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A report by the All-Party Parliamentary Sustainable Resource Group and the All-Party Parliamentary Manufacturing Group

TRIPLE WIN

THE SOCIAL, ECONOMIC AND ENVIRONMENTAL CASE FOR REMANUFACTURING

Triple Win: The Economic, Social and Environmental Case for Remanufacturing
December 2014

This report follows an eight-month inquiry chaired by Rt Hon Caroline Spelman MP and Barry Sheerman MP.

On behalf of the inquiry co-chairs, the report was written by Anne-Marie Benoy (Researcher and Project Coordinator, APSRG), Laura Owen (Manager, APSRG) and Michael Folkerson (Manager, APMG). These individuals work for Policy Connect, a non-profit social enterprise that provides secretariat services to both the All-Party Parliamentary Sustainable Resource Group and the All-Party Parliamentary Manufacturing Group.

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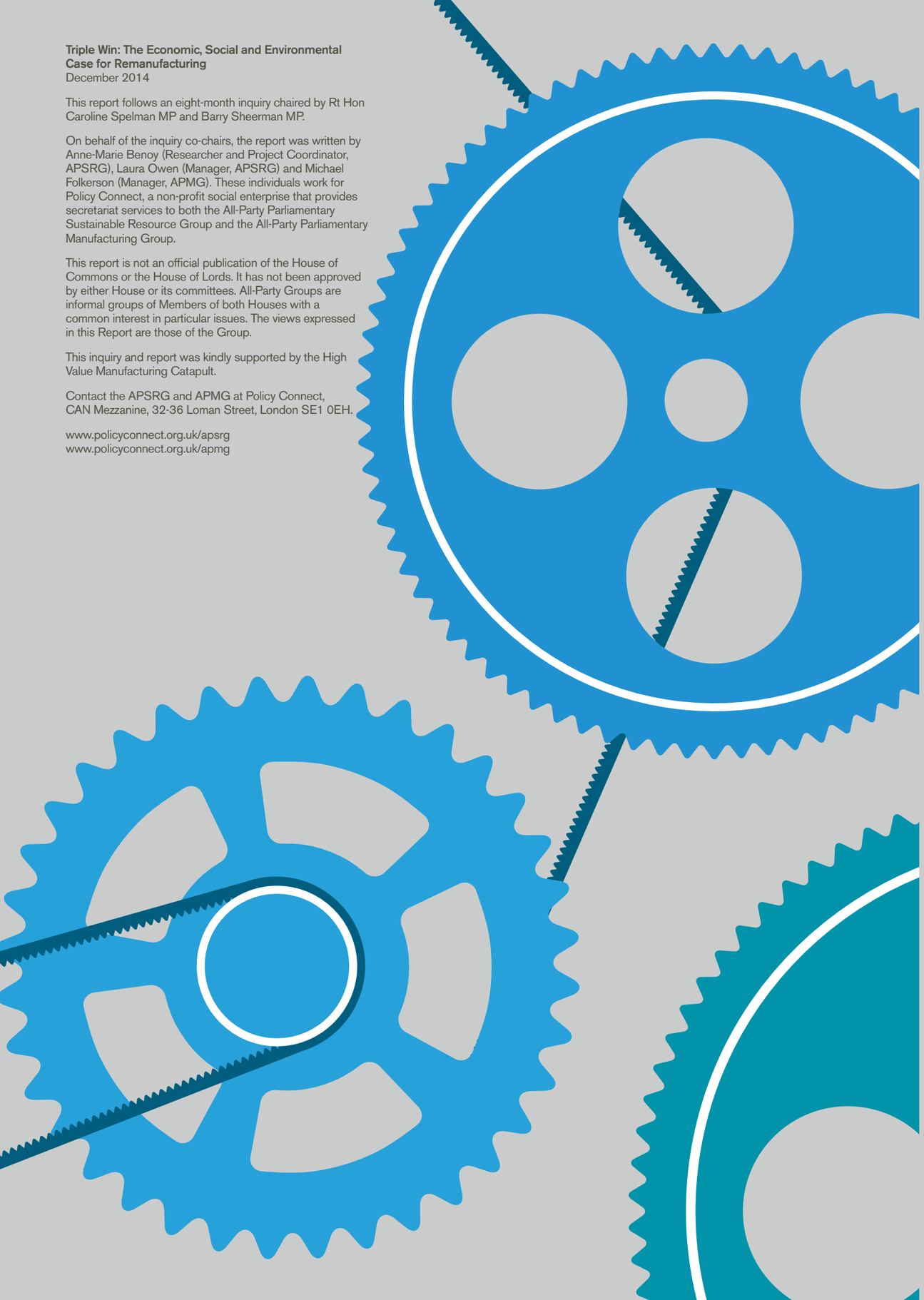
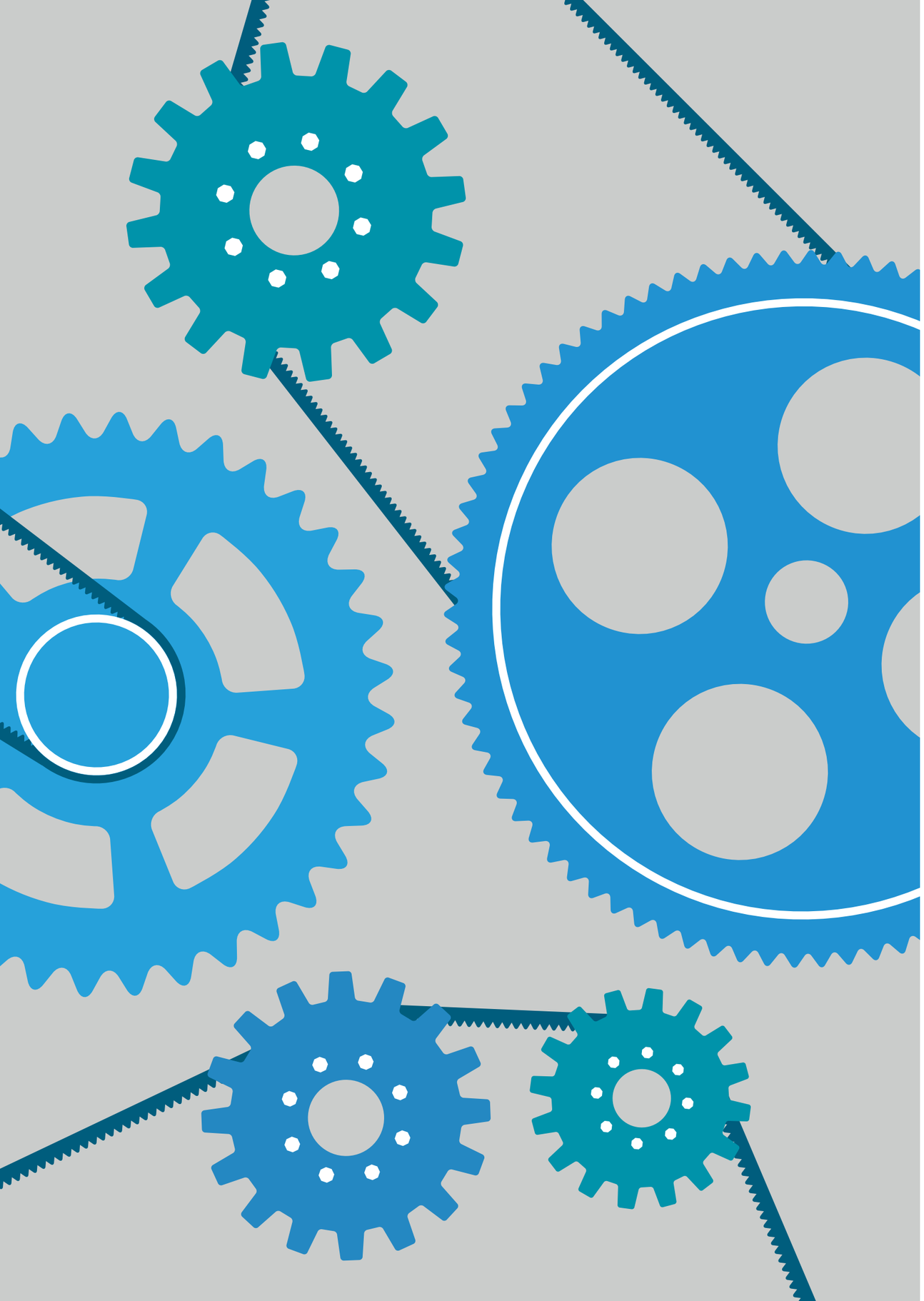


"Although opportunities for remanufacturing are far-reaching, Government and industry need to work together to develop its full potential"

- Rt Hon Caroline Spelman MP



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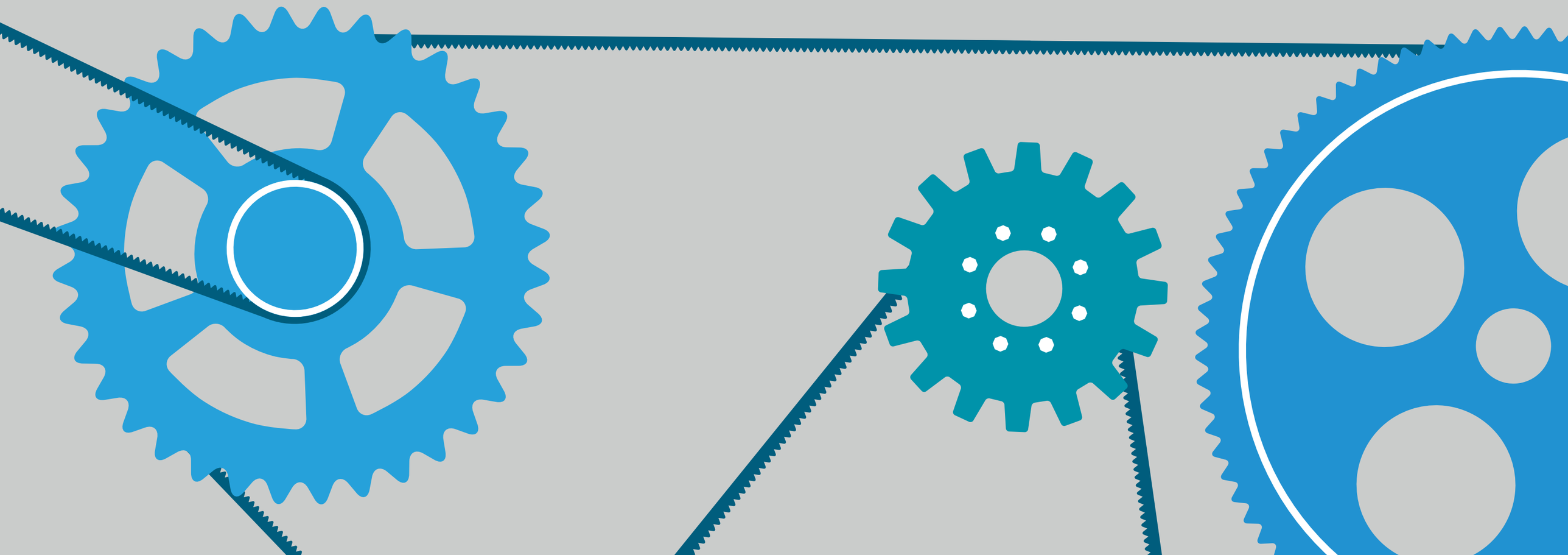
Even the most conservative estimates suggest that the potential of remanufacturing in the UK is £5.6billion

(APSRG, 2014)

54.5% of manufacturers are unaware of or have not considered remanufacturing

(EEF, 2014, unpublished data)



Foreword

This inquiry comes at a critical time. The UK has made huge improvements in how it manages its resources in the past few decades and the waste management sector has sustained growth despite financially challenging times. The future of the manufacturing industry, however, is inextricably linked to environmental sustainability, reducing the consumption of virgin raw materials, and exploiting new areas of comparative advantage, and remanufacturing plays a critical role in this.

The process of remanufacturing is a growing sector in the UK that continues to face barriers to growth caused by continuous regulatory focus on lower denominators of the waste hierarchy such as recycling instead of encouraging minimisation of materials (through remanufacture, refurbishment and reconditioning). The UK also has weak coordination between small centres of knowledge and expertise compared to China and the United States, where remanufacturing is more prevalent. This is inhibiting the UK from developing its full potential in remanufacturing.

Further to the All-Party Parliamentary Sustainable Resource Group (APSRG) report *Remanufacturing: Towards a Resource Efficient Economy* launched in March 2014, this new report examines the potential for remanufacturing in the UK in greater detail.

The strengths and possibilities for industries that are already engaged in remanufacturing and the difficulties for newcomers are outlined. Also presented is an analysis of how different businesses have successfully adopted remanufacturing processes into their business models and how these support growth in remanufacturing. This report also uncovers the optimal policy environment to encourage remanufacturing, which has an important role to play in delivering extensive economic, environmental and social benefits to the UK - the triple win of remanufacturing.

There is huge potential for growth in the UK remanufacturing industry. Remanufacturing increases the potential for reshoring parts and products, provides opportunities in improving national resource resilience and has the potential for economic growth and the creation of thousands of skilled jobs. Remanufacturing also has the potential to support small and medium-sized enterprises (SMEs). There are thus large-scale inward investment opportunities if the UK highlights its expertise and policy package to aid remanufacture.

In order to make the most of the opportunities from remanufacturing, work is required both from Government and industry to ensure that barriers to development are addressed. Government and industry should be ambitious in aiming for the UK to become a world leader in this field.

Remanufacturing is an incredibly diverse sector, and one that merits detailed, cross-departmental and cross-industry thinking.

This report makes recommendations to central Government and industry on how to build UK remanufacturing into a socially, economically and environmentally robust industry, which can revolutionise the manufacturing industry. We believe that Government and industry must do more and we hope that adoption of these recommendations will result in the growth of a more streamlined UK remanufacturing industry, and provide further steps for moving towards a more circular and resource efficient economy.

We would like to thank everyone who generously gave their time and expertise to contribute to this inquiry, including the steering group members for their direction and oversight. We would also like to thank the High Value Manufacturing Catapult for sponsoring this inquiry, and Laura Owen, Anne-Marie Benoy and Michael Folkerson for compiling this report.

Barry Sheerman MP
Co-Chair

Rt Hon Caroline Spelman MP
Co-Chair

Executive Summary

The key objective of this inquiry has been to outline the UK's position in the global remanufacturing sphere, looking at particular industries where remanufacturing is already developed and where it may need further support.

Defined as a series of manufacturing steps acting on an end-of-life part or product in order to return it to like-new or better performance with warranty to match, remanufacturing presents a triple win for the UK. These economic, environmental and social opportunities warrant Government action.

The United States is a leader in the field of remanufacturing, with China also recently investing heavily in the industry. Although robust figures on the size of the remanufacturing sector are not readily available, incentive schemes put in place by the governments of these countries are supporting and growing the practice. Within the UK, Scotland is leading the drive towards remanufacturing.

Recommendation 1

Government departments such as the Department for Environment, Food and Rural Affairs (Defra), the Department for Business, Innovation and Skills (BIS) and the Department of Energy and Climate Change (DECC) should actively promote remanufacturing and learn from practices in countries which are leaders in this industry. The UK should take advantage of the knowledge that has already been developed elsewhere.

Existing drivers that spur on remanufacturing include lower input costs and subsequent lower prices for customers, resource security and resilience in a volatile world, reduced carbon emissions and reduced water and energy use. These drivers need to be highlighted and promoted to industry in order to change perceptions and encourage take-up

Recommendation 2

Government should encourage companies, universities and public services to include data on the procurement or production of remanufactured goods and landfill diversion in their Corporate Social Responsibility (CSR) reports. It should also encourage these sectors to develop waste prevention targets similar to carbon footprint targets to encourage waste prevention.

There are also significant barriers to remanufacturing, such as the lack of a global legal definition, engrained linear business models, design and intellectual property (IP) conflicts, negative regulatory frameworks, inadequate public procurement rules and a shortage of skills. Here Government has a crucial role in overcoming the main elements holding back the development of remanufacturing.

Recommendation 3

Government should adopt this report's definition of remanufacturing to provide clarity as to what constitutes remanufacturing versus other aspects of the circular economy.

Recommendation 4

Government should work towards improving consumer awareness of remanufacturing including through the use of national campaigns.

Recommendation 5

Government should develop a certified mark for remanufacturing to demonstrate that products have been tested and fully comply with those standards of a new product to improve clarification for consumers on which products have been remanufactured.

Recommendation 6

Government should work towards procuring UK remanufactured products such as office furnishing and equipment, carpet flooring, electrical equipment and medical appliances where possible. Government should also work towards increasing its procurement through service models to support the remanufacturing industry.

Recommendation 7

Government should encourage the development of an online platform with clear standards where businesses can exchange knowledge, components and products to encourage the reusing of materials and products and allow remanufacturers and manufacturers to access products at the end-of-life stage.

Recommendation 8

Original Equipment Manufacturers (OEMs) and third party remanufacturers should work together to mobilise supply chain communication.

Recommendation 9

Government should amend its Guidance on the Legal Definition of Waste to distinguish a product that is due to be remanufactured as being exempt from those products considered as waste. This will ensure that they do not fall within the remit of waste regulations. These products could also be labelled under a "Remanufactured in the UK" certification scheme.

Recommendation 10

Government should review the regulatory barriers to remanufacturing and address the legal anomalies identified.

Recommendation 11

Government should work with the European Commission (EC) to place more policy emphasis on setting targets for those activities at the top of the waste hierarchy such as reuse and remanufacture.

Recommendation 12

Government should consider implementing a tax break for remanufacturers in order to encourage economic resilience in the UK remanufacturing industry.

Some industries are already relatively well-developed in terms of remanufacturing activity. Aero engines, heavy duty off-road (HDOR) equipment and automotive components have already been the subject of numerous case studies. This inquiry further identifies particular industries where remanufacturing has not yet taken hold, but which demonstrate significant potential. White goods, paints and chemicals, post-industrial but pre-consumer textiles, and carpet flooring are all on the cusp of developing robust remanufacturing markets. These are areas in which Government has a particularly key role to play in eliminating barriers and in some cases should work with the EC to address them as uptake of remanufacture can be hindered by specific EU regulatory barriers.

Recommendation 13

The European Commission should consider changing rating law such that energy efficiency ratings can also be applied to remanufactured products.

Recommendation 14

The European Commission should, on a case-by-case basis, consider exempting remanufacturing activities from the scope of authorisation and restrictions if there are clear overall environmental benefits in allowing remanufacturing to continue.

Recommendation 15

Government should develop a *Resource Efficiency Action Plan for Leftover Decorative Paint* together with representatives from Defra, local authorities, waste management companies, paint manufacturers and retailers, and third party paint remanufacturers.

Remanufacturing differs significantly from other waste reduction activities like recycling largely due to opaque structures of ownership. Alternative business models are thus important in facilitating and encouraging a functional market for remanufactured goods, where access to supplies of end-of-life products is a central concern. Fee for service, where the consumer never retains ownership, and incentivised return are relatively well-known, with case studies having been highlighted in the APSRG's first report on remanufacturing. Third party remanufacturers are gaining

importance, however, and may represent the best chance to truly expand the UK's remanufacturing capacity. However, experimenting with fundamental business models is inherently risky. Small businesses need government support to facilitate the process. Government can also kick-start the remanufacturing industry by adopting these business models internally and setting procurement targets.

Recommendation 16

Government should increase awareness of remanufacturing by adopting procurement targets to include leasing of remanufactured products, and by creating an education programme aimed at changing behaviour to extend the pure leasing business model to other items.

Recommendation 17

Industry should explore a system of extended producer responsibility on purchased products to encourage their return to manufacturers or remanufacturers at the end-of-life stage, and promote shared responsibility throughout the supply chain

Recommendation 18

Government should work towards improving and increasing financial investment in the UK remanufacturing industry.

Recommendation 19

Government should raise awareness in the financial sector about how low cost lending can support remanufacturing start-ups with various alternative business models.

Moving forward, specific issues around resource security and skills need to be addressed. Remanufacturing could play a substantial role in improving resource efficiency as well as protecting natural capital by reducing the continuous consumption of finite and precious elements and minerals.

In terms of skills, this inquiry notes that at present there are only a very limited number of degree courses and apprenticeships targeted at remanufacturing. Significant investment is also needed in research and development as this will be key to realising the full potential of the remanufacturing industry. Special interest groups (SIGs) and research networks for remanufacturing already exist in other countries where remanufacturing is taking place, although these interactions are often fluid and no common method of setting up such collaborations has been identified. Collaboration between Government, industry, academia and consumers is crucial to properly understand the practice of, and the market for, remanufacturing and to capture the full range of benefits that it offers. Only by working together to address barriers to remanufacturing will current best practice become the standard of the future.

Recommendation 20

Government should work with industry to create an educational programme and support network to help businesses change their business models to incorporate remanufacturing

Recommendation 21

Government should invest in developing more apprenticeships in the remanufacturing industry. It should also encourage the development of sustainable design and sustainable engineering modules and courses at universities.

