator	€14.29 (~£9.72)
Plasma TV	€6.72 (~£4.57)
TV	€6.72 (~£4.57)
DVD recorder	€2.52 (~£1.71)

Exhibit 3.3 *Typical take-back fees in the Netherlands*

evaluation of the incoming material. Producers submit market-share data based on total weight of product with a product category including the costs for orphan and free-rider products.

Consumers have two options to discard scrap electronics free of charge:

- Via retail stores when purchasing an equivalent product, a system that also applies to household electronics for which no waste disposal fee is paid
- Via municipal collection facilities

There are approaching 600 municipal collection points in the Netherlands. These sites also accept WEEE originating from retailers and companies that generate WEEE that is similar in nature to WEEE that originates from households. There are a further 70 regional centres that collect and separate WEEE. The regional centres also accept WEEE dropped off by retailers although this service may incur a charge and usually applies to retailers that do not operate a distribution centre. Additionally, between 3 and 4% of WEEE is collected from retailers' distribution centres, with a further 10% collected from small to medium sized retail stores. Third-party logistics companies collect the WEEE, transporting it to authorised recycling companies that must be able to demonstrate that they can achieve the recycling and recovery targets laid down by the directive.

3.4 Austria

Under the Austrian 'Electro Ordinance' which transposes the WEEE directive into Austrian law, compliance schemes must conduct the following:

- Take back all products in one or more of the following five collection and treatment categories (product categories defined due to handling and requirements during collection and processing):

  – Large appliances
  – Refrigeration equipment
  – CRT-containing devices
  – Small electrical appliances
  – Gas discharge lamps

- Offer a take-back centre in each of the 100 or so districts

- Reporting and statistics

- Represent at least 5% of electrical and electronic products by weight of the category covered

Producers must participate in a collection scheme for historical waste (sold in advance of 13 August 2005).

Consumers are able to return WEEE free of charge via municipal collection centres, take-back points or collections. Producers must finance the collection of WEEE from the collection sites onwards to the recycling facilities. Local authorities have the ability to invoice the 'Clearing House' established under the Ordinance to pay for costs of setting up their WEEE collection infrastructure, a cost which is then passed on to producers. The Clearing House distributes an annual lump sum to the municipalities for these WEEE infrastructure costs.

4 SORTING AND SEPARATION

Sorting and separating can occur at various points in the take-back system including at the collection point, at sortation centres and at the treatment plant prior to shredding.

The collection system in Sweden from civic amentity sites separated WEEE into large white goods, fridges and freezers, small/medium goods, and luminaires (three further separated groups), whilst in Germany it was separated into five groups.

However, it is clear from the site visits to WEEE recyclers in Sweden, Germany and Spain that there was little further sorting of the input streams before processing. The infeed materials contained a range of hazardous equipment such as monitors containing CRTs, coffee machines and toasters (containing asbestos), and non-hazardous equipment like vacuum cleaners, fans, microwaves, stereos and kettles.

In the Netherlands, WEEE is collected at municipal collection points in sea containers and sent to one of 20 sorting centres. At the sorting centres, material is manually sorted to remove coffee machines (asbestos), toasters (asbestos), batteries, polychlorinated biphenyl (PCB)-containing capacitors, ink cartridges, smoke detectors (potentially radioactive), wood (potentially dusty) and non-WEEE. Material not to be further treated on site is sorted into categories:

- Large white goods
- Small WEEE including small white goods such as microwaves
- CRTs
- Lamps

IT equipment is collected and treated separately by ICT Milieu.

Municipal collection points in Spain collect fridges and large domestic appliances separately. The rest of the WEEE is collected in one container which is sent directly for treatment. When the container is received at the treatment plant, the WEEE is sorted into different categories (consumer electronics, photocopiers and printers, mobile phones, lighting and lamps) and weighed. Each of the Producer Compliance Schemes is informed of the weight of WEEE collected in its category. Hazardous components are also removed including batteries, micro switches, capacitors and CRTs.

All sites weighed incoming WEEE, and at least one also checked for radioactivity in the load. It was noted that sometimes the WEEE was stored at the treatment plant internally and sometimes externally. Those who stored externally had some method of collecting rainwater such that it did not enter the local watercourse.

In Sweden a manual sorting process at the treatment plant included the separation of mobile phones and liquid crystal displays (LCDs). In Germany the manual sorting process only removed products with a CRT. The level of manual sorting at each site is dependent upon the capability of the treatment plant. Several of the plants used an initial crusher to ‘open up’ bulky products before further manual sorting, thereby allowing access to batteries etc.

In general the whole sorting and separation process was carried out manually with very little automation. For example, at Sysav a suction device was used to lift CRT screens.

It should also be noted that this initial manual sorting and separating was noisy, dusty and potentially hazardous due to the weight of the WEEE, sharp edges, broken glass, conveyors and movement of the WEEE on the conveyors. The requirement to wear protective clothing such as steel-capped boots, thick gloves, safety goggles and possibly ear protectors was not always enforced.

5 DEPOLLUTION AND TREATMENT

5.1 Depollution

Annex II of the WEEE directive lists a number of materials and components that must be removed from collected WEEE (see Exhibit 5.1) in order to prevent damage to the environment or exposure of operators. Two general approaches were in evidence: manual disassembly, and automated 'opening' followed by manual picking of the hazardous components. Some appliances such as CRTs and heating equipment likely to contain asbestos were always manually treated, often as a separate stream to other collected WEEE.

As a minimum the following substances, preparations and components have to be removed from any separately collected WEEE:

- Polychlorinated biphenyl (PCB)-containing capacitors in accordance with Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCBs/PCTs)
- Mercury-containing components, such as switches or backlighting lamps
- Batteries
- Printed circuit boards of mobile phones generally, and of other devices if the surface of the printed circuit board is greater than 10 cm^2
- Toner cartridges, liquid and pasty, as well as colour toner
- Plastic-containing brominated flame retardants
- Asbestos waste and components which contain asbestos
- Cathode ray tubes (CRTs)
- Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs), hydrocarbons (HC)
- Gas discharge lamps
- Liquid crystal displays (LCDs) (together with their casing where appropriate) of a surface greater than 100 cm^2 and all those back-lighted with gas discharge lamps
- External electric cables
- Components containing refractory ceramic fibres as described in Commission Directive 97/69/EC of 5 December 1997 adapting to technical progress Council Directive 67/548/EEC relating to the classification, packaging and labelling of dangerous substances
- Components containing radioactive substances with the exception of components that are below the exemption thresholds set in Article 3 of and Annex I to Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation
- Electrolyte capacitors containing substances of concern (height >25 mm, diameter >25 mm or proportionately similar volume)

These substances, preparations and components shall be disposed of or recovered in compliance with Article 4 of Council Directive 75/442/EEC

The following components of WEEE that is separately collected have to be treated as indicated:

- CRTs: the fluorescent coating has to be removed
- Equipment containing gases that are ozone depleting or have a global warming potential (GWP) above 15, such as those contained in foams and refrigeration circuits: the gases must be properly extracted and properly treated. Ozone-depleting gases must be treated in accordance with Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer
- Gas discharge lamps: the mercury shall be removed

Exhibit 5.1 *Excerpt from Annex II of the WEEE directive*

Manual disassembly was seen at Sysav's Bjurögatan plant. This can handle a throughput of some 50 t/h, and virtually all forms of WEEE were in evidence, from laptops to microwave ovens. The disassembly is very much as had been seen in Japan with the glaring difference being the mixture of items – the technicians would one minute be dealing with a PC and the next a vacuum cleaner.

Exhibit 5.2 *Mixed WEEE arriving at Sysav*

Exhibit 5.5 *Sysav depollution line*

The alternative approach of automated 'opening' followed by manual picking was observed at Recydur in the Netherlands.

Recydur specialises in processing small domestic appliances (SDAs). The facility has a treatment capacity of 40,000-45,000 t/y of SDAs.

Exhibit 5.3 *Depollution at Sysav*

Exhibit 5.6 *WEEE arriving at Recydur*

Exhibit 5.4 *Cabinet for removal of hazardous dust*

Exhibit 5.7 *WEEE storage at Recydur*

Exhibit 5.8 *WEEE fed to 'opening' shredder*

Exhibit 5.9 *Manual picking of 'opened' WEEE*

The choice of approach to depollution is influenced by capacity but also by the preceding collection and transportation steps. Lack of segregation and handling by front loader and bulk containers can preclude any significant manual disassembly. It was apparent that the level of segregation of different materials and how completely hazardous materials were removed was completely dependent on the operators. A number of instances of poor segregation were observed, eg LCDs placed with mixed plastics, TV electron guns with mixed waste.

The level of depollution also varied but was probably never complete, as evidenced by the capacitors and batteries seen in the downstream treatment processes.

Training of operators was seen as key to the effectiveness of depollution and segregation.

5.2 Treatment

After depollution, the treatment process to purify and segregate the waste into saleable streams was similar in all the facilities visited (see the Eldan visit report – Appendix C.6 – for an outline of a typical process). While the unit operations in each facility were essentially the same, the layout and operation of the plants varied. These variations were evident both in the throughput achieved and the quality of the material streams produced.

An excellent example of layout and operation was seen at Remondis where very good separation was achieved in a single pass through the plant. Another significant feature was that products were only discharged at floor level once they had been upgraded to saleable products. Older facilities or those with poorer design seen elsewhere were characterised by material needing to be reprocessed through the plant and having to be handled and loaded a number of times.

Exhibit 5.10 *Evolving facilities can lead to poor layout and more handling*

6 MARKETS FOR RECYCLATES AND FUTURE TRENDS

6.1 Introduction

Markets for recyclates presuppose the concept that they have economic worth, rather than cost, to the owner. For example, hazardous materials clearly may incur a cost associated with their safe disposal, and WEEE is creating a waste stream that comprises a diverse array of materials of widely varying value and toxicity. The option to landfill these wastes has effectively closed in the EU, but the technologies to process wastes into useful materials and markets to utilise the outputs are only just forming.

