Potential Markets for Recovered TYRES

RESEARCH CARRIED OUT BY ENVIROS

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Summary

The DTI are in the process of developing policy on producer responsibility for tyres, it is expected the a consultation document will be available in late Spring 2002.

There are several mature markets for used tyres, in particular the manufacture of retreaded tyres. This market has a poor image in the UK, but there is a healthy market for the export of tyres for retreading overseas. There is also the potential for a vast new market using crumbed rubber for asphalt and concrete manufacture. Further work needs to be done by research bodies before this can be an accepted market.

There is the expertise for processing and recycling tyres in the UK, however all reprocessors appear to use similar techniques and currently entry into more sophisticated markets has proved uneconomic.

From this study the current estimate of tyre waste arisings in the London area is 45,000-50,000 tonnes p.a. The projected estimate of tyre waste arisings in London is for volumes to remain at their current levels of 45,000-50,000 tonnes p.a.

The research reached the following conclusions on the markets for used tyres:

- that the retread market is well established in the London area and therefore does not need additional support, unless from Government to make the purchase of retreaded tyres more attractive than new tyres.
- the materials recovery market is not well represented in the London area. There is a need to stimulate demand for products using recycled tyres. In the UK there is currently excess shredding and crumbing capacity. There is also a need to find new markets for products incorporating recycled tyres.
- There is limited energy recovery capacity in the UK that can utilise used tyres. This is not an attractive market as the investment required for energy recovery plants is high and the main company operating this type of plant is working below capacity. There are opportunities to used tyres in cement kilns, but this route is limited by the need to gain permission from the Environment Agency.

Finally, the trials required to prove that road surfaces using rubber is a viable option are still on-going. The main opportunity is to begin the process of developing a market for crumbed rubber by raising awareness about this product amoung London Local Authorities.

The existing markets for play, sports surfaces and underlay appear to be well provided for within the UK. The main opportunity in the short-term for London Remade appears to be the promotion within London of products manufactured from recycled rubber, specifically raising the awareness of products containing recycled rubber within the London Local Authorities such as rubberised asphalt, sports and play surfaces and underlay.

RESEARCH Findings

Potential Uses for Tyres

According to The Used Tyre Working Group (UTWG), the main methods by which tyres are recycled/ recovered in the UK are:

Retreading

Retreading is the process of removing the worn tread on a tyre and replacing it with a new tread to extend its life. Car tyres can only be retreaded once but commercial tyres, having a much deeper tread, may be retreaded several times. Retreading is the UTWG's preferred method of tyre recovery because it is efficient in terms of use of energy and materials, and gives rise to less waste. In the UK 25-30% of used car tyres and 62-65% of commercial tyres are suitable for

retreading but in practice only 20% of used car tyres and 45% of commercial tyres are actually retreaded each year.

Energy Recovery

In 1998, energy recovery was responsible for 18% of the total recovery of tyres. Whole or shredded used tyres are burnt in special incinerators which generate electricity for use by industry and local communities. Cement kilns are also large potential users of used tyres, although currently only two kilns in the UK have received full authorisation to burn tyres with a combined capacity of 35,000 tonnes. Other kilns, however, are carrying out trials or considering the use of tyres as fuel.

Gasification

Gasification is the process of converting tyres into oil and gas. This option has been the focus of much research, but there has been little interest in its application.

Materials Recovery

This is the process of shredding, granulating and crumbing tyres so the shredded or crumbed rubber can be used in other applications. There is continuing strong interest in this sector. Competition in this sector is fierce with new entrants making it increasingly so. The tyre-granulate end products tend to have a higher initial cost than their conventional counterparts, although full life costs can be competitive.

The rubber crumb market in the UK is relatively small at 48,500 tonnes per annum. Shredded or crumbed rubber can be used for a number of applications.

- **Road Surfacing - Aggregate/Filler Replacement in Concrete**

  There are two general methods for using tyre rubber in asphalt mixes; asphalt rubber concrete (ARC) and rubber modified asphalt concrete (RUMAC).

  - **ARC** is hot mix asphalt concrete in which ground tyre rubber is mixed with asphalt cement for as a binder for the mineral aggregate particles. Recycled rubber ground to a mesh size of 0.84 mm can form 18-26% of the ARC.
  - **RUMAC** uses ground rubber to replace 2-5% of the mineral aggregate in hot-mix asphalt concrete.

  The Highways Agency and DETR are contributing to two studies looking at the materials recycling sector.

  - The first relates to the use of crumb in roads. Trials on road surfaces containing rubber crumb have been undertaken in the UK. One that was laid in Surrey in June 1999 - has experienced both summer and winter use, the surface is performing well. The signs are therefore encouraging, and the Highways Agency are hopeful that by the end of the trial period there will be a number of further trial stretches of roads containing rubber crumb in other parts of the country being evaluated. If successful, it is likely that the material would then be certified for general use.
  - The other study relates to the use of rubber crumb as an aggregate or filler replacement in concrete. Both of these applications could potentially create very significant rubber crumb demand (App3. Ref 1).

- **Carpet Underlay**

Duralay utilise rubber crumb to manufacture their range of rubber underlay. They are actively promoting using crumb rubber from used tyres in their underlay because tyres are manufactured from high quality rubber compounds. This means that using high percentages of recycled crumb rubber in underlay manufacture provides performance benefits for example high degree of sound impact, heat insulation and durability in a range of domestic/contract applications (App3. Ref 2).

Duralay currently they command 7-8% of the UK's domestic underlay market. They installed a plant in the early 1990's in Durham on the same site as Colway tyres retreading operation. The plant utilises tyres rejected by Colway as unsuitable for retreading, these are ground to rubber crumb.

