CENTRE FOR REMANUFACTURING & REUSE

Market Failures in Remanufacturing

An examination against major categories by Centre for Remanufacturing & Reuse

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About the CRR:

- The Centre for Remanufacturing and Reuse (CRR) was established in 2006 to support and promote, where appropriate, the activities of product remanufacturing and reuse.
- The CRR is funded by Defra (the UK Government's Department for the Environment, Food & Rural Affairs).
- Remanufacturing is the process of bringing End-of-Life products back to life by repairing, refurbishing, upgrading and/or replacing parts. Remanufactured products are provided with a warranty matching that of a new product, ensuring customer confidence.
- The CRR's website www.remanufacturing.org.uk provides comprehensive and free interactive information, including:
    - who is remanufacturing
    - what products can be remanufactured
    - how to remanufacture
    - the benefits of remanufacturing
- The CRR is managed by Oakdene Hollins Ltd, a clean technology and resource management consultancy based in Aylesbury, Buckinghamshire. www.oakdenehollins.co.uk
- The CRR believes that product remanufacturing and reuse (r&r):
    - is vital to the conservation of resources including materials and energy
    - presents benefits to both the environment and businesses
    - boosts skills, employment and economic activity in the UK.

Printed on recycled paper

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Glossary

BERR	Department for Business Enterprise and Regulatory Reform
CRR	Centre for Remanufacturing and Reuse
Defra	Department for Environment, Food and Rural Affairs
DTI	Department for Trade and Industry
ECA	Enhanced Capital Allowances
FA	Final Assembler
FER	Federation of Engine Re-manufacturers
IPR	Intellectual Property Rights
OEM	Original Equipment Manufacturer
OECD	Organisation for Economic Co-operation and Development
WRAP	Waste & Resources Action Programme

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Executive Summary

Remanufacturing, the manufacturing process of returning used products to as-new condition or better, has an estimated UK turnover of £5bn and employs 50,000 people. In 2009 the industry generated CO_2e savings of 10 million tonnes and there is potential to contribute towards over 800 million tonnes of cumulative savings by 2050. However a number of market failures for remanufacturing could limit its uptake.

The causes of market failure identified are transaction costs, information failures, externalities (climate change, technological and consumption) and market power. Additionally some existing policies act as barriers for the greater adoption of remanufacturing and thus need to be reformed.

A wide variety of measures to mitigate the market failures are suggested; some could be led by the market but supported by intervention (M) and others would need to be led by government policy (G). These are outlined below:

1. Transaction costs:
   - incentivise return of products (M)
   - web exchanges to link buyers & sellers (M)
   - subsidies for remanufacturing (G)
   - capital grants (G)
   - VAT rebates (G)

2. Information failures:
   - warranties (M)
   - long-term contracts (M)
   - creating standards (M)
   - certification schemes (M)
   - provide or subsidise testing facilities (G)
   - penalising miss-sellers (G)
   - provision of information (G or M)

3. Externalities:
   - strengthen underlying signals of externalities pricing (G)
   - modular design and open standards (M)
   - provision of information (G or M)
   - supply chain initiatives to encourage whole life management (G & M)

4. Market power:
   - national competition policy (G)

Some of the suggested measures are currently underway; notably the creation of standards, the provision of information and the offering of warranties, but other actions are not currently in progress.

1 Introduction

This report assesses the market failures relevant to the remanufacturing of used products. As way of introduction it is first necessary to introduce the concepts of remanufacturing and market failure, and to discuss the role of policy in mitigating market failure.

1.1 What is remanufacturing?

This section, outlining the concept of remanufacturing, draws upon the existing report Oakdene Hollins (2008), "A review of policy options for promoting remanufacturing in the UK".

Remanufacturing has been practised for at least 100 years in the UK. It is estimated that its turnover value could be as high as £5bn, employing around 50,000 people[a]. Remanufacturing activities are concentrated within the aerospace, automotive and defence sectors.

Remanufacturing is a process similar to manufacturing. The starting point is a product comprising components, that has reached the end of its useful life (i.e. it no longer performs the function it was designed for), but which may not yet be defined as 'waste'. The failed or worn components of the product can be remanufactured, repaired or replaced so that the utility value of the whole is restored. Remanufacturing therefore resurrects the functionality of the product with minimised energy and virgin material inputs. Hence it can be seen as a transformative process: used products are turned into useful components that are then reassembled[b]. To that extent it is more likely to see remanufacturing in respect of complex products comprising different parts and materials[c].