Recommendation 22

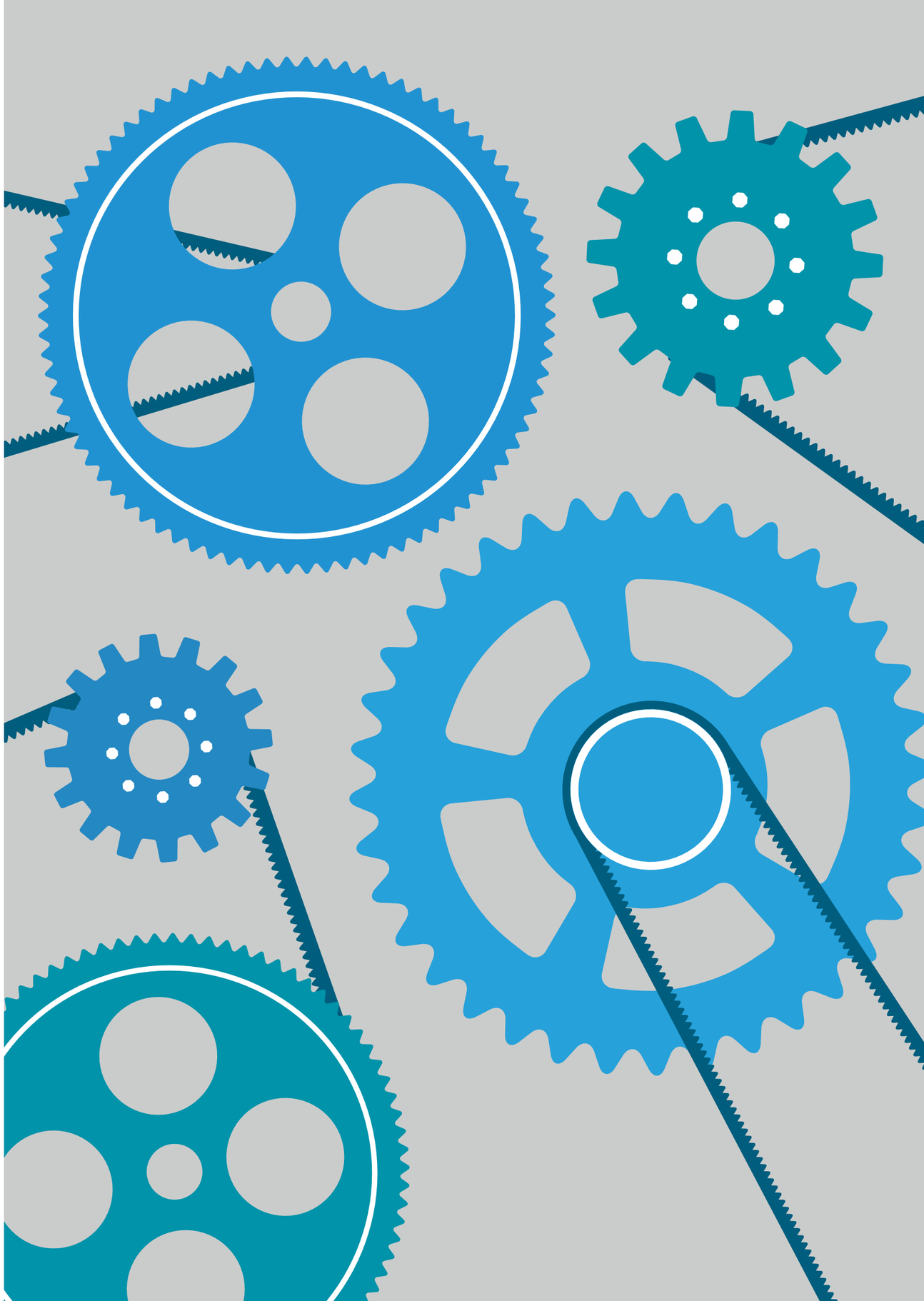
A more formal Special Interest Group should be established to support industry in the development of a comprehensive and inclusive mechanism to drive remanufacturing forward, utilising all expertise and excellence present in UK institutions.

Recommendation 23

Government should work across departments to review relevant legislation and remove perverse incentives.

Recommendation 24

Government should continue to facilitate the setting up of stakeholder meetings between the UK remanufacturing industry and Government departments such as Defra, BIS and DECC.



Chapter One

Introduction

Remanufacturing is commonly defined as "a series of manufacturing steps acting on an end-of-life part or product in order to return it to like-new or better performance, with warranty to match"[1]. It is often confused with other aspects of the circular economy, such as refurbishment, reconditioning and repairing. However, remanufacturing in itself has immense social, economic and environmental potential in the UK if the right measures are set in place to support the industry and its development.

Even the most conservative estimates suggest that the value of remanufacturing in the UK is £2.4 billion, with a potential to increase to £5.6 billion alongside the creation of thousands of skilled jobs[1]. Alongside economic opportunities, remanufactured products also emit fewer greenhouse gases and consume less materials, resources and water. Collectively, these social, economic and environmental benefits are often referred to as the 'triple win' of remanufacturing.

This report will outline the drivers of, and barriers to remanufacturing in the UK, show the industries where remanufacturing is already developed and where it continues to be in its infant stages, and assess the importance of circular business models in driving remanufacturing forward.

1 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

1.1 The Waste Hierarchy

Efforts towards moving to a more circular economy continue to have a strong focus on developing policies that focus on lower value options in the waste hierarchy, such as recycling and disposal. Putting emphasis on increasing the tonnage of materials to be recycled, for example, is a strategy that targets specifically the lower end of the waste hierarchy. This is not always the most resource efficient solution and often entails a great loss and downgrading of resources.

In the waste hierarchy, remanufacturing is placed towards the top of the tier, between reuse and waste minimisation as it encourages the reuse of parts and products with minimal additional input of raw materials (Figure 1). However, at times the UK has introduced sustainable resource policies that hinder the remanufacturing industry through promoting strategies that target the lower end of the waste hierarchy.

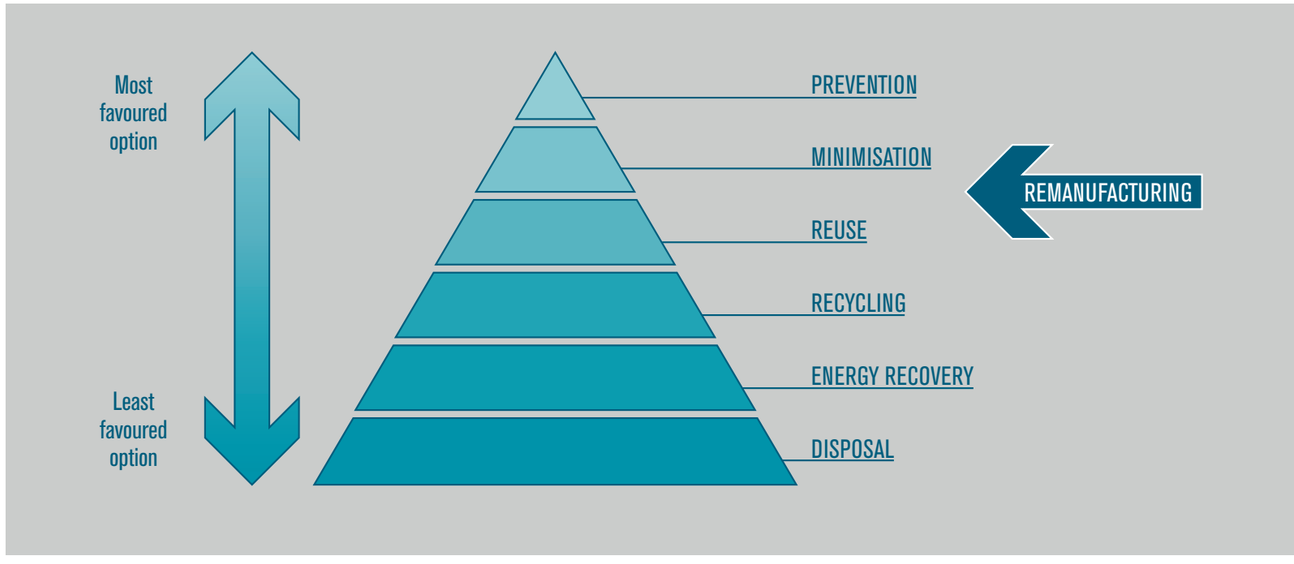


Figure 1: Where remanufacturing fits into the waste hierarchy

1.2 Definition of Remanufacturing

> "*Remanufacturing is not simply restoring the product to its original state; it can also include upgrading of parts or products.*"
> - British Standards Institution[2]

The APSRG report *Remanufacturing: Towards a Resource Efficient Economy*[3] defined remanufacturing and other aspects of the circular economy as follows:

Repairing	The fixing of a fault but with no guarantee on the product as a whole
Reusing	The simple reuse of a product with no modifications
Refurbishing	The largely aesthetic improvement of a product which may involve making it look like new, with limited functionality improvements
Reconditioning	The potential adjustment to components bringing an item back to working order, although not necessarily to an 'as new' state
Recycling	The extraction of a product's raw materials for use in new products. This is a good option for products which are easily constructed and have minimal numbers of components
Remanufacturing	A series of manufacturing steps acting on an end-of-life part or product in order to return it to like-new or better performance, with warranty to match

Box 1: Definitions

The failure of parts of the UK's resource, waste, manufacturing and design industries' ability to understand the definition of remanufacturing and the opportunities that it carries continues to be one of the sector's key barriers. This also forms one reason for much of the over-focus on recycling targets as recycling is more easily defined and understood.

Although a commonly accepted academic definition of remanufacturing exists (Box 1) there is not yet a globally accepted legal definition of remanufacturing. This uncertainty continues to limit its uptake because unscrupulous operators claim to be remanufacturing when actually they are conducting a lower form of resource recovery.

Both in the UK and throughout the world, remanufacturing is done by a variety of different types of businesses: original equipment manufacturers (OEMs), manufacturers assimilating products, and by independent third party remanufacturers.

2 Inquiry evidence
3 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

The business relationships between these different companies vary, as some OEMs have strong relationships with third party remanufacturers, whilst other third party remanufacturers source the products they remanufacture independently. The remanufacturing industry is also shaped by the variety of different sectors where it is taking place. This complexity, whilst showing the extent to which remanufacturing can take place, also proves that policies to encourage remanufacturing need to be flexible (Chapter 7).

It is also important to recognise that remanufacturing may not always be the best option, either economically or environmentally. In some industries such as small personal electronic items, the market conditions are such that there would not be consumer interest in remanufacturing. Fashion and technology advance too quickly in the market and even if functionality remained the same as a new product, aesthetically it would not be in demand (Chapter 6). For these items, recycling may be the most viable option until the rate of technology improvement slows or manufacturers adopt a timeless fashion aesthetic (for example, as is largely the case for the furniture industry).

It is also important not to remove options or layers of the waste hierarchy. During our research we found little evidence to show that by taking away bottom layers of the waste hierarchy that businesses will move to the top – in most cases businesses would simply move one nudge up. This approach will therefore not necessarily encourage remanufacturing.

1.3 The Circular Economy and Remanufacturing

With rising concerns over resource security, climate change and water shortages, businesses and Government are increasingly focusing on developing a more circular economy.

Unlike the traditional take-make-consume-dispose linear economy of the past, the circular economy restores so-called "old" parts and products back to their original state using methods which consume fewer resources. In its most basic form, the circular economy encourages the reuse of materials to the furthest extent possible. Remanufacturing fits directly into the circular economy through intrinsic systems being focused on the return and reuse of valuable materials, and making them last for as long as possible.

One of the key challenges currently experienced with successfully moving to a circular economy revolves around business models. The majority of organisations and companies currently still operate on linear business structures, which transfer producer responsibility for products to retailers or consumers upon their sale. Developing business models in which manufacturers acknowledge their producer responsibility is vital for moving to a more circular economy. Circular business models through leasing or servitisation are slowly being acknowledged as both ecological and economical, though much development is still needed in this area.

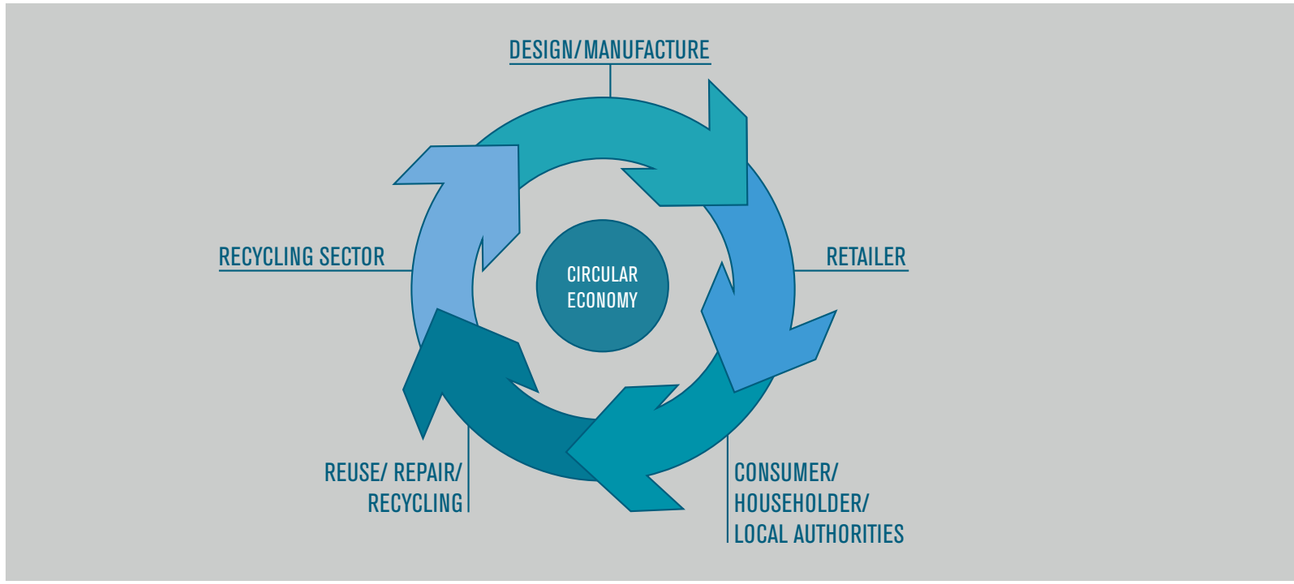


Figure 2: The Circular Economy
Source: Adapted from WRAP

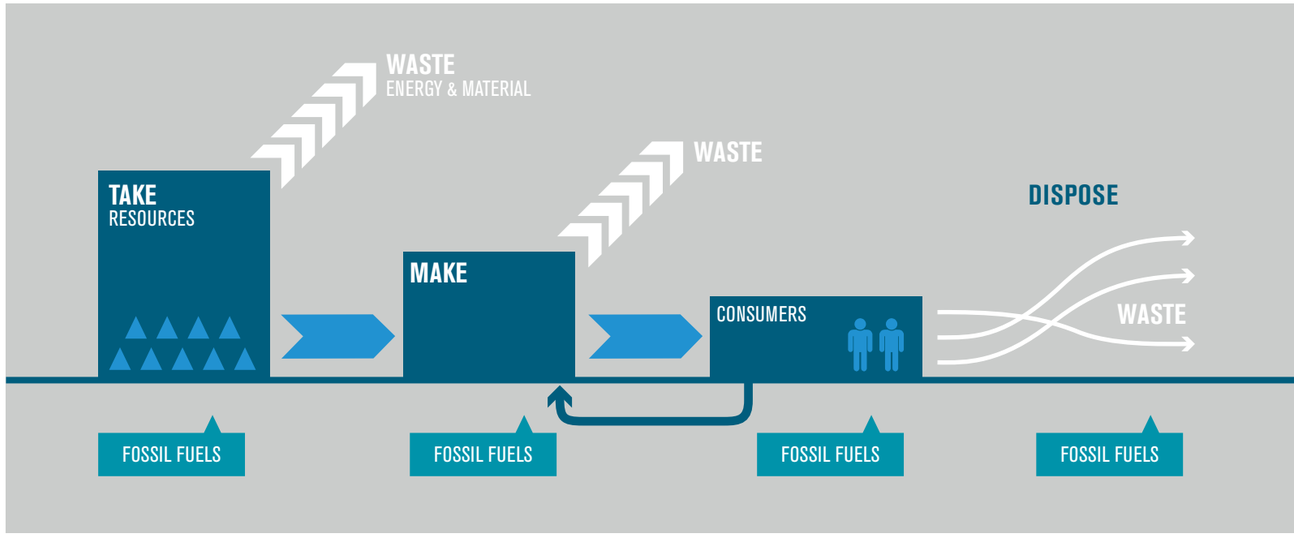


Figure 3: The Linear Economy
Source: Adapted from Ellen McArthur Foundation

Chapter Two

The State of Remanufacturing

2.1 Remanufacturing now in the EU and globally

Remanufacturing is not new, and has already made significant inroads around the world. The UK is considered by some as a leader in this field already, but by others as having some catching up to do. Either way, for remanufacturing to reach its full potential in the UK, we must learn from other countries that are already remanufacturing and build upon their success.

There is a real need to push remanufacturing higher up the worldwide political agenda. Whilst conducting research for this inquiry, an expert in this area told us that during a series of individual training programmes delivered on product sustainability to 20 Chinese companies based in Hong Kong, 19 out of 20 CEOs had no idea what happened to their products at the end-of-life stage. Nevertheless, there are countries and individual businesses who are leading the way in this field and it is important to learn from these to enable current best practice to become the global standard of the future.

The United States

While several countries have been looking towards remanufacturing as a key element of a circular economy in recent years, the United States is the undisputed leader in terms of producing, consuming and exporting remanufactured goods. In 2011, production of remanufactured goods in the United States totalled $43 billion (£27.4 billion) and accounted for 2% of all sales of manufactured goods.[5] The aerospace and automotive sectors were by far the most active in remanufacturing (Table 1). Other significant industries included heavy duty and off-road (HDOR) equipment, motor vehicle parts, machinery, IT products, medical devices, retreaded tyres, consumer products, electrical apparatus, office furniture, and toner cartridges (Table 1). Further, in the same year, small and medium enterprises (SMEs) are estimated to have accounted for 25% of United States production of remanufactured goods, and 17% of their exports. The United States also dominates in terms of employment. Remanufacturing supports over 180,000 full-time jobs, with 36% of these in SMEs.[5]

The United States is a net exporter of remanufactured goods. With a total value of remanufactured exports in 2011 estimated at $11.7 billion (£7.4 billion); an increase of 50% from two years previous, the overall success of the export market is impressive.[5] This is a particularly salient point for the UK, which, as mentioned in the 2014 budget[6] is increasingly cognizant of the need to increase its own manufacturing activity. Remanufacturing can play a large and important role in realising these aims.

The United States continues to develop and prioritise remanufacturing policy. The internationally recognised Center for Remanufacturing and Resource Recovery (sic) located in New York, delivers advanced technologies and tools for efficient and cost-effective remanufacturing. The Department of Commerce has remanufacturers on its International Trade Advisory Committee to help assess and examine trade barriers

5 USITC (2012) *Remanufactured Goods: An Overview of the United States and Global Industries, Markets, and Trade.*
6 HM Treasury (2014) *Budget 2014.*

to remanufacturing. State governments have even gone a step further, legislating remanufactured goods into procurement and disposal requirements, penalising OEMs that restrict remanufacturing, and instituting tax credits to benefit remanufacturers.[7] However, in contrast to the support available to the remanufacturing industry in other countries such as China, firms that remanufacture in the United States receive no direct subsidies, yet remain profitable[8].

Industry sector	Products	Firms in the Database	Estimated firms not in Database	Total
Automotive	Alternators, Starter Motors, Water Pumps, Clutches and Engines	4,536	46,000	50,536
Compressors & Refrigeration	Air conditioner and refrigerator compress	55	100	155
Electrical Apparatus	Transformers, Electrical Motors and Switch gear	2,231	11,000	13,231
Machinery	Machinery and Equipment for various industries	90	30	120
Office Furniture	Desks, Files and Partitions	220	500	720
Tires, retreaded	Truck, Auto and Off-road tires	1,210	180	1,390
Toner Cartridges	Laser toner cardridges Ink jet cartridges	1,401	5,100	6,501
Valves, industrial	Control & Relief valves	110	300	410
Other	Diverse	50	200	250
Totals		9,903	63,410	73,313

Table 1: Companies engaged in remanufacturing by industry sector in the United States
Source: Gallo et al. (2012)[9]

Europe

The United States International Trade Commission (USITC) notes that there is not a robust set of figures to rely on, but assumes that after the United States, the bulk of global remanufacturing happens in the European Union (EU), with the UK and Germany being some of the principle players[10]. Some estimates place the value of European remanufacturing at over €40 billion (£31.8 billion), with the creation of 300,000 jobs[11], bringing the EU quite close in numbers to the United States.