- **Landfill Engineering**

  The use of tyres for landfill engineering, as leachate drainage layers, is an accepted beneficial application for used tyres: used tyres replace virgin aggregate which would otherwise be used to form the drainage blanket. Its use for this purpose will continue even when the ban on landfilling under the EU Landfill Directive comes into force. In 1999 31,000 tonnes of tyres were used for this purpose, some 7% of the total.

- **Fill in Road Embankments**

  Shredded scrap tyres can be used as a lightweight fill in road embankments. Landslipping can occur under road embankments. One repair method is to return the road to its former elevation is to use a lightweight fill instead of soil. This technique prevents the road structure from overloading the weak slip plane in the future, and allows improved drainage. Previously sawdust or chipped lumber has been used. However these materials tend to rot. As a result, shredded waste tyres are considered as a low cost, high volume alternative (App3. Ref 2).

- **Play Area and Sports Surfacing**

  Rubber crumb manufactured into tile sections can be used in playground applications. There are advantages over existing asphalt surfaces because of reduction in the severity of 'falling' injuries together, with cost advantages. Environmental Moulding Concepts, a US company produce the 'Kid kushion' product. App3. Ref 2.

- **Golf Courses**

  An American entrepreneur has patented his rain trap idea whereby old tyres are cut in half and buried half a metre below ground. Water collects in the tyre halves and is then taken up by the grass roots! (App3. Ref 3)

  Royal Lytham St Annes Golf Course has discovered a novel way to utilise old tyres and save wear at the same time. The golf course had experience exceptional wear on some of the paths that link the holes. As an experiment they applied a treatment of rubber crumb (1-3mm) to the surface and allowed it to "bed in". Within six months the grass was already much thicker and richer, and with the same traffic movement, the grass has retained its texture thanks to the rubber crumb [from REG web pages - REG is recycling company, part of Continental Tyres]

- **Other Applications**

  Other uses included applications as dock fenders, silage clamps on farms, playground swings etc. It is estimated that 20,000 tonnes of tyres were used in this way in 1999 in the UK - some 4.5% of the total

Another alternative use has been as artificial reefs. Since 1998, there has been an experimental tyre artificial reef structure in Poole Bay, towards which the Engineering and Physical Sciences Research Council (EPRSC) provided funding. The tyre modules are still in their original position and have been colonised successfully by marine life. If the results of the continuing study are favourable, it may open up new applications for tyres, not only in artificial reefs but also for coastal defence uses, harbour walls, etc.

- **New uses for scrap tyres**
  Using shredded tyres as a bulking agent in composting. Tyres are shredded into almost square chips that can partially replace wood chips in aerated static pile composting. These provide structure, and allow air to permeate the mix. When the compost is ready, the tyre chips can be separated and reused almost indefinitely.
  The use of rubber plastic composites has been developed in Australia. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has patented a surface treatment technology that can created a plastic-rubber composite (rubber Acrylonitrile-Butadiene-Styrene). This form of ABS uses 50% rubber crumb to replace plastic, offering an alternative to PVC.

The findings of the UTWG's 4th Annual Report (June 2000) (App3. Ref 4) claims that the UK performance generally compares favourably with our European partners, especially in view of the UK's level of tyre arisings and comparative balance in the range of recovery options available to it. Table 12 contains information compiled from BLIC data (an EU trade association for the rubber industry), which provides a breakdown for 1998. The figures should be viewed as indicative only.

Table 12 Indicative data showing European rates of recycling

Country | **Tyre arisings (tonnes)** | **Overall recovery rate (%)** | **Reuse (%)** | **Retreading (%)** | **Materials recycling (%)** | **Energy recovery (%)** | **Export (%)**

Belgium | 45,000 | 94 | 22 | 11 | 33 | 28 |

Finland | 30,000 | 80 | 6 | 6 | 02.5 | 11.5 |

France | 370,000 | 39 | 20 | 9 | 73 | |

Germany | 596,000 | 92 | 21 | 41 | 54* | 16 |

Italy | 330,000 | 60 | 15 | 9 | 33 | |

Netherlands (car only) | 45,000 | 100 | 16 | 29 | 84 | 7 | 47

Spain | 241,000 | 19 | 13.5 | 0.5 | 3.5 | 1.5 |

Sweden | 58,000 | 98 | 19 | 8.5 | 6.5 | 54 | 10

UK | 468,000 | 70 | 16 | 18.5 | 10.5 | 187.5 | *

** Capacity, not actual usage*

Belgium, Finland and Sweden operate highly managed tyre recovery systems supported by set fees. Sweden exports significant volumes of used tyres to the Baltic states.

The Netherlands has also taken a managed approach, again supported by a set fee structure. UTWG understands that specific targets are being introduced for particular recovery sectors, with a 60% target for re-use and retreading combined. The table shows 1998 combined recovery at 45%. Although the Netherlands entry shows no exports, their own reuse of tyres and retreads is negligible. As such, the 45% figure is effectively an export one, with the 60% figure an export target. The UTWG is concerned that these targets will encourage greater exports rather than any stimulation of recovery within their own markets. Such measures, if based on statute, will need to be notified under the EU single market provisions, and the UTWG will actively pursue its concerns at that time.

Tyre Processing Techniques & Technologies

Shredding and chipping

Shredding or chipping involves the mechanical shearing of whole tyres into pieces ranging in size from 25 - 300 mm. Shredded tyres may be used directly, however more often, they are shredded as a pre-treatment to crumbing, or either to facilitate their transport, or for use in energy recovery processes.

Crumbing

Crumbing usually involves the removal of the steel and fabric components so the rubber compounds can be processed to a fine granular or powdered form. Crumbing has been made more difficult by the development of the modern steel braced tyres.

Several facilities exist across the UK. A typical facility separates the basic components of scrap tyres using a shredding and granulating process with magnetic extraction to remove the steel and a calcium density separator to remove the fibre.