There is a considerable quantity of literature about the key ingredients of a successful remanufacturing operation:

a Oakdene Hollins (2004)

b Nakajima (2000)

c Tojo (2001)

- **A supply of returned products**, sometimes termed 'core'. A successful remanufacturing operation requires a regular flow of returns, which themselves must be of sufficient quality to be remanufactured successfully.
- A **collection and recovery process** and infrastructure in place that involves careful **deconstruction and/or sorting**. This process is likely to be more labour and capital intensive than that currently employed in relation to recycling, because the potential functionality of the product needs to be preserved.
- Inspection, disassembly, cleaning and reassembly by **skilled personnel** which enables malfunctioning or worn components to be identified and remanufactured. This requires a good understanding of the product and access to a manufacturing/engineering skills base.
- Market demand at a **price** that reflects the cost of remanufacturing but which is still competitive in comparison to a new product. Typically remanufactured products sell at a price at least 20% and maybe 50% less than brand new products[a].
- There is **customer acceptability** of remanufactured products, which must demonstrably deliver a required functionality.

The activities identified as remanufacture appear to be organised in one of three ways:

- By the original equipment manufacturer (OEM) or final assembler (FA). The OEM/FA organises collection and recovery of returns, undertakes disassembly and reassembly and re-selling. The relationship between user/customer does not end with a sale but is developed over the life of the product. Caterpillar operates a good example of this, whereby the customer trades in products to dealers at the end of their useful lives, or subscribes to a through-life maintenance programme centred on the use of remanufactured components.
- By the market. The market organises remanufacturing as a separate activity via independent third party remanufacturers. A good example is the automotive sector, in which remanufacturing of components is commonplace and there is a market-organised system of recovery of used products.
- A hybrid model in which the OEM/FA and an independent third party remanufacturer maybe tied by contracts, or accredited or licensed (e.g. Nortel and Paragon in respect of telephonic equipment).

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a Business Week (2005)

1.2 What are market failures?

Market failure is a term used in economics to refer to a situation where the market has not, and cannot by itself be expected to deliver an efficient outcome[a].

In general terms there are a number of possible market failures that might prevent a market from operating efficiently and often a market may experience multiple market failures. The major sources of market failure are public goods, externalities, imperfect or asymmetric information, increasing returns and market power as listed in Table 1. Additionally there may be a number of characteristics in a market that may not cause a market to fail, but could amplify the failings within a market and therefore deserve discussion alongside market failures. Such characteristics include transactions costs and risk aversion.

Table 1: Major Sources of market failure

Failure	Definition	Examples
Public Goods	Goods which are non-rival and non-excludable	Defence, Police, Medical Care, Public health
Externalities	Actions of individuals or firms affect others but the cost or benefit of this is not reflected in the value of the transactions	Pollution, road congestion, intellectual property
Imperfect information and Asymmetric information	Transactions where the parties (e.g. buyer and seller) have different sets of information; or where individuals often do not have good information about risk	Dentistry, legal services, second hand cars, insurance, personal behaviours that may be detrimental to health
Increasing returns	Average cost decreases as output increases	Natural monopolies
Market power	One or a few buyers or sellers have sufficient market power to influence prices	Monopolies; single buyers, cartels

Source: BERR, available at http://www.berr.gov.uk/files/file44550.pdf

a HM Treasury (2009)

1.3 What is the role of policy?

Market failure is often put forward as a justification of government intervention in markets to improve their efficiency, (although governments may also choose to intervene on equity grounds[a]).

Policy instruments can be economic e.g. subsidies, taxes, tradable permits etc. or non-economic e.g. regulation and public provision. In theory economic instruments and regulation can be used to achieve the same outcome but that is not necessarily the case in practice[b]. Economic instruments are often more efficient since they minimise the abatement costs and provide a continuous incentive to innovate, but they must be set at the right level or they will be ineffective[c] (the right level is often difficult to determine in practice). Regulation on the other hand can specify exact conditions. Where there are multiple market failures, a combination of policy instruments may be appropriate as no single one will be able to effectively address the market failures and other barriers to efficiency[d.]

It is important to consider carefully a number of other elements when devising policy. This is to avoid so-called 'government failure', which is where the policies fail to correct the market failure or even make the problems worse. The OECD has set out seven criteria[e] for the development of useful, and hopefully successful, policy instruments:

- Environmental effectiveness: The environmental damage is prevented or mitigated.
- Economic efficiency: Cost effectiveness in achieving the given level of abatement
- Administration and compliance costs: Minimising these as they absorb potentially productive resources.
- Revenues: Generation of or reductions in expenditures
- Wider economic effects: Inflation, employment growth etc.
- Soft effects: Changes in attitudes and awareness. These issues are increasingly seen as important in order to deliver changes in behaviourf.
- Dynamic effects and innovation: Ensuring that innovation is promoted or at least not stifled.

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[a] HM Treasury, (2009)

b Gruber (2007)

[c] Mickwitz et al (2008)

[d] Defra (2010b)

[e] OECD (1997)

f Defra (2010a)

2 Market failures in remanufacturing

2.1 Overview

The OECD's report "Improving Recycling Markets" gives an analysis of the main causes of market inefficiency for recycling markets. These include transaction costs, information failures, externalities (technological and consumption) and market power as shown in Table 2. These market inefficiencies are all of relevance to remanufacturing, which in many respects is like a secondary material. Each of the market failures will be discussed in turn in the following sections.