The main focus areas for remanufacturing in the EU are similar to those in the United States: aerospace, motor vehicle parts, HDOR equipment, IT products including toner

7 EEF (2014) *Materials for Manufacturing: Safeguarding Supply.*
8 Lund, R. T. and Hauser, W. M. (2010) *Remanufacturing: An American Perspective.*
9 Gallo, M. et al. (2012) *A perspective on Remanufacturing Business: Issues and Opportunities.*
10 USITC (2012) *Remanufactured Goods: An Overview of the United States and Global Industries, Markets, and Trade*
11 Morley, N. (2013) *The contribution of Reuse and Remanufacturing to the Conservation of Raw Materials and to Green Growth*

cartridges and medical equipment. In toner cartridge and ink jet remanufacturing alone, the European Toner and Inkjet Remanufacturers Association (ETIRA) estimates that there are between 2,000-3,000 firms operating in Europe[12], with a market worth over €1 billion (£0.8 billion)[12]. The remanufactured motor vehicle parts industry is also well-developed, and had an estimated value of $5.2 billion (£3.3 billion) in 2005.[13]

China

There is a dearth of empirical data on the size of the remanufacturing sector in China. However, concerted government efforts exist to establish and promote it. The USITC notes that "the development of China's remanufacturing industry is an outgrowth of national policies and laws aimed at reducing environmental pollution and promoting recycling and sustainability".[13]

China has focussed heavily on supporting remanufacturing through regulation. Having first established a laboratory dedicated to developing remanufacturing technologies in 2001, over the next ten years several laws were passed in China to deal with environmental issues and expand the application of remanufacturing. Cross-departmental pilot programmes for the motor vehicle parts sector and industrial machine and electrical equipment sector were established. Twelve ministries also successfully collaborated on guidance notes to promote the development of China's remanufacturing industry, which further established broad goals, noted the major challenges, and presented a strategic road map for implementation.

More recently, the National Development and Reform Commission (NDRC), one of China's economic planning bodies, has supported and funded the remanufacturing industry through the 12th Five-Year-Plan-Period (2011-2015).[14] This includes funding for pilot enterprises and research in car component, construction machinery and tyre remanufacturing.[14] China also hosted the 4th China International Remanufacturing Summit in May 2014 to facilitate and encourage knowledge exchange within the Chinese remanufacturing industry. Together with the Ministry of Finance, the Ministry of Industry and Information Technology and the General Administration of Quality Supervision, Inspection and Quarantine, the NDRC has recently issued the Quality & Technical Control Standards on Remanufactured Units, in order to standardise the industry and ensure consistency in quality of remanufactured products within China.[15]

Significant barriers remain for the Chinese remanufacturing industry, such as restrictions on trade in remanufactured goods related to a lack of consensus on its definition, but the extent of government support means that China may soon become a dominant force in the global remanufacturing sphere. Total output value of the remanufacturing industry in China is estimated to reach ¥150 billion (£15 billion) in 2015.[15]

12 European Toner and Inkjet Remanufacturers Association. See: www.etira.org
13 USITC (2012) *Remanufactured Goods: An Overview of the United States and Global Industries, Markets, and Trade*
14 China Daily (2011) *Remanufacturing stress in Circular Economy Boost.*
15 Construction Shows (2014) *4th China International Remanufacturing Summit 2014.*

Other countries

The USITC also highlights other countries where remanufacturing might be growing in importance, but suffer self-imposed barriers similar to China. Brazil and India, for example, are both identified as having nascent remanufacturing sectors in aerospace, motor vehicle parts, HDOR equipment, medical devices and IT, but these remanufacturing industries are often confused with repair services, and also suffer from trade restrictions.[16]

More relevant perhaps for policymakers worldwide is South Korea's recent identification of remanufacturing as "an industrial activity that could foster sustainable growth in 'green' industries, create employment, and stabilize prices in the country".[16]

In 2011, Singapore launched the Advanced Remanufacturing and Technology Center (sic), which brings together local universities and remanufacturers such as Boeing, Rolls-Royce and Siemens, as well as SMEs, to develop technologies in aerospace, motor vehicle parts, marine and HDOR equipment sectors.

In Sweden remanufacturing began in 1945. After the Second World War materials were scarce and automotive remanufacturing started to develop. Despite little to no financial support or enabling legislation from government, remanufacturing now covers all mechanic products. Volvo has been particularly active in this field. Although it outsources all remanufacturing, Volvo tightly handles all specifications and has developed a successful network of dealers and partners[17]. Volvo now sells to more than 150 countries.[18]

Japan has a relatively well-developed remanufacturing industry for photocopiers and single-use cameras. Having grown steadily over the past 10-20 years, the sector has been called a 'Hidden Giant', with significant market potential. Interestingly, however, the remanufacture of automotive parts is not nearly as common as in other countries. In addition, whilst design for remanufacture is advanced, certain legislation that can increase the export of end-of-life products can undermine the implementation of more widespread remanufacturing.

In addition to the data alluded to above, there are other, more qualitative indicators of remanufacturing activity around the world. Targeted government policies and research centres such as those in China, South Korea and Singapore, for example, demonstrate that remanufacturing is increasingly becoming a priority around the globe.

Other measures of activity

Remanufacturing is a priority area for the Asia-Pacific Economic Cooperation (APEC) countries. The Market Access Group, which aims to facilitate trade in remanufactured goods, coordinates workshops to highlight research and raise awareness of remanufacturing, and maintains the Remanufacturing Resource Guide, a living

16 USITC (2012) *Remanufactured Goods: An Overview of the United States and Global Industries, Markets, and Trade*
17 Inquiry evidence
18 Matsumoto, M. and Y. Umeda (2011) *An analysis of remanufacturing practices in Japan, Journal of Remanufacturing*, 1:2, pp. 1-11.

document that details numerous global remanufacturing information sources, research institutions, industry associations and businesses.[19]

Industry events, where remanufacturers and other stakeholders convene to exhibit their businesses and share knowledge, are also becoming more common, from 'The Big R' in Las Vegas, to 'ReMaTec' in Amsterdam and the 'Remanufacturing China Expo' in Shanghai.

On the academic side, the University of Bayreuth in Germany is well-known for research and engineering service solutions, particularly for the remanufacture of automotive parts.

Sharing research and best practice on a global scale is also becoming more common. This is extremely important if best practice today is to become the recognised global standard of the future. The World Remanufacturing Summit, which serves as a forum for international remanufacturing research and industry-related collaboration, takes place each year and has grown significantly over the past four years (Box 2). One-off events such as the 'EU-China Eco-design and Green Remanufacturing Seminar' in 2012 are also helping "share knowledge on the practices for the market sector, which may influence the review of market regulatory requirements".[20]

2012	Bayreuth, Germany
2013	Shanghai, China
2014	Rochester, United States
2015	Amsterdam, the Netherlands

Box 2: Locations of the World Remanufacturing Summit

The EU in particular has been active in research into remanufacturing, having sponsored several targeted projects in recent years that expand its knowledge base. The Developing Resource Efficient Business Models (REBus) project, for example, is a collaboration between several institutions that exists to provide support and advice to European companies looking to switch towards more resource efficient business models.[21] Principles of remanufacturing feature prominently within these. At the time of writing, REBus is developing 30 business model pilots that will go on to be exemplars across different sectors, and a 'how-to' guide on implementing them. These will be published online, in view of inspiring further uptake to remanufacturing. By collecting data and putting together numerous case studies, REBus contributes to the

19 APEC and US Aid (2013) *Remanufacturing Resource Guide.*
20 EU-China Low Carbon Economy Platform (2012) *EU-China Eco-design and Green Remanufacturing Seminar.*
21 REBus. See: www.rebus.eu.com

general knowledge base on the benefits of remanufacturing, and raises the profile of remanufacturing as a viable alternative to traditional, linear manufacturing from virgin materials.

Other projects in the EU include the €4.37 million (£3.47 million) funding[22] for the Resource Conservative Manufacturing (ResCom) lifecycle management software platform, which works on the development of closed-loop product systems, with a focus on remanufacturing and reuse.[23] In addition, the Project Remanufacturing Service System (PREMANUS) project aims to provide on-demand 'middleware' which combines information and product services within one service-oriented architecture, with the goal of providing economic and ecologic decision support for remanufacturing per individual product based on product lifecycle information.[24]

More recent EU funding opportunities for remanufacturing were published in December 2013 and opened in October 2014. Entitled *Call for Factories of the Future*, this funding opportunity has a budget of €1.43 million (£1.14 million) for projects developing innovative reuse and remanufacturing technologies and equipment for sustainable product lifecycle management.[25]

The EC has also dedicated €1.5 million (£1.2 million) of Horizon 2020 funding to grow remanufacturing in the EU. The project will map "the size of the opportunity, and deliver a series of tools and workshops that will encourage best practice and promote remanufacturing across the industrial landscape".[26] Most notably, it will develop a permanent European Council for Remanufacturers.

Recommendation 1

Government departments such as Defra, BIS and DECC should actively promote remanufacturing and learn from practices in countries which are leaders in this industry. The UK should take advantage of the knowledge that has already been developed elsewhere.

22 The Recycler (2013) *EU approves funding for project studying remanufacturing.*
23 ResCom. See: www.rescoms.eu
24 PREMANUS. See: www.premanus-project.eu
25 European Commission Horizon 2020 Funding (2013) *Call for Factories of the Future: Re-use and remanufacturing technologies and equipment for sustainable product lifecycle management.*
26 Oakdene Hollins (2014) *EU supports €1.5m Project on Remanufacturing. Press release: September 2014.*

2.2 Remanufacturing in the UK

> "*Understanding of remanufacturing is not as advanced as people think it is*"
> - Martin Charter, University for the Creative Arts, Farnham

The UK's position amongst other remanufacturing nations needs to be strengthened. There is not a lot of robust data on remanufacturing levels around the world, so the global leaders can be hard to identify. Nevertheless, more governments are taking a keen interest in remanufacturing, putting money into research and knowledge transfer initiatives, and cooperating on trade liberalisation. In order to not fall behind, and indeed maintain its position of relative leadership (as some responses to our call for evidence have stated), the UK must understand where its domestic remanufacturing sector currently stands.

The direct precursor to this report, written by the APSRG, notes that the value of remanufacturing in the UK in 2010 stood at £2.4 billion.[27] That figure, drawn from research by the Centre for Remanufacturing and Reuse (CRR), is associated with savings of 10 million tonnes of CO2.[28] It is also estimated that UK remanufacturing firms currently employ around 50,000 people.[29]

The UK industries where remanufacturing is most economically important are the automotive, ink and toner cartridges, pumps and compressors, HDOR equipment and rail industries.

The data on remanufacturing levels in the UK that is available (and indeed the very existence of that data) indicates that there is a market for remanufacturing. In addition, the research activity, information resources and international collaboration that UK institutions engage in shows that there is a growing awareness in industry and academia that remanufacturing is an important part of the circular economy.

There is a long list of such organisations that conduct research and actively promote remanufacturing, including the Waste & Resources Action Programme (WRAP), the Institute for Manufacturing, the High Speed Sustainable Manufacturing Institute (HSSMI), and the EEF, the manufacturers' organisation.

UK expertise in this area is recognised internationally. The CRR is administered by consultancy Oakdene Hollins, which will be leading the European Council for Remanufacturing with a consortium of partners.

Within the UK, Scotland is currently leading the drive towards remanufacturing. The CRR was recently commissioned by Zero Waste Scotland to investigate the size of the remanufacturing industry in Scotland and to identify key barriers, enablers and opportunities for the industry. In addition, the Scottish government announced in

27 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy*
28 CRR (2010a) *Remanufacturing in the UK: A Snapshot of the UK Remanufacturing Industry, 2009.*
29 CRR (2010b) *Market Failures in Remanufacturing: An examination against major categories.*

November 2014 £1.3 million of funding for a new Scottish Institute of Remanufacture "to realise the value of materials like gold and electrical components harvested from recycled televisions, mobile phones and computers"[30]. Unfortunately, no other similar institute exists for England and Wales.

Remanufacturing remains below 2% on average for durable products in the UK as a whole.[31] Further, the CRR estimates that although the recycling and remanufacturing industry were the same size in 2005, remanufacturing has only grown by 15-20% since then, in comparison to the UK recycling industry which has grown by 300% during this time.[32]

There is still a lack of awareness and understanding in industry and in Government about what constitutes remanufacturing and its benefits to the UK. The only mention of remanufacturing in Government policy is in the Government Review of Waste Policy in England in 2011, where an indication is given that that there will be growth opportunities for the sector as the country moves towards a zero waste economy.[33]

The UK Government has previously sponsored research that touches on remanufacturing through the Circular Economy Taskforce, which made some valuable recommendations,[34] but there has so far been little action. In fact, existing policies actually make it more difficult for remanufacturers to compete. Some barriers to remanufacturing were identified in the first APSRG report, and this report seeks to further highlight these barriers as well as provide further detail on other factors that currently hinder the uptake of remanufacturing in the UK (Chapter 3).

An initiative is being developed by a consortium that includes the Knowledge Transfer Network (KTN), HSSMI, the CRR and the Carbon Trust. It is specifically looking at the best ways to exploit the potential for increasing remanufacturing through, for example, investigating the proposal in the last APSRG report on remanufacturing that there might be a merit in setting up a special interest group in remanufacturing (Chapter 8).

The consortium outlined above has already engaged with industry across different sectors, along with academia, funding bodies and organisations whose remit relates to innovation in this space. In October 2014, the KTN hosted a workshop which was designed to: (a) gather the views of experts and evidence for industry support, and (b) ensure that any synergies with organisations that are already active in related fields are exploited (including the High Value Manufacturing Catapult and the EPSRC Centre for Innovative Manufacturing in Industrial Sustainability).

To address the challenges of resource efficiency and the costs of a volatile resource market, Innovate UK is also preparing to launch a competition to encourage the development of alternative business models for circular economy systems, with specific mention of models that integrate remanufacturing. This is encouraging given that a

30 Vallely, L. (2014) *New Institute of Remanufacture to drive Scotland's Circular Economy*. EdieWaste.
31 Lavery/Pennell (2014) *The New Industrial Model: Greater profits, more jobs and reduced environmental impact.*
32 Reece, A. (2014) *Picking up the Pieces.*
33 Defra (2011) *Government Review of Waste Policy in England 2011.*
34 Green Alliance (2013) *Resource Resilient UK: A Report from the Circular Economy Task Force.*

well-adapted business model is key to successfully engaging in the sector (Chapter 7). Innovate UK is particularly concerned with design aspects of how to prolong the life of products, business-to-business collaboration, and relationships with the end-user.

Movements such as the ones mentioned above are an indication of how industry is currently ahead of policy in this area. Government now needs to support initiatives that encourage remanufacturing. There is much more that Government can do in terms of promoting research and collaboration, and encouraging industry to explore remanufacturing as a distinct and viable option in its pursuit of a zero waste economy. As the particular drivers and barriers to remanufacturing become better understood, Government will have a crucial role to play in coordinating the different strands of the economy and society to truly take advantage of its full potential.

Chapter Three

The Potential for Remanufacturing in the UK

3.1. Since the last APSRG report

In March 2014 the APSRG launched a report entitled *Remanufacturing: Towards a Resource Efficient Economy*. This report provided a summary of remanufacturing in the UK, placing the UK onto the spectrum of international remanufacturing with several examples of how the country has been falling behind compared to its international counterparts such as the United States. The report briefly outlined the drivers and barriers of remanufacturing in the UK and how these challenges could be addressed.

Since that report was published, there has been a significant amount of movement in the UK remanufacturing sphere. Remanufacturing has gained significance and acknowledgement in the UK, particularly at industry level, and is increasingly being referred to in waste management, circular economy, manufacturing and resource efficiency research papers and reports.

Most notably since the launch of the last report, developments of a SIG have evolved in the UK. Key stakeholders involved in remanufacturing through research, product design, innovation funding and manufacturing have been involved in unifying the industry in order to improve communication between the various actors involved and drive the industry forward.[35] At the end of October 2014, Scotland's Environment Secretary, Richard Lochhead MSP, announced the development of the Scottish Institute of Remanufacture.[36] Furthermore, the end of October also marked the opening of a €143,170,000 (£113,345,000) funding pot from the EC for "reuse and remanufacturing technologies and equipment for sustainable product lifecycle management".[37]

35 Inquiry evidence
36 Verrinder, J. (2014) *Scotland to launch remanufacturing institute. MRW Magazine.*
37 European Commission Horizon 2020 Funding (2013) *Call for Factories of the Future: Re-use and remanufacturing technologies and equipment for sustainable product lifecycle management.*

3.2 Drivers of Remanufacturing

There are several arguments for why countries around the world are increasing their remanufacturing activity and why the UK should act to maximise its own remanufacturing sector. These generally revolve around resource security and business efficiency imperatives on the one hand, and environmental and sustainability concerns on the other.

3.2.1 Economics: Balance of Trade and Reshoring

At the most basic level, it is almost always less expensive to remanufacture a given product than to start the manufacturing process from scratch. Savings are accrued throughout the production process, from not needing to source new raw materials, to using simpler and shorter supply chains.

The reduced cost of remanufacturing means that like-new products can be sold at a much lower price than newly-manufactured ones. These savings can range between 50-90% of the price of a comparable new product.[38] The argument can be made that there is no need to sell a remanufactured product more cheaply if the quality is so high, with a guarantee to match. Indeed, a discount for remanufactured products can increase perceptions of inferiority and actually act as a barrier to the growth of the market. Nevertheless, the ability to undercut manufacturing competitors and gain market advantage, and the lower cost to customers, ultimately helps to encourage competition and growth in the market.

The recovery of end-of-life products is one of the key elements of a successful remanufacturing business model. To ensure the return of core, this recovery tends to be in close proximity to the original consumer. This reflects similar principles in reshoring and near-shoring trends, whereby firms choose to locate production close to their customers. With rising transportation costs, rapidly evolving customer demand, greater quality assurance and better skilled labour, shortening of supply chains is becoming increasingly important.[39]

> Companies are beginning to understand that remanufacturing is not just about saving money but also about maximising revenue.

Being closer to your customer, as remanufacturing entails, also means being more responsive and adaptable to rapidly changing preferences and demands.

Keeping production, and particularly remanufacturing, local also has significant benefits for the UK economy as a whole. If the sourcing of input materials and subsequent processing is mostly domestic, imports would invariably go down. This would be a boon to the UK's chronic and problematic trade deficit. There are also

38 Inquiry evidence
39 APMG (2013) *Reshoring: Bringing Making Back?*

positive benefits in terms of job creation, as remanufacturing typically requires a local source of skilled labour.

A drive to implement remanufacturing practices can itself be strong motivation for reshoring production from overseas. A reshored business then also contributes to decreased imports if it was originally selling into the UK, and increased exports if it its market was global.

3.2.2 Resource Security and Resilience

One of the most important drivers of remanufacturing is the rising insecurity of supply and associated cost of raw materials, caused by swelling world demand, restrictive trade policies from producer nations, and vulnerable global supply chains increasingly put at risk by natural disasters and geopolitical conflict.

This represents a very real threat to growth as materials and resources are extremely important for businesses and can account for up to 40% of a manufacturer's costs.[40] In a 2012 survey of their membership by the EEF, over 80% of chief executives of manufacturing companies said that raw materials shortage was a risk to their business,[41] and the EU currently identifies 20 critical raw materials that need to be managed in order to maintain growth, jobs and overall quality of life (Box 3).[42]

EU Critical 20 Raw Materials

Antimony	Magnesite
Beryllium	Magnesium
Borates	Natural Graphite
Chromium	Niobium
Cobalt	PGMs
Coking coal	Phosphate Rock
Fluorspar	REEs (Heavy)
Gallium	REEs (Light)
Germanium	Silicon Metal
Indium	Tungsten

Box 3: The EU Critical 20 Raw Materials
Source: European Commission

40 EEF (2014) *Materials for Manufacturing: Safeguarding Supply.*
41 Defra and BIS (2012) *Resource Security Action Plan: Making the most of valuable materials.*
42 European Commission (2014a) *Report on Critical Raw Materials for the EU.*

More than simply being an added financial pressure on business, however, is the importance of these materials for the ubiquitous products that the UK depend on such as electrical, automotive and chemical products. This means that their potential scarcity can be viewed as a national security threat.

Remanufacturing keeps these valuable materials within the domestic supply chain, thereby securing and stabilising supplies and reducing costs. This has obvious benefits for businesses and increases the resilience of the UK economy as a whole.

Defra recognises the importance of resource resilience on the national economy:

> "*The UK's prosperity and national security depend heavily on global stability… Access to reliable supplies of such resources is essential for our economy to prosper and grow.*"
> - Defra, *Resource Security Action Plan 2012*[43]

Of course, resource security is a bigger driver for those products where they consist of materials on the EU Critical 20 Raw Materials list (Box 3)[44]. As resource insecurity and input costs continue to increase, efficiency and circular economy principles such as remanufacturing will become ever more important.

3.2.3 Carbon Emissions and Energy Savings

In addition to the economic and environmental advantages on the input side of remanufacturing, there are also fewer negative by-products on the output side such as carbon, general waste and pollution.

The environmental benefits of remanufacturing are intimately linked to overall economic and social benefits. With processes that require significantly less raw materials, energy and water, and which produce less carbon and waste, remanufacturing has a critical role to play in meeting UK and EU carbon and waste reduction targets, and safeguarding our shared resources.

Overall, the CRR estimates that reuse and remanufacturing currently contribute to approximately 7 million tonnes of CO2 reduction every year[45] with a further potential to contribute towards over 800 million tonnes of cumulative savings by 2050[46]. In addition, WRAP has estimated that, "changing how we design, make, buy and dispose of electrical and electronic equipment could reduce the UK's carbon footprint by up to 15%"[47]. Remanufacturing can play a significant part in this redesign.

Retaining resources and materials through remanufacturing also diverts them from landfill, incineration or recycling. Methane emissions from landfill continue to make a significant contribution to UK greenhouse gas emissions[48]. In 2012, the waste management sector was responsible for around 4% of UK greenhouse gas emissions.