Cryogenic fragmentation

Cryogenic fragmentation is a method of crumbing tyres. The tyres are shredded and cooled to below minus 80 C. A hammer mill then pounds the chips to separate the components. The energy input required for such low temperatures is relatively high.

De-vulcanisation

Treating vulcanised rubber with heat or chemicals can produce de-vulcanised rubber which can be used to replace part of the virgin material in automotive and cycle tyres, conveyor belts and footwear. The development of the steel braced radial tyre has affected this industry and the process has declined over recent years. Current activity in the UK has been estimated at 50,000 tonnes per annum.

Gasification

Gasification processes can be used on tyres and used oil, to produce clean gas for power generation and chemical manufacture.

- Texaco are currently looking at turning this into a commercial process.
- Project plant in Staffordshire planned to process around 60,000 tonnes a year.

Pyrolysis

Pyrolysis is a process of thermal decomposition in an inert atmosphere which yields gas, oil, steel and carbon char which can be used to strip 90% of hydrocarbons from liquid effluent. The oil and gas can be used as fuels within the pyrolysis system, or for an adjacent heat and power system.

Compared to recovery of energy by direct burning, pyrolysis is a self-contained process which avoids the release of large volumes of combustion gases. This saves on the cost of cleaning or "scrubbing" systems needed with normal incineration to remove pollutants from the gases. It also means that the process can be controlled to recover products for resale (*App3. Ref 6)*.

Energy recovery

Tyres are a high calorie waste, but energy recovery is not without its problems. Sulphur is an essential component for vulcanisation - the process which transforms soft, natural or synthetic latex into a more durable wear-resistant material. Incineration oxidises the sulphur in the rubber to sulphur dioxide - atmospheric emissions can only be prevented by ‘bolt on’ flue gas desulphurisation. This is costly option, not only in terms of additional plant, but

as reduced net energy output, because the process itself uses considerable electrical power. The desulphurisation process also consumes large quantities of limestone, but produces gypsum (calcium sulphate) as a useful by-product.
There are two main methods tyres are used for energy recovery:

- for electricity generation;
  It is not common practice to use tyres to generate electricity in the UK because of the requirement to control emissions of sulphur dioxide.
- as a fuel in cement kilns;
  the use of tyres as a fuel in cement kilns is a proven process and indeed is an improvement on the fuel that it displaces (coal) in that it can add to the quality of the cement produced. It can represent the Best Practicable Environmental Option for used tyres in many cases and it is the option most likely to offer significant tyre recovery growth in the UK.

Estimated Current and Projected Tyre Waste Arisings in London

Estimates for the London area have been generated using national waste arising figures and a variety of conversion factors to calculate the percentage attributable to the London area, see Appendix 6. These include population/number of households (both 12%), number of licensed vehicles (10%) and GDP (16%) according to the type and source of material. We have followed the convention of using population or number of households to derive quantities of domestic waste and GDP for waste generated by commercial and industrial sources. In each case, the baseline figure is derived using population (or number of households).

UK Waste Arisings

In 1998, according to the Used Tyre Working Group, UK tyre arisings totalled 39.5 million tyres representing 467,650 tonnes with a recovery rate of just over 70% (i.e. 328,000 tonnes). The recovery rate included all collected tyres which are used for the following - re-use as part-worns, as retreads in UK and exported for retreading, materials recovery by crumbing or granulating and other recovery either via landfill engineering or for energy (see Table 13 below for more details). By 1999 the recovery rate had risen to 73% albeit from a lower level of used tyre arisings (down to 436,400 tonnes); this represented a tonnage of tyres recovered of 320,000 tonnes slightly below the figure for 1998. Materials recovered (i.e. for applications using granulated or crumbed rubber), however, rose from just over 48,000 tonnes to 83,000 tonnes (representing 19% of total waste arisings in 1999). The amount going to landfill has increased from 50,400 tonnes to 73,500 tonnes. Table 13 shows tyres recovered in 1999; it does not attempt to show details of tyres that may be stockpiled or otherwise stored awaiting disposal.

Table 13 Used Tyre Recovery/Disposal, 1999

Used Tyre Recovery **Tonnes** **%** Retreaders 74,015 Exports of used casings 10,000 UK part-worn market 32,392 Other reuse 20,000 **Total reuse 136,407 31.2** Materials recovery (crumb) 83,000 Energy recovery 70,000 Landfill engineering 31,000 **Total recycled 184,000 42.2** **Recovery Total 320,407 73.4** **Used Tyre Disposal** Landfill 73,500 Automotive shredder residue 46,850 Other/ Stockpile- 4,348 **Disposal Total 116,002 26.6** **Grand Total 436,409 100** *Source: UTWG*

Waste Arisings in London

The previous London Remade report estimated that the arisings for Greater London were 56,000 tonnes in 1998 (using population as a conversion factor). UK arisings were expected to continue to increase at 2% per year, but it was thought that figures for Greater London would remain more constant due to its relatively stable population base at that time. In fact, UTWG figures indicate that the UK figure fell by between 6% and 7% from 1998 to 1999. Assuming London's waste arisings fell at a similar rate then the figure for 1999 would be 52,000 tonnes. Also from a different angle, given UK waste tyre arisings of 436,400 tonnes in 1999 and the fact that London represents 12% of the UK's population then London's waste arisings, based on population, would be expected to be around 52,000 tonnes.

The Environment Agency's Strategic Waste Management Assessment 2000, London uses the number of licensed vehicles as the conversion factor rather than population. According to the EA figures, London accounted for 11% of the UK's total waste tyre arisings in 1998 (i.e. of 468,000 tonnes), equivalent to about 52,000 tonnes (based on the number of licensed vehicles); this suggests an estimate of 48,000 tonnes for 1999. The Environment Agency's estimates by

region, however, are based on licensed vehicles in England and Wales only while the tyre arisings figure is for the UK as a whole. Thus these figures are probably slightly inflated.