Table 2: Potential sources of market inefficiency in recycling markets

Causes of market inefficiency	Explanation
Transaction costs in secondary market materials	Arises from the diffuse and irregular nature of waste generation. May also arise from the heterogeneous nature of secondary materials.
Information failures in relation to waste quality	Arises from the difficulty of buyers to detect waste quality and the relative ease with which sellers can conceal inferior quality waste.
Consumption externalities and risk aversion	Perceived costs associated with the quality of final goods derived from secondary materials relative to those derived from virgin materials.
Technological externalities related to products	Complexity of recycling due to the technical characteristics of the recyclable material and products from which secondary materials are derived.
Market power in primary and secondary markets	Substitution between primary and recyclable materials may be restricted due to imperfect competition and strategic behaviour on the part of firms.

Source: OECD, Improving Recycling Markets (2006), Table 1.3 p20

2.2 Transaction costs

An often mentioned barrier to the adoption of remanufacturing is that of high transaction costs. Transaction costs occur whenever there are frictions in the market that prevent costless transactions. These frictions include costs involved in price discovery, searching for buyers/sellers, administration or negotiating and

bargaining[a]. It should be stated at this stage that high transaction costs are not in themselves necessarily a market failure. In some cases high transaction costs might relate specifically to a type of market failure such as the cost of obtaining information in the presence of asymmetric information or because of technological externalities. However high transaction costs need not be a consequence of market failure, but instead may be an inherent feature in the market, although if transaction costs are prohibitively high then the market will not exist.

For remanufacturing the transaction costs relate to the cost of collecting and sorting of used products that arise diffusely and irregularly. For many firms the collection of products, often termed 'reverse logistics', is outside their competencies. The prevalent logistics supply chain is geared towards one-way movement from manufacturer to customer i.e. from a single point to many points[b]. The cost and the availability of storage space for unpredictable amounts of product returns are also important[c]. More importantly perhaps, there may be a limited quantity of returned product or 'core'[d], partly because there may be insufficient incentives for the user to return an item.

2.3 Information Failures

A key concern relating to remanufacturing markets is that of the provision of information. Information is critical for the efficient functioning of markets to ensure that effective choices are made. Without reliable information behaviours and actions that have positive economic or environmental impacts may be missed[e].

There are a number of conditions that are necessary for effective choices. These include that information must be either readily available or at a cheap cost and the individuals must be able to process it[f]. Typically conventional economics assumes that individuals are always able to process information, but behavioural economics has shown that this is not the case especially where information is complex or there are considerable uncertainties[g]. Another issue in consumer choice relates to the cost of choosing badly. If this is high, such as where there are issues relating to safety, then individuals have been shown to be highly risk averse.

A common problem is that information is asymmetrically distributed, typically with the seller of the product having more information on the quality of the product than the buyer. The effect of asymmetric information is that it can greatly increase the

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[a] OECD (2006)
[b] Oakdene Hollins (2008)
[c] King & Burgess (2005)
[d] Slowinski (1998)
[e] Defra (2010b)
[f] Simon (1955)
[g] Bernheim & Rangel (2003)

costs of transaction or lead to the breakdown of the market except for the lowest qualities. This result was illustrated by Akerlof's Nobel Prize paper "The market for 'Lemons': quality uncertainty and the market mechanism" (1970). In his model there are different qualities of cars that are available to trade, the proportions of which are common knowledge to all market participants. It is always efficient for trade to occur as the potential buyers value a given quality more than sellers. A problem arises however because the seller knows the quality of the car that they are offering but the buyer does not. Sellers therefore have incentives to offer low quality cars. Consequently buyers will reduce what they are willing to pay, and this leads to a reduction in the qualities offered because sellers are unable to achieve high prices for high qualities. The net result is that only low quality products are traded (unless there are large differences between buyer and seller valuations).

The severity of the problem of asymmetric information will vary. Where transactions are infrequent the severity is likely to be much greater as reputational effects for companies are unimportant[a]. Kerton and Bodell (1995) offer a number of factors that influence the incentives suppliers have to place low quality products onto the market. These include the cost of concealment, the cost of mitigating low quality, cost of detection and the implications of detection. Where the cost of concealment is low, the cost of detection high and the implications of detection low, there are much greater incentives to conceal quality. If the cost of mitigating the low quality is low then sellers will have little incentive not to mitigate it. Together these factors all relate to the cost to buyers of obtaining the necessary information. If it is possible to obtain the relevant information then the effect of asymmetric information is ultimately one of increasing the cost of transactions.

The application of asymmetric information to remanufactured products is relatively straightforward. The seller in general possesses much greater knowledge regarding a product as he has repaired it and replaced component parts. However the buyer is unable to verify the quality of the product. The concept may also be of relevance when remanufacturers purchase used products from a separate collector or broker.