43 Defra and BIS (2012) *Resource Security Action Plan: Making the most of valuable materials.*
44 European Commission (2014d) *Press release: 20 critical raw materials – major challenge for EU industry.*
45 Morley, N. (2013) *The contribution of Reuse and Remanufacturing to the Conservation of Raw Materials and to Green Growth.*
46 CRR (2010b) *Market Failures in Remanufacturing: An examination against major categories.*
47 WRAP (2014b) *Switched on to Value*
48 DECC (2014) *2013 UK Greenhouse Gas Emissions, Provisional Figures and 2012 UK Greenhouse Gas Emissions, Final Figures by Fuel Type and End-User.*

The majority of these emissions are from landfill sites which emit methane, the most prominent gas (93%) of the waste management sector.

Remanufacturing not only preserves valuable raw materials, but also uses less energy, which can in turn also signify additional cost savings for businesses.

Demand for energy is increasing. In turn, energy costs are rising. This is a critical issue for any UK manufacturer where energy use accounts for a significant proportion of its operational costs. However, the energy required to remanufacture a product can be up to 90% less than to manufacture from raw materials.[49] These savings can then be passed on to the consumer, helping create a viable market for remanufactured goods.

While investing in renewable energy technology is important, some industry leaders suggested during this inquiry that implementing remanufacturing processes can be even more beneficial in terms of reducing energy costs.

In the case study of a remanufactured desk (Chapter 7), the process involved a carbon saving of 28 kg of CO2. For the ink and toner cartridge remanufacturing industry, remanufactured cartridges can have a 45%-60% lower carbon footprint or a saving of 72 tonnes CO2 nationally per year.[50] Landfill gas recovery schemes can reduce these emissions.

Including specific emphasis on remanufacturing-related initiatives in official environmental reports and voluntary Corporate Social Responsibility (CSR) reports can bestow significant advantages on a business, such as gaining a better understanding of exposure to the risks of climate change, demonstrating leadership, strengthening green credentials, and helping generate new business opportunities.[51] Publicly sharing such information also contributes to the overall knowledge base associated with remanufacturing activity in the UK, which in turns informs future in-depth research and policy-making.

Recommendation 2

Government should encourage companies, universities and public services to include data on the procurement or production of remanufactured goods and landfill diversion in their CSR reports. It should also encourage these sectors to develop waste prevention targets similar to carbon footprint targets to encourage waste prevention.

49 WRAP (2014a) *Alternative Business Model Caste Study: Remanufacturing Office Furniture.*
50 Inquiry evidence.
51 Defra (2013) *Environmental Reporting Guidelines: Including Mandatory GHG Emissions Reporting Guidance.*

3.2.4 Water

Remanufacturing eases pressure on water supplies through closing the loop on raw materials flows and reductions in energy inputs. This indirectly reduces costs further.

Previous case studies have shown that for a typical desk, the remanufacturing process has a water footprint of around 35% of that of new manufacture, equating to a saving of 0.19 m^3 of water per desk.[52]

Mining for raw materials in ever more remote areas around the world implies higher costs to ensure water supplies. This reflects the increasing inter-correlation between resources generally, whereby "the inputs to extract one resource become the inputs to extract another".[53] If power generation is becoming increasingly water-intensive, then remanufacturing, which uses less energy, will have a corresponding benefit for the overall water supply system.

3.2.5 High Value Products

The multi-faceted and costly manufacturing processes associated with high value products such as in the aerospace and automotive industries provide the greatest incentive to adopt remanufacturing. Lengthy and complex supply chains, components made with various types of rare earths and metals and the inherent durability of cores all contribute to a clear business case for remanufacturing. Unsurprisingly, these are the areas where it is most developed in the UK and around the world

The relatively high cost to the consumer of an aero engine or HDOR equipment lends itself well to a service-based business model, which in turn facilitates remanufacturing (Chapter 7). Consumers of these products also typically do not succumb to fashion trends or aversion to 'pre-owned' goods.

3.2.6 Technological Advances

Technological advances are making manufacturing, and therefore remanufacturing, easier and more accessible. As a remanufactured product is 'like new or better', so long as it fulfils the original functionality, the proliferation of mass customisation and additive manufacturing capabilities places remanufacturing at the fingertips of more SMEs and individuals.

New developments in automation could also mean that end-of-life product disassembly for remanufacture will become easier, faster and more cost-effective. Currently in its experimental stage, the potential for robots to be used to quickly extract high value components from cars is being examined.

52 WRAP (2014a) *Alternative Business Model Caste Study: Remanufacturing Office Furniture.*
53 EEF (2014) *Materials for Manufacturing: Safeguarding Supply.*

Overall, as technology develops more rapidly, it makes more sense to remanufacture a product, incorporating the latest improvements at a fraction of the cost, than to continuously design and manufacture new products and new production lines. New technologies often depend on rare minerals and metals, such as carbon fibre, meaning that demand will increase, leading to competition, supply chain bottlenecks and price increases.[54]

54 EEF (2014) *Materials for Manufacturing: Safeguarding Supply.*

3.3 Barriers to Remanufacturing

> *"Remanufacturing has its problems, but it's also an opportunity"*
> - Sean Feeney, Environcom

Barriers to remanufacturing are felt in different ways depending on the manufacturing sector and the size and nature of individual remanufacturers. Barriers to remanufacturing also vary between independent remanufacturers (IRs), third party remanufacturers and OEMs due to the differing nature of accessing cores or product, data and IP rights.

The following section identifies the key barriers identified for remanufacturing in the UK, with examples from a number of relevant industries.

Barriers to remanufacturing as identified in *Remanufacturing: Towards a Resource Efficient Economy*
- Lack of legal uptake of a definition
- Design
- Supply chain communication
- The sustainable resource industry and regulatory framework
- Market dynamics and consumer concepts
- International trade
- Skillset
- Buying standards

Box 4: The barriers to remanufacturing

3.3.1 Definition of Remanufacturing

The most prevalent barrier to remanufacturing, which continues to be an issue within a number of industries revolves around its definition. As well as consolidating a lack of trust in remanufactured products, the lack of a clear legal definition of remanufacturing has resulted in disparities between so-called remanufactured products in most industries[55].

Some companies market products as 'remanufactured' when they are in fact refurbished, reconditioned, recycled or upcycled. This could prove harmful to remanufacturers who genuinely adhere to the commonly accepted definition of remanufacturing. Using incorrect terminology can destabilise the industry by affecting customer confidence.

55 Lavery, G. et al. (2013) *The Next Manufacturing Revolution: Non-Labour Resource Productivity and its Potential for UK Manufacturing.*

Upcycled products, for example, are not designed to be as good as new, but if they are classified as remanufactured products the consumer automatically thinks they will be of the same standard as a remanufactured product. Consumer trust is lost when falsely branded remanufactured products malfunction. A clear legal definition of remanufacturing alongside a certification scheme could restore consumer confidence.

The definition of remanufacturing adopted by the British Standards Institution (BSI) can help[56]. The BSI defines remanufacturing as a process "returning a used product to at least its original performance with a warranty that is equivalent to or better than that of the newly manufactured product"[57]. This definition is in line with the academic definition outlined at the beginning of this report and the previous APSRG report on remanufacturing and needs to be legally supported.

Recommendation 3

Government should adopt this report's definition of remanufacturing to provide clarity as to what constitutes remanufacturing versus other aspects of the circular economy.

A lack of a legal definition of remanufacturing is also linked to consumer perception that remanufactured products are 'second best'. This constrains demand and depresses prices for products such as retreaded tyres and remanufactured cartridges, thereby undermining the economics of remanufacture.[58] The entire concept of remanufacturing therefore needs to be promoted as the current lack of understanding of remanufacturing both from the public and industry, as well as from within Government, continues to hinder the sector. Government and industry need to actively educate the public on what remanufacturing entails. Indeed, remanufacturing can also consist of upgrading products, such as with some electrical products where remanufacturing can improve a product's energy efficiency grade.

Changing public perceptions so it is understood that remanufactured goods are of the same quality standards as new products is vital. Developing a certification mark alongside a new legal definition of remanufacturing, which demonstrates that a remanufactured product has been tested and fully complies with standards of a new product, was commonly suggested by industry member as the way forward to achieving this.[58] Certification marks are particularly vital for SME's and micro businesses, which cannot rely on their brand names as proxies for certification the way larger companies can.

Consumers also need to be reminded that end-of-life goods have intrinsic value and that returning items[58] at the end of their first life is a vital step towards increasing remanufacturing. Schemes to support this need to be put in place.

An example of where the lack of legal definition of remanufacturing is having a negative impact on industry can be found in the remanufacture of ink jet and toner cartridges.

56 BSI. See: shop.bsigroup.com
57 BSI (2009) BS 8887-2:2009. *Design for manufacture, assembly, disassembly and end-of-life processing (MADE), Part 2: terms and definitions.*
58 Inquiry evidence

Due to a lack of legal definition of what their remanufacturing entails, many producers brand their cartridges as remanufactured when they have, for example, simply been refilled with ink. Customers are thus sold cartridges branded as remanufactured, but of a lower quality than genuinely remanufactured cartridges. This has had a strong impact on companies who do genuine remanufacturing.

Recommendation 4

Government should work towards improving consumer awareness of remanufacturing including through the use of national campaigns.

Recommendation 5

Government should develop a certified mark for remanufacturing to demonstrate that products have been tested and fully comply with those standards of a new product to improve clarification for consumers on which products have been remanufactured.

3.3.2 Consumer Society and Procurement

We are living in a world with a growing middle class and an ever increasing turnover of changing products.[59] This demand for continuous new products is also constraining some industries such as the mobile phone industry from taking up remanufacturing as technology and purchasing turnover moves too quickly. In these sectors, remanufacturing would not be profitable due to a lack of consumer demand.

Consumers tend to enjoy owning products, whilst many remanufacturing companies are built on service or leasing business models, where consumers pay for a service rather than owning a product. At the beginning of the twenty-first century, many products were too expensive for individuals to purchase, so leasing models for products such as televisions, fridges or washing machines were relatively common. However, this has changed over the twenty-first century as these products have become cheaper and a stigma has been attached to not owning products. If the circular economy is to move in a successful direction and for remanufacturing to gain traction, this stigma needs to be addressed.

The lack of awareness and negative perceptions associated with remanufacturing has meant the market demand for remanufactured products remains limited. Customers continue to purchase new products over remanufactured products.[60] Some interviewees for this inquiry outlined that there is a 'green' and environmentally conscious customer base that is currently purchasing remanufactured products, in particular large electronics such as washing machines or fridges, and the growth of this demand is imminent. Reliance on this 'green' customer base alone, however, will not sustain growth of the remanufacturing industry. The general British public needs to be educated about the environmental, economic and practical benefits of remanufactured products.

59 EEF (2014) *Materials for Manufacturing: Safeguarding Supply*
60 CRR (2008) *Review of Policy Options for Promoting UK Remanufacturing.*

Confidence in remanufactured products could be substantially increased and the market of remanufactured products supported if sustainable government procurement standards would include a minimum percentage of remanufactured products. In the UK, these range from medical appliances, carpet flooring, electrical equipment, office furnishing, to paints and many more. Government should act as a leader in showing confidence towards UK remanufactured products.

In August 2014, Government published new *Greening Government Commitment Targets*, which include goals for Government to procure "more sustainable and efficient products and engage with its suppliers to understand and reduce the impacts of its supply chain", alongside goals to reduce greenhouse gas emissions, waste generated and water consumed. However, no specific procurement targets on remanufacturing have been outlined.[61] If Government lead the way in procuring remanufactured products this would not only raise the profile of the industry, but considering the economic and environmental savings linked to remanufacturing and the fact that public sector spending is worth around 16% of the UK's Gross Domestic Product (GDP)[62], it would also imply significant cost savings. Defra has made steps towards this goal, by including encouragement for the use of refurbished furniture in its Government Buying Standard for Office Furniture[63]. However, compulsory targets would be much more effective in securing growth in the UK remanufacturing sector.

Recommendation 6

Government should work towards procuring UK remanufactured products such as office furnishing and equipment, carpet flooring, electrical equipment and medical appliances where possible. Government should also work towards increasing its procurement through service models to support the remanufacturing industry.

Manufacturers and third party remanufacturers would also benefit from an online platform similar to WRAPs platform associated with the *Halving Waste Landfill Commitment*[64], where participants can exchange knowledge and experiences as well as trade materials to ensure they remain within a closed production loop. This would avoid valuable materials and resources from being landfilled or incinerated when another manufacturer can still make use of the products for remanufacturing. WRAP's *Halving Waste to Landfill Commitment* involved over 800 companies making the commitment to reducing waste in the construction industry through the tools and guidance developed by WRAP and support action across the supply chain.

61 Defra (2014a) *Policy Paper: Greening Government Commitment Targets.*
62 Defra (2014b) *Making Sustainable development a part of all Government policy and operations.*
63 Defra (2014c) *Government Buying Standard for Office Furniture.*
64 WRAP (2011a) *The Construction Commitments: Halving Waste to Landfill. Signatory Report 2011.*

Recommendation 7

Government should encourage the development of an online platform with clear standards where businesses can exchange knowledge, components and products to encourage the reusing of materials and products and allow remanufacturers and manufacturers to access products at the end-of-life stage.

3.3.3 Return of Products and Linear Business Models

An additional barrier to the uptake of remanufacturing continues to be the return of end-of-life products (or 'core') from the consumer back to the remanufacturer.[65] Most current product supply chains are geared toward one-way movement of products from the point of manufacture, to sale to the customer and ultimately then, to landfill or incineration (Figure 4).[66] These linear business models make it difficult for both OEMs and third party remanufactures to gain access to products at their end-of-first-life stage. The collection of products at their end-of-life or end-of-first-life stage is often referred to as 'reverse logistics' and the success of the return of products is strongly linked to a company's business model (Chapter 7).

Figure 4: Typical linear business models

Although many remanufacturers are currently experiencing difficulties in getting access to products or 'core' to remanufacture, changing linear business models to more circular or service oriented models can truly reverse this trend. Some companies such as Xerox and Caterpillar have already overcome this barrier by providing incentives for product return[66] or developing more circular business models around their products.

Third party remanufacturers are often at a particular disadvantage due to their lack of control over return of products. As such, these companies must develop innovative ways to gain access to products at their end-of-life stage. Companies such as Kleenstrike and Honest Inks that remanufacture toner cartridges and ink jets respectively have developed collection schemes within certain supermarkets to gain access to products for remanufacture. Premier Sustain, which remanufactures office furniture, has incorporated a collection service for furniture into their business strategy

65 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*
66 CRR (2008) *Review of Policy Options for Promoting UK Remanufacturing.*

in order to gain access to products and incentivise product return. Autocraft Drivetrain Solutions Ltd and Mackie Automatic Transmissions Ltd have strong relationships with car manufacturers who outsource remanufacturing to these third parties.

Although several success stories exist, the majority of products which could be remanufactured continue to be disposed of through landfill and incineration or are recycled. Recycling does provide a solution which is more resource efficient than incineration or landfill, but does not take full advantage of the environmental and economic opportunities it could benefit from if it was remanufactured.

3.3.4 Design for Remanufacture

> "*Product designers are willing and able to respond to the challenges of remanufacture. The task for Government is to create the economic framework in which they compete to do so.*"
> - David Fitzsimons, Oakdene Hollins

Design can be both a driver and a barrier to remanufacturing. It can act as a technical barrier towards remanufacturing because it directly impacts the ability of a company to monitor, disassemble, inspect and reassemble products.[65] Barriers both impact the ability for design for remanufacture based on restrictions from the top-down within organisations but also the training and education system involved with designing and engineering for remanufacture. Design can also support remanufacturing when products and cores are made to be easily disassembled and reassembled.

Design for remanufacture needs to be incorporated into product design and engineering courses at Higher Education level. These courses do not currently provide enough opportunities for students to learn about a designer's role in making products more sustainable. Different institutions may have one or two professors who are passionate about sustainability and teach about these issues; however, these individual professionals continue to remain a minority. Encouraging the new generation of designers and engineers to incorporate eco-design and sustainable engineering in their practice is, thus, lacking. This means that the UK continues to fall behind because universities are not investing in appropriate measures. Sustainable design needs to be grown within universities and practitioners already working in product design and design engineers need to be re-educated.

Products need to be designed with the circular economy, and particularly remanufacturing, in mind. Decision makers at large OEMs need to identify the benefits of remanufacturing and allocate design for remanufacturing specifications to designers accordingly. Although sustainable design is not approached enough at Higher Education level, several respondents to our Call for Evidence mentioned that

design for remanufacture involves the simple process of design for disassembly which all designers are in practice able to do. Designers we spoke to have been eager for and adaptable to change but feel constrained due to being given design briefs from top-down that don't incorporate design for remanufacture.

> "*You have to design the 2017 products using 2014 machine components (because the 2014 components will be the remanufactured cores of the future)*".
> - Professor Steve Evans, University of Cambridge

Some product specifications will stay more similar (e.g. engines) over time than others (e.g. mobile phones), but the current lack of designing towards the future is limiting the growth of remanufacturing.

Ensuring product quality is crucial for remanufacturing. Several remanufacturing industries, including tyre retreaders, toner cartridge and ink jets, struggle to remanufacture returned products due to their poor quality. For example, low-cost tyres are frequently not suitable for retreading due to the 'single life' design of their casting. These low budget tyres represent 42% of car and van tyre replacement sales in the UK. The pool of castings available to tyre remanufacturers is therefore significantly reduced.[67] Cheaply produced products have a strong impact on the remanufacturing industry and there is a strong necessity to move towards encouraging quality over quantity in the design of products.

When thinking about design for remanufacture it is also important to think about full service design. Service design acknowledges the importance of designing a business in a holistic and circular way which moves beyond seeing different aspect of the business separately and acknowledges the interconnectivity of the different parts of a business.

Businesses need to understand that the design of business models suited to remanufacturing is just as important as the designing of a product (Chapter 7). Design for remanufacture has to be approached in a very holistic manner which includes the strategic business aspect.

3.3.5 Data for Remanufacturing

Design is also linked to the sharing of data from OEMs to third party remanufacturers. Some third parties have recognised opportunities to remanufacture products, and although some OEMs work together with these third parties,[68] many third party remanufactures continue to be restrained in remanufacturing products due to lack of service and product design data available to them.

The prevalent battle in remanufacturing continues to be that often third party remanufacturers cannot take OEM cores and remanufacture them due to the lack of

67 Inquiry Evidence.
68 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

design specifications available to them. OEMs are understandably reluctant to share confidential data to competitors. Any regulatory change forcing OEMs to share data runs the risk of manufacturers offshoring their production to avoid the legislation.

Third party remanufacturers have no rights over the IP of the products they remanufacture and this limits their ability to remanufacture. There is a clear necessity for the coordination of licensing deals or the development of a marketplace where licenses can be sold and traded between OEMs and third party remanufacturers where both parties will gain a benefit. Several companies, for example MCT ReMan, Autocraft Drivetrain Solutions Ltd, Xerox and Megalans (in Sweden) have already demonstrated that these symbiotic relationships may be the way forward. OEMs need to recognise that sharing information and data with third party remanufacturers is not detrimental to their manufacturing business.

Recommendation 8

Original Equipment Manufacturers (OEMs) and third party remanufacturers should work together to mobilise supply chain communication.

Beyond design data, there is also a lack of in-service data from products available to remanufacturers. Remanufacturers collect and buy products at their end-of-life stage without knowing the quality of this product and this makes many companies financially vulnerable as some products will be too worn out to remanufacture.

Researchers at Loughborough University are working on the EU's Seventh Framework Programme's funded PREMANUS projects. One of these projects studies remanufacturing information services and suggests that remanufacturing practices could become more efficient if more in-service data was collected during a product's first life and if this information would then be accessible to remanufacturers.[69] In-service data could give an indication of the quality of the product at the end-of-life stage which could avoid remanufacturers obtaining cores that are unsuitable for remanufacture.

3.3.6 Skillset and Job Creation

The remanufacturing sector has the potential for substantial job creation at a number of different skill levels.[70] However, the availability of skilled staff has been cited as a big barrier for remanufacturing in a number of different sectors in the United States[71] and this is likely to also be the case in the UK. Remanufacturing involves manual engineering as well as business and management knowledge to develop the business models needed to develop remanufacturing businesses.

There are both not enough STEM[72] graduates coming through in the UK as well as too few apprenticeships in remanufacturing. Manufacturers' and businesses' knowledge

69 PREMANUS. See: www.premanus-project.eu
70 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*
71 USITC (2012) *Remanufactured Goods: An Overview of the United States and Global Industries, Markets, and Trade.*

about the alternative business models vital for remanufacturing and how to implement these is also somewhat lacking. SMEs in particular need to be educated about remanufacturing as many are unaware or have not considered it as an option. This lack of business awareness on how to implement circular business models is a main reason why remanufacturing is continuing to experience low growth.

3.3.7 Regulatory Frameworks

On top of a number of technical and structural barriers to remanufacturing in the UK, there are several regulatory frameworks on sustainable resource management, energy using products, waste and chemicals that inhibit the uptake of remanufacturing. Many of these regulatory frameworks and Directives focus too strongly on classifying products as waste when they have reached their end-of-first-life stage. Parts and products due for remanufacture should not be classified under these systems as waste.

The Waste Electrical and Electronic Equipment (WEEE) Directive

The WEEE Directive requires EU member states to ensure that producers do not prevent WEEE from being reused "unless such specific design features or manufacturing processes present overriding advantages, for example, with regard to the protection of the environment and/or safety requirements".[73] Therefore, WEEE should not prevent OEMs from remanufacturing. However, in practise this is sometimes the case as there is no clarification as to whether a product at the end of its life, but before being remanufactured is classified as 'waste'.