In 1998, there were 27.5 million licensed vehicles in Great Britain and 2.73 million in London i.e. close to 10% of the national total. Using the number of licensed vehicles as a conversion factor suggests that London would account for 10% of the total waste tyres arising in the UK as a whole representing around 45,000 tonnes in 1998/99. Assuming a recovery rate (i.e. re-use and recycling, see Table1.1) of at least 70%, in line with the UK as a whole, would suggest that the amount of recovered tyre rubber material coming from the London area should be over 30,000 tonnes and the amount of tyre rubber for crumbing and granulating at least 8,000 tonnes.

From this study the current estimate of tyre waste arisings in the London area is 45,000-50,000 tonnes p.a.

Projected Volumes

Nationally there has been an increase in car ownership over recent years, but in the London area there has been virtually no change. The number of vehicles licensed in London was 2.72 million in 1994 and in 1998 was 2.73 million. By contrast, licensed vehicles in Great Britain rose from 25.2 million in 1994 to 27.5 million in 1998. The net effect is that the number of vehicles registered in London has fallen as proportion of the total number of vehicles registered nationally from 10.8% in 1994 to 9.9% in 1998 (see Appendix 6). This may be due to increasing congestion and parking difficulties having a deterrent effect.

Between 1994 and 1998 the number of licensed vehicles in Great Britain rose by 2.3 million, about 2% p.a. If car ownership continues to rise at say 1.5% p.a. then by 2005 there would be 30.5 million licensed vehicles in Great Britain. Assuming London's car ownership remains at 2.7 million then its share of national car ownership will drop to 8.9% by 2005.

UK tyre arisings totalled over 467,000 tonnes in 1998 when car ownership was 27.5 million in Great Britain. If car ownership were to reach 30.5 million by 2005 and the tyre arisings were to rise accordingly then total waste tyre arisings would be expected to reach 520,000 tonnes. Given projected waste tyre arisings for the UK as a whole of 520,000 tonnes and London's proportion of national car ownership set to fall to 8.9% then London's tyre waste arisings would represent 45,000 tonnes by 2005.

The level of car ownership in London, and therefore tyre waste arisings, is expected to remain largely unchanged.

From this study the current estimate of projected tyre waste arisings in London is for volumes to remain at their current levels of 45,000-50,000 tonnes p.a.

Tyre Reprocessors

A database has been produced which lists companies, contact details and the findings of the telephone research undertaken to understand the current market position. As the database is large it has not been included here, but is available from London Remade.

One of the main issues affecting the disposal of used tyres in London is logistics, according to the Tyre Industry Council (TIC). There is currently plenty of landfill space available, but it is outside the London area and most waste goes to Kent or the Midlands. As new legislation comes into force, however, the situation will change. After 2003 whole tyres will no longer be accepted to landfill and after 2006 shredded tyres will no longer be accepted. Business and consumers are not yet ready to accept the increased cost of environmental disposal of used tyres and probably will not accept these costs until 2006 when there will not be any other option. There is already a problem in some areas of London with fly-tipping and this is likely to increase unless action is taken.

Retread Market

This market is well established in the London area. In 1999, the retread market accounted for 74,000 tonnes of used tyres i.e. 17% of total waste tyres by weight. Most retreaders are collectors of used tyres and because many of the tyres collected are unsuitable for retreading (or for resale as part-worns or export) they have to dispose of large numbers of used tyres. The leading collector/retreader in London is ETD in Edmonton. In addition, there are probably another 3 or 4 companies involved in collection/retreading/export of used tyres. Tyres which are unsuitable for re-use are shredded and either sent to landfill, or to a cement kiln or pyrolysis plant in the Midlands. ETD expressed the opinion that energy recovery/tyre derived fuel is the way forward in terms of environmental disposal.

Materials Recovery

The materials recovery market is expanding and (having risen from 48,600 to 83,000 tonnes from 1998 to 1999). However, a number of companies which had entered this market have gone out of business, including companies in the South East. The UTWG in its latest report expresses “some concern that growth is driven more by an ability to secure premises and equipment to carry out the process of shredding/granulating the tyre rather than an eye for any new end-use applications for the granulated product itself. As a consequence competition in this sector is fierce, with new entrants making it increasingly so.”

As with other reprocessing sectors, new capacity takes time to develop and funding is scarce. The tyre granulate end products tend to have a higher initial cost than their conventional counterparts and, although full life costs can be competitive, individuals do not look beyond the immediate costs of a product, this depresses demand.

The materials recovery market encompasses a wide range of many, mostly niche, markets. The UK market is still relatively undeveloped because demand for these products is limited. The number of granulators servicing this market therefore is fairly restricted. The larger ones tend to be vertical operations that supply in-house manufacturing facilities, e.g. Charles Lawrence Sports Surfaces.

There are a number of larger projects currently under consideration. These are probably more medium term opportunities being subject to approval by Government such as the use of rubber crumb in road surfacing and as a filler in concrete as discuss earlier.

While there is continuing strong interest by companies in materials recovery projects, and new mechanical shredding capacity is being developed, future

success will depend on the development of increased end uses for the tyre granulate. Unless this happens the result of new capacity in this sector might therefore be an increasing number of companies competing for the same end use markets.

The main market sectors in the UK are currently road surfacing, sports surfaces/play areas and carpet underlay. These sectors appear to be dominated by one major company plus several smaller companies competing for smaller projects/acting as middlemen between retreader/crumbers and end users. Most reprocessors address more than one market because demand is quite low and often seasonal (as is the case for most surfacing work). Table 14 provides an indication of how the market is made up. Please note these findings are based on relatively few interviews and the figures quoted are for illustration only.