2.4 Externalities

Another considerable form of market failure is that of externalities. Externalities occur when the actions of individuals or firms affect others but the cost or benefit of this is not reflected in the value of the transactions. Externalities are widespread and pervasive both generally and for remanufacturing in particular. Three types of externalities that are thought to be important for remanufacturing[b] are considered in this section:

[a] OECD (2006)

[b] OECD (2006)

- Climate change externalities
- Technological externalities
- Consumption externalities

The first and perhaps most obvious externality is the failure to account for the effects of climate change during transactions. This leads to a bias towards the production of higher carbon products and activities. This of course is a problem that is not unique to remanufacturing but its relevance here is that remanufacturing is a process that leads to carbon savings. The total carbon savings attributed to remanufacturing in the UK in 2009 was 10 million tonnes CO_{2e}[a]. The textile and construction sectors dominated the estimated CO_{2e} savings but a number of different sectors are represented as shown in

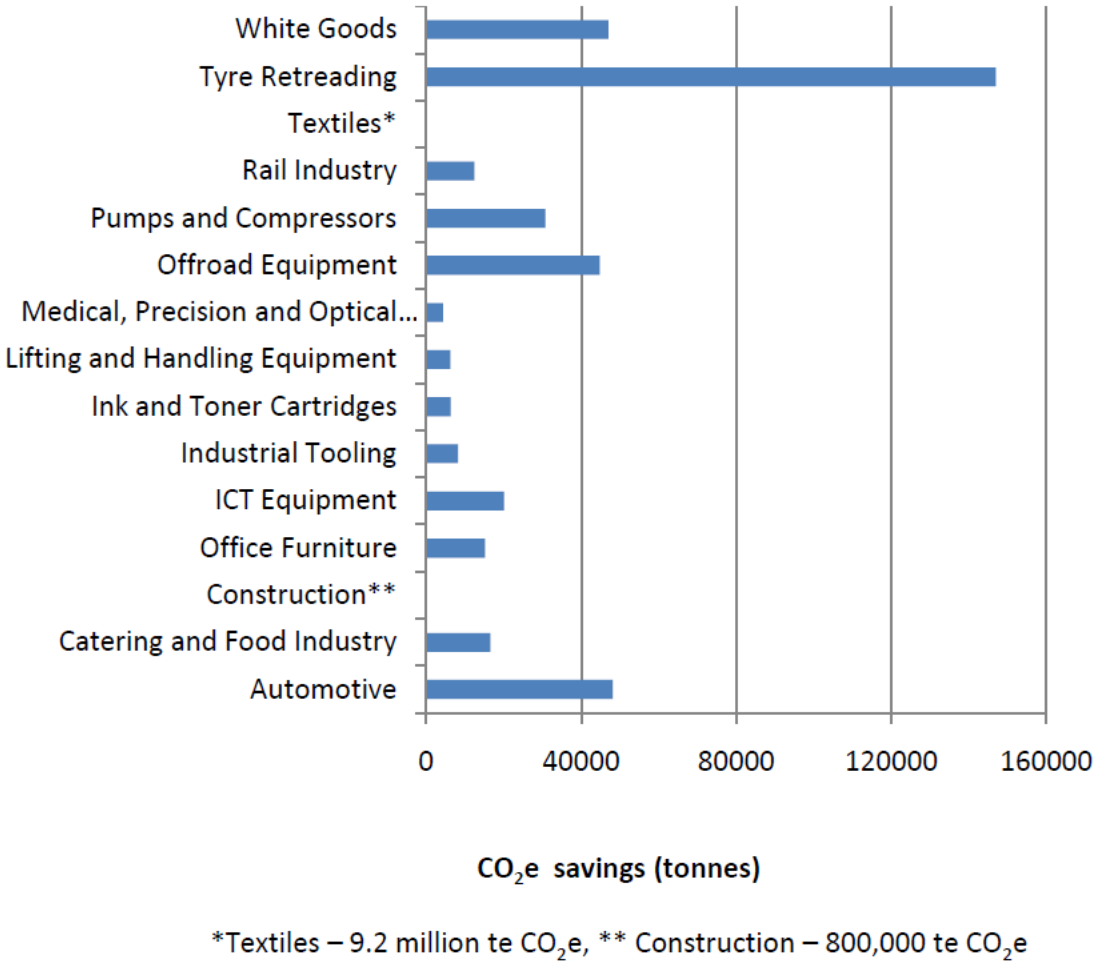
[a] Oakdene Hollins (2009)

Figure 1.

The potential contribution of remanufacturing in meeting carbon targets has been investigated by WRAP (2009). "Lifetime optimisation" (ensuring that products are used by households for their full useful life) was estimated to have the potential to reduce cumulative greenhouse gas emissions by 800 million tonnes by 2050, and the "restorative economy" (extending the life of products by improving product durability) had similar potential[a]. It was noted that these two areas overlapped and complemented one another but these measures were estimated to have amongst the largest potential carbon savings of the potential actions considered.