The technologies described within this report are typically associated with refining or transforming the waste stream to concentrate the fractions of value. The three principal streams emerging from WEEE waste are metals, polymers and energy, or rather the useable energy content of the waste stream. A mineral stream, comprising glass and other matter also exists, but it is not clear if currently there are any real markets for these materials.

Exhibit 6.1 illustrates the markets served by the recycling facilities visited by the mission team. The high value of the metal contained within the waste stream makes it the most valuable commodity. The intrinsic energy of combustion within the organic components is also highly attractive, and may be utilised within the processing cycle. Recycling of WEEE polymers is not served by most facilities, with only a few facilities such as MBA processing this type of waste.

Facility	Metal	Polymer	Energy
Kuusakoski Recycling	✓		✓
Sysav	✓		✓
RVF	✓		✓
Recydur BV	✓		✓
Remondis Electrorecycling GmbH	✓	✓ Planned	✓
Müller-Guttenbrunn/ MBA Polymers Austria		✓	

Exhibit 6.1 Markets served by recycling facilities

6.2 Metals

These are the highest value components within the waste stream and find ready markets within the refining industry, with value and use dependent upon purity. The readiness of the market is clearly a driver for the development of processes to maximise the value of this stream.

It was notable that the value of the waste stream was sufficient to support a degree of hand sorting to remove sources of toxic material such as batteries, which may contain cadmium. If a waste stream can be concentrated sufficiently, then even these toxic materials may be used as feedstock in the refining industry, and so gain in intrinsic value.

It is fair to say that there are no challenges in finding markets for metal-rich waste streams as long as they are reasonably pure in content and homogenous in particle size. This was emphasised during a

Exhibit 6.2 Metals stream

presentation made by Hamos GmbH, a manufacturer of sorting and grading equipment for the recycling industry, which is justifiably proud of how its equipment meets these goals. Hamos also raised the question of what to do with the rest when the metals have gone (Exhibit 6.2).

6.3 Polymers

The remaining fraction of the purified WEEE stream contains a complex mix of polymers, some of which may also contain halides (as fire retardants) and so be subject to additional restrictions on their safe disposal.

Two strategies are available to add value to this waste stream, and so find commercially viable and sustainable markets. The first is to purify the stream in much the same way as with metals. The lower value and higher bulk requires more automation and a much larger territory to collect and process sufficient material on which to base a viable business. This is seen in both Recydur BV and Müller-Guttenbrunn/MBA Polymers Austria that have huge catchment areas to support their business. The scale of MBA is impressive, as is the quality control associated with its process which produces polymer pellets as feedstock to the injection moulding industry. It was not entirely clear what the European market for the pellets was, and the relatively low value (and high bulk) of the product supported a stock holding that would have been unacceptable for most businesses. Consistency of material properties is a major challenge to gain acceptability of polymers manufactured from recycled feedstock.

For example, BSH Bosch und Siemens Hausgeräte stated that there have been problems with the use of recycled plastics in the production of worktops for washing machines. The lack of consistency of the materials has been a problem and the use of these materials was withdrawn in early 2006. BSH considers recycled plastics as too difficult to use in visible components such as control panels, since the colour varies too much.

Exhibit 6.3 Plastics recycling loop (MBA Polymers Austria)

Given these comments, the MBA Polymers Austria plastics recycling loop (Exhibit 6.3) must be seen as an ideal goal rather than a representation of current practice. These observations put into context the huge effort and emphasis MBA places on its quality system, and why it stresses the consistency of its product, as it is clearly key to opening the market.

The challenge in providing product consistency helps in understanding the attractiveness of the second strategy for polymer recycling, which is to utilise the energy content. Kuusakoski Recycling, Sysav, RVF, Recydur BV and Remondis Electrorecycling GmbH all have capacity to incinerate waste and utilise the heat in some form. However effective this use is, it is hardly a viable market to service for most waste streams, since the heat is really only available at the point of incineration.

A more attractive option is to transform the polymer stream into a high-value energy-rich fuel that can be used in a wide variety of standard processes. As no commercial demonstrations of such techniques were seen by the mission team, they are described here under future trends.

6.4 Future trends: advanced polymer processing

6.4.1 CreaSolv process

The process has been developed in cooperation by the Fraunhofer Institute for Process Engineering and Packaging (Fraunhofer-Institut für Verfahrenstechnik und Verpackung – IVV), Freising and CreaCycle GmbH, Grevenbroich, Germany.

It is based on selective extraction of a targeted polymer from plastic waste, followed by a cleaning step. Impurities, undesired additives (eg flame retardants) and toxic degradation products can be separated effectively to obtain a high-purity polymer.

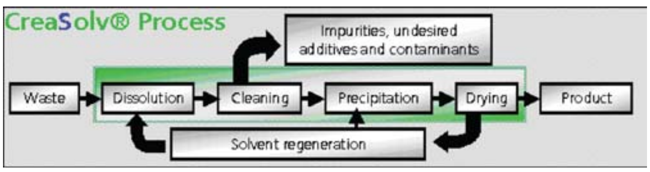

Exhibit 6.4 CreaSolv process

This process can utilise polymers that contain bromine flame retardants (BFRs). This is particularly important given the difficulty of separating out such materials. A particular challenge is that, under thermal stress, BFRs can break down to produce dioxins. Although in Europe there is much control over the use of retardants, and modern materials are much less likely to break down into dioxins, there is a problem with legacy products and products imported from elsewhere in the world.

Mechanical processing can also increase the dioxin content in the material. As the particle size reduces, the dioxin level increases. Smaller particle sizes are desirable in shredders to improve the metal recovery process. Put bluntly, improving metal recovery increases the problems for effective polymer recovery – the more impacts the polymer sees, the more chance there is of producing dioxins.

The tar residue from this process is rich in bromine. If this level is >10% then it can be used as a feedstock into the bromine industry. This is a particularly good example of how refining and purification of a waste stream adds to the value, and how almost any substance can have value, even toxic substances.

Although the mission did not visit Forschungszentrum Karlsruhe (FZK), it is worth noting its low-temperature fast-pyrolysis process (Haloclean) that can convert WEEE into three valuable fractions: almost debrominated pyrolysis oil; a residue containing noble metals in a concentrated form; and gaseous bromine. This is arguably the closest process to commercialisation, with a 3,000 t/y plant being built in Italy by Sea Marconi.[4]

6.4.2 CDP – conversion of polymers into diesel fuel

The mission team saw evidence of a process that can convert polymers into diesel fuel at Hamos, agents for the

4 www.achema.de/data/achema_/congress/1791.pdf#search=%22haloclean%20hornung%22

process. The fuel was said to be suitable for use for either the automotive market or for feedstock in the oil refining supply chain.

Presumably such fuel would compare with biodiesel and be suitable for low-compression engines, such as found in agricultural vehicles and heavy goods vehicles (HGVs), rather than the performance engines in many consumers' personal vehicles.

Like the CreaSolv process, the catalytic depolymerisation process (CDP) is said to be able to take a wide range of polymer or other organic inputs and transform them into a diesel fuel. The process was described as closed loop, and energy efficient as it could be powered from the fuel it generated!

Exhibit 6.5 *CDP plant (Hamos)*

Exhibit 6.5 shows the core reactor for the process in a large-scale pilot plant. Although not clear from this illustration, a key part of the process is the use of mechanical friction to heat the material to be processed. This technique is said to give very accurate control of the temperature in the process, and prevent overheating which would lead to the production of dioxins. One can speculate that wear on the components used in the friction heating process will be the limiting factor in the reliability of this process.

Little other information is available about this process and research in this area.

6.4.3 Concluding remarks

It is clear from the nascent technologies described that research is under way on how to add value contained within the low-value components of WEEE-sourced waste streams. Although the two technologies described here are in the early stages of development, they illustrate that much is possible, given sufficient research.

We recommend that research be targeted into the development of technologies that purify and/or transform the low-intrinsic-value components in the WEEE waste stream into useful commodities.

There is little doubt that companies that eventually supply the equipment and processes are likely to enjoy a boom as EU member states implement strategies to collect and collate products that have reached the end of their useful life.

7 RECOMMENDATIONS AND CONCLUSIONS

- Recovery of the plastics fraction will be essential to meet the recovery targets of the WEEE directive – further effort is required in this area to develop separation and treatment technologies and stimulate markets for recovered materials
- Collection and handling facilities should enable and encourage reuse, eg segregated collection and transport in small containers
- Environment, health and safety standards were varied – highlighting the need for training of operators and senior staff through the supply chain
- Brominated flame retardants (BFRs) are a particular problem and further work is required to develop systems for detection and removal/separation
- Developing solutions for anticipated problems, eg the increase in LCDs, could provide opportunities as they are included in future amendments to the directive
- The issue of when 'waste' ceases to be 'waste' is critical for the transborder recycling market – community-wide definitions need to be developed
- Segregation of different categories of WEEE and hazardous/non-hazardous equipment early in the supply chain pays dividends in the later processes

In conclusion, while the mission saw many examples of best practice, a single unified solution adopted by any one country would have shortcomings if adopted without modification into the UK. Clear areas to concentrate on are primary segregation of material at source and any solution that looks at the identification, separation and recovery of the plastics fraction. Advanced solutions for the future would be to work with manufacturers to design for disassembly and reuse components to reduce manual depollution and sorting, eliminating the potentially most hazardous part of the supply chain. Finally, European-wide legal definitions for when 'waste is not a waste' are vital to stimulate the recovered material market.