Classifying products as 'waste' at their end-of-life stage can hinder the rapid re-entry of those materials into the circular economy because organisations are required to have waste handling certificates. This is the case even if a part or product that arrives as waste could easily be remanufactured. This is an impediment to remanufacturing, since items that could be remanufactured or re-used almost immediately have to be processed and handled as waste. The situation is extremely complex as legislation on waste is important to stop dangerous materials being handled irresponsibly, yet at the same time it hinders remanufacturing.

The definition of waste has been in use in its current wording for over three decades and is now embedded in the 2008 Waste Framework Directive as: "...any substance or object which the holder discards or intends or is required to discard...".[73] The current 'Guidance on the Legal Definition of Waste' and its application also adopts this definition but does not mention remanufacture products.

72 STEM = Science, Technology, Engineering and Math
73 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

Recommendation 9

Government should amend its Guidance on the Legal Definition of Waste to distinguish a product that is due to be remanufactured as being exempt from those products considered as waste. This will ensure that they do not fall within the remit of waste regulations. These products could also be labelled under a "Remanufactured in the UK" certification scheme.

The Freedom of Information (FOI) Act

The FOI Act seeks to give individuals the right to access information held by governments and corporate bodies. However, some repsondents to our Call for Evidence outlined that a key opportunity is being missed as there is currently little scope for remanufacturers to access product design or in-service data or specifications. Third party remanufacturers who are not directly working with OEMs or manufacturers must reverse engineer all products before any remanufacture process can begin, adding to time and investment costs of remanufacturing as well as adding to the risk that not all remanufactured products are of as high a standard as they could be. In the United States the Freedom of Information Act allows remanufacturers access to OEMs' design specifications, allowing third party remanufacturers to remanufacture to original specifications.[74]

The End of Life Vehicles (ELV) Directive

The effect of the ELV Directive on remanufacturing is unclear. It should encourage remanufacturing due to the requirement that vehicle manufacturers take responsibility for vehicles. However, no credit is offered for remanufacture, making other options such as recycling more attractive to some manufacturers.

Sale of Good Act (SoGA)

The SoGA also presents a barrier to remanufacturing as the burden is placed on the retailer instead of the manufacturer if a product is faulty. This does not incentivise an OEM to make long-lasting products that are easily remanufactured.

Trade Description Act (TDA)

The TDA prevents manufacturers, service industry providers and retailers from misleading consumers as to what they are purchasing. Remanufactured products are often considered by consumers to be less reliable than new products. Following the recommendations surrounding a legal definition of remanufacturing and certified mark for remanufactured products could increase consumer acceptance.

REACH

The Registration, Evaluation, Authorisation and restriction of CHemicals Regulation (REACH) requires manufacturers of products which contain more than 0.1% of weight of any Candidate List Substance of Very High Concern (SVHC) to provide customers

74 Gray, C. and Charter, M. (N/A) *Remanufacturing and Product Design: Designing for the 7th Generation. The Centre for Sustainable Design.*

with sufficient information to allow safe use of the product. The use of chemicals must therefore be managed through the supply chain and this can be a large financial burden to remanufacturing. REACH has a particular impact on the paints and chemicals industry (Chapter 5).

Restriction of the Use of Certain Hazardous Substances in Electrial and Electronic Equipment (RoHS) Directive

The RoHS Directive can also be a barrier to remanufacturing. It has recently been added to the Conformité Européene (CE) Directive and means that if part of a product is replaced, the whole product will have to be reassessed in order to be awarded a CE mark. In this respect, the RoHS represents a legal black hole when looked through the prism of reuse and remanufacturing.

The Energy using Products (EuP) Directive

Remanufactured components may not be as energy efficient as new components of more recent design. The EuP Directive is continually revised to reduce standby and in-use energy consumptions. There is the possibility through this Directive that it could become impossible to sell remanufactured products if they use more energy than new, low-energy models. Although lowering stand-by and in-use energy consumption is beneficial in isolation, it may not be the best measure to drive holistic improvement. A more holistic approach focusing on the entire supply chain of products should be used to assess energy-saving potential. This Directive is particularly relevant for large electrical appliances such as white goods, which have a high potential to be successfully remanufactured.

The EU Waste Shipment Regulation

The EU Waste Shipment Regulation[75] bans all exports of hazardous waste to non-OECD countries and all exports of waste for disposal outside the EU. Although this is a very important and extremely necessary piece of regulation, industry members interviewed during our inquiry stressed the need for both remanufactured items and items due to be remanufactured to not get caught up in this regulation.

Recommendation 10

Government should review the regulatory barriers to remanufacturing and address the legal anomalies identified.

75 European Commission (2014b) *Regulation (EC) No 1013/2006 on shipments of Waste.*

Recycling Targets

> *"Historically legislation has tackled the lowest level of the waste hierarchy, and although the theory has said that the best way to escape the next legislation is to go three tiers up, nobody has actually done that."*
> - Professor Steve Evans, University of Cambridge

Increasing recycling targets has an indirect and perhaps unexpected impact on the remanufacturing industry. Government policy transformed the recycling sector between 1990 and 2010 by diverting wastes from landfill to recycling. The next step toward greater resource efficiency however is thought to be diverting more products away from recycling and towards methods higher up the waste hierarchy. This development has the potential to transform the existing remanufacturing sector. Although the EU is recognising the potential of the remanufacturing industry by funding numerous research and development projects in this area, legislation is still largely focussed around recycling rates with the most recent EU recycling targets set at 50% by 2020 and 70% by 2030.[76] Some companies, for example Lexmark, have begun to set internal management targets that aim to reduce recycling rates, enabling them to achieve higher rates of remanufacture. European policy makers have perhaps not recognised that to move on to the next stage of a resource efficient economy the familiar policy framework favouring recycling may need to be reversed. By continuing to promote materials recycling, the policy framework may hinder the development of product remanufacture in Europe.

Policy focus both in the UK and in the EU as a whole needs to move up the waste hierarchy with policies driving reuse, refurbishment, reconditioning and remanufacturing which manage to pertain the value of products to a much greater extent than recycling.

Recommendation 11

Government should work with the European Commission to place more policy emphasis on setting targets for those activities at the top of the waste hierarchy such as reuse and remanufacture.

Recommendation 12

Government should consider implementing a tax break for remanufacturers in order to encourage economic resilience in the UK remanufacturing industry.

76 European Commission (2014c) *Waste: Review of Waste Policy and Legislation.*

Chapter Four

Industries where Remanufacturing is developed

Remanufacturing has been taking place in a number of industries since 1945 when resource shortages after the Second World War led industries, such as the car manufacturing industry, to start remanufacturing[77]. This chapter will focus on outlining a few industries in the UK where remanufacturing is already commonplace, albeit not without its struggles (Figure 5). As outlined in Chapter 3, remanufacturing is largely successful in industries where products are of a high value and quality, technology does not change quickly, fashion or trends are rarely prevalent, products are durable, easy to disassemble and can easily be leased or delivered as a service instead of hardware.[78] Criteria for successful remanufacturing vary and not all of the above criteria are appropriate for all products. In fact, the industry is highly varied and versatile and this is one of the many reasons why regulations and legislations around it need to be flexible. Remanufacturing also works best when OEMs and third party remanufacturers work together, developing strong business models to exchange design specifications and gain access to products at their end-of-life stage.

Industries where remanufacturing is successful and prevalent in the UK

- Aerospace
- Machine tools
- Automotive and vehicular parts
- Defence
- Marine
- Industrial processing equipment
- Wind turbines
- Power bearings
- Rolling stock (railway vehicles)
- Toner cartridge and ink jets
- Some electrical equipment, in particular large electrical equipment such as printers
- Office equipment and furniture

Figure 5: Industries where remanufacturing is successful in the UK

77 Inquiry evidence.
78 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy*.

4.1 Automotive Remanufacturing

The remanufacturing of automotive parts is particularly prevalent in the United States, and the UK can learn more from this transatlantic expertise. In the UK, Caterpillar and Rolls Royce continue to be two of the most famous and most cited examples of successful remanufacturing. Caterpillar has been operating since the 1970s and has created a separate remanufacturing business through CatReman. Rolls Royce is most famous for its 'Power by the Hour' business model approach. However, a number of smaller automotive remanufacturers also operate in the UK, proving that the industry has an immense potential if the right support is provided. Third party remanufacturers in the automotive industry are also common in the UK.

End-of-life cars contain raw materials worth on average £850 per tonne.[79] With metal and resource scarcity a concern for the UK, the remanufacturing of cars is vital to retain resources and materials within the UK. However, although the resource efficiency argument is evident, the majority of stakeholders interviewed for this inquiry argued that moving into the remanufacturing business was, for them, a purely economically-driven decision. Numerous studies have confirmed that remanufacturing can be financially beneficial for OEMs.[80]

All third party remanufacturers in the automotive industry interviewed for this inquiry either had strong relationships with OEMs allowing them access to products and cores for remanufacture or had developed other successful business models allowing for the return of products.

This shows the importance of a win-win relationship between OEMs and third party remanufacturers where OEMs use their power to gain access to cores and products at their end-of-first-life stage, share product data with third parties and outsource the remanufacturing expertise to these third parties.

This symbiotic relationship is further supported by the existence of the Automotive Parts Remanufacturers Association (APRA),[81] an international association bringing together remanufacturers of automotive parts. Autocraft Drivetrain Solutions Ltd, Mackie Automatic Transmissions Ltd and MCT Reman Ltd are strong examples of third party remanufacturers that have developed a strong relationship with OEMs and car manufacturers.

Some industry members interviewed during this inquiry identified that the reason why remanufacturing practices continue to be outsourced in the automotive sector is because remanufacturing continues to be a small business that requires highly skilled manual labour. It does not therefore fit into the large-scale automated production of new automotives.[82]

79 Green Alliance (2013) *Why we need landfill bands*. [Online] Available at: www.green-alliance.org.uk
80 Subramoniam, R., Huisingh, D. and Chinnam, R. B. (2009) *Remanufacturing for the automotive aftermarket-strategic factors: literature review and future research needs*. Hammond, R. et al. (1998) *Issues in the automotive parts remanufacturing industry – a discussion of results from surveys performed among remanufacturers*.
81 APRA. See: www.apra.org
82 Guide, D. et al. (2003) *The challenge of closed loop supply chains*.

Although remanufacturing in the automotive aftermarket is one of the most developed and successful remanufacturing industries, there continues to be a need to better understand the strategic decision-making framework for remanufacturing as a more holistic approach will provide support for businesses.

Autocraft Drivetrain Solutions Ltd has been remanufacturing since the 1970s and currently remanufactures around 1,200 automotive products per month such as engines or cylinder heads. Based in Lincolnshire, around 80% of its remanufactured products are exported, mostly to other European countries. It is difficult to infiltrate the market in some other countries such as China or Brazil as they classify remanufactured products as used products. As such, they cannot be imported.[83] The greatest barrier to remanufacturing for Autocraft Drivetrain Solutions Ltd is however not related to this trade barrier. Less than 0.5% of all engines sold fail, so Autocraft as well as other remanufacturers are chasing a very small volume of cores and products. What's more, of this 0.5%, only a proportion is available to them. If engines fail during the warranty period,it is for the OEM to replace the engine. Most OEMs will do so with new engines rather than remanufactured ones, because they are cheaper compared to the mass-produced new engines from OEM engine plants. At the other end of the scale, when engines or parts fail beyond their warranty and extended warrantee periods, it is for the consumer to pay for repair or replacement. Due to the diminished value of the car, customers often find the cost of a new or remanufactured engine to be prohibitive. They therefore explore other options such as salvaging engines from other third parties. Alternatively, the car is scrapped. The market available to Autocraft is limited therefore to the extended warranty and customer pay period (Figure 6).

Companies such as Autocraft Drivetrain Solutions Ltd rely on OEMs to choose more sustainable marketing by procuring remanufactured engines during the car warranty period to sustain and grow their businesses.

83 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

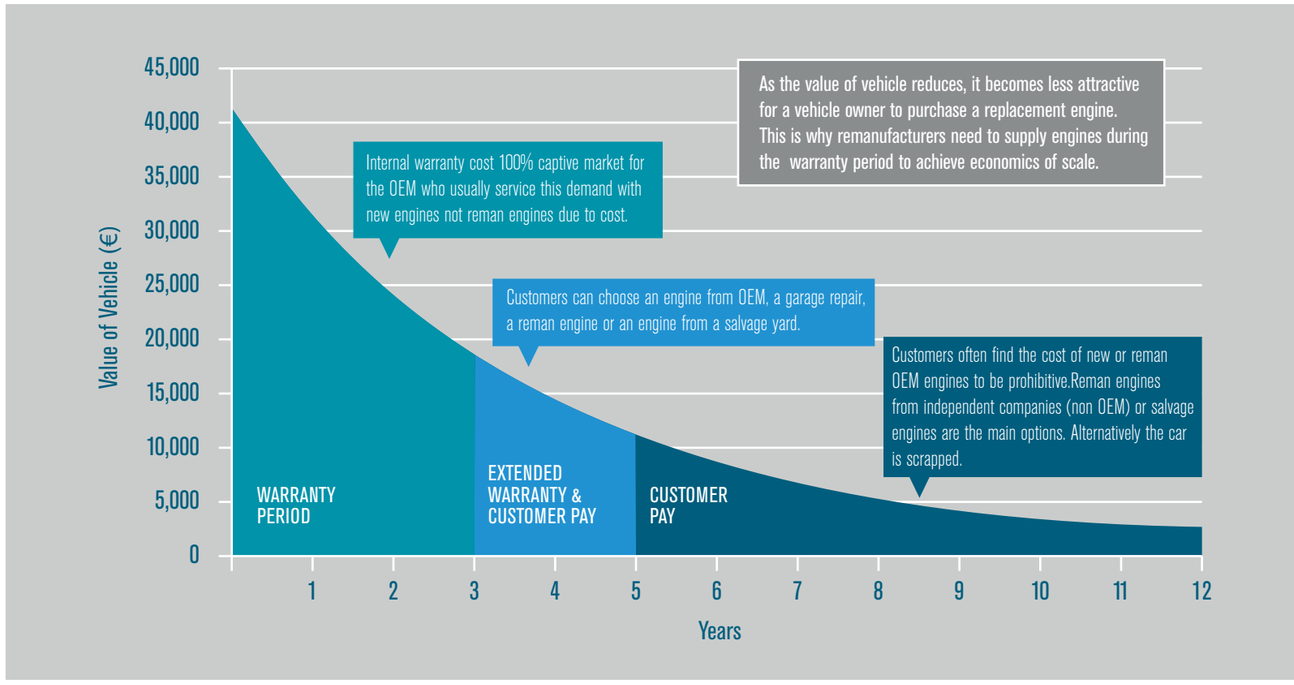


Figure 6: The market available to third party automotive remanufacturers such as Autocraft Drivetrain Solutions Ltd
Source: Autocraft Drivetrain Solutions Ltd

4.2 Office furniture

The remanufacture of office equipment and furniture, though not as widely cited as the remanufacturing of automotive products, is a growing industry in the UK. Furniture and other office equipment, if designed correctly, can easily be disassembled and remanufactured.

Most office furniture has a lifespan of between 9 and 12 years and is usually replaced for aesthetic reasons rather than due to malfunction. Much of this furniture is currently being sent to landfill.[84]

The most environmentally valuable materials within furniture are the metals. A remanufactured desk has the carbon footprint of 30% that of a new desk and a water footprint of 35% that of a new desk. Further, remanufacturing office furniture can save up to 90% of the original energy input . In contrast to recycling, remanufacturing furniture allows for much of the original value and materials to be preserved.[85]

There are currently two main challenges to the office furniture remanufacturing industry. These are the return of core to remanufacturers as well as the quality of this core. Cheap imports with inferior component quality or products that are not designed for disassembly cannot be remanufactured. UK furniture remanufacturers therefore have a limited product pool from which to remanufacture.

Senator is one of several companies in the UK offering furniture remanufacturing services[85] and is the largest office furniture manufacturer in the UK. Premier Sustain and Orangebox, although much smaller than Senator, also currently remanufacture.

Orangebox, an SME based in South Wales is well known for its 'Cradle to Cradle' certified furniture that is designed, manufactured and remanufactured within the company. The design aspect of Orangebox furniture is key to its business model and means that Orangebox is successful in remanufacturing because all products are designed with a closed loop system in mind. Materials are either naturally biodegradable, fully recycled into high quality materials or remanufactured.[86] Typically an Orangebox office chair includes around 98% recyclable content. Again, a key challenge to the company is getting the products back from customers at the end of their lives in order for them to be remanufactured.

Premier Sustain has developed its business around the difficult logistical issues related to the return of office furniture for remanufacture. Along with providing remanufacturing services, Premier Sustain also organises all logistical issues around collecting furniture and supplying this to 'The Renew Center' where components are remanufactured and returned to the customer. Premier Sustain is a flexible business, working around customer demands with competitive prices. A remanufactured desk

84 CRR (2009) *Reuse of Office Furniture – Incorporation into the 'Quick Wins' Criteria. A study of the market potential for reused and remanufactured office furniture in the UK.*
85 WRAP (2014a) *Alternative Business Model Caste Study: Remanufacturing Office Furniture.*
86 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

will typically cost the consumer around £50 and with delivery costs at around £80 the desk can still be up to 50% cheaper than the cost of a new desk (circa £200-300). Workplaces, particularly in large cities, are competing for office space and this is driving Premier Sustain's business. Premier Sustain can remanufacture the work space such that more people can sit in the same space.

A key opportunity to drive the UK office equipment and remanufacturing industry forward is through Government procurement. Some estimates state that Government procurement currently accounts for around 10% of the UK furniture market.[87] Increasing this procurement percentage would thus have a significant impact on the office remanufacturing sector in the UK and bring it closer to that of the United States. In the United States remanufactured products account for 9% of total commercial sales in the American furniture industry.[88] This opportunity is available to the UK.

87 CRR (2009) *Reuse of Office Furniture.*
88 WRAP (2014a) *Alternative Business Model Caste Study: Remanufacturing Office Furniture.*

4.3 Large Electricals

A variety of large electrical appliances are remanufactured due to the inherent material and metal value within them. Large electrical appliances also provide the opportunity to be designed for remanufacture, particularly because there is little emotional value attached to them (in comparison to smaller, more personal electricals such as mobile phones). Large electricals that are currently remanufactured include vending machines, air conditioning units, white goods, printers and medical devices such as CT scanners, MRI scanners and X-ray equipment.

Medical Devices

There is a large market for remanufactured medical devices in the United States and this market is now growing in Europe. The NHS currently buys only new equipment for liability reasons.[89] However in light of NHS funding cuts, purchasing remanufactured products could help make the most of its economic resources. Remanufacturing of medical equipment is done both by OEMs such as Siemens Healthcare and Philips Healthcare as well as by third parties and is regulated in the UK by the Medicines and Healthcare products Regulatory Agency (MHRA), in accordance with EC Medical Devices Directives (MDD)[90].

The NHS has increased its carbon footprint by 40% since 1990.[91] Further, of the 18 million tonnes of CO2 emitted each year, 60% is allocated to procurement. Meeting the Climate Change Act targets of a 26% reduction by 2020 (from a 2009/2010 baseline) and an 80% reduction by 2050 will be challenging. Remanufacturing and its associated energy savings could be a great step forward in meeting these targets.

Printers

Japan is one of the few countries where automotive remanufacturing has not yet taken off. Rather, the majority of Japan's remanufacturing industry is in the large electrical remanufacturing sector, specifically printers and ink cartridges.[92] Remanufacturing of printers is successful due to customers not being emotionally attached to the products and the development of successful design for remanufacture. Furthermore, printers have long shelf lives but do need servicing or repair throughout their life. This is not only likely to encourage manufacturers to stay involved in the servicing of their products but also encourages them to develop more circular business models. Printers specifications have not changed substantially over the past few years, and even the parts that do change are easily replaceable.

Remanufacturing printers can reduce resource consumption and waste generation over the life cycle of a photocopier by up to a factor of 3, with greatest reductions if a product is designed for disassembly and remanufacturing.