[a] WRAP (2009)

Figure 1: Comparison of savings of CO_2e by sector



Source: Oakdene Hollins (2009), p22

Another type of externality relates to the many layers of supply chains, where there are often conflicting incentives between organisations, which are not captured within transactions. The construction sector supply chain illustrates some of the externality issues involved in supply chains. Here, the main stages are manufacturer to wholesaler to builder/contractor, architect/consultant and on to the final client as shown in the simplified diagram given in Figure 2. Problems arise however because the different actors in the supply chain have differing incentives and objectives. For example with lighting systems, wholesalers are interested in the ease of storage, electricians consider reliability, builders consider the cost; consultants might look at performance, architects at aesthetics and the

final client at energy efficiency[a]. Consequently manufacturers must make allowances in their design for each of these considerations.

Figure 2: Simplified supply chain for the construction industry

For remanufacturing the main issues are the technological externalities between the OEM/FA and the company that will remanufacture the product. A key aspect of this is when the manufacturing company increases the cost of remanufacture by, for example, increasing the complexity of design or by not allowing easy disassembly, repair and upgrade. Remanufacturers have no means of being compensated for this (unless of course the same company is manufacturing and remanufacturing). It should be noted that the OEM/FA may have good reasons for complex product designs but from a whole life perspective it may be undesirable. Indeed it may even be the case that OEMs/FAs may deliberately make design complex in order to make it more difficult for their market to be cannibalised.

Externalities in consumption are possible too. Those of particular relevance to remanufacturing are associated with the initial stages of its adoption. The externalities relate in part to the considerations regarding information, but the issue here is that consumers are unaware or misinformed of the characteristics associated with remanufactured products. For example consumers may have safety and quality concerns for some products or they are unaware of their potential benefits due to deeply embedded beliefs. A good example here would be remould tyres which, in Europe, conform to rigorous per-tyre testing beyond that of even new tyres, but which are still perceived by domestic users as second rate. There is a misapprehension that roadside tyre shred is from remoulds, when the reality is that there is no bias in its origin.

Networks have been shown to lead to two significant externalities in consumption during the adoption of a new technology[b]. The first is where individuals follow each other's lead due to mutual trust whereas the second is where individuals decide to 'wait and see' and learn from each other. The second effect is likely to be more pronounced if there is a high cost of mistakes or if consumers are strongly risk averse. Whilst the consumer externalities are likely to diminish over time, they could provide sufficient initial barriers in order to block the take-up of remanufacture.

[a] Gary Haynes, Thorn Lighting Limited, personal communication

[b] Bandiera and Rasul (2006)

2.5 Market Power

The final potential cause of market inefficiency is that of market power in primary and secondary markets. This could limit the degree of substitution between new and used products[a]. There are several possible cases that will be considered here. The first point to note is that market power in secondary markets is constrained by competition from primary markets and vice versa. Thus market power in primary goods will lead to demand being shifted to the secondary so market power may actually lead to greater demand rather than less for remanufactured products. A separate case might be where remanufacturing is undertaken by the OEMs who have market power in both markets due to the advantages of possessing the designs for the products. Research is needed to determine whether this is a significant problem.

Market power is not likely to be an issue in used products if there is a lack of economies of scale in collection and remanufacturing. This was shown to be the case for recycling markets[b] and is likely to hold for remanufacturing as well. Empirical work finds little evidence that the markets for secondary materials have been suppressed due to the exercise of market power by primary producers[c].

2.6 Summary

As this section has demonstrated there are multiple market failures that limit the potential uptake of remanufacturing, with particularly severe problems relating to externalities (climate change, technological and consumption) and information failures. The next section of the report will discuss potential measures to overcome market failures.

[a] OECD (2006)

[b] Beede & Bloom (1995)

[c] OECD (2006)

3 Measures to overcome failures

In this section measures to overcome the market failures are suggested. Some require government policy but others may be possible within the market. It needs to be noted at this stage what the overall policy objective actually is. This is to maximise social welfare, which within this context means to prevent environmental 'bads' and to increase the efficient use of natural resources[a]. Therefore remanufacturing (and for that matter recycling) is not an end in itself, but rather needs to be viewed with reference to its role in achieving the overall objective.

3.1 Existing Policies

Previous public policy interventions were summarised in the prior report: Oakdene Hollins (2008), "A review of policy options for promoting remanufacturing in the UK".

The interventions accepted that firms faced inadequate incentives to internalise the environmental impacts of their production choices[b]. There are two types of policy approaches have been employed:

- policy measures to directly internalise the cost of waste-related expenditures e.g. landfill tax, subsidies for waste processing facilities;
- the removal of policy failures in substitute primary material markets e.g. inappropriate product and material standards and subsidies for virgin materials.