Appendix A

ACKNOWLEDGMENTS

The mission team would like to thank all the individuals and organisations that made this mission possible:

- The Resource Efficiency Knowledge Transfer Network which acted as the principal coordinating body
- DTI Global Watch Service
- Andy Compton, technology analyst, Pera
- The DTI International Technology Promoter (ITP) network, particularly the ITP for Europe on environmental, energy and chemical technologies, Nicki Smoker
- All the individuals and companies who were extremely helpful in making time for us and answering our questions
- All the local embassy and consular staff who helped in arranging visits, particularly Sofia Norberg from the British Embassy in Stockholm and Evelin Walzer from the British Embassy in Vienna

Appendix B

MISSION TEAM AND ITP

Exhibit B.1 *Mission team at BSH, L to R: Paul Palmer, Tom Perret, Arnold Black, Peter Murphy, Darren Kell, Richard Hooper, Kate Geraghty, Philip Lober, Stuart Randall, Jan Bellenberg (BSH)*

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Arnold is a project manager with 20 years' experience in the heavy industrial sectors of mining, chemical and waste treatment industries with multinational manufacturing and UK contracting companies. He has worked overseas on world-scale industrial plants and with UK manufacturing sites with hazardous chemicals and effluent treatment. Arnold was formerly Deputy Director and Technology Translator of the Mini-Waste Faraday Partnership and is now Operations Director of the Resource Efficiency Knowledge Transfer Network with extensive experience of technology auditing and knowledge transfer from academia into industry.

The Resource Efficiency Knowledge Transfer Network is a government-funded project to promote resource efficiency and waste minimisation through UK industry. It seeks to bring academic research into the industrial base to provide meaningful diversion of waste from landfill, at the same time promoting innovative technologies to save companies money.

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Paul is a Senior Research Fellow at Loughborough University and Technical Manager within the Electronics-Enabled Products Knowledge Transfer Network. He has interests in electronic design, manufacture, technology road mapping and associated tools and methodologies.

His industrial career has included engineering posts within a range of small and large organisations. He ran a technical consultancy, ITB, for four years specialising in web-related applications, including early examples of tools to support sustainable design practices, before joining the Prime Faraday Partnership (now the Electronics-Enabled Products Knowledge Transfer Network) in 1998. Prior to that he was Engineering Manager for Hawker Fusegear 1990-1994. He also spent three years forging links between industry and academia as a Senior Teaching Company Associate with the University of Salford.

He graduated from the University of London in 1977, and gained an MSc from Cranfield Institute of Technology in 1985.

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Tom has worked it the electronics industry since graduating with a degree in chemistry. He has spent most of his working life in various commercial roles supplying joining materials and test equipment to the European electronics assembly industry. He now works in a business development role at Tin Technology and has been active in rolling out their RoHS screening programme. He is also Vice Chairman of the UK SMART Group Technical Committee.

Tin Technology is the world's foremost authority on tin with access to more than 60 years' experience through its association with ITRI Ltd (formerly the International Tin Research Institute). In recent years the laboratory has expanded its customer base to offer its services and expertise to a wider range of non-tin related industries. The St Albans based laboratory offers a comprehensive range of analytical techniques providing solutions to diverse issues and problems.

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Peter has 30 years' experience in manufacturing. He joined the firm aged 19 and worked on the shop floor learning the trade which was a mixture of material component supply for the cutlery, agriculture and horticulture trades. Peter went on to set up a division of the company which made and sold a range of handmade knives and he was invited to some of the premier shows in the UK to exhibit and sell.

After trying to dispose of some personal mobile phones in an environmentally friendly way the idea of mobile phone recycling was conceived. Peter undertook research assisted by Environmental Business Network (Sheffield University) and found that the WEEE directive offered an excellent business opportunity and a chance to help the environment. Active Recycling was formed in July 2000 with the express intention of being a recycling company that could completely recycle a mobile phone with zero landfill.

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Stuart is a technical engineer with 27 years' experience in the industrial sectors of gas distribution, electrical and electronic equipment repair, refurbishment, recovery and recycling. He started his career aged 16 as an apprentice with British Gas, rising to Senior Technician for nonroutine operations. He changed direction in 1994 into R&D management and has designed and developed refrigeration-recycling processes and developed a novel closed loop WEEE regulation plant. He acts as CEO for the WEEE Recycling Network.

Stuart is currently the Technical Director and Chairman of DARP Group, an international consultancy specialising in recycling technologies, and has extensive contacts in the UK, Japan and Germany in the recycling and waste management sectors.

DARP is in a unique position of being able to offer market research, technology intelligence and expertise. Its primary market is global businesses developing and adapting their environmental and recycling strategies in the wake of legislation such as WEEE. DARP provides consultancy in all aspects of WEEE from interpreting legislation, material output analysis, technology process design, feasibility studies, business applications and specialised research.

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Richard is a Materials Technologist for the Recycling Solutions division of Sims Group UK Ltd, based in Long Marston near Stratford upon Avon, Warwickshire. He is also responsible for most of the R&D activities within the company. A chemist by training with a PhD in polymer synthesis and characterisation, he is also a Chartered Chemist.

Prior to joining Sims in 2002, Richard worked at the University of Brighton in a research team dedicated to waste minimisation and recycling, specifically plastics recycling. This work covered diverse topics including domestic waste plastics, WEEE plastics as well as plastics from shredder waste.

Richard's duties include implementation of mechanical separation processes for all nonmetallic materials present in goods processed by Sims Group UK Ltd. He has helped develop a mechanical plastics recycling line, a CRT glass cullet separator, and more recently a mechanism for recovering plastics from shredder waste. Richard is also working on mechanical solutions to separation and further recovery of materials from processing WEEE goods.

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Darren has 10 years' experience in the chemical and process industries, initially working as a research chemist before moving into process engineering and project management. Having worked in a range of sectors from precious metals to pharmaceuticals, he recently joined C-Tech Innovation as project manager.

C-Tech Innovation is an independent R&D company with expertise in novel heating processes, electrochemistry, waste treatment and recovery and biotechnology. C-Tech also hosts two of the newly formed Knowledge Transfer Networks in resource efficiency and bioscience.

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Kate has recently been appointed as Technical Manager for NISP (National Industrial Symbiosis Programme) in the West Midlands with responsibilities including providing support to the electronics industry in the region.

Before assuming her current role she was employed as Environmental Projects Manager by Rohm and Haas Electronic Materials, where she gained valuable experience in WEEE recycling and the development of sustainable technologies for materials recovery and reuse. Kate has also worked as an Environmental Specialist for Intellect. She has gained a BSc. Environmental Science from the University of Aberdeen and an MSc with distinction in Environmental Monitoring and Assessment from Coventry University.

NISP focuses on the sharing of information and supporting collaboration to identify cross-cutting, cross-sectoral solutions to improve resource efficiency. Based on the principle of industrial symbiosis, it requires companies (and other organisations) to look beyond their organisational boundaries, which are inherently limiting, and embrace the opportunities that working with others can offer. NISP's approach is not limited to any particular resource and can encompass materials (wastes and by-products), energy, water expertise, logistics, capacity etc.

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Philip has been Business Development Manager at Engelhard in Cinderford since April 2005. He gained experience in recycling at Sims UK as an Operations Administrator. He has worked as a Business Analyst for a world-leading minerals supplier and also has worked for other companies as a Marketing Analyst and Data Analyst. He holds a masters degree with honours in Engineering Manufacture and Management from University of Manchester Institute of Science and Technology (UMIST).

Engelhard Corporation is a surface and materials science company that develops technologies to improve customers' products and processes. A Fortune 500 company, Engelhard is a world-leading provider of technologies for environmental, process, appearance and performance applications. At its plant in Cinderford, Gloucestershire, Engelhard offers a unique combination of innovative recycling processes. The first electronic scrap refinery in the world was opened on this site in 1982 and has since grown to become a fully licensed world-class waste management and recycling company.

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Nicki is the ITP for Europe covering environmental, sustainable energy, chemical and process technologies.

DTI Global Watch Service's network of 23 ITPs provides support to UK firms ranging from information and referrals to more in-depth assistance with licensing arrangements. ITPs facilitate inward technology transfer to the UK from the leading R&D investor countries of the world, assisting UK companies to:

- Identify overseas technology partners
- Develop or transfer technologies, products, processes or management practices
- Gain entry to new industrial and geographical markets

With wide-ranging technological, linguistic and commercial expertise, the ITPs are well-placed to help navigate the often complex and time-consuming business of international technology transfer.

Appendix C

VISIT REPORTS

C.1 Kuusakoski AB
C.2 Boliden Mineral AB
C.3 MiMeR
C.4 Sysav
C.5 RVF
C.6 Eldan Recycling A/S
C.7 Gaiker Centro Tecnológico
C.8 Indumetal Recycling SA
C.9 Recydur BV
C.10 Remondis Electrorecycling GmbH
C.11 Fraunhofer IVV
C.12 BSH Bosch und Siemens Hausgeräte GmbH
C.13 Hamos GmbH
C.14 MBA Polymers Austria
C.15 KERP GmbH

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Kuusakoski is an international metal recovery corporation. The parent company is Finnish with subsidiaries in 10 other countries, mainly in Scandinavia but also in China and India.

Kuusakoski, Sweden, is a traditional metal recycling company based just across the river (connected by a dedicated bridge) from the Boliden Rönnskär Smelter, located within the Skelleftehamn harbour complex.

It receives materials from northern Sweden via the El-Kretsen waste collection system and is paid a treatment charge per tonne. It also receives a limited quantity of end-of-life (EOL) vehicles. With excellent road, rail and sea links it is the major recycling centre in North Sweden and exports the recovered materials, mainly metals, all over the world including substantial quantities by sea to the Far East.

The recycling technologies are similar to those seen throughout the rest of Europe. The material is received into a covered reception area and depolluted by hand. This is to reduce the noise and provide environmental protection but more importantly it allows work to continue in the winter months. A ring shredder is then used to coarsely break the material. Hand sorting removes the higher value components; the larger metal fractions are separated using magnets. Both fractions are then shredded using hammer shredders and the finer metal fraction separated again using magnets and eddy-current separators. The nonferrous fraction is then fed to the Rönnskär smelter to recover copper. Some of the plastic fraction and fines are also fed to the Rönnskär smelter to contribute to energy savings. Prices are paid to Kuusakoski by Boliden, based on the metal assay.