Table 14 Material Recovery Market Sectors

Market sectorEstimated TonnesCompanies involved Road surfacing20,000Colas Sports surfaces/play areas20,000-25,000Charles Lawrence (plus Alruba, Enko, SRC)Carpet underlay15,000-20,000Duralay, Haslingden - crumbing carried out at Colway Tyres/Waste Tyre Solutions site in Durham (plus SRC)Other applications20,000**Total80,000**The main focus for this market should be to stimulate demand for products made using recovered tyres. Most tyre reprocessing companies are aware of the need for finding new markets for products incorporating recycled tyres.

It is unlikely that there will be a need for further shredding and crumbing capacity within the UK until market demand increases. The tyre reprocessing sector is not well represented in the London area. However, London will need a boost in the area of tyre recycling, and this could be given by attracting an established company to the London area who is already active in reprocessing and selling to end markets.

Energy Recovery

Energy recovery in the UK is either by incineration (and use for electricity generation) or as a fuel in cement kilns. Energy recovery accounted for 70,000 tonnes of waste tyres in 1999 - 50,000 tonnes by incineration and 20,000 tonnes as a fuel for cement kilns.

Sita Tyre Recycling took over operation of the tyre fuelled electricity generating plant in Wolverhampton in January 1999. Throughput was 50,000 tonnes in 1999 a fall from 66,000 tonnes in 1998. Potential capacity for the plant is rated at 80,000 tonnes of tyres a year.

There are two sites with full licences to burn tyres in cement kilns (Cauldon and Ketton) and applications for burning tyres at Westbury and Dunbar are under consideration. Cement kilns are widely distributed around the UK, and this offers the ability to handle the used tyres close to their point of arising. For both the reprocessor and its tyre suppliers, consistency and continuity of service are important. Large reprocessors rely on a significant throughput of tyres to keep their lines running, and the used tyre supply infrastructure established to maintain that throughput cannot easily accommodate that demand being switched on and off. The UTWG report highlights that the Westbury kiln took some 400,000 car tyres and 13,000 commercial vehicle tyres during trials last year but the complex supply arrangements put in place to meet that volume requirement were neither easy to establish nor to dismantle at the end of the trial period.

UTWG estimates put the likely capacity for cement kilns at 80,000 tonnes within the next couple of years based on those kilns which are already using tyres and those where trials are well advanced. There is a key difference between other

tyre reprocessors and cement kilns. Unlike tyre reprocessors, the core activity of cement kilns is cement production with used tyres improving competitiveness by reducing fuel input costs. They are not as reliant as other reprocessors on the income they receive for treating used tyres. It should also be noted that used tyres face competition for their use as fuel in kilns from other waste streams.

Other projects under development that could deliver additional recovery capacity include a gasification plant in Staffordshire (60,000 tonnes a year) and a pyrolysis plant at the Coalite site in Derbyshire (50 -60 tonnes per year).

There are no energy recovery sites in the London area. Owing to their large capacities and existing cement production, they have been sited in the Midlands.

The investment required for energy recovery plants is high and the main company, Sita, is operating below capacity. Future demand for tyre derived fuel is likely to come from cement kilns (and possibly in the longer term from pyrolysis plants).

End Users in London

A database was produced listing companies, contact details and the findings of the telephone research undertaken to understand the current market position. As the database is large it has not been included here, but is available from London Remade.

This research has been focused on some of the markets for tyres. In particular, the use of:

- tyres for rubberised asphalt and civil engineering uses;
- tyres for rubber polymer blend products such as carpeting.

Existing Market for Asphalt

Asphalt is widely and regularly used for highway construction and maintenance. Figures supplied by Quarry Products Association show tonnes of asphalt used in London last year:

- 1.5 million tonnes of asphalt were used in Greater London last year
- 0.5 million tonnes of which was used in the construction of the surface layer (the layer in which recycled rubber can be incorporated)

Potential to Use Rubberised Asphalt

The application of rubberised asphalt in the UK is still at a trial stage. At present there is no market for rubberised asphalt as trials are still in early stages (see Table 15). If the trials that are being conducted by Colas and the Highways Agency are successful then it is likely that rubberised asphalt will be certified for general use and new specifications produced. New European Standards (CEN Standards) which set out specifications for end uses for crumbed rubber such as in asphalt should be available in Mid-2002.

Some of the road surfacing contractors that operate in London felt that once the new specifications were released the London Boroughs would need to be convinced that the new product was equally acceptable as standard asphalt before they would specify it use to their contractors.

London Remade could play a key role in the raising the awareness of London Boroughs to the benefits and opportunities for using asphalt containing recovered tyres in new road surfaces. Environmental advantages of recycling rubber from tyres include limiting the use of natural resources. It also disposes of tyres in an energy efficient and environmentally clean way. Incorporating recycled rubber in asphalt can also improve the performance of the road surface, some of the benefits are listed below:

- Resistance to oxidation, therefore fewer ruts, potholes and cracks in the surface.
- Long lasting.
- Increased elasticity.
- Increased temperature range.
- Reduction of traffic noise.
- Easy to lay and replace.
- Reduced glare when wet due to high carbon content of tyres.
- Full life costs are competitive with conventional counterparts.

By extrapolating the figures of tonnes of asphalt used in London last year (see above) it is possible to estimate the potential demand for rubber incorporated in asphalt in London. For example, if only half the London Boroughs decided to use rubberised asphalt the following tonnage of recycled tyre crumb would be required in London alone:

- ARC (asphalt rubberised concrete) 45,000 - 65,000 tonnes of rubber crumb
- RUMAC (rubber modified asphalt concrete) 5000 - 12,500 tonnes of rubber crumb

Existing market for sports and safety surfaces

The market for sports and safety surface is well established and serviced. There are a number of companies in the UK using recycled rubber tyre for surfacing products such as play and sport ground surfaces, although all of the companies identified are established outside of London. According to the Sports Industry Federation (SIF) the market for sports surfaces is larger than the market for play surfaces.