However whilst these measures have increased recycling rates[c] they have not caused an equivalent increase in remanufacturing. One reason may be that there continue to be policies that restrict remanufactured goods as substitutes even if they are 'as good as new'. Some legislation, such as Enhanced Capital Allowance (ECA) schemes and Feed-in Tariffs, explicitly preclude the use of remanufactured products. These may be health and safety or hygiene related, but the balance between environmental protection and public health may not have been properly reflected.

[a] Oakdene Hollins (2008)
[b] OECD (2007)
[c] OECD (2006)

A second reason may be that existing policy instruments have been promoting one form of material recovery (materials recycling) and this may conflict with increased remanufacturing. There is evidence that for example in dealing with demolition waste in the UK, the amount of recycling has increased while the amount of reclamation for re-use or remanufacturing has declined[a]. Certainly, specific incentives (such as financial subsidies for recycling plants) would seem to favour recycling, which is not always the most appropriate route to achieve a reduction in CO_2 emissions and energy conservation in all cases. As this policy undermines activities that may be more environmentally and carbon beneficial, such as remanufacturing, then the emphasis on recycling could be regarded as a policy failure. To overcome this a more sophisticated, layered approach to resource efficiency to determine highest value actions on a product by product or sector basis is required, such as using a common framework for recycling and reuse.

3.2 Transaction costs

Although it has been noted that transaction costs are not necessarily a form of market failure it is nevertheless worth minimising them where possible, in order to improve or maximise profitability; and policies to reduce them may indeed be an effective intervention point. Measures to overcome the costs of collection might be to incentivise the return of products after use through deposit systems or regular maintenance schedules[b]. Other measures to minimise transaction costs include linking together potential buyers and sellers or introducing web exchanges to improve price discovery[c].

As for policy measures, a subsidy could be granted for remanufacturing activity similar to that offered to recycling plants. This would even out the imbalance towards recycling and compensate for the costs of collection, sorting and disassembly of products which the market cannot bear due to the price of remanufacturing – because it incorporates these costs - being too high relative to virgin materials. Additionally it is known that such support is often necessary to aid the penetration of emergent technologies, which initially have high costs but which become more competitive as scale increases[d]. Whilst the techniques of remanufacturing may not necessarily be advanced technology, the process concepts are nevertheless very new for many industries.

A key issue in the imposition of any subsidy would be at which point it would apply. It is likely that it easiest to administer by directing it to the final remanufactured product[e], but an alternative would be to provide capital grants for

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[a] BRE (2006)
[b] Oakdene Hollins (2008)
[c] OECD (2006)
[d] HM Treasury (2008)
[e] Oakdene Hollins (2008)

reuse engineering-enabling equipment. Another key issue is in setting the level of subsidy at a level high enough to compensate for these activities yet at the same time not outweigh the costs of carbon saved or the savings from reduced waste management. Mitra & Webster (2008) have undertaken work in this area that may be relevant. They modelled the effects of government subsidies as a means to promote remanufacturing activity. They looked at various rates of subsidy, the allocation of subsidies between OEMs and remanufacturers and investments to increase the rates of return. They came to two relevant conclusions:

- that remanufacturing activity is generally higher, and the OEM's profit and the remanufacturer's profit are both likely to increase, when the manufacturer and the remanufacturer share the subsidy, even though they may be in competition;
- that remanufacturing activity is sensitive both to the rate of recovered products and the rate of subsidy, and that these are mutually dependent.

A similar policy to direct subsidies is the provision of a VAT rebate on remanufactured products at the point of sale. An EU study[a] found that a permanent reduction of VAT on a particular product or service will usually lead to "an equivalent reduction in the price of that service". There is usually therefore full pass-through of any rebate. The study found that the extent of any pass-through is dependent on labour intensity and strength of competition. The higher the latter factor the greater the degree of pass-through. This is likely to be the case because price elasticities are correlated with labour intensity, and remanufacturing activity is usually highly labour intensive (collection, cleaning, disassembly etc).

A later study by the Institute for Environmental Studies (2008) came up with a number of general considerations for using VAT as an instrument for environmental purposes. These included:

- application of reduced VAT rates requires a clear and unambiguous distinction between the qualifying 'green' products and their 'non-green' counterparts;
- due to continuous innovations, products may cease to be the 'greenest' in their class after some time, and thus lose their eligibility for a reduced VAT rate;
- there is evidence for the existence of a 'signalling effect': subsidies and fiscal incentives, if properly communicated, tend to have an impact on consumer demand beyond the purely financial advantage they confer;
- if some Member States would opt for VAT differentiation when others would not, there would be some increase in cross-border purchasing;
- the introduction of differential VAT rates within a product group will probably lead to legal disputes (borderline cases) and some fraud (attempts to sell non-eligible products under the low rate);

[a] Copenhagen Economics (2007)

- the introduction of multiple VAT rates implies a non-negligible increase in the burden of administrative and compliance costs of the firms concerned;

An alternative policy that would obtain similar results is the introduction of product take-back laws, according to previous work conducted by Mitra & Webster (2007). The key driver in this context was that the cost of disposal of a product was met by the OEM, but that this cost could be partly offset by the sale of the end of life product to a remanufacturer. The OEM would therefore be incentivised because of a reduction in its disposal costs. An additional policy outcome would be that the OEMs would have the incentive to design products for disassembly or to release technical information that made them easier to disassemble etc.