Both the treatment facility and the outlet for the recovered materials have considerable excess capacity. Clearly the very close proximity of its key customer, Boliden, and a guaranteed supply chain make the operation profitable. It clearly also has good relationships with Boliden, which works closely with Kuusakoski to assess and recover the high-value materials.

The residuals and toxic components are either incinerated or landfilled. Incineration is the favoured route, because good ‘clean air’ legislation and energy recovery from district heating mean there is little opposition to this solution in Sweden.

C.2 Boliden Mineral AB

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Manager, Business Development

Hans Henriksson
VP, Secondary Raw Materials

Oskar Stavren
Manager, Secondary Raw Materials

Boliden is one of the largest European mining and smelter conglomerates; Rönnskär is their largest copper smelter, served by concentrates from mines in the far north of Sweden. Boliden is thus interested in recovering secondary materials from 'clean' scrap fractions, particularly those such as copper with high precious metal (PM) content, as it has the facility to recovery this stream.

The main features of Boliden's recycling are:

- Rönnskär Cu-Pb-Zn-PM smelter and refinery
- Harjavalta Cu-Ni-Co-PM smelter and refinery
- Kokkola Zn smelter
- Odda Zn smelter
- Bergsöe Pb smelter and refinery
- Boliden ore concentrator

Boliden's recovery operation is a complete and flexible system involving all the smelters working together. The integration strengthens old recycling paths and offers opportunities for new ones. The following for niche materials are due to their specialised processes and knowledge:

- Fuming process for recovery of Zn from slags and electric arc furnace (EAF) dust
- Electric furnace for smelting of inert secondary raw materials
- Kaldo process for treatment of electronic scrap
- Nickel flash smelter and electric furnace for residues
- Shaft furnace for recovery of waste lead batteries
- Zinc purification plant adapted for extraction of zinc from recycled oxides and copper-containing feed

This can be translated into the large variety of raw materials that are accepted as feed. It also translates into a variety of products with the same high purity, independent of the source of feed, thus adding value.

Rönnskär is claimed to be a world-class smelter, focusing on sustainable production. It maintains very high standards towards environmental requirements and resource efficiency while treating and refining metals from concentrates and various recycled materials.

The majority of raw materials processed at Boliden's smelters are mineral concentrates from mines. However, a significant proportion of metal production also comes from recycling secondary materials.

From these materials, it recovers everything from copper, zinc and lead to gold, silver, platinum, palladium, nickel, selenium and cobalt. The recovery of metals has played a significant role in Boliden's supply of raw materials since the 1930s, and the amount of recovered metal is steadily increasing.

Constant process development and use of the latest purification technology have put Boliden ahead when it comes to adapting smelters and creating the flexibility to accommodate the recyclables on the market. Its large scale, efficient processes mean it can recover a range of valuable metals from many different types of secondary raw material. The high level of purification in the processes also makes Boliden's recycling extremely competitive from an environmental perspective. With the metals, the level of recovery is almost 100%, while all the plastics are used as a reducing agent and fuel in the smelting process.

Boliden's recycling capacity as proportion of total metal production:

- Circuit boards – 50,000 t
- Metal shred/bullion – 40,000 t
- Components/metal alloy – 20,000 t
- Slag/slime/EAF dust – 150,000 t

The Rönnskär smelter operates under a permit from the Swedish authorities. This permit allows for a variety of primary and secondary raw materials and wastes to be treated for the recycling and recovery of metals. As a consequence, Rönnskär has installed and adapted gas-cleaning devices to keep emissions of dioxins well below European emission limits (<0.1 ng/m^3 tetrachlorodibenzodioxin – TCDD). Due to metal values in the dusts from these gas-cleaning units, they are attractive for internal recycling, and landfilling is minimal. Regarding flame retardants, measurements reveal that the destruction of BFRs is complete (>99.99999%) in the Kaldo process.

Dust fallout concentrations at the property boundaries with the local community are below detection limit. For example, blood concentrations of workers engaged in the handling, sampling and recovery of electronic scrap are at levels comparable to hospital cleaners and IT technicians.

With fewer than 500 employees Boliden produces nearly 300,000 t/y of metal. Production levels are:

- Copper – 230,000 t
- Lead – 30,000 t
- Zinc clinker – 40,000 t
- Silver – 475 t
- Gold – 15 t
- Sulphuric acid – 600,000 t
- Liquid SO_2 – 50,000 t

The keys to Boliden's WEEE recovery processes are a strategic relationship with Kuusakoski Recycling, which it supplies with high-quality recycled material, and its Kaldo process and the PM plant for recovery.

Kaldo Plant

The Kaldo furnace is used for lead smelting and treating electronic scrap. Lead is extracted in two stages, and lead concentrates are smelted autogenously in the Kaldo furnace. The bullion is transferred to the lead refinery to produce high-purity lead that is cast into 42 kg ingots. Electronic scrap is melted into black copper. The melt is transferred to the converter aisle.

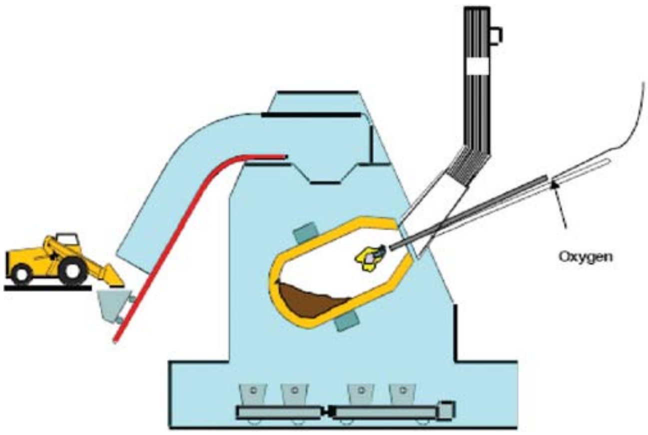

Exhibit C.1 Boliden's Kaldo process

PM Plant

Anode slimes containing gold, silver, palladium and platinum together with impurities are pressure leached. From the solvent, copper telluride and nickel sulphate are recovered. The leach residues are dried and after the addition of fluxes smelted in the PM Kaldo furnace. During smelting, selenium is recovered. The converted silver is cast into silver anodes. A high-intensity electrolytic refining produces high-purity silver and gold slimes. The gold slimes are leached, and high-purity gold as well as palladium/platinum sludge is precipitated. The silver is granulated and the gold is cast into 12.5 kg bars or granulated.

C.3 MiMeR

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Bo Björkman
Professor of Process Metallurgy
Director of MiMeR

MiMeR stands for the Minerals and Metals Recycling Research Centre and is based in the School of Process Metallurgy at Luleå University of Technology. It is one of the Swedish Centres of Excellence founded in 1995 with funding from VINNOVA, the Swedish Agency for Innovation. It has a network of over 22 industrial companies with a variety of interests in the recycling arena, including Boliden Mineral AB, Stena Metals, Outokumpu, Linde and Vattenfall.

MiMeR carries out research projects and contract research regionally, nationally and internationally. Research is conducted in many areas depending on members' current needs but the current focus is on:

- Minimisation of the generation of mineral and metal bearing residues
- Use and recycling of mineral and metal bearing residues
- Recycling of mineral and metal from consumer goods
- Raw material utilisation

A key component of its research is the ability to characterise wastes and recovered materials. With experience in surface chemistry, pyro and hydro metallurgy and thermodynamics it is well equipped to carry out very detailed projects from a number of angles.

The present research is being carried out in two main programme areas:

- Dry and wet fine particles – including dewatering of fine sludges, recycling of wet and dry fine particles, techniques for injection and agglomeration, and behaviour of minor elements in complex waste such as shredded electronic scrap

- Slags and ashes – including in-plant recycling, use in cementatious products such as Eco-Clinker, and use in road building and landfill cover. For example, it was quoted that 100 million tonnes of material is needed to cap landfills in Sweden and it is investigating the inclusion of sewage sludge into ashes and slags. One key area of this research was looking at characterising slags formed during the smelting of high plastic fractions from WEEE

MiMeR obviously has close relationships with Boliden, and indeed Theo Lehner is a Visiting Professor. Its vision statement is that all residues with a potential for recycling or reuse are used in a way that gives best utilisation from a raw material perspective, creating growth and job opportunities within the minerals, metals and recycling sector.

C.4 Sysav

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Head of Department, Hazardous Waste Handling

South Scania Solid Waste Company (Sysav) is owned by 13 local authorities. At the Bjurögatan plant, WEEE is manually disassembled and the materials are sold or sent for recycling elsewhere. Hazardous waste is pretreated down the road at another plant.

Electronic waste is moved from collection points to waste transfer stations. Combustible waste is used to make energy. Sysav has a new plant of capacity 50 t/h which runs 24 hours a day, 365 days a year. The furnace temperature is 1,000°C. Steam at 400°C drives the turbine.

Sysav Kemi collects and handles hazardous waste originating from households and industry in 14 areas. It has a hazardous waste capacity of 25,000 t and oily waste capacity of 16,000 t.

Site tour: WEEE recycling plant

There are two methods of delivering waste electronic equipment: containers and metal cages. Each container contains 25 cages.

Sysav processes 150 boxes in one day. It estimate that between 6,000 and 8,000 tonnes of WEEE will be processed this year (up to 40 tonnes per day), of which 3,000 tonnes is household WEEE. Sysav has a problem with thieves stealing WEEE from its site.

Sysav's process is based on manual disassembly. At present all the material entering the disassembly process is mixed up, but it plans to segregate TVs and monitors in the future. Suction lifting devices are used to lift heavy equipment onto benches. It dismantles 100 monitors per day. Sysav is investing in a new crusher (due for delivery on the day of the visit) to reduce the amount of manual disassembly. It is looking at shredding technologies by Malin (Malin 250 ring shredder) and MeWa (QZ) to reduce the amount of manual handling (50 people employed will be reduced to 30 people).