89 CRR (N/A) *Remanufacture of Medical Imaging Devices.*
90 MHRA. See: www.mhra.gov.uk
91 NHS Sustainable Development Unit (2014) *NHS Carbon Reduction Strategy.*
92 Matsumoto, M. and Y. Umeda (2011) *An analysis of remanufacturing practices in Japan.*

Remanufacturing printers has been particularly successful in OEMs such as Xerox Corporation, Ricoh and Kyocera that have closed the loop in printer production cycles.[93]

Xerox Corporation has one of the most widely reported and successful remanufacturing systems, having recovered equipment since the 1960s.[94] Remanufacturing has greatly increased the company's profitability and today Xerox remanufactures in the United States, the UK, the Netherlands, Australia, Mexico and Japan. Remanufacturing at Xerox has been successful due to the robustness and value of its products, the successful implementation of leasing or servitisation business models that allow for the return of products, and designing products for disassembly[95]. Xerox's returns programme which includes equipment remanufacture as well as reuse and recycling schemes prevented over 45,000 metric tons of waste from entering landfills in 2009 alone.[94]

Kyocera printers are also remanufactured although this is not done by Kyocera. Founded in Japan in the 1950s and with strong environmental values, Kyocera has developed strong and stable relationships with specific third party remanufacturers. It provides these third parties with full design specifications and in-service data on their printers which can allow third parties to remanufacture Kyocera products successfully. There is a mutual benefit to Kyocera as it increases its revenue through selling spare parts to these third party remanufacturers. Although Kyocera does not do any remanufacturing in-house, their products are designed for disassembly and with the concept of a circular business model in mind. Kyocera products are largely manufactured in Japan where it is standard practice for designers in training to visit waste plants to understand what happens to parts and products at the end-of-life stage.[96]

93 Inquiry evidence
94 Xerox (2010) *Nurturing a Greener World through Sustainable Innovation and Development. Our 2010 Environment, Health and Safety Report.*
95 Kerr, W. and Ryan, C. (2001) *Eco-efficiency gains from remanufacturing: a case study of photocopier remanufacturing at Fuji Xerox Australia.*
96 Inquiry evidence

4.4 Toner Cartridges and Ink Jets

Toner cartridge and ink jet remanufacturing has been taking place in the UK since the beginning of print services when typewriters were first invented. Some companies such as Kleenstrike originally remanufactured typewriters, line printer ribbons, drummer users and transfer belts and have now adapted to industry changes over the past three decades.[97] Considering the extent of printing services, the remanufacture of toner cartridges and ink jets has the potential to be a very successful industry. However, it is currently in decline due to a variety of economic and geographical factors. Although large manufacturers such as Xerox and HP do remanufacture toner cartridges or ink jets, many of the companies that currently remanufacture these items are SMEs acting as independent third party remanufacturers.

Cartridges and ink jets remanufactured in the UK are currently being challenged by the import of cheaper products from China[97], as well as by a lack of regulation. This is causing the industry to decline and will potentially move it into the 'underdeveloped' category of remanufacturers, despite it being one of the oldest and previously most established industries for remanufacturing. The import of cheap virgin cartridges and ink jets not only cannibalises the market for remanufactured products, but has also reduced consumer trust in remanufactured cartridges and ink jets.

In terms of business economics, remanufactured toner cartridges and ink jets are usually sold for 30% less than the price of new products.[97] According to Xerox, remanufactured cartridges can contain up to 90% reused and recycled content and are tested to the same specification as new products. The result is a cheaper product which is as good as new and with a significantly smaller environmental impact.[98] Whilst refilling short-life cartridges saves 25-40% of the carbon footprint compared to using new cartridges, the carbon footprint avoidable by remanufacturing cartridges rises to about 60%.[99] When considering that cartridges can be remanufactured up to 4 times, the carbon and material savings associated with remanufacturing cartridges are substantial.

There is currently no distinction between toner cartridges and ink jets remanufactured by an OEM and imported toner cartridges and ink jets. Purchasing decisions are therefore mostly price-driven. There is a strong need for the cartridge and ink jet industry to be supported through sustainable procurement targets. A certification scheme for these items which is international recognized would also allow customers to have confidence in remanufactured toner cartridges and ink jets.

Finally, some respondents to our Call for Evidence outlined that the toner cartridge and ink jet industry is feeling a negative impact due to the WEEE Directive.[97] Whilst encouraging recycling the WEEE Directive has reduced the return of cartridges and ink jets in EU member states including the UK. There is a strong need for policy regulating

97 Inquiry evidence.
98 Xerox (2010) *Nurturing a Greener World through Sustainable Innovation and Development. Our 2010 Environment, Health and Safety Report.*
99 Xanfeon: Energy & Environmental Services (2008) *Carbon Footprints and Ecodesign of Toner Printer Cartridges.*

this industry to move up the waste hierarchy as too many products are being shredded for recycling when remanufacturing provides a simple environmentally friendly and economic alternative.

Chapter Five

Industries where Remanufacturing is underdeveloped

Although remanufacturing has successfully been taking place in a variety of industries since the middle of the 20th century, there are several other industries where remanufacturing has not yet taken off or where the industry needs more Government support to develop further. This chapter will focus on outlining some industries in the UK where remanufacturing should be supported. Industries where remanufacturing is currently struggling are usually industries where products have a lower value or quality, such as textiles and paints or where technology and fashion changes quickly, such as in certain electronic industries. Certain legislation such as the WEEE Directive has perhaps stopped some remanufacturing industries from reaching their full potential. Unlike in industries where remanufacturing has been taking place for several decades, strong business relationships between OEMs and third party remanufacturers have not yet developed in all industries where remanufacturing is taking place. Criteria for the lack of success in industries where remanufacturing is not developed or is uncommon vary between industries.

Due to the lack of raw data available on the remanufacturing industries discussed below, it continues to be difficult to assess the state of these industries. The discussion thus focusses on estimations and experiences shared by key stakeholders from the respective industries. Lack of product data, in-service data and business data continues to be a key issue within the remanufacturing industry and the struggle of identifying the state of the various industries is illustrated through this.

5.1 Other Electrical Appliances and White Goods

Although not the most uncommon sector, remanufacturing of white goods is still a lot less developed than within the industries discussed in Chapter 4.

The case for remanufacturing electrical appliances is strong as metal and platinum are key components. Around 7-10% of global greenhouse gas emissions are derived from metal mining alone and the carbon footprint of platinum is around 14,500kg of CO_2 per kilogram.[100] The footprint from secondary recovery of platinum, such as from used electrical goods, is significantly lower at around 750kg of CO_2 per kilogram.[100] Although recycling metals within electrical appliances and white goods is one relatively resource efficient option, it is also an example of where resource policy is focused perhaps too much on the lower ranks of the waste hierarchy as better resource savings can be achieved through remanufacturing.

The cores of products such as washing machines and refrigerators have not changed substantially over the past 20 years and are easily remanufactured in a similar fashion to automotive parts, providing significant energy and material savings. A lot of large electrical appliances and white goods are unwanted by owners because a newer model of the product is available on the market. However, these products are usually still functional or at least easily repairable and a secondary market is available. Companies such as Environcom buy second hand large electrical appliances such as laptops, cameras, TV flat-screens and washing machines from manufacturers, retailers and consumers and remanufacture them in the UK.[101] The remanufactured products are then sold on with three possible quality scales: platinum (likely unused product which underwent a quality check), gold (products in very good condition and less than two years old) and silver (products up to four years old).

Customer demand currently drives the market for remanufactured electrical appliances. According to industry members consumers buy remanufactured electricals not only because they are up to 30% cheaper, but also because they are aware of the environmental benefits associated with remanufactured products. This confidence in the remanufactured market however, continues to be limited to a population passionate about environmentalism and needs to be expanded to a larger customer basis.

As in several other remanufactured industries, the data sharing and design aspect produces a strong barrier to the large electronic equipment remanufacturing industry. There are currently no incentives in place for OEMs to share their design and in-service data with third party remanufacturers. Unlike in industries such as automotive parts, electrical products manufacturers continue to be reluctant to share data. There is also little uptake of remanufacturing in this sector as OEMs fear that remanufacturing would cannibalise the market for their virgin products. Several

100 Defra & BIS (2012) *Resource Security Action Plan: Making the Most of Valuable Materials.*
101 Environcom. See: www.environcom.co.uk

electrical appliance companies do not make the purchase of spare parts available to third parties, making it almost impossible for their products to be remanufactured.

Refrigerator cabinets are being remanufactured, albeit on a much smaller scale than is potentially possible. Remanufacturing of refrigerator cabinets largely involves remanufacturing the core body and engine of the product, whilst refurbishing the exterior design to match the demands of the client. Driving this small remanufacturing industry forward is the fact that 90% of cabinets are thrown away by their owner but of these 50% are still functional and can be resold after a small remanufacturing effort. Furthermore, companies such as The Bond Group can remanufacture each cabinet up to four times, each sold at about 80% of the price of a new cabinet. This provides both environmental and financial savings to the consumer.

Remanufacturing of large electrical appliances and white goods continues to be threatened by cheap imports from countries such as China and Turkey, and the low quality products which then satiate the market and their return products. Cheap imports not only outbid remanufacturers' tenders but also reduce the amount of high quality products in the UK market available for these companies to remanufacture.

EU energy efficiency ratings also continue to be a very specific barrier to remanufacturing of electronic and white good products in the UK. Many electrical products such as refrigerators, freezers, washing machines, electric tumble dryers, dishwashers and air conditioners fall under this rating system.[102] Remanufactured products, however, continue to be excluded from being rated as the products are not accepted as 'new'. As explained by several companies we spoke to, many remanufactured electrical appliances have the highest energy efficiency rating possible when looking at the whole life cycle of products and confidence in these products would improve significantly if EU energy ratings could also be applied to remanufactured electrical products.

Recommendation 13

The European Commission should consider changing rating law such that energy efficiency ratings can also be applied to remanufactured products.

102 Defra (2014) *EU Energy Label*. See: www.direct.gov.uk/energylabel

5.2 Paints and Chemicals

> "*Waste paint has a surprising intrinsic value so can be remanufactured competitively*"
> - Keith Harrison, New Life Paints

According to the British Coatings Federation (BCF) and AkzoNobel, 337 million litres of paint are sold each year in the UK.[103] Water based paint constitutes 80% of all paint circulated in the UK and is recognised by the BCF as relatively non-toxic in comparison to solvent-based paint and has been identified as very easy to remanufacture. Remanufacturing in this industry, however, continues to be hindered by the large volume of paint which remains unused all over the UK, particularly in households where paint is opened, used, stored and often never reused. The BCF estimates that approximately 10% (or 50 million litres) of all paint bought each year in the UK remains unused. This would fill 20 Olympic-sized pools. Although this figure needs to be treated with caution, in total, 50 million litres of paint go to incineration or landfill in the UK each year.[103] It needs to be noted that not all of this paint is of high enough quality to be reused and some of it is hazardous,[104] but the intrinsic value of paint is actually higher than often recognised and the environmental impact of paint is significant. Furthermore, the price of disposing of waste paint via landfill and incineration is increasing in line with the landfill tax escalator. It is estimated that local authorities in England are spending £6.7 million per year on managing waste paint, assuming that only 45% of waste paint is collected.[105]

There are numerous environmental concerns linked to waste paint. Paint is recognized and classified as hazardous in the European Waste Catalogue and the List of Wastes (England) Regulations 2005[106] due to its liquid state, and although it is illegal to be sent to landfill, much waste paint still ends up in the residual waste stream directed at landfill or incineration.

The environmental impacts of landfilling paint and the carbon savings possible through remanufacturing it are substantial. Although schemes to avoid wasting paint through reusing and swapping exist through community campaigns such as Community RePaint,[107] remanufacturing of paint in the UK is only done by a very small number of SMEs. An estimated 200,000 litres of paint are already recollected and distributed through these charitable and social organisations.

According to the British Coatings Federation (BCF), remanufactured paint has a carbon footprint which is 50% lower than virgin manufactured paint. Concerns around resource scarcity do not greatly affect the coatings industry as most materials used to produce paint, such as limestone and clay, are not scarce. Titanium Dioxide (TIA2) however, used as whitening in paints and paper production, contributes up to 70% of the carbon footprint of virgin paints and is thus the most valuable mineral used in the

103 Inquiry evidence.
104 Inquiry evidence from Community RePaint / Resource Futures.
105 Inquiry evidence.
106 *The List of Wastes (England) Regulations 2005*. See: www.legislation.gov.uk
107 Community Repaint. See: www.communityrepaint.org.uk

production of paints. As such, it is exposed to a volatile price market which has a high impact on the price of paint.

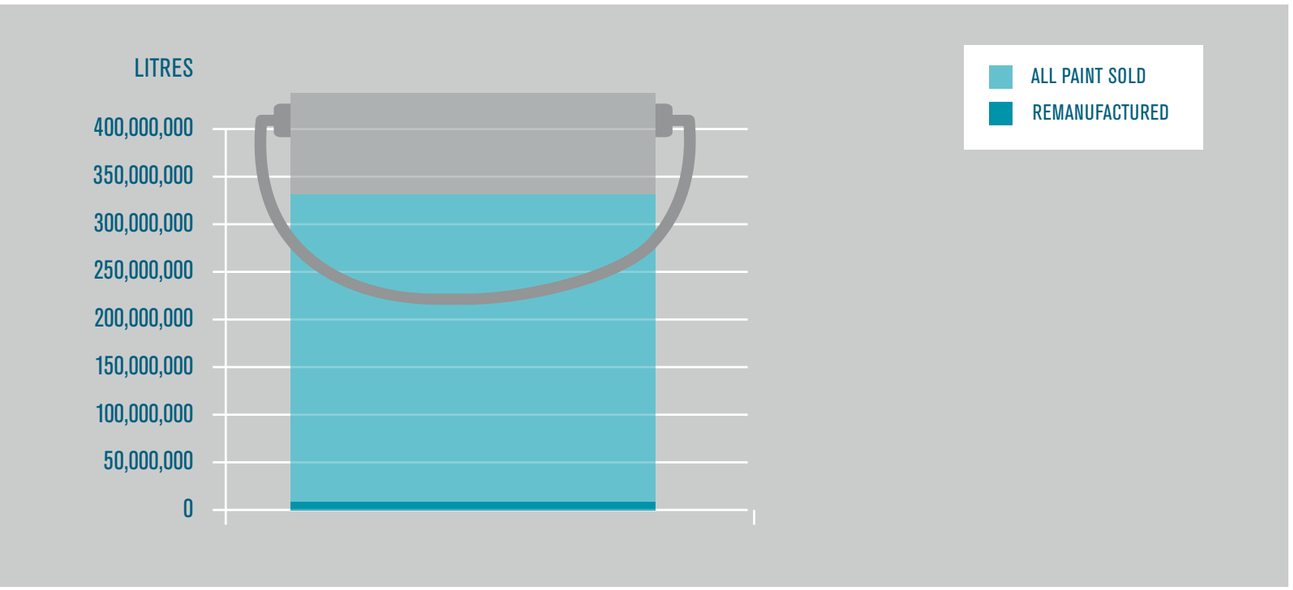


Figure 7: Total paint sold by volume and the proportion of this currently remanufactured

Currently only 1% of waste paints are remanufactured in the UK (Figure 7) and most of this is done by micro-SMEs. The process of paint remanufacturing differs to that of paint recycling. Paint recycling, which may also be called paint consolidation, involves a process where waste paint is used as a raw material for other products, such as concrete and other construction purposes[108] or where post-consumer and/or post-industrial paint is sorted and reclaimed by type, colour and sheen. The waste paints are filtered and blended into large batches resulting in a 100% recycled content paint, which is often limited in colour and sheen as well as availability, as batches will vary[109].

In contrast to this, remanufacturing paint involves adding some virgin materials like minerals such as limestone, clay or marble to post-consumer or post-industrial waste paint so that around 10-30% of the remanufacture of paint constitutes of virgin materials.[109] This processing allows remanufacturers to achieve greater colour, sheen and pH consistency and generally involves greater efforts towards filtering and sorting of colours, creating a paint which is of a much greater quality than recycled

108 Houshamand, A. et al. (2013) *End-of-Life Options for Waste Paint in Australia.*
109 Legacy Paints and Coatings. See: www.legacypaints.com

paint. Remanufactured paint is of the same, if not better quality as new paints.[109] Uncertainties around the definition are important to address to improve customer confidence in the quality of the product and reduce the stigma that remanufactured paint is not as good as virgin paint.[110] Supporting the industry through national communication as well as a certification mark for remanufactured paint could also help address this issue.

Household Waste Recycling Collection (HWRC) centres currently inconsistently accept and treat waste paint. Although some HWRCs accept waste paint, the majority of HWRCs do not have a waste paints collection scheme, so many consumers remain unaware of how to sensibly dispose of waste paints.[111] In 2013 there were 1055 HWRCs in the UK.[112] 40% of these HWRCs accepted paint which was then either reused in Community RePaint schemes or incinerated or landfilled, and 60% of HWRCs did not accept paint at all.[112] Consumers are, therefore, dealing with a so-called "postcode lottery" when disposing of paint. This inconsistency affects local authorities financially and also reduces the ability for paint remanufacturers to access the resources they rely on so greatly for the growth of their industry.

The extent of the loss of resources becomes even more apparent when acknowledging that only around 2% of paint submitted to paint remanufacturing companies can be used for remanufacturing, either because they are solvent-based or because the paints are too old and therefore of too poor a quality to remanufacture. A vast quantity of end-of-life paint is therefore needed to sustain the remanufacturing industry.

REACH

The Registration, Evaluation, Authorisation & Restriction of CHemicals (REACH) Regulations have been identified by the coatings industry as a barrier to the development of paint remanufacturing. REACH outlines that chemical materials cannot be reused if the exact origin and content of the material is unknown. This is typical for post-consumer and post-industrial paint, so the ability for paints to be remanufactured is restricted. In addition, since May 2010, the Environment Agency allows for the "treatment of up to 5 tonnes a week of non-hazardous paint for re-use as full specification paint". [113] This limits the treatment of non-hazardous paint and the remanufacturing of paint to small scale remanufacturers, preventing the upscaling and growth of the industry.

Recommendation 14

The European Commission should, on a case-by-case basis, consider exempting remanufacturing activities from the scope of authorisation and restrictions if there are clear overall environmental benefits in allowing remanufacturing to continue.

110 McMaster, J. (2003) *Household waste paint in Manitoba: an assessment of the feasibility of management alternatives.* Greiner, T. et al. (2004) *A Background Report for the National Dialogue on Paint Product Stewardship.*
111 Inquiry evidence.
112 Inquiry evidence from Community RePaint / Resource Futures
113 Russell Finex. See: www.russellfinex.com

Increasing the use of chemical and paint leasing schemes would boost the paint remanufacturing industry. Chemical leasing comprises of selling chemicals on their functionality rather than their volume. For example, with a chemical leasing model, paints could be sold by coverage rather than by volume. This is already taking place in the chemical industry where some solvents and catalysts are 'leased' and the waste materials are returned to the provider for reprocessing or recycling.[114] Leasing paints would mean that more paints are returned to the original manufacturer allowing for paint remanufacturing to be scaled up and possibly even automated.

The United States remanufactured paints industry is much more established than in the UK. The halls of the United States Pentagon, the California State Capitol Building and the Environment Protection Agency offices in New York City are all painted with remanufactured paint. Green procurement targets of Government should include a percentage of paints sourced from paints remanufacturers in order to support the industry and raise its profile. Furthermore, there is a clear need to increase knowledge of the potential of the paints remanufacturing industry in the UK. Government should develop a Resource Efficiency Action Plan for Leftover Decorative Paint together with representatives from Defra, local authorities, waste management companies, paint manufacturers and retailers, and third party paint remanufacturers.

Recommendation 15

Government should develop a *Resource Efficiency Action Plan for Leftover Decorative Paint* together with representatives from Defra, local authorities, waste management companies, paint manufacturers and retailers, and third party paint remanufacturers.

114 UK Chemicals Stakeholder Forum (2013) *A Guide to Chemical Services.*

5.3 Post-Industrial and Pre-Consumer Textiles

Despite the textiles industry having numerous opportunities to move to a more circular system, the majority of the industry continues to largely function on a linear, or 'cradle to grave' system.

Around 2.5 to 2.7 million tonnes of new textile items are bought in the UK each year, of which about 1.1 to 1.4 million tonnes are clothing items.[115] The volume of textiles in the waste stream is thus substantial, but has also provided opportunities for repurposing, recycling and upcycling, as well as remanufacturing. In 2010, around 700,000 tonnes of textile items were collected for re-use or recycling in the UK. (Figure 8) The largest proportion of this collection, around 400,000 tonnes, was done through local charity shops.

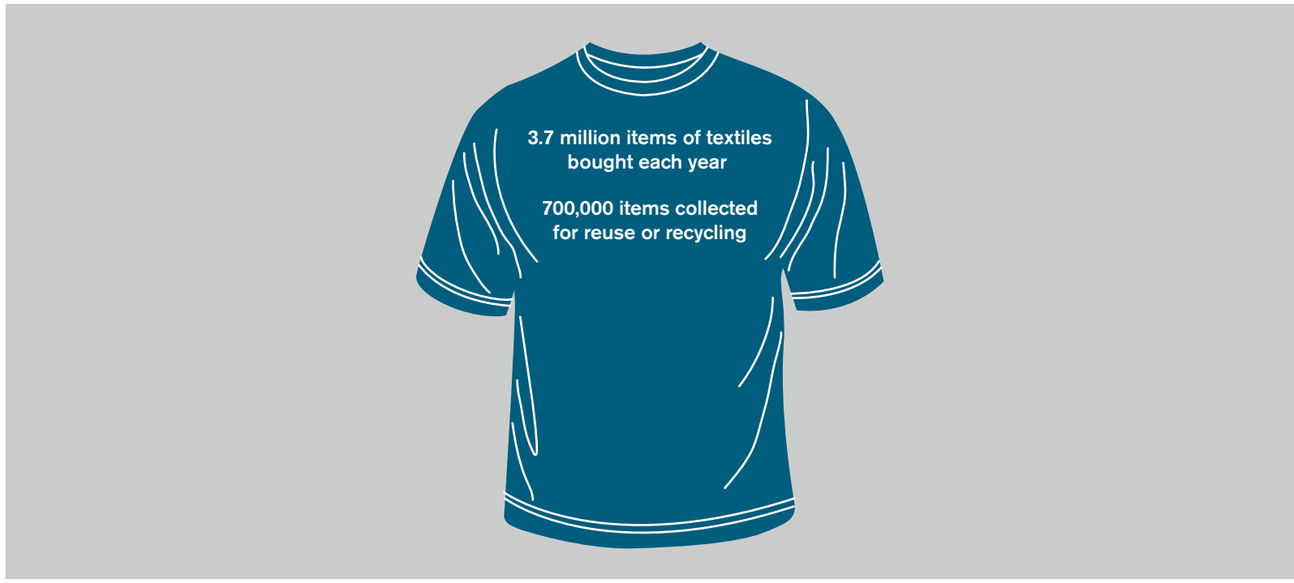


Figure 8: Proportion of all textiles bought each year that are reused or recycled

Many measures to encourage the transition of the textiles industry to a more circular system are already taking place through retailer 'Shwopping' schemes, fabric and textile recycling or the reuse of clothes via charity shops. However, the majority of these mechanisms take place at a post-consumer level. Experts in the textile industry have suggested that remanufacturing by definition cannot be undertaken on textiles at a post-consumer level.