3.3 Information failures

There are a number of ways of potentially overcoming the problems of imperfect or asymmetric information. Some of these solutions may be driven by the market but could be strengthened by intervention.

The market driven approaches essentially involve sellers with high quality products attempting to signal their quality. Price will only act as signal for quality if a proportion of buyers are informed about quality. A common signalling approach would be to offer warranties as a direct guarantee of quality. This is able to provide a signal if it is profitable to offer a warranty for a high quality product (low likelihood and cost of repair) but unprofitable to offer a warranty for a low quality product (higher likelihood or cost of repair). Advertising can also serve as a signal if it is known to correspond to high quality products. Both of these measures could benefit from being strengthened by intervention e.g. regulation, information provision etc. Other possible approaches to mitigate informational problems include the use of long term contracts between collectors and remanufacturers or the use of brokers with specialist skills in identifying quality[a].

Possible interventions to overcome the informational problems and to regulate quality include:

- provision of information e.g. labelling;
- providing or subsidising testing facilities to verify quality;
- creating standards;
- certification schemes;
- penalising sellers who misrepresent information.

[a] OECD (2006)

In creating standards it is important that the standards set are balanced between the need to protect purchasers whilst at the same time encouraging remanufacturing activity. A particular danger is that standards may be set unduly high under the influence of lobbying from OEMs and FAs. Testing facilities or certification schemes are useful both in themselves, but also to complement the creation of standards by ensuring that the standards are upheld. An example of an existing standard is The Federation of Engine Re-manufacturers (FER) which restricts its membership to companies whose standards comply with a strict engine and machining specification[a].

A suite of actions is currently under way with BSI. Key issues are to define terms (BS8887:2), end-of-life practices, and validated processes for remanufacture. There have been a number of issues that have meant the pace of development has been slow, notably in reaching an agreement of what remanufacturing actually is and how it differs from other concepts such as refurbishment. Progress has, though, been made on the introduction of standards. A very recent accomplishment has been the development of a general standard of the steps required for remanufacturing (8887-220)[b]. Because the standard has concentrated on processes it should be general enough to be applicable for all industries but yet stringent enough to exclude the lowest refurbishment processes. The aim is that it will act as a foundation standard upon which more product-specific standards might be built upon. It is too early to gauge how much industry acceptance there will be, but the CRR note that there is interest from the automotive sector already[c].

3.4 Externalities

As noted already three types of externalities were thought to be important for remanufacturing[d]:

- Climate change externalities
- Technological externalities
- Consumption externalities

To overcome climate change externalities there needs to be strengthened underlying signals regarding the pricing of externalities e.g. carbon, in order to

[a] http://www.fer.co.uk/fer/portal/main/?Section=About%20FER&SubSect=10

[b] http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030205839

[c] CRR personal communication

[d] OECD (2006)

account for the externalities in the transactions. This issue has had considerable interest and coverage so is not discussed in length here.

To overcome technological externalities there is a need to engage whole supply chains to join up thinking across the whole life management from initial design right through to remanufacture. Invariably these kinds of supply chain initiatives require government support, but significant improvements are possible. An example of a successful supply chain initiative is the Courtauld Commitment, a voluntary agreement with WRAP between brand owners, retailers, manufacturers and suppliers in the food supply chain aimed at reducing food and packaging waste. Of particular relevance within this context are the targets relating to design, notably to design out packaging waste growth by 2008 (which has already been achieved) and to deliver absolute reductions in packaging waste by 2010[a]. The commitment is now about to move into a second phase aimed at to achieving more sustainable use of resources over the entire lifecycle of products, throughout the whole supply chain.

For the example of the construction sector discussed earlier, a possible solution could be in collapsing the supply chain so that manufacturers deal more directly with the final client. The influential Egan Report suggested that there was a need to focus more on the final products and end-consumers rather than on each of the different actors; and designers should work more in collaboration with other participants[b]. There has been some movement in this direction with the establishment of companies that build, design and maintain buildings and hence avoid much of the externalities in the supply chain, but there remains room for policy to regulate quality, such as through standards[c].

One way to mitigate the effect of technological externalities by improving the flows of information is through modularity of design and the development of open standards. This has shown to have been important in facilitating dismantling and remanufacturing in the automotive industry[d]. The concept of modular design is to have a system that can be sub-divided into smaller parts or modules, which can be commoditised and made available to other OEMs/FAs. A key issue in this approach is to ensure the flows of information to facilitate remanufacturing whilst upholding intellectual property rights (IPRs). On this, there is literature which suggests that modular design approaches actually protect proprietary knowledge because information can be hidden and access is controlled through interfacing rules[e]. In this way modular design and open standards at a system level may offer a resolution of the potential conflict between retention of IPR and diffusion of technical knowledge.