Some of Sysav's employees in the WEEE recycling plant have been with the company for over ten years. Employees have a 10 minute break every hour.

Products:

- LCDs go to special treatment
- Mixed plastics go to China
- E-scrap goes to Boliden (it has 300 g/t PM – €6/kg ≈ £4/kg)
- Mobile phones go to Boliden

Site tour: collection point

There are 15 different places in the area for dropping off WEEE. The mission visited Sysav's collection point for household waste near its plant. It is laid out in a well organised manner with skips around the outside. It is open all day, every day except Fridays. Round the perimeter is an electric fence to deter thieves. On site is a reuse centre (flea market) which is run by Emmaus Björka.

Sysav plans to build a 200-300 m^2 building at the collection point for handling electronic waste and provide under-cover storage of WEEE. At present, WEEE is not segregated into different categories.

Sysav is investing in an Innovex spark gun to identify plastics containing flame retardants (cost £20,000). Currently, flame retardant plastics are incinerated.

Sysav uses a baling machine to increase plastic packing. This increases the container load from 11-13 t to 20 t.

C.5 RVF

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Jon Nilsson-Djerf
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Jessica Christiansen
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RVF – soon to be renamed 'Waste Sweden' is the Swedish trade association for the recycling industry. Its main activities are:

- Monitoring developments and safeguarding members' interests
- Exchanging experience
- Working with development and investigations
- Educating and disseminating knowledge
- Providing information

The association has 400 members and 17 employees based at the office in Malmö.

It was explained that a pragmatic solution to the collection and treatment of WEEE had been developed in Sweden. Known as the 'Elretur' system it balances the responsibilities under law of the producers and municipalities with the practicalities of the existing infrastructure.

El-Kretsen is a not-for-profit company set up to manage the WEEE take-back system throughout Sweden. Set up in 2001, El-Kretsen now collects over 14 kg/y of WEEE per person. Cooperation between the parties involved and having one collection system means that only 5% of costs are attributed to administration, with 30% on transport and the rest on treatment. Collection is a mixture of civic amenity sites (manned and secured to prevent theft) and kerbside collection. There is no retailer take-back.

Not all treatment is carried out in Sweden, eg there are no facilities for dealing with radioactive WEEE (eg from smoke detectors), and lamps are treated at facilities in Norway and Denmark.

LAW	REALITY
Producer responsibility Municipal responsibility – all household waste All WEEE has to pass a certified facility before being landfilled, incinerated or fragmented	Cooperation between municipalities and producers – the Elretur system A standard agreement has been developed by RVF, the Association of Swedish Municipalities and El-Kretsen AB

Exhibit C.2 *Law vs reality in Sweden*

C.6 Eldan Recycling A/S

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Bertil Eklöv
Product Manager

Eldan manufactures and supplies process plant for treating mixed wastes. Product lines include equipment to treat:

- Cable and WEEE
- Tyres (60% of its revenue)
- Other complex waste

Established 50 years ago and employing 85 people, Eldan has been involved with WEEE recycling since the early 1980s. Equipment is made and assembled in Faaborg, Denmark. Eldan offers a turnkey service including ongoing service and maintenance.

A typical Eldan WEEE processing line incorporates a shredder, eddy-current magnet, heavy pregranulator, another eddy-current magnet, heavy granulator and separation table. Additional manual disassembly and hand sorting up front was seen as necessary to remove hazardous components. This is followed by grab loading to the feed conveyor.

Eldan's key competence is in shredding machines, and these are manufactured at their facility in Faaborg. Some other process machinery is bought in, eg separation equipment. Improving the shredding process is the focus of any development work.

C.7 Gaiker Centro Tecnológico

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Gaiker is a privately owned not-for-profit R&D organisation. It forms part of the IK4 alliance of leading research centres focused around the Basque country. The IK4 alliance comprises around 1,000 researches in total. Gaiker employs around 100 people and has a turnover of around €8.4 million (~£5.7 million). Income for 2005 was 78% from industrial contracts and EU funded projects with the rest from collaborative R&D and other government funding.

Research is focused in four broad areas:

- Plastics and composites
- Biotechnology
- Recycling and recovery
- Environment

Projects often combine these areas, eg many of the recycling projects involve recovered plastics, and input from both areas is used. Plastics is the core area of expertise and accounts for about one third of the project income. It was estimated that around 25% of the research projects are developed further or commercialised.

Recent projects relevant to WEEE:

- Active Disassembly using Smart Materials (ADSM)[5] – application of shape memory materials, low melting point alloys and adhesives for disassembly of consumer electronics (ended 2003)
- Liquid Crystal Display Reuse and Recycling (ReLCD)[6] – testing, reuse, disassembly and treatment of LCDs. Process flow suggested and the feasibility of using the recovered plastics demonstrated
- Eco-efficient Life Cycle Technologies – From Products to Service Systems (ECOLIFE-II)[7] – life-cycle analysis (LCA) methodology (2002-2006)
- Extraction of BFRs using supercritical fluids
- Identification of BFRs using mid-IR spectroscopy, detection limit of ~1%; also an alternative technique using sliding spark spectroscopy
- Electrostatic separation of waste plastics (collaboration with Hamos – see Appendix C.13)

Current and future projects:

- Emerging recyclates – design of collection facilities for CDs and DVDs
- Energy from waste – pyrolysis/gasification
- Analysis of solid residues to determine suitability for cement kiln fuel

5 http://cordis.europa.eu/data/PROJ_FP5/ACTIONeqDndSESSIONeq112242005919ndDOCeq83ndTBLeqEN_PROJ.htm
6 www.activedisassembly.com/projects/eu/public.htm
7 www.ihrt.tuwien.ac.at/sat/base/EcolifeII/index.htm

Comments on WEEE in Spain

A cross-functional group was set up at the beginning of 2006 to establish standards and markets for recycled plastics. Collection of mobile phones is low as they tend to be reused locally or by commercial and charitable organisations.

A laser cutting facility for separating funnel and screen glass in CRTs is thought to be being installed in Saragossa. It was agreed that the reducing quantity of CRTs and lack of markets for the leaded glass makes investment in CRT separation technology uneconomic in most cases.

C.8 Indumetal Recycling SA

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Mercedes Malaina

Presentations were given at Gaiker's facilities – the mission was unable to visit the facilities at Indumetal.

Indumetal Recycling was founded in 1984 to recycle complex scraps, telephone exchanges and electronic equipment. The company's origins are in the mining industry so it has much experience in concentration of the materials of value in the recovery process.

Indumetal has facilities across Spain and receives material from Spain, Portugal and Southern France. It is part of the European Advanced Recycling Network (EARN).

Exhibit C.3 Indumetal locations

Facility	Location	Capacity
Indumetal Recycling	Bilbao	All WEEE except fridges
Recypilas	Bilbao	Batteries and lamps
IRSA	Madrid	All WEEE except fridges
Electorecycling SA (JV)	Barcelona	All WEEE except fridges
Recilec SA (JV)	Sevilla	All WEEE

Exhibit C.4 Indumetal facilities

Bilbao facility

The Bilbao facility has a capacity of 40,000 t/y and employs around 90 people. Material arrives in pallet boxes and is manually depolluted to remove hazardous materials. The depolluted material is then shredded and sorted by air table to give separated metal streams and a plastics stream. Residual plastics and other organics are used for energy recovery. On average, 10% of the waste collected in Spain is incinerated in energy from waste plants.

Plastics recovery is considered the most important area for development, and Indumetal has been working with Gaiker on identification of BFR plastics. It is not currently considered cost-effective to separate and clean plastics into a saleable product, therefore new processes or markets are required.

The situation in Spain

Collection facilities are organised by the 17 local authorities in Spain which leads to large disparities from region to region. Catalonia has 250 collection points, the Basque country has 45, the other regions in Spain have very few. There are also nine different collection and compliance schemes in Spain dealing with different categories of WEEE. It was considered that the number of schemes was not sustainable and a certain amount of rationalisation was likely.

C.9 Recydur BV

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Reint Sekhuis
Director

Established in 1992, Recydur is a Netherlands-based specialist recycler of small appliances and IT equipment certified to ISO 9001 and ISO 14001. The plant is stated to have a capacity of 45,000 t/y of EEE scrap. During the visit the mission team was told that the plant was currently operating at 10 t/h, only 45% capacity. The team later considered this claim to be difficult to substantiate from what was viewed during the visit.

Recydur is a member of the European branch organisation of WEEE recyclers: the European Electronics Recyclers Association (EERA). EERA represents all larger European WEEE recyclers towards the European Committee, national authorities and producer organisations. To obtain high-quality standards in the branch, all EERA members have signed a joint quality guideline to safeguard high standards of WEEE recycling.

Recydur states on its website that it offers a WEEE registration and WEEE consultancy service to producers and/or importers. The consultancy service entails all necessary elements important for a producer/distributor with respect to WEEE: registration service with 27 European authorities, registration with 27 European compliance schemes, setting up reporting structures and answering all relevant questions regarding WEEE.

The site consisted of an outer yard where incoming feedstock was stored, one small covered area for preliminary treatment, and a larger covered area housing the majority of the dismantling equipment. The outer yard sat on a sheet-metal base which collected and channelled rainwater so that the site did not pollute the local water ecosystem.

Most of the feedstock comes from the Dutch national take-back scheme through 20 collection centres.

A schematic for the plant is provided in Exhibit C.5 based on discussions with Reint Sekhuis after the plant tour. It was difficult for even the most experienced of the mission team to understand the layout of the plant during the visit. It must be surmised that the plant has been constructed over many years and evolved into its current form as there seemed to be vast lengths of conveyor when compared with similar operations viewed during the tour. Indeed there were also concerns voiced by the team that moving parts on some of the equipment were left unprotected and the potential for an accident was high. There were also concerns that operators were not protecting themselves with safety goggles, gloves etc.