115 WRAP (2013a) *Textile flows and market development opportunities in the UK.*

During research for this inquiry, concerns were raised from the textiles industry about the requirement within the definition of remanufacturing for remanufactured products to be 'like new' as a certain level of wear-and-tear of garments is unavoidable. Preventing ageing, even if only visual, is not possible as textiles are soft and fluid materials which change throughout their life cycle.

However, whilst the recycling of textiles involves the breaking down of core and using these components to create new items, it is thought that the remanufacturing of textiles could successfully take place at a pre-consumer level if more research and development is conducted. During the production of clothes, unused scraps of textiles are often discarded; however these materials could be remanufactured into new items of clothing.

This report therefore suggests that one possibility for remanufacturing textile products could involve using discarded high quality fabrics in order to turn them it into new but different products. Although this may not fit exactly within the definition as described in Chapter 1 of this report since the material is not returned into its original state, it still fits with the concept of remanufacturing as the material is repurposed into a similar product.

More and more companies are already remanufacturing unused post-industrial and pre-consumer textiles from factories to create new garments using patchwork methods. Sweaters from a company called Antiform, a UK fashion brand, are produced using three different types of previously unused pre-consumer but post-industrial textiles, diverting these materials from landfill, incineration or downcycling.

There is certainly an opportunity for the remanufacturing of fabric and textile products to take place with post-industrial surplus fabric, although research on the extent to which this is currently happening in the UK is limited. The textiles industry should consider investing in more research and development to understand the potential role of remanufacturing of post-industrial textile surplus in moving towards a more circular and resource efficient economy.

5.4. Carpet Flooring

The environmental impact of discarding carpets has encouraged some carpet manufacturers to also investigate the possibilities of carpet flooring remanufacture. Companies such as Milliken and Interface have developed methods to separate the two layers of carpets, recycle them separately and reassemble them to create a remanufactured carpet.

Although an increasing amount of carpet is being diverted from landfill, and Carpet Recycling UK[116] is working to set a landfill diversion target of 25% by 2015 in July 2010, a substantial amount of carpet still ends up being landfilled. Industry calculations suggest that around 12 million m^2 of carpet from major events alone go into landfill in the UK every year.[117] Carpet Recycling UK estimates that each year 400,000 tonnes of carpet waste is buried in UK landfill sites.[118] Efforts to divert carpet from landfill are increasing as companies engage in efforts to increase carpet recycling and remanufacturing. In 2011, 66,000 tonnes of carpet were diverted from landfill.[119] Of these, 32,000 were sent for reuse and recycling and 34,000 tonnes were sent to energy from waste plants (Figure 9).[119]

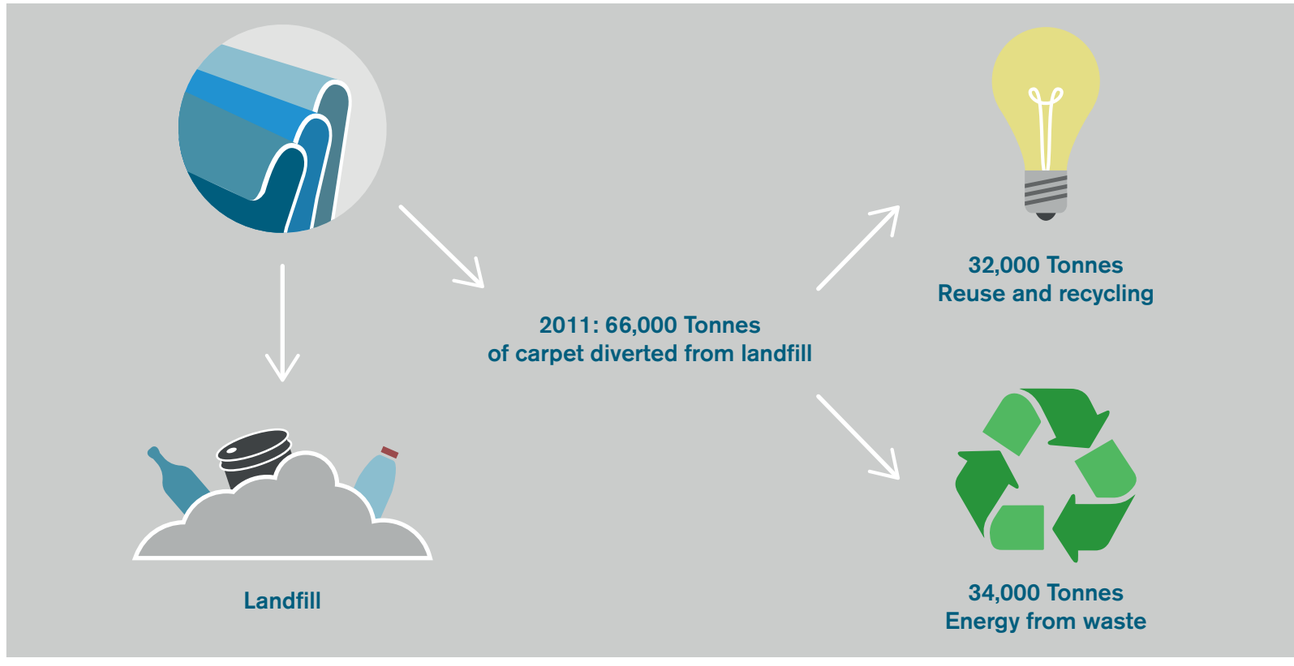


Figure 9: Proportion of carpets diverted from landfill in 2011

116 Carpet Recycling UK. See: www.carpetrecyclinguk.com
117 WRAP (2013b) *Refurbishment Resource Efficiency Products, Case Study: Carpets, Reeds.*
118 Carpet Recycling UK. See: www.carpetrecycling.uk.com
119 Let's Recycle (2012) *UK diverts 16.5% of carpet waste from landfill.*

Whilst Reed Carpet is approaching efforts to minimise the carpet industry's resource impact by developing technologies which can fully recycle plastic based carpets, Interface has developed innovative technologies to remanufacture carpet as well as encouraging customers to lease carpets to retain access to the products at the end-of-life stage.

Case Study: Interface

Interface, founded in 1973 in the United States by Ray Anderson, identified a need for 'flexible' floorcoverings in the modern office environment. It has since grown to a global company with manufacturing sites in Europe, the Americas and Asia-Pacific. Interface's sustainability campaign is called Mission Zero and encompasses sustainability across 7 fronts:

1) Eliminating waste
2) Benign emissions
3) Consuming renewable energy
4) Closing the loop
5) Using resource efficient transportation
6) Sensitising stakeholders
7) Redesigning commerce

Eliminating waste and closing the loop specifically fit into the circular economy agenda. The company's focus on the elimination of waste has been particularly successful, and the company estimates that it has saved in excess of $430M through avoided landfill, material and energy costs since 1996.

In terms of embodied energy of their products, nylon yarn is the most important material that Interface uses. Nylon yarn contributes around 50% of the total environmental impact of a carpet tile.[120] In the 1990s, nylon was perceived as an "unrecyclable" material, but Interface now sells over 400 different colours of carpet tiles made out of 100% recycled nylon yarn.

Both the nylon yarn and backing compounds used to produce Interface carpets are derived from oil. In Europe alone, it is estimated that 30 million m^2 of end-of-life carpet tiles end up in landfills each year. Interface looked at ways to reuse waste materials in their design and manufacturing process, reducing the reliance on virgin resources and moving towards closing the internal manufacturing loop. Interface provides services to collect and recycle post-consumer carpet tiles, as well as realising ways of developing new products which are specifically designed to align with circular economy ethics, such as minimising material usage. Recycled material now makes up 52% of carpet backing for Interface's European products and globally 40% of products are now made from recycled or bio-based content, up from just 0.5% in 1996.

120 Interface. See: www.interface.com

For the past decade, Interface has worked particularly hard on developing a design technology which could facilitate the debonding of carpet and allow for the remanufacture of this product. In 2007, Interface launched ReEntry, a technology which, for the first time, enabled carpet yarn to be successfully separated from the carpet backing and recycled into virgin yarn material. In 2011, this technology was improved and ReEntry 2.0 in the Netherlands now allows for both yarn to yarn, and backing to backing recycling to successfully take place.

One of Interface's biggest challenges with the remanufacturing of carpet continues to be the return of the end-of-life product to its remanufacturing facilities. Due to the longevity of carpet, the original purchaser of the carpet may not be able to have influence over its disposal. Additionally, many consumers are unaware of where to return the product or simply do not recognise the carpet as valuable enough to return to a manufacturer. When refurbishing a building interior, it is common practice to send the carpet to landfill along with other internal fixtures and fittings. The relatively low cost of disposal for carpet in the UK has meant that there is little incentive to look for alternatives to landfill.

In an attempt to tackle this issue, Interface has developed a business model which leases carpet tiles instead of selling them, allowing the company to maintain ownership of the product and ensure it returns to Interface at its end-of-life stage. The Evergreen Lease was first launched in 1995 and Interface was one of the pioneering companies to adopt this type of service model approach. Interface produces, installs, cleans, maintains and replaces the carpets for customers, shifting the carpet cost to the consumer from a capital to a maintenance cost. However, this model has faced constant challenges, as it can often be difficult for the costs to be off-set from a one-time expense to a facilities budget.

Chapter Six

Industries where Remanufacturing may not be the best option

Although remanufacturing can help the UK move to a more circular economy, not all products lend themselves to the remanufacturing model and it is likely that for some product areas, other end-of-life solutions will be more resource efficient. Recycling and remanufacturing are also not the only two options: reuse, repair, refurbishment and reconditioning are other important components of a circular economy. Industry and Government need to invest in research and development to identify which options prove most viable for various industries.

6.1 Personal electronics

The average home contains around £1,200 worth of electrical and electronic equipment, amounting to around £3 billion across the UK.[121] However, many householders do not realise the significant value of their used products .

One example where remanufacturing might not be the best option is small personal electronics such as mobile phones and tablets, as well as other handheld devices such as hairdryers or kettles. Although one reason why many of these products are currently not remanufactured is due to their design specifications not being fit for disassembly, the low value of the products might lead to a net loss rather than a financial gain when attempting remanufacture. A further issue with personal electronics is that the industry is fast moving both in design and in technology and a lot of consumers enjoy buying new products as they become available. Finally, the energy and time efforts it could take to remanufacture these products might exceed the value of the remanufactured product.

Research indicates that 23% of electrical items disposed of at HWRC sites have reuse potential and market value greater than that of their material value.[122] This presents a strong argument for encouraging ruse and repair of electricals through concepts such as 'The Restart Project'.[123]

Although some mobile phone manufacturers have already started offering customers a lump sum when they hand in old phones for an upgrade because their material value is recognised,[124] the majority of these mobile phones are recycled in order to retrieve their material and metal value.

Government should therefore focus on research, development and innovation in more efficient WEEE recycling.

One of the key aspects in the future for developing a balanced circular economy in the UK is to identify and research which end-of-life recovery process is best for specific materials and products stream. Remanufacturing will not provide the best or most resource efficient solution for all product streams, but nor does the continuous focus on WEEE tonnage and increased efforts towards recycling all electronic products provide a solution for all electrical products which could be remanufactured.

121 WRAP (2014b) *Switched on to Value: Why extending appliance and consumer electronic product lifetimes and trading used products can benefit consumers, retailers, suppliers and the environment.*
122 WRAP (2014) *Re-using and repairing electricals.*
123 The Restart Project. See: therestartproject.org
124 Institute for Public Policy Research (2014) *The Waste Line: Redefining 'Waste' and Improving Resource Management Policy.*

6.2 Post-Consumer Textiles

Apart from the opportunities that carpet flooring and post-industrial textiles present for remanufacturing as discussed in Chapter 5, for the majority of textiles products and fabrics it might be more efficient and practical to find alternative resource efficiency methods than remanufacturing.

Alternatives such as upcycling, downcycling, recycling, repair and reuse have slowly flourished within the UK textiles and clothing industry but need to be encouraged further as it has potential for substantial growth. Shredded textiles can, for example, be downcycled within the manufacturing of wall insulations or furniture stuffing, keeping the materials in the loop and avoiding landfill or incineration.

Recycling and reusing textiles shows a significant environmental benefit over sending textiles to landfill[125] and is second only to aluminium in terms of its CO2 benefits compared to the recycling of other components in the household waste stream[126] and this opportunity needs to be addressed. The Carbon Metrics Guidance produced by Zero Waste Scotland ranks textiles the highest in terms of the "environmental benefit of primary resource displacement".[127] The carbon metric reporting system for recycling performance ranges the weighting from 0 to 100 based on the materials' environmental benefit of primary resource displacement, with those with the greatest environmental benefit ranked 100 down to the least ranked 0.[127]

As shown in Table 4, textiles stand out significantly in its carbon metric weighting and the necessity to recycle and reuse these products. This argument is only strengthened by WRAP estimates that clothing accounts to 5% of the global carbon footprint of UK goods and services.[128] Therefore textiles recycling and reuse mechanisms are particularly important to address due to the enormous size of the industry and the continuous flow of material which enters the industry stream as fashion trends and seasons change.

Waste Stream	Carbon Metric Weighting
Textiles (recycling and reuse)	100.00
Textiles and footwear	84.70
Alluminimum cans and foil	65.87
Scrap metal	16.07
PET (incl. forming)	12.12
WEEE – Small	10.54
WEEE – Mixed	9.77
WEEE – Large	9.00
WEEE – Fridges and Freezers	4.66

Table 4: Zero Waste Scotland Carbon Metric Weightings of a number of materials (2011)

125 Sahni, S. et al. (2010) *Textile Remanufacturing and Energy Savings.*
126 Oakdene Hollins, The Salvation Army Trading Company, and Nonwovens Innovation & Research Institute (2006) *Recycling of Low Grade Clothing Waste.*
127 Natural Scotland, Scottish Government (2011) *Scotland's Zero Waste Plan: Carbon Metric Guidance.*
128 WRAP (2011b) *Valuing our clothes: The true cost of how we design, use and dispose of clothing in the UK.*

In 2010, around 700,000 tonnes of textile items were collected for reuse and recycling in the UK.[129] The largest proportion of these items, around 400,000 tonnes, came through donations of clothes and other textile products to charity shops. At the same time, 2,724,000 tonnes of new textiles were bought, so the secondary textile industry collected around 30% of all new textiles consumed domestically for reuse or recycling.[129]

Of all textiles donated to charities, around half are sold in UK charity shops[130], with the rest sold on to international markets, mainly in the global south and Eastern Europe.[131] The primary reason why so much clothing is sold on the international market is because there simply is too much of it in the UK and the demand for used clothing in the UK is not sufficient to resell all donated items domestically. A study by Axion Consulting, on behalf of WRAP, showed that 88% of clothes donated to charity shops was suitable for reuse[132], however the demand is simply not there.

This situation is a good example of how the overconsumption of textile products in the UK is posing a challenge to the processing of these products domestically at their end-of-life stage. Individuals engaged in the textiles industry suggested that the UK, and much of the rest of the developed world, needs to re-evaluate its overconsumption of cheap clothing, and move towards encouraging the purchasing of higher quality, long lasting products.

The post-consumer textile waste market, however, has opportunity for further growth in the UK. Every year, an estimated 31% of end-of-life clothing, some 350,000 tonnes, still goes to landfill.[133] A further 80,000 tonnes of clothing go to incineration annually, whilst only 14% of end-of-life clothing is recycled. However, for every kilogram of virgin cotton diverted from landfill and used by the secondary clothing industry approximately 65kWh is saved; for every kg of polyester around 90kWh is saved. The diversion from landfill of textile products, thus, results in a significant reduction in environmental burden in comparison to purchasing new clothing made from virgin materials.[134]

More recently large retailers such as H&M and Marks & Spencer's (M&S) have started to engage mechanism to encourage customers to return their old clothes. In February 2013, H&M rolled out a global take-back of textiles scheme, following the success of M&S' 'Shwopping' initiative.[135] In these initiatives, customers can hand in used clothes from any brand and in any condition in exchange for vouchers. Retailers such as H&M and M&S have both identified the intrinsic value of fabrics and textiles, as well as recognised the high environmental footprint which clothes production continues to have.

Industry is also working towards more resource efficient and sustainable textiles materials flows by committing to the WRAP coordinated Sustainable Clothing Action

129 WRAP (2013a) *Textile flows and market development opportunities in the UK.*
130 192,400 tonnes of clothing/textiles were sold in charity shops in 2010. This compares with the nearly 400,000 tonnes collected by charity shops each year, so around 48% of donations are sold in UK shops.
131 Inquiry evidence.
132 Axion Consulting / WRAP (2012) The Impact of Textile Feedstock Source on Value.
133 WRAP (2011b) Valuing our clothes: The true cost of how we design, use and dispose of clothing in the UK.
134 Woolridge, A. et al. (2006) Life cycle assessment for reuse/recycling of donated waste textiles compared to use of virgin material: An UK energy saving perspective.
135 Peralla, M. (2012) H&M rolls out global Shwopping' scheme for textile recycling.

Plan (SCAP) 2020 Commitment, which encourages leading organisations from across the clothing sector – supply, reuse and recycling – to work together to reduce the environmental footprint of clothing.[136] Working in a similar way to the very successful Courtauld Commitment, which encourage food waste reduction across the UK, the SCAP Signatories have committed to 15% carbon footprint, water footprint and waste to landfill reductions as well as 3.5% reduction in waste arising over the whole product life cycle, starting from a 2012 baseline.[136]

Alternatively, the leasing of textile products could also further be encouraged to reduce textile consumption. Leasing business models for textiles have been around for a long time. Wedding garments, table linen, carpets and pregnancy clothes are among several textiles products which, due to the nature of their quality, lend themselves well to leasing models.[137]

Encouraging the continuous growth of these industries would provide a significant step forward in moving the textiles industry to a more circular economy as remanufacturing of post-consumer textiles is not the most practical or profitable solution.

136 SCAP 2020 Commitment. See: www.wrap.org.uk/content/scap-2020-commitment
137 Inquiry evidence.

Chapter Seven

Business Models for Remanufacturing

> *"The common feature of business models that enable remanufacturing is that they extend product life, conserve resources and prevent materials from becoming waste"*[138]
> - REBus

A company's business model is the way it strategically positions itself in a particular market. It can include every aspect of a firm's logistical operations, financing and strategic vision, describing both what a particular firm does and, more importantly, how it does it. The business model will often be a decisive factor that distinguishes the company from other players in a given industry. Almost as much as an original idea for a product or service, how these are delivered is an area ripe for, and rife with, innovation and disruption. Remanufacturing, in this context, can either be a single element or practice among many in the overall offering of a business, or constitute the entire Unique Selling Proposition (USP) and modus operandi of another. It can also sit anywhere between these two extremes, within a spectrum of business models with almost as many variations as there are businesses.

Innovation is an integral part of carving out competitive advantage. Sometimes referred to as 'the commercialisation of new ideas', it can take the shape of slightly improved new products and services, or completely disruptive ways of doing business. As competition increases in a given industry due to new entrants, regulations or rising input costs (energy, materials, etc.), firms are often forced to continually innovate. The adoption of remanufacturing can be a step in this direction, and how a business engages in this practice, and how it delivers its products or service, will differentiate it from its competitors. Several individuals, businesses and organisations submitted evidence to this inquiry about particular business models that might lend themselves well to remanufacturing activities, and which need to be studied further.

This chapter will seek to highlight the main elements of the most commonly found business models: fee for service, leasing, and incentivised return and reuse, as well as explore the lesser-known but commonly practiced third party remanufacturing. The first section explains why alternative business models are important from a sustainability and circular economy perspective. The variety of business models related to remanufacturing are then explored and described using examples and case studies. Finally, the risks of experimenting with alternative business models are highlighted, along with how policy might facilitate or accelerate transitions towards business models that fully exploit the benefits of remanufacturing.

138 REBus. See: www.rebus.eu.com/case-studies

7.1 Understanding Business Models and Concept of 'Ownership'

The defining factor of remanufacturing is the non-linearity of products. An engine component does not begin from raw iron ore and petrochemicals, to be processed and put together, sold, used, and disposed of or recycled. As mentioned above, that is representative of the old unsustainable system, which has contributed to a loss of finite resources and environmental degradation. Conversely, remanufacturing is a crucial element of the circular economy, in which products, reaching the end of their lives, are reclaimed, disassembled, and eventually returned to the consumer as a functional product[139].