Whilst the consumer externalities are likely to diminish over time they could provide sufficient initial barriers in order to block the take-up of remanufacture. Indeed the make-sell-dispose paradigm is deeply ingrained in behaviour. There

[a] See http://www.wrap.org.uk/retail/courtauld_commitment/index.html for more info

[b] DTI (1998)

[c] Gary Haynes, Thorn Lighting Limited, personal communication

[d] Tojo (2001)

[e] Baldwin & Clark (2006)

are a number of policies that overcome the initial barriers. The first is to actively provide information in order to educate consumers, such as by the labelling of products or the distribution of leaflets targeted to particular segments. To maximise the impact of information provision the structure of the information should be considered in order to trigger responses[a]. Whilst information provision is a policy that can deliver significant benefits on its own, it is especially effective when used in conjunction with other policies[b]. These include underpinning labelling and the information provided with standards in order to lessen risks.

3.5 Market Power

As noted earlier, market power in primary or secondary markets is likely to have had relatively limited effects on market efficiency. Where market power is identified as an issue national competition policy is suggested as the means to mitigate it where appropriate[c].

3.6 Summary

As the previous sections have indicated there is a wide variety of potential policies that would mitigate the market failures identified for remanufacturing. These are summarised in Table 3. Some of the measures could be led by the market perhaps supported by intervention (listed M); whereas others would need to be government led initiatives (listed G). Information provision is listed as a measure that could be implemented by the market or government, and supply chain initiatives would require co-operation between the market and government in order to be successful.

Some of the suggested measures are currently underway; notably the creation of standards, the provision of information and the offering of warranties, but others actions are not currently in progress.

[a] Defra (2010b)
[b] Defra (2010b)
[c] OECD (2006)

Table 3: Summary of measures to overcome market failures in remanufacturing

Type	Who	Measures
Existing Policies	G	Relax health & safety and hygiene regulations
	G	Move emphasis from recycling and look at most appropriate routes to reduce CO_2 emissions
Transaction Costs	M	Incentivise return of products after use e.g. deposit systems, regular maintenance
	M	Web exchanges to link buyers and sellers
	G	Subsidies for remanufacturing activity
	G	Capital grants for reuse engineering-enabled equipment
	G	VAT rebates on remanufactured products
	G	Product take-back laws
Information	M	Warranties to guarantee quality
	M	Long-term contracts between collectors and remanufacturers
	M	Use of brokers with specialist skills in identifying quality
	G or M	Provide information e.g. labelling, advertising
	G	Provide or subsidise testing facilities to verify quality
	M	Create standards
	M	Certification schemes
	G	Penalise sellers who misrepresent information
Externalities	G	Strengthen underlying signals of pricing externalities
	G & M	Supply chain initiatives to encourage whole life management
	M	Modular design and open standards
	G or M	Provide information to deal with consumer misconceptions
Market Power	G	National competition policy

Key: G = government led, M = market led

4 Conclusions

The causes of market failure in remanufacturing identified were:

- Transaction costs: collecting and sorting used products that arise diffusely and irregularly
- Information failures: imperfections preventing effective choice and asymmetric information (sellers know more about quality than buyers)
- Externalities:
  - climate change: failure to account for costs of climate change in transactions
  - technological: layers of supply chains leading to complex designs making remanufacturing more difficult
  - consumption: misconceptions and effect of networks in adoption
- Market power in primary or secondary markets

Information failures and externalities were thought to be particularly severe market failures. Market power on the other hand was thought to be much less of an issue, although it was noted that further research is required to determine whether OEMs possess significant market power due to the advantages of owning the designs for the products.

A wide variety of measures to mitigate the market failures were suggested; some which could be led by the market perhaps supported by intervention (M) and others would need to be led by government policy (G). These included:

1. Transaction costs:
   - incentivise return of products (M)
   - web exchanges to link buyers & sellers (M)
   - subsidies for remanufacturing (G)
   - capital grants (G)
   - VAT rebates (G)
2. Information failures:
   - warranties (M)
   - long-term contracts (M)
   - creating standards (M)
   - certification schemes (M)
   - provide or subsidise testing facilities (G)
   - penalising miss-sellers (G)
   - provision of information (G or M)
3. Externalities:
   - strengthen underlying signals of externalities pricing (G)
   - modular design and open standards (M)
   - provision of information (G or M)
   - supply chain initiatives to encourage whole life management (G & M)
4. Market power:
   - national competition policy (G)

Additionally it was noted that existing policies, such as stringent health and safety regulations and a current emphasis towards recycling, act as barriers for the greater adoption of remanufacturing. These policies thus need to be reformed to balance environmental protection and public health and promote the activities that are the most environmentally beneficial.

Some of the suggested measures are currently underway; notably the creation of standards, the provision of information and the offering of warranties, but other actions are not currently in progress.

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