The schematic was simplified as it is assumed that whatever happens to the larger particle portion after sieving would also happen to the smaller portion in some form. Again it should be stated that whilst the plant obviously makes profit it has an unusual layout that will necessitate reprocessing of ‘tailings’ in an effort to upgrade the final waste streams to maximize the profit. However, the plant was relatively lightly staffed so this may balance the need for extra processing.

Recydur claims that 80% of all EEE is reclaimed for material use; the remaining 20% is partly used as fuel for energy recuperation. The metal fraction contained 3-5% SS, 12% Al, 3%Cu, with 20% plastic. The plastic was sent for recycling with a stated 70% reuse rate.

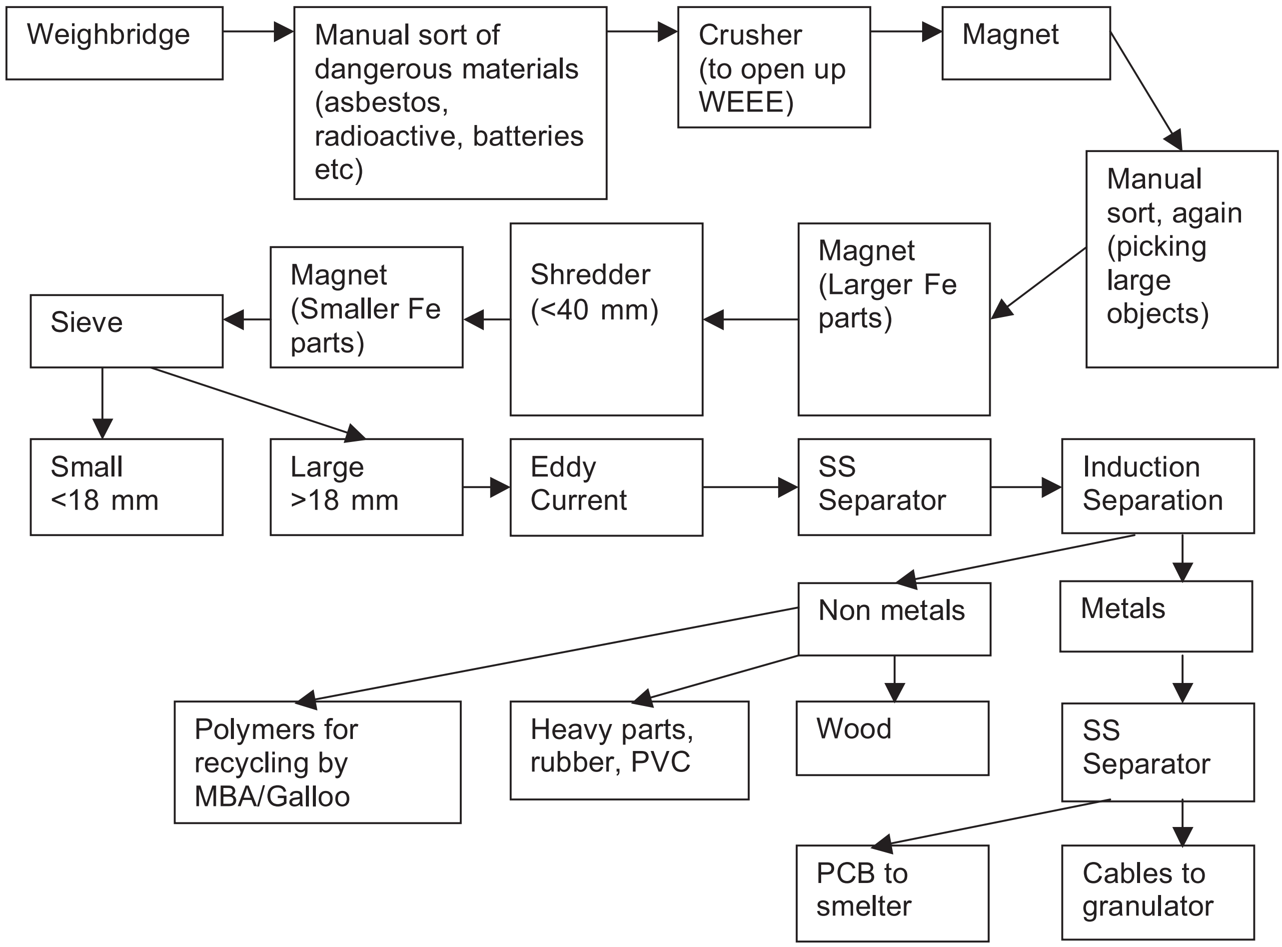

Exhibit C.5 Recydur process flow

C.10 Remondis Electrorecycling GmbH

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Marcus Krause
Sales Director

Remondis has over 35,000 employees and a turnover of €6 billion (~£4.1 billion), making it the fifth biggest recycling company in the world. Remondis has invested €17 million (~£11.6 million) this year in WEEE recycling. It has completed a new WEEE plant at Lünen and is currently building a new fridge plant there too. It recycles all 10 categories of WEEE.

In Germany, Remondis has several companies processing WEEE within a radius of 300 km (see Exhibit C.6).

Remondis has a joint venture (JV) development in Poland and is also investing in the Czech Republic, Greece and France (looking to invest in North, South and West France). There is, however, no need to invest in Denmark, Finland and Sweden as these markets can be served by existing facilities. In Italy and Spain, Remondis is looking for contracts to justify an investment. It is also aiming for a contract with WEEE Ireland, but six-month contracts are too short to justify investment. There is a possibility of investing in the UK, perhaps by acquisition.

In Bavaria, it is having problems getting material, which is being shredded by metal recyclers.

Remondis WEEE processing capacity by type:

Fridges – 50,000 t
Big household appliances – 75,000 t
Small appliances – 85,000 t
Monitors/TV screens – 49,000 t
Gas discharge lamps – 10 million pieces

Logistics and market share

At each logistics site there are 32 different trucks. There are 8,000 trucks for all waste. In Germany there are 1,500 containers (25% of the total market). The next largest player is IGEA, then RWE (market share 15%). Allegedly Stena has built a new fridge plant in Harmstadt (capacity 500,000 fridges).

According to the press, the German household WEEE market is in excess of 1 million t/y. However, Remondis estimates the market is more like 600 kt/y. The B2B market is of unknown size. The target of recycling 4 kg/person of WEEE is no problem in Germany.

Processing capacity (kt/y) by type by location	Lünen	Berlin	Selm	Neumünster	Baar Ebenhausen	Hockenheim	Stausberg
Fridges		13	13	13	9		
Large household appliances		19	19	19	18		
Small appliances		10	10	10	15		
Monitors/TV screens	25	10	10	10	9	15	
Gas discharge lamps							10 million pieces

Exhibit C.6 *Remondis facilities*

Each civic amenity site has to place four bins for the collection of WEEE.

Plant tour

Material is received unsorted into a large waste electronics tip inside the building, comprising mostly of TVs. It is transported to the infeed conveyor by a bulldozer.

The material is fed into a crusher, which opens up the outer casings of the WEEE. It then passes through a two-man picking line where hazardous waste such as canisters is removed. The material then goes into a shredder based on whirlwind technology.

After the shredder, the material goes through a granulator to produce pieces small enough for magnetic separation and eddy-current separation systems. All plastics including polystyrene (PS), polypropylene (PP) and acrylonitrile butadiene styrene (ABS) go to a plastics recycler. Aluminium is separated into coarse and fine grades. Plastics, iron and aluminium products were of high quality and consistency.

Remondis has also invested in a robotic disassembly line for a particular product for which they have a long-term contract.

There is a CRT processing line which splits the funnel glass from the screen glass using a hot-wire technique. The glass is sent to China for use in new TVs/monitors.

C.11 Fraunhofer IVV

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The Fraunhofer Society (Fraunhofer-Gesellschaft – FhG) undertakes applied research of direct utility to private and public enterprise and of wide benefit to society, with roughly 80 research units, including 58 Fraunhofer Institutes, at over 40 different locations throughout Germany. Amongst other areas, Fraunhofer IVV develops concepts for reducing and recycling industrial waste, characterisation of waste polymers, and methods for recycling plastics.

CreaSolv process

The CreaSolv process is the selective extraction of targeted polymers from plastic waste streams, followed by a purification step, the process being particularly useful for the removal of BFRs. The company CreaCycle GmbH has been formed to commercialise this process.[8]

Fraunhofer IVV has found that reducing the size fraction of the plastic to increase the metal separation increased dioxin production during subsequent incineration steps. The CreaSolv process, however, operates by a different method and can take fractions that are around 30 mm and eliminates the incineration step.

A pilot plant has been built to prove technical feasibility and to evaluate the economics. Based on these studies the process has been optimised for scale-up and profitability, a demonstration plant of 500 t/y being the logical next step. Impurities, undesired additives (eg flame retardants) and toxic degradation products can be separated effectively and a high-purity mixed polymer regained.

The waste fractions are added to a holding vessel in which a selective solvent is added and the solvent is left to dissolve the plastics for approximately 12 hours. The mixture of dissolved polymer and solvent is pumped though a purification step that filters out any undissolved foreign materials. The remaining polymer is a grey mass that is RoHS compliant and able to be reused in the plastics industry.

Tests aimed at a chemical decontamination of the solvent fraction and at recycling of bromine were successful but not economical. As an alternative, a project has been started for direct injection of the brominated solvent fractions into a pyrolysis process with a flue gas wash for bromine recycling.

8 www.creacycle.de/homepage.html

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Dr Peter Böhm
Jan Bellenberg

BSH is a domestic appliance manufacturer dealing only with white goods. It has 14 brands and 35,000 employees with a turnover of €7.3 billion (~£5 billion) in 2005. It has 71 companies in 40 countries with 42 factories; 80% of its turnover is outside Germany – Viva is the UK entry brand.

Market share is 35% in Germany (number one - #1), 21% in Western Europe (#1) and 7% worldwide (#3: Electrolux #1, Whirlpool #2). It is a member of the white goods association.