Potential markets for sport and safety surfaces

The UK market for sports and safety surfaces is small, and estimated to be in the region of £20 million. Charles Lawrence Ltd currently dominates the market for recycled rubber surfacing products although there are a number of smaller companies manufacturing safety and sports surfaces using recycled rubber. Enko Products, produces a range of products including underlay shock pads and rubber safety tiles. The safety surfaces generally contain between 95 - 100% recycled rubber.

The main barriers to the development of these markets for recycled rubber by London Remade include:

- the relatively small market size compared to the potential market for road surfaces;
- the higher initial cost of recycled rubber granules compared to virgin;
- the domination of the market by a few large companies;
- The location of manufacturing facilities outside London.

Therefore the opportunities to expand in this area are limited and subject to competition from the existing manufacturing base. However, a there may be the opportunity to develop an interesting local demonstration project within London Remade probably in conjunction with an existing manufacturer/ reprocessor.

Existing market for underlay

The UK underlay market is fragmented as there are many small, one-man operations producing small amounts of felt underlay. As discussed previously under the plastics section, the carpet market in the UK has declined since the beginning of the 1990's, but it is still of considerable value, with retail sales worth an estimated £1.64bn in 1999.

Potential markets for underlay

Duralay presently dominates the market for recycled rubber underlay. Only one of its competitors uses recycled rubber in its underlay range, and this is on a very small scale. While the underlay industry using virgin raw materials seems to be declining, Duralay sales of recycled rubber underlay are increasing. The underlay produced is the top of the range product because of the high rubber content - generally recycled tyre underlay contains approx. 90% natural rubber.

London Remade have the opportunity to develop the market for recycled rubber in underlay. However, the manufacturing base for this product is predominately based in the North of England and tends to be located near reprocessing facilities. The main opportunity for London Remade is to promote the use of underlay containing recycled rubber.

Trials

Road and Civil Engineering research institutes are continuing research into construction applications that utilise tyres and recycled rubber to ensure that they are appropriate and durable for their intended use and do not impact negatively upon the environment.

The trials required to prove that road surfaces using rubber is a viable option are still on going. In the future it appears that London Authorities will need to be persuaded of the benefits of specifying recycled rubber in road surfaces.

Table 15 Rubber Crumb Trials

Aggregate/Filler replacement in concrete Highways Agency and DEFRA are contributing to two studies looking at the materials recycling sector. The first relates to the use of crumb in roads. The Highways Agency is hopeful that the study will demonstrate that this use is not only a good option when it comes to putting the road surface down, but also when it comes to replacing that surface, as roads inevitably only have a finite life. The surface needs to be easily stripped off at the end of its life - safely and economically. The second study relates to the use of rubber crumb as an aggregate or filler replacement in concrete. Both of these applications could potentially create very significant rubber crumb demand and the Group views this as a future key recovery route. **Road surfacing**A road surface containing rubber crumb was laid in Surrey in June 1999. The surface has now experienced both summer and winter use, and is performing well. The Highways Agency are hopeful that by the end of the trial period there will be a number of further trial stretches of roads containing rubber crumb in other parts of the country being evaluated. If successful, it is likely that the material would then be certified for general use. Concerns centre on ease of removing the surface at a later date and the fact that costs are much higher - 20% higher quoted (though the life of the road is also said to be 20% longer and there are other benefits in terms of reduced road noise). **Road surfacing**Nottingham University's School of Engineering in conjunction with the Highways Agency is also conducting trials on the incorporation of rubber crumb into road surface. These trials are currently still laboratory based but a trial application is planned for the near future. Two early outcomes from the trial are: Only industrial (truck and tractor) tyres with a high natural rubber content are suitable for reprocessing. Normal car tyres have a lower natural rubber content and therefore produce a sub-standard product. The cost of producing rubber crumb is very high. Source: John Murther, Highways Agency, a member of the trials steering group**Road surfacing**Liverpool University's School of Engineering is also conducting laboratory trials on 'wet pour' rubberised asphalt.**Carpet Underlay**Duralay from Haslingden, Lancashire utilise rubber crumb to manufacture their range of crumb rubber underlay. They are actively promoting using crumb rubber in underlay as currently they command 7-8% of the UK's domestic underlay market. They installed a plant in the early 1990's in Durham on the same site as Colway tyres, one of the largest tyre retreaders in the UK. Tyres rejected by Colway as unsuitable for retreading are ground to rubber crumb via an Eldam and Blackfriars automated granulator. The plant granulates 14,500 tonnes of crumb per annum, which accounts for 2.25 million passenger tyres that would otherwise go to landfill. Tyres are manufactured from high quality rubber compounds. Thus using high percentages of recycled crumb rubber in underlay manufacture provides performance benefits for example high degree of sound impact, heat insulation and durability in a range of domestic/contract applications.

Appendix 1: STRUCTURE of THE project

This project was instigated in response to discussions between London Remade and Enviros to meet London Remade's desire to research and documents that outline the 'Recycling Market Opportunities' in London.

The purpose of this work was to provide critical information for potential inward investment or local business interests seeking to explore the potential opportunities for developing a recycling related business in the Thames Gateway project area. The primary market information on each material is intended to describe the existing and potential market(s) in the Greater London area i.e. the market size, value and possible segmentation. This will provide business with

the intelligence to estimate the opportunities that exist in there area of interest or for their specific operation.