BSH was the first company to market CFC-free fridges – manufactured in China. Ninety-two per cent of its plants have ISO 14001. It has internally reduced production waste by 11%, down to 89 kg/t.

In the 1990s it looked at demanufacturing and set up a recycling line, looking at all products and the difficulties associated with them. Initially it thought that all recycling would be completed via disassembly, not realising that it was more efficient with shredders.

Remondis is the specialised partner for recycling within Germany. There is a collaboration of between 30-35 small appliance producers to avoid antitrust regulations.

BSH now has internal standards for recycling 'friendly' products – ie it is limiting the number of different plastics being used. In the past 10 years its product development department has helped to increase the recyclability of each product. It has also developed 'repair friendly' parts to limit technical assistance time. For example, in a washing machine the stainless steel tub was replaced with a plastic one, reducing the amount of water needed by 25% as the space between the drum and the housing has been minimised. In large white goods virtually all of the life-cycle assessment (LCA) is within the consumption stage (>90% – water, energy, CO_2, raw materials). The disposal cost is <0.5% of the LCA, with an average lifetime of 12 years per product.

R-Plus data on materials recovery from fridges, plastics has increased by 130% in 15 years (Exhibit C.7).

Material	1990 %	2005 %
Plastics	11.9	28.3
Foam	8.3	10.6
Nonferrous	6.2	6.2
Ferrous	55.2	44.7

Exhibit C.7 *BSH materials recovery*

BSH has tried in the past to use recycled plastics in manufacturing; it tried using ABS in a workshop top but the material kept breaking – it stated that consistent characteristics and material supply is essential. It went back to virgin polymer in early 2006 as it manufactures 10,000 pieces per day and does not make money if it loses production. Non-visible parts are being considered at the moment. It does use a regrind from its own production waste but has to consider the working environment of the component and the lifetime of the product.

BSH is of the opinion that 'energy recovery should be more important than material recycling'. In Germany it cost €50/t (~£34/t) for landfill in 2004, and this figure is now increasing. There are no incentives for design-friendly products when foreign products are so cheap, and separate collection is not going to happen. Also, mechanical recycling deters innovation in design for recycling.

'RoHS is only affecting EU producers – Asia does not seem to worry or care about this directive.'

Hydrocarbon gas-filled fridges are not considered hazardous waste in Germany. BSH is developing HC guidelines for recycling with the European Recycling Association (ERA), the WEEE Forum and SESA to make recycling efficient and explosion proof.

BSH is in favour of the visible fee system which is implemented in most EU countries – but has to pay for a collection system. In Germany there are 15 take-back schemes and BSH's own obligation of the collected material is hard to control and adds costs. There is a €20/t (~£14/t) fee from the producer to the recycler from the German 'clearing house' system. With large white goods there needs to be at least three or four take-back schemes to avoid antitrust laws if there is only one scheme in place.

It has set up a JV with Remondis to recycle only BSH products. Germany has been divided into five areas for collection. If it is given a collection assignment it uses a partner company – given 48 hours to collect the material from a site.

Would they blow the whistle on a non-RoHS compliant producer? All their suppliers have to provide RoHS-compliant materials and also provide written evidence that they are so. BSH is not too comfortable with self-policing RoHS. It has over 10,000 small domestic appliances and has not had the opportunity to assess the LCAs of these and their impact – most likely these are not going to conform to RoHS as most are imported from Asia.

Views on the Energy-using Products (EuP) directive? BSH thinks that most of the energy is in the 'use' phase, therefore it is looking at lowering overall energy consumption. There is a big driver in this direction for all producers.

There are too many technologies regarding EuP, depending on how the information is put together. The Fraunhofer Institute for Reliability and Microintegration (IZM) is looking at these studies, and the Institute of Studies for the Integration of Systems (ISIS) and the Italian National Agency for New Technologies, Energy and the Environment (ENEA) are completing studies on freezers/fridges and dishwashers/ washing machines.

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Hamos specialises in electrostatic separation technologies. More recently it has started to offer turnkey recycling plants, and also a system to convert organic residues into biodiesel.

Presentations on all three areas were given to the mission team, and demonstrations of the electrostatic separation process.

WEEE processing

Hamos has two systems – ERP I and ERP II. ERP I is suitable for heavy WEEE, ERP II is suitable for lighter WEEE with no large metal housings. Hamos emphasises the need to dedust during the process to improve operator health and safety and to improve the separation process. Unit operations are the same as other systems observed, generally milling, magnetic separation, eddy current separation etc.

Plastic recycling systems for WEEE scrap

Mixed plastic waste from WEEE is problematic to recover. It is even difficult to segregate during manual disassembly as even the manufacturer may be unaware of multiple materials used in the same product. Even the markers used to indicate the material may be incorrect.

For example, Hamos has tried to work with Chrysler to sort front lights and found this to be very difficult as there may be up to 12 different polymers.

The reality is a very mixed source stream of material. What to do with mixed scrap which may contain 65 or more different types of plastic?

Electrostatic separation

Generally a certain amount of separation/upgrading of the plastics stream is required before electrostatic separation – eg, specific weights indicate how polymers can be separated by flotation using brine or other media. Electrostatic works best with only two types of plastic, particles of small size, and no dust. High-impact polystyrene (HIPS) and ABS are a common mixture for separation as they have similar densities. Electrostatic separation can achieve 99% purity in the ABS fraction.

The first stage of the process is to charge the polymers using friction. Differing polymers acquire opposing charges and can then be separated in a high electric field.

The big question is who will take the materials? Where are the markets? The German expression for this kind of situation is: 'The broth should not be more expensive than the meat.'

Catalytic depolymerisation process (CDP)

The Germans provided the mission team with an interesting analogy. A pig bought for winter food is half offal – but this is used to make the sausage. It is the same with electronic waste. Removing all the valuable waste leaves offal. Where is the sausage? – It is diesel fuel which can be made from the plastic residues.

During the manufacture of plastics, 10-20% is waste. The main interest is the metal in post-consumer products, but there is often 60-70% plastics in this stream. What to do with the fine dusts, fibres and foils? The solution is to convert plastic residues to diesel fuel.
Dr Kohnlechner sees this as a solution to complement the waste recovery process.

CDP originated with Dr Christian Koch, inventor and patent owner in Erlangan. Material is pretreated to remove the nonorganic contaminants. Suitable feed materials for the process are claimed to be almost any HC-based material from mixed plastic to tar lakes. Material must be dry, less than 10 mm (if solid) and free of metals and other inert materials (glass, stone etc). PVC is transformed into nontoxic salts like calcium chloride. Chalk is added to the reactor which also regenerates the catalyst. The process does not produce dioxins or furans.

Apparently the pumps are one of the key parts of the process. Heating is carried out in the pump, rather than in the large vessel. This ensures that no part of the fluid is heated to the point (400ºC) at which dioxins are produced. The process is carried out at 300ºC. The pump uses friction to heat the reactants: the friction brings the reactants and catalyst into contact with each other.

Catalyst consumption is around 3% of the diesel produced by weight. The process is around 90% efficient: 90% of the calorific value of the input material is available from the diesel produced. A further 10% is used to power the plant so the process is around 80% efficient overall.

The first operational plant is located in Mexico and can produce ~500 l/h of diesel. A second, larger plant capable of 1,500 l/h is planned for Canada. The design has been adapted to be modular so it can be easily transported as standard containers and easily installed on site. This also makes it possible to transport the plant to the waste rather than the other way round.

C.14 MBA Polymers Austria

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MBA Polymers Austria separates mixed plastic streams, typically residues from metal recyclers, into single polymer streams. Single polymers are ground and pelletised ready for supply into the plastics moulding industry. Details of the separation process are considered commercially sensitive so were not discussed. Feed material needs to be relatively clean, ideally >95% thermoplastics with very low levels of wood, glass, rubber etc.

Exhibit C.8 *Recycled plastic pellets (MBA Polymers Austria)*

MBA's facility is less than a year old and cost €17 million (~£12 million). There has clearly been significant investment by local/national government on local infrastructure. New roads were in evidence and a dedicated spur to the rail network is planned for 2007.

The plant is currently running with around 40 staff, and it is envisaged that about 60 will be working there once it is at capacity.

Sourcing sufficient raw material to meet the plant's nameplate capacity of 40,000 t/y is clearly an issue as the plant ramps up. MBA is encouraging its suppliers to upgrade the plastics as much as possible and is promoting a mobile separation unit (Mbox) to improve the purity of the infeed material when required.

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KERP (Centre of Excellence – COE – for Electronics and Environment) opened in Wiener Neustadt (about 50 km south of Vienna) in 1997. It is a continuation of previous work from the Department of Systems Engineering and Automation (SAT) of the Scientific Academy of Lower Austria and the Institute of Handling Devices and Robotics (IHRT) at Vienna University of Technology in 1991 regarding automated and intelligent disassembling of electronic consumer goods and problems of sustainable development.

It then established itself in Vienna in 2001 as one of 23 Industrial COEs and Networks (K_ind/K_net) as formulated in the Austrian Federal Ministry of Economics and Labour's guidelines on public-private partnerships (PPPs) aiming at close cooperation with partners from industrial and scientific branches.

Its activities focus on research, development and consulting in the electronics industry, increasingly in the automotive branch. These fields of business are carried out by three units:

- KERP Research Electronics & Environment GmbH focuses on applied research in the fields of recycling and recycling-oriented product design
- KERP Engineering GmbH markets the software tools ProdTect and Recycling Passport supporting designers in the field of recycling-oriented product development
- KERP Consulting GmbH advises companies how to implement the EU directives WEEE, RoHS, EuP, ELV and Battery

Kerp was established with the direct intention of identifying solutions and technologies of electronic scrap recycling and sustainable development which is one of the high-tech areas identified by the Austrian Government. Austria believes itself to be an environmental model country and intends to take a pioneer role in this field.