In addition, to the potential market(s) information, this work was also attempts to estimate the current and projected (to 2010) tonnage's of specific materials recovered from the London waste stream.

This work was intended to achieve the following:

To support London Remade's efforts to market the opportunities that exist for processors and end users. This report summarises the information that has been collected to allow potential investors and other interested parties access to information concerning:

- existing and developing sources of material;
- existing, emerging and potential end-use applications for specific materials derived from the London waste stream.

To present to existing and potential waste material re-processors and collectors information concerning existing, developing and future markets for recyclables.

In addition the information could be potentially be used to support London Remade's strategic planning initiative - by highlighting market opportunities.

Separately, pamphlets have been produced summarising the position on some of the materials studied. These were intended to describe the potential markets for selected waste derived materials and the opportunities that may be economically and commercially attractive to interested parties.

Scope

The work has primarily focused on the Greater London area, within the M25. For some of the data, it has been necessary to widen that boundary to determine the situation in the south of England or even to look at the national picture.

From discussions between London Remade and Enviros it was agree that the focus for this project would cover:

- Plastics
- Tyres
- Waste Electrical & Electronic Equipment (WEEE)

The definition of end-user markets used within this report includes any operation that will take waste derived materials as a substitute for raw materials in their services or products - with or without the intervention of a reprocessor. An example of an end-user would be a plastic goods manufacturer, but not the purchasers of those plastic goods manufactured with a recycled content.

In addition, this report attempts to identify any new/emerging end-use markets which would potentially be relevant in Greater London.

Project Methodology

The following tasks were carried out for each material and the findings are presented within this report. However, because of the nature of the targeted materials, certain variations will be made on a material specific basis.

Task One

For each material, the various alternative markets which have proven economically and environmentally viable were investigated. This information sets out to describe the various commercial applications that have been developed in the UK and other countries.

Task Two

For each material the processing techniques and technologies have been investigated and defined.

Task Three

The priority to be given to potential markets identified under Task One was determined through discussion with London Remade with the aim of identifying opportunities with the greatest potential for Greater London. Later work was focussed on these priorities.

Task Four

The current and projected volumes of recovered materials were estimated using existing data, such as the London Remade Prioritisation Study, the Environment Agency's Strategic Waste Management Assessment: 2000 and Government's Waste Strategy 2000.

Task Five

An analysis of current activities in the potential market areas highlighted in Task Three was undertaken. In particular this included:

Part One - Identification of companies in the Greater London area which are or could reprocess one or more of the materials being examined and those which service the end-user markets identified.

A selection of these companies where contacted to ascertain:

- the quantity (in tonnes) of material processed;
- the end-use markets serviced;
- current and planned processing capacity;
- interest in diversifying their markets;
- if support was required to assist them in maximising their potential to exploit their existing and new markets for recycled materials.

Part Two - Identification of companies in the Greater London area who are or could be end-users of waste derived materials being examined.

A selection of these companies were contacted to ascertain:

- the current consumption of recycled materials in their products and services
- the perceived potential to include recycled materials in their products and services;
- the barriers to uptake of recycled materials in their products and services;
- if support was required to assist them in developing their products and services to take advantage of recycled materials.

All information received was recorded on a simple spreadsheet.

Task Six

Writing pamphlets which could be used by London Remade for promotional purposes. The intention was that :

- the content of the pamphlets would depend on the material concerned.
- the pamphlets should attract the attention of businesses and encourage a more serious exploration of the commercial opportunities offered through London Remade.

Any issues identified during the previous tasks were highlighted, such as gaps in the supply chain and market opportunities for both re-processors and end-users. Also, problems with the supply chain were identified and reported as appropriate, e.g. where material (i.e. waste) supply is restricting market growth.

Task Seven

This report constitutes the final report summarising the findings of the market research undertaken and presenting the market data in detail for future use.

Appendix 2: References

Ref. 1: Tyres3.htm - Waste Watch Information Sheet: Car Recycling has section on Tyres.

Ref. 2: Feasibility Report (tyres).doc - tyre reprocessing prepared for Clean Merseyside Centre (February 2001).
Ref. 3: TyresWW.htm - Waste Watch Information Sheet: Scrap Tyres covers options for used tyres including processes involved and UK activities.
Ref. 4: Utwgreport2000.doc - Fourth annual report prepared by Government/Industry Used Tyre Working Group (June 2000).
Ref. 5: Rubber and tyres.htm - Sheet 47 Rubber and tyres from web site of ETRA (European Tyre Recycling Association) covers material recovery, energy recovery and pyrolysis. Also available Sheet 190 Conversion to energy.

Appendix 3: Equipment & Costs for recycling TYRES

Equipment used in the recycling of tyres (Ref 7) is briefly described below:

Shredder and granulators

Shredders reduce material bulk, while granulators prepare material for re-use. Shredders tend to be used to reduce bulk so the material can then be granulated to produce a smaller more consistent sized product. If feedstock material is pre-shredded, the granulator need not be as powerful or grind for as long, so it can make economic sense to use a shredder and a granulator for some operations. Using a smaller granulator would also reduce start-up and operating costs, as well as reducing the amount of time material spends in the granulator cutting chamber, reducing wear and fines. According to figures produced by one supplier, pre-shredding can also extend the life of knives by 50 - 100%.

Hammer mills

These are the most heavy-duty shredders below fragmentiser mill size, and the prices reflect this (£100,000+). Their technology is single shaft and based on 'hammers on a spider rope', or heavy beaters at the end of a criss-cross rotor. Essentially this processes uses high-speed impact to break material down, rather than shears to tear it apart. They can cope with metals and other heavy material, such as tree trunks, or wood containing nails etc. Although expensive, they are durable.