KERP believes that the role of the COE is to be a catalyst and distribution hub for future technologies, and is very proactive in this field. It runs eco X, a biannual conference dedicated to the multifaceted topic of sustainability in both the electronics and automobile sectors. The conference serves as an excellent forum for discussion and debate on the electronics sector but also enables KERP to be able to fulfil one of its founding goals which is dissemination to the wider audience.

It seems likely that small or medium sized enterprises (SMEs), which dominate Austria's economy, are predestined for the work in this high-tech area, not least because of their flexibility. With support from international research results, these companies will be able to develop such technologies and adapt them for their needs. Therefore an urgent technology transfer from KERP to the SMEs is necessary.

KERP has several other services that it offers, such as the Recycling Passport – a fact sheet giving an overview of all relevant recycling and dismantling information:

- Materials and components to be removed
- Parts and components to be treated separately
- Parts and components interfering with the recycling process
- Parts and components presumably realising profit
- Hazardous substances

The Recycling Passport merely provides product information related to disassembly and recycling. No proprietary product know-how is disclosed.

KERP´s ecological computer mouse

One of the products KERP has designed to illustrate its capabilities and to highlight the sustainable design that is possible in everyday equipment is the Eco Mouse (Exhibit C.9).

The Eco-mouse represents the implementation of a comprehensive, ecologically based approach which features:

- Improved power management
- Use of components with low levels of hazardous substances
- Lead -free soldering
- Recycling-oriented product design

These individual aspects lead to a vast improvement and its ability at end of life to be recycled and have much less environmental impact throughout its life cycle.

The following information shows the concept's design and improvements made:

- No batteries
- No accumulators
- Operating time: 2-5 h
- Charging time via external power source: 5 minutes
- Charging time via USB: 13 minutes
- Casing made of Arboform, a natural material

Overall, the concept of KERP is a good one and should and hopefully will be replicated throughout Europe as it is a concept that works!

Exhibit C.9

Eco-mouse (KERP)

Appendix D

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Appendix E

LIST OF EXHIBITS

Appendix F

GLOSSARY

~	approximately
≈	approximately equal to
<	less than
>	greater than
>	greater than or equal to
%	per cent
#	number
£	pound sterling (£1 ≈ €1.47 ≈ SEK13.5, Aug 06)
€	euro (€1 ≈ £0.68, Aug 06)
ABS	acrylonitrile butadiene styrene
ADSM	Active Disassembly using Smart Materials (project, EC)
Al	aluminium
B2B	business-to-business
BFR	brominated flame retardant
BSc	Bachelor of Science
BSH	Bosch und Siemens Hausgeräte GmbH (Germany)
°C	degrees Celsius
CD	compact disc
CDP	catalytic depolymerisation process
CEng	Chartered Engineer
CFC	chlorofluorocarbon
cm	centimetre = 0.01 m
cm^2	square centimetre = 10^{-4} m^2
CO_2	carbon dioxide
COE	centre of excellence
CRT	cathode ray tube
Cu	copper
dioxins	family of chlorinated aromatic chemicals, persistent in the environment, some toxic
DTI	Department of Trade and Industry (UK)
DVD	digital versatile disc
EAF	electric arc furnace
EAR	Elektro-Altgeräte Register
EARN	European Advanced Recycling Network
EC	European Commission
ECOLIFE	Eco-efficient Life Cycle Technologies (project, EC)
EEE	electrical and electronic equipment
EERA	European Electronics Recyclers Association
ELV	End-of-Life Vehicle (directive, EC)
ENEA	Ente per le Nuove tecnologie, l'Energia e l'Ambiente – Italian National Agency for New Technologies, Energy and the Environment
EOL	end of life
ERA	European Recycling Association
EU	European Union
EuP	Energy-using Products (directive, EC)
F	fax
FhG	Fraunhofer-Gesellschaft – Fraunhofer Society (Germany)
FIChemE	Fellow of the Institution of Chemical Engineers (UK)
FZK	Forschungszentrum Karlsruhe (Germany)
g	gram = 0.001 kg
GWP	global warming potential
h	hour
HARL	Home Appliance Recycling Law (Japan)
HC	hydrocarbon
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
HGV	heavy goods vehicle
HIPS	high-impact polystyrene
ICT	information and communication technology
IHRT	Institut für Handhabungsgeräte und Robotertechnik – Institute of Handling Devices and Robotics (Vienna University of Technology, Austria)
ISIS	Institute of Studies for the Integration of Systems (Rome, Italy)

ISO	International Organization for Standardization (HQ: Switzerland)
IT	information technology
ITP	International Technology Promoter (network, DTI, UK)
ITRI	(formerly) International Tin Research Institute
IVV	Fraunhofer-Institut für Verfahrenstechnik und Verpackung – Fraunhofer Institute for Process Engineering and Packaging (Freising, Germany)
IZM	Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration – Fraunhofer Institute for Reliability and Microintegration (HQ: Berlin, Germany)
JV	joint venture
Kaldo	Swedish smelting process using oxygen blown from a lance into a rotating furnace
KERP	Centre of Excellence for Electronics and Environment (Austria)
kg	kilogram
kt	kilotonne = 1,000 t = 10^6 kg
l	litre = 0.001 m^3
LCA	life-cycle analysis/assessment
LCD	liquid crystal display
Ltd	Limited (company)
LTU	Luleå Tekniska Universitet – Luleå University of Technology (Sweden)
m	metre
m^2	square metre
m^3	cubic metre
MIET	Member of the Institution of Engineering and Technology (UK)
MiMeR	Minerals and Metals Recycling Research Centre (LTU, Sweden)
mm	millimetre = 0.001 m
MSc	Master of Science
ng	nanogram = 10^{-9} g = 10^{-12} kg
NISP	National Industrial Symbiosis Programme (UK)
NVMP	Dutch Foundation for the Disposal of Metal and Electrical Products
OWEB	overig wit en bruingoed – other white and brown goods
Pb	lead
PC	personal computer
PCB	(1) polychlorinated biphenyl (2) printed circuit board
PCT	polychlorinated terphenyl
PhD	Doctor of Philosophy
PM	precious metal
PP	polypropylene
PPP	public-private partnership
PS	polystyrene
PVC	polyvinyl chloride
R&D	research and development
ReLCD	Liquid Crystal Display Reuse and Recycling (project, EC)
RoHS	Restriction of Hazardous Substances (directive, EC)
RVF	Svenska Renhållningsverksföreningen – Swedish Association of Waste Management
SDA	small domestic appliance
SEK	Swedish kroner (SEK1 ≈ £0.074, Aug 06)
SMART	Surface Mount and Related Technologies (Group)
SME	small or medium sized enterprise
SO_2	sulphur dioxide
SS	stainless steel
t	tonne (metric ton) = 1,000 kg
T	telephone
TCDD	tetrachlorodibenzodioxin (most toxic dioxin)
TV	television
UK	United Kingdom
UMIST	University of Manchester Institute of Science and Technology (UK)
VAT	value-added tax
VCR	video cassette recorder
vs	versus
WEEE	Waste Electrical and Electronic Equipment (directive, EC)
y	year
Zn	zinc

Other DTI products that help UK businesses acquire and exploit new technologies

Grant for Research and Development – is available through the nine English Regional Development Agencies. The Grant for Research and Development provides funds for individuals and SMEs to research and develop technologically innovative products and processes. The grant is only available in England (the Devolved Administrations have their own initiatives).
www.dti.gov.uk/r-d/

The Small Firms Loan Guarantee – is a UK-wide, Government-backed scheme that provides guarantees on loans for start-ups and young businesses with viable business propositions.
www.dti.gov.uk/sflg/pdfs/sflg_booklet.pdf

Knowledge Transfer Partnerships – enable private and public sector research organisations to apply their research knowledge to important business problems. Specific technology transfer projects are managed, over a period of one to three years, in partnership with a university, college or research organisation that has expertise relevant to your business.
www.ktponline.org.uk/

Knowledge Transfer Networks – aim to improve the UK's innovation performance through a single national over-arching network in a specific field of technology or business application. A KTN aims to encourage active participation of all networks currently operating in the field and to establish connections with networks in other fields that have common interest.
www.dti.gov.uk/ktn/

Collaborative Research and Development – helps industry and research communities work together on R&D projects in strategically important areas of science, engineering and technology, from which successful new products, processes and services can emerge.
www.dti.gov.uk/crd/

Access to Best Business Practice – is available through the Business Link network. This initiative aims to ensure UK business has access to best business practice information for improved performance.
www.dti.gov.uk/bestpractice/

Support to Implement Best Business Practice – offers practical, tailored support for small and medium-sized businesses to implement best practice business improvements.
www.dti.gov.uk/implementbestpractice/

Finance to Encourage Investment in Selected Areas of England – is designed to support businesses looking at the possibility of investing in a designated Assisted Area but needing financial help to realise their plans, normally in the form of a grant or occasionally a loan.
www.dti.gov.uk/regionalinvestment/

The DTI Global Watch Service provides support dedicated to helping UK businesses improve their competitiveness by identifying and accessing innovative technologies and practices from overseas.

Global Watch Information
Global Watch Online – a unique internet-enabled service delivering immediate and innovative support to UK companies in the form of fast-breaking worldwide business and technology information. The website provides unique coverage of UK, European and international research plus business initiatives, collaborative programmes and funding sources.
Visit: www.globalwatchservice.com

Global Watch magazine – distributed free with a circulation of over 50,000, this monthly magazine features news of overseas groundbreaking technology, innovation and management best practice to UK companies and business intermediaries.
Contact:
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Global Watch Missions – enabling teams of UK experts to investigate innovation and its implementation at first hand. The technology focused missions allow UK sectors and individual organisations to gain international insights to guide their own strategies for success.
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Global Watch Technology Partnering – providing free, flexible and direct assistance from international technology specialists to raise awareness of, and provide access to, technology and collaborative opportunities overseas. Delivered to UK companies by a network of 23 International Technology Promoters, with some 8,000 current contacts, providing support ranging from information and referrals to more in-depth assistance with licensing arrangements and technology transfer.
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For further information on the Global Watch Service please visit
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