Single shaft rotary shredders

These use knives rather than hammers and come in a range of sizes: the largest can cope with complete tyres and cable. Rotary shears operate at lower speeds than hammer mills, but offer a high level of torque. Different sized knives are used depending on the size reduction required, and are more widely spaced than in a typical granulator. Single-shaft rotary shredders' main advantage lies in their versatility: they can handle virtually anything (e.g. plastics, wood, tyre pieces), but their major disadvantage is that they do tend to become hot. Prices are £150,000+.

Contra-rotating shredders

Again, these are versatile shredders that can handle a wide range of materials (e.g. tyres, plastic drums). As the name suggests the consist of two or more shafts rotating against each other. There can be problems with large pieces of material being forced between the shafts, distorting them. However this can be overcome by the use of a lid or hopper. Due the differences in size, power, number of shafts and knives, prices can range from £15,000-70,000 and higher.

Granulators

The technique is basic but the variety of granulators on the market is huge: ranging in size, power, number of knives. Essentially rotating blades on (usually) a single rotor cut against 'bed' (i.e. fixed) knives, with a screen below determining the size of the granulate. Only material small enough to fall through the screen holes passes though

the system: the remainder stays in the cutting chamber until it cut down to a small enough size. If different sized screens are to be used to produce varying granule size, then the speed of screen changes may be an important consideration. The number of knives on both the rotor and the 'bed' varies, and the rotor can be open or closed. An average sized granulator would tend to have c. 400mm x 500mm throat, three rotating knives and two bed knives. Sizes do vary from around 170mm x 220mm to 800mm x 1000mm. These machines can become hot due to their speed. Prices are around £20,000.

Hogger

These are similar to granulators, but the knives tend to be smaller and closer together. They are not as high speed as granulators and so don't become as hot and are usually cheaper at c. £9000.

Appendix 4: Task 4 Conversion Factors

Details of conversion factors used in making estimates for current and projected London volumes based on national waste arisings.

Car Ownership

Nationally there has been an increase in car ownership over recent years but in the London area there has been virtually no change, see Table A. The net effect is that the number of vehicles registered in London has fallen as proportion of the total number of vehicles registered nationally. This may be due to increasing congestion and parking difficulties having a deterrent effect.

Table A Licensed Vehicles, millions

YearLondonGBLondon as % of GB19942.7225.210.819952.6825.410.619962.7226.310.319972.7227.010.119982.7327.59.9*Source: Driver Vehicle Licensing Agency*The number of households without a car is much higher in London than elsewhere in Great Britain (39% compared to 30% for GB and just 20% for the rest of the South East), see Table B. In London, multiple car ownership is lower than the national average (16% compared to 25%) and considerably lower than the rest of the South East (with 33%).

Table B Percentage of Households with Cars (1996-98)

RegionNo CarOne CarTwo CarsThree or More London3944142Rest of South East2047276GB3045214*Source: DETR****Population***

The UK's population is projected to increase gradually from an estimated 59.2 million in 1998 to reach 63.6 million by 2021 (Table C). This is equivalent to an annual average growth rate of 0.3%. The combined population of England and Wales was 52.4 million in 1998 accounting for 88.5% of the total UK population and their share of the UK's population is expected to rise slightly to 89.2% by 2021.

The population in London was 7.2 million in 1998 representing 12.2% of the UK, 12.5% of Great Britain and 13.7% of England and Wales.

Table C UK Population Trends (Thousands)

Country1998200120112021 England4949550187519225371 5Wales2933295029933047Scotland5120510950875058N. Ireland1689170817711821**UK59,23759,95461,77363,641***Source: Government Actuary's Department*In 1999, the population of London was 7,285,000 and the UK's population was 59,954,000 (and therefore London's share remained at 12.2%), see Table D. London's population is set to rise to 7.7 million by 2021 (still 12.2% of UK).

Table D London's Population Trends (Thousands)

Year1999200120062011201620 21 London7,2857,2157,3377,4707,6097,736UK59,50159,95460,86061,77362,72963,641London as % of UK12.212.012.112.112.112.2***Number of Households***

According to ONS data, there are 2,925,000 households in London and 24,554,000 households in the UK as a whole (Spring 2000).

According to DETR data, there were 3,061,000 households in London in 1998 and this figure was set to increase to 3,128,000 by 2001, a rise of 2% over the three years (or 0.07% pa), see Table E. Household numbers in the London area are projected to grow from just over 3 million in 1998 to 3.6 million by 2021, an increase of 19%. Household numbers for England are projected to grow at slightly below this figure from 20.5 million to 24 million over the same period, a rise of nearly 17%.

Table E Household Numbers and Projections, Thousands

YearLondonEngland19983,06120,54020013,12820,99220063,24521,73320113,37722.51920163,52023,31320213,64524,000*Source: DETR*

Gross Domestic Product

Table F GDP by Industry Group, 1997

Industry GroupUKLondonLondon as % of UK£ million%£ million%Agriculture10,5951.544-0.4Mining & quarrying4,0030.52030.25.1Manufacturing148,61921.312,49011.58.4Electricity, gas & water16,2302.31,6031.59.9Construction36,9275.34,5564.211.4Distribution, hotels & catering, repairs108,45015.518,34716.916.9Transport & communications57,9168.310,99510.119.0Financial/business services*158,48522.735,97833.122.7Public admin & defence38,1015.45,0704.713.3Education & health85,16212.311,49110.613.5Other services34,5674.97,8687.222.8**Total699,055100108,64510015.5**** includes adjustment for financial servicesSource: Office for National Statistics, Region in Figures - London***Table I GDP by Selected Regions, 1999**

RegionGDPUK (=100%)£771.9 billionLondon15.9%South East15.8%East10.6%North West10.0%England85.5%Wales4.0%Scotland8.3%Northern Ireland2.2%*Source: ONS*