	OEM-owned	Consumer-owned
Fee for Service	✓	
Pure Leasing	✓	
Incentivized return and reuse		✓
Third party remanufacturing		✓

Table 5: Remanufacturing business models and product ownership

This emerging economy presents several new business opportunities, as well as market conflicts, as a product changes ownership several times over the course of its life, from OEM to consumer, to repairer, to waste disposer, to remanufacturer, to recycler, and to a new manufacturer, the ownership of that product and the valuable materials it is composed of can come into doubt.

Remanufacturing has the potential to put pressure on the linear production systems, even more than recycling, because end-of-life products straddle the border between waste and what might often be patented product. IP is always valuable, and is jealously guarded. If a product is reclaimed and remanufactured to original design specifications with a warranty to match and resold under the same brand name some may regard the OEM as entitled to claim ownership of, and compensation for that product. If this is not the case, some may regard it as counterfeit.

139 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

From another perspective, the OEM might retain ownership from the consumer outright, and instead can offer a service related to the product, or lease the product before taking it back. In this scenario, end-of-life products are decreasingly being considered waste. Such arrangements might negatively affect companies specialising in waste management, as their revenue streams may dry up.

The remanufacturing industry is currently struggling in its efforts to both distribute and reclaim products. Whether the difficulty stems from conflicts over ownership, or how to efficiently satisfy and coordinate the needs of the customer and the business, particularity of company business models has shown to have a significant impact on its respective success in this competitive market.

7.2 Fee for service

Originally referred to by academics and adopted by WRAP as the 'product service system', the most well-understood and well-developed alternative business model to set-price systems is that based around providing a service to a customer for a term-based fee rather than an actual product at a set price. Rather than simply making a stand-alone sale, the 'servitised' OEM provides the customer with certain performance outputs.[140] This model guarantees a result instead of a product: hours of flight instead of a jet engine, full print services instead of a printer, or whole flooring services instead of carpet tiles. It is similar to leasing a product, but goes a big step further as the client doesn't simply pay for the use of an asset, but for the desired output.

The exact service provided may vary depending on the product and the company, but would normally consist of the initial installation, ongoing maintenance, replacement of parts or the entire product at end-of-life, and final reclamation at the end of the contracted period (notwithstanding renewal). Some companies may also provide remote monitoring and usage support, whereby the manufacturer receives data in real-time about how a customer is using a given product, and is able to provide advice on how to optimise that usage. Similarly, the manufacturer will also be notified when a product is approaching the end of its life, or a consumable product such as printer toner is running out, and can thus have a replacement ready for the customer as soon as it is necessary, thereby eliminating costly downtime whilst simultaneously improving customer satisfaction. The data on product usage and performance can thus enhance the entire user experience considerably.

Additional advantages for the customer include a guarantee of functionality regardless of warranty, and the simplicity of all-inclusive pricing and high-quality manufacturer maintenance. Simplicity is the biggest factor for the customer, who no longer needs to shop around every time there is need for repair or replacement, for someone to install the product, or for someone else to dispose of it. Of course, the integrated service provision would have to come at a lower or comparable cost. The bottom line needs to be advantageous as a whole.

There are also numerous advantages for the manufacturer. By entering into a service-based contract, the OEM establishes a long-term relationship with its customers, guaranteeing revenue streams and increasing predictability. Providing a service entails a much more intimate interaction, with recurring contact and problem-solving. This, in turn, foments trust, and increases the likelihood of contract renewal. Capturing big data in this way represents a significant opportunity for businesses to understand their customers and grow their brand. Moreover, by including reclamation of end-of-life products as a central aspect of its service, the manufacturer has direct access to the component parts and materials which it can remanufacture.

140 WRAP (2014c) *Innovative business models.*

Servitisation facilitates remanufacturing. It is the most well-known alternative business model, partly due to some high-profile examples such as Rolls-Royce's 'Power by the Hour' and Enterprise Print Services now common in many office environments, but is also perhaps based partly due to the fact that servitising is relatively more straightforward to implement than other alternatives. In providing a full service, the manufacturer retains control of, and access to the product, and the client base remains stable and predictable. This identification and control of end-of-life product streams is crucial. Waste management companies could lose out in this scenario, but to what extent is difficult to measure.

This business model is perhaps most appropriate for the remanufacture of complex, high-value products that imply a high degree of IP, but is also being increasingly taken up in such diverse industries as tyres for long-haul trucks and specialist coatings and paints. Its simplicity and ease of use also makes it attractive from the customer's point of view, as it does away with issues of product return/disposal and quality of 'used' products. While already relatively well-understood and displaying active engagement by manufacturers, this field has the potential to become increasingly robust if more businesses are made aware of the benefits.

7.3 Pure Leasing

Another business model where remanufacturing might fit well is the hiring or leasing model. The average consumer is generally more familiar with this model for short-term rentals, be it fancy dress for a party, a car for the weekend, or a venue for a corporate event. However, longer-term hiring and leasing of a variety of products is also possible, with associated benefits for the manufacturer and the customer.

In this model, a relatively high value product can be leased for a fixed amount of time at a fixed cost, with a variety of additional benefits throughout and at the end of the agreed period. The business might offer a discounted repair service for the duration of the lease for example, or grant access to other privileges. When the leasing period comes to an end, the customer then has the option to either buy the product outright, or return it to the manufacturer.

Whilst similar to servitisation, the leasing model differs in a few important respects. Firstly, the service to the customer is not all-inclusive. Additional services like repair incur an additional cost. While there are benefits and discounts, they are not necessarily so substantial, and the customer retains the choice to make use of them or not. Thus, the total cost/revenue is less predictable. The other major difference is that, depending on the terms of the lease, final ownership may not reside with the manufacturer, but is decided by the customer at the end of the lease period. The OEM thus has less control of the product and materials throughout its life, and does not maintain any kind of intimate long-term relationship with the client.

This option might be more attractive to the customer for this exact reason. It allows for the testing of a product before purchase, at a price that is affordable, and without getting locked in to a single provider for all related services. Leasing contracts of this kind can also be for a shorter duration than full service models. This allows for the temporary planned utilisation of a product. In the world of fashion, for example, a designer piece might be desirable for a year, and then become unwanted. An interesting caveat to the leasing model is if the customer retains the ability to choose what to do with the product at the end of the contract. The supply of materials for a remanufacturer that subscribes to the leasing model may then be unpredictable.

For the manufacturer, some of the benefits of servitisation also apply, in the potential for long-term customer loyalty, though predictability and stability might well suffer in terms of material costs. Additional revenues based on extra services over the course of the lease are also uncertain. Nevertheless, there is still a degree of access to products and materials retained by the OEM that doesn't exist in the traditional linear model based purely on product sales. It is important to note that the market for hiring and leasing remains niche, based upon the relatively small but recognisable desire of some customers for temporary usage of costly products.

As with the fee for a service model, leasing generally suits capital goods best for high capital industrial applications or for items that are not needed regularly. To drive a change in behaviour, other industries may require incentives or value transformation models that encourage consumers to move away from an ownership driven model to a fee for service or leasing model.

In some cases, businesses may be wary of leasing products from a remanufacturer, as some may want to have a lot of assets on their balance sheet to show that they are asset rich. Moreover, the mentality of procurement staff doesn't necessarily fit in with leasing model: while leasing often involves 'solving a problem', procurers often want to know 'how much they're buying', with want specific numbers over a specific time. Customer accounting systems may thus not be fit for leasing. Though remanufacturers should be aware of these potential drags on securing new clients, leasing is still a viable business model in the right circumstances.

Recommendation 16

Government should increase awareness of remanufacturing by adopting procurement targets to include leasing of remanufactured products, and by creating an education programme aimed at changing behaviour to extend the pure leasing business model to other items.

7.4 Incentivised Return and Reuse

The final business model commonly associated with remanufacturing is based upon incentivised return and reuse. In this variation, the customer pays an additional surcharge at the point of purchase, a fee that is repaid upon the return of the product to the OEM at the end of its life. There is thus a direct incentive for the customer to return the product. This is similar, in a way, to the return of glass bottles and drink cans in North America or plastic bottles in Germany, where every bottle might be worth ¢5 or ¢10. So while the customer does buy a product outright, he or she has the option of returning it to the supply chain, and is rewarded for doing so, even if only nominally.

The advantage for the customer in this model is the clear and permanent ownership of the product. In addition, one up-front cost might be more attractive than repetitive payment periods, and the product might be usable for far longer than a lease or service contract might stipulate. The ability to own, modify, transfer ownership and dispose of a product, and to not be beholden to a company, can be desirable in its own right. And whilst the reward for returning products can be superficial, as the customer might have paid more at the original point of purchase, the psychological draw of getting paid for returning a product should not be underestimated. The success of this model might depend, however, on the ease of returning the product. It is easier to return a spent ink cartridge via a prepaid envelope than to walk a mile to the nearest collection point to return an end-of-life vacuum cleaner. Moreover, the potentially significant cost advantages for buyers of remanufactured products might itself help develop a recognition for the importance of returning those end-of-life products, not to mention ever-growing public awareness and concern for amounts of landfill waste.

The most famous example incentivised return and reuse is, of course, Caterpillar, which manufactures and remanufactures construction equipment. Its incentive scheme has several significant and well-documented benefits[141], including guaranteed buy-back (with price depending on condition of the part) for a high-degree of returned 'cores', reduced raw material costs, fairer pricing for a happier customer, and regained control over materials at the end of the product's life. For all these reasons, this type of incentivised return and reuse can be a boon for manufacturers, particularly of complex high value machinery, which face rising material costs. There is a market even for products that are no longer manufactured, but which are still in use. Caterpillar's engine refurbishment programme also takes up engines for defence and rail that are no longer manufactured, and remanufactures them with a new warranty.

This system initially follows more closely the principles of the linear economy based on product sales, whereby the customer buys the product outright, with no more link to the OEM. However, instead of that product ending up as landfill waste at the end of its life, it finds itself back into the supply chain. This model holds lots of potential, as it requires the least behaviour change on the part of consumers, who simply buy

141 APSRG (2014) *Remanufacturing: Towards a Resource Efficient Economy.*

and return products. WRAP identifies incentivised return and reuse as the most commercially viable business model for resource efficiency in the clothing sector over the long and short term, and providing the quickest payback period, due to a low cost base and reasonable profits.[142]

Crucially in this model, relationships between product manufacturers and brand owners need to be developed throughout the product's life to add value for the consumer. This creates an incentive to return the product at the end of its life, and provides an opportunity for the remanufacturer to sell a replacement product, or further understand the consumers' needs in order to tailor a service that suits them. Consumers might also be given information to contact manufacturers in order to facilitate the return of products reaching the end of their useful life, and remanufacturers could focus on offering added value to the products they sell by providing extra services, such as selling related consumable items, offering repair to products, or setting up 'user clubs' to provide information and problem solving.[143] The important thing is to create that long-term relationship between the consumer and the remanufacturer.

Even if there isn't an incentive for the consumer to return a product per se, this is the space where waste management companies have a decisive role to play and market share to gain: knowing that remanufacturers are willing to pay for end-of-life products, new types of commercial collection schemes should be developed in partnership with Government. This would be particularly helpful for products that are more difficult to dispose of, such as paint. Remanufacturing can also contribute to supporting the UK economy whereby remanufactured products are exported to other markets. This type of second-hand market already exists for buses and HGVs, and could be strengthened.

Recommendation 17

Industry should explore a system of extended producer responsibility on purchased products to encourage their return to manufacturers or remanufacturers at the end-of-life stage, and promote shared responsibility throughout the supply chain

142 WRAP (2013c) *Evaluating the financial viability and resource implications for new business models in the clothing sector.*
143 Inquiry evidence.

7.5 Third party Remanufacturing

Whilst organisations such as REBus and WRAP have publicised several excellent case studies on the innovative business models related to remanufacturing explained above, looking at photocopiers, aerospace engines, furniture and textiles, another model that has not yet received much attention is third party remanufacturing. Returning to the crucial issue of ownership, this model encapsulates those businesses that never own the product, but simply remanufacture them for clients. When a product nears the end of its first life or usability, the owner/client hires the third party remanufacturer to return the product to a like-new or better condition with a guarantee to match. This inquiry refers to these companies as third party remanufacturers because they are not OEMs.

In the first instance, a specialised engineering company may offer the remanufacturing of OEM products as a service. Numill, for example, has been remanufacturing machine cutting tools for over 40 years, though it is more common to refer to what they do as 'tool reclamation'. Their USP lies in their flexibility and a particularly skilled and knowledgeable workforce. As clients bring them tools from a wide range of OEMs, Numill engineers are able to remanufacture them mostly through reverse engineering, or simply from long years of experience with similar products to work with.

Intellectual property can become an issue here, as remanufacturing products might be considered patent infringement. A remanufactured tool might only cost a tenth of a new one or perhaps have other financial benefits for example Clubcard points or money off a future purchase. The remanufactured item will however be the same quality as a new product, thus OEMs have a potentially large market share to lose. It is interesting to note that in some cases, however, Numill clients have been able to purchase original designs from OEMs, mooting sometimes difficult reverse engineering problems as well as any IP issues. The ink jets and cartridge toner remanufacturing industry is also very much shaped by IP issues.

Another type of third party remanufacturer might not even primarily be a remanufacturer at all. Premier Sustain remanufactures office furniture, but is actually just a part of the larger Premier Workplace Services, which is an entire 'workplace solutions provider' offering a range of services from transportation, to storage, to document shredding, to IT support. As part of the company's environmentally sustainable service offering, Premier Sustain can take a client's office furniture near the end of its life, remanufacture it, and return it to the customer as good as or better than new with a guarantee to match. Like Numill, Premier Sustain never actually owns the product it is remanufacturing. Unlike Numill, however, the core business of Premier Sustain is not actually remanufacturing or engineering at all. Rather, remanufacturing is actually only one service that it provides amongst many. With this configuration of the third party remanufacturer, it is actually dependent on the core services related to commercial relocation as a whole.

In terms of the scale of remanufacturing, OEMs will either resist third party remanufacturers remanufacturing their products or they will embrace it. One thing is clear – there is a select group of remanufacturers leading the way.

7.5.1 Case Study: Premier Sustain

Premier Sustain is a specialty sustainable office furniture division of Premier Workplace Services, an award-winning relocation, refurbishment and IT services provider set up in 1996. Today the larger company's core business continues to be its corporate relocation service, but principles of sustainability permeate its entire ethos, of which Premier Sustain is a key feature.

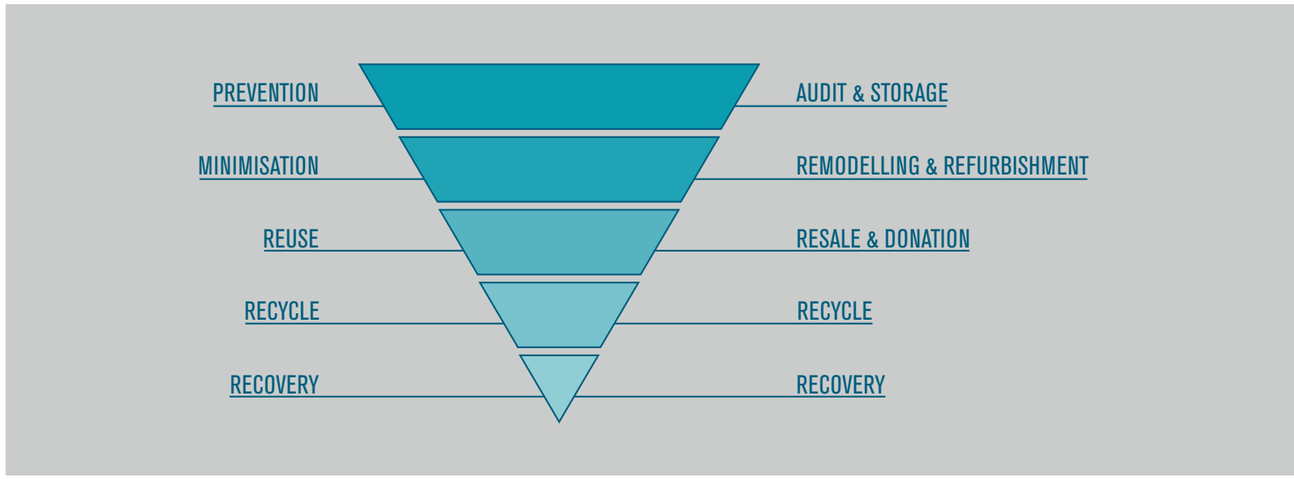


Figure 10: All the operations of Premier Sustain revolve around their waste hierarchy:

The company is committed to not only cost effectiveness for their clients, but also to supporting local charities and delivering zero waste to landfill. Alongside these, the remanufacturing (or 'remodelling') of office furniture is an integral element of its overall offering to clients. With charity donations, recycling and remanufacturing services at its heart, Premier Sustain is not a traditional manufacturer or remanufacturer. It operates according to a significantly different business model that does not align with the 'traditional' business models commonly associated with remanufacturing. Furniture is not disposed of at end-of-life, neither is it leased from Premier Sustain (the OEM) and neither do they operate a deposit scheme. Premier Sustain's clients retain ownership of products being serviced (or remanufactured) at the company's Renew Centre.

This Renew Centre is Premier's specialist facility in North London that remodels and remanufactures office desks and chairs. In line with standard remanufacturing processes, equipment is brought to the Centre, component parts are replaced, and the exact same product is returned to the customer 'like new'. All remanufactured products are also tested on quality and a warranty is provided.

The economic and environmental benefits of remanufactured furniture are overwhelming. A remanufactured desk can be less than half the cost of a new one. Further, WRAP estimates that remanufacturing office furniture can reduce original energy inputs by up to 90%.[144] A remanufactured desk will also have a carbon footprint of 30% that of manufacturing a new desk from raw materials. Similarly, the water footprint of a remanufactured desk is 35% that of manufacturing a desk. Part of Premier Sustain's standard service includes reporting the carbon savings a client will make through remanufacturing their furniture rather than landfilling. By creating a market for remanufactured goods Premier Sustain has also provided training and skilled jobs to previously unemployed members of the local community The Renew Centre currently employs five full time members of staff as well as providing additional work for others employed across the organization.

With a turnover of over £500,000 in 2013, Premier is a strong example of a remanufacturing company which is continuing to grow. However, while it enjoys some prestigious clients such as Tesco, the Cabinet Office, the Home Office and No. 10 Downing Street, a big hurdle for the company continues to be the negative perception associated with remanufactured goods. To combat this, Premier has embarked on a public relations campaign, adopting the slogan 'Reused Never Looked So Good'.

The distinguishing feature that sets Premier Sustain apart from other businesses is that it is not an Original Equipment Manufacturer i.e. it does not manufacture equipment from raw materials. It remanufactures office furniture as one aspect of a full service offered to clients. Its main expertise continues to be in commercial relocation, and remanufacturing ties in with these operations. The flexibility of Premier's operations constitutes a significant advantage over OEM furniture companies. As OEMs incorporate remanufacturing into their business models, they often encounter severe difficulties in creating sales. The mindset of the traditional seller may simply be attuned towards marketing virgin products, and the small quantities involved may hold too little value to break production cycles.

As the prices for raw materials and of disposal continue to increase, so too does the incentive for the big players to get involved in remanufacturing. For the moment, however, Premier Sustain's innovative business model has secured it a place in the sustainable office furniture industry.

144 WRAP (2014a) *Alternative Business Model Caste Study: Remanufacturing Office Furniture.*

7.6 Risks and Recommendations

Encouraging a business to change its business model can be extremely difficult, but the first step is to raise awareness of what is possible. The examples above might serve as good case studies to help businesses make the transition. It is not a project without risk, particularly for early adopters with little empirical data to rely on, and even more so for an already growing and profitable company.

The risks of experimenting with business models are plentiful. Existing business arrangements and supply chains will invariably need to be reframed due to conflicts over ownership. Customer interaction will change and reactions might be negative. The skills involved might be radically different from an existing base, and even more difficult to come by. Financial companies might also be more reticent to lend money to firms with such alternative business models. In addition, important issues confront different business models generally, relating to establishing a balance between the remanufacturer and the customer, with stability and simplicity on the one hand, and freedom and ownership on the other. These tensions make experimentation with business models in remanufacturing even more difficult.

Nevertheless, the alternative business models described above are all conducive towards establishing a circular economy. The reduced reliance on imported raw materials and reduced waste that this would entail not only benefits the environment, but makes the UK less susceptible to volatile international markets and rising prices. In short, transitioning to a business model that facilitates remanufacturing is an investment, a gamble, for which intrepid experimenters should be assisted both in terms of sponsored research and data-sharing as well as risk reduction through public financial support.

The Innovate UK competition (Chapter 2) is thus significant as 'when companies are doing well, they don't wish to change, and when they're not doing well, they can't afford to change.'[145] Firms need time and resources to experiment with their business model, and to discuss with partners about how to re-engage with the value chain in a circular economy. A competition of this sort can cover up to half the costs of experimentation, it can help a business transform itself, and successfully achieve circularity more quickly.[146]

Initiatives such as REBus and the Innovate UK competition are essential for encouraging companies with traditional business models to move towards remanufacturing, by presenting them with evidence that it can be made to work in their industry. By showing businesses how their system would operate if remanufacturing were implemented, with quantitative information on changes in resource use and monetary flows, these initiatives can help bestow the confidence necessary to experiment and invest in the implementation of remanufacturing.

145 Inquiry steering group meeting.
146 Inquiry evidence.

Recommendation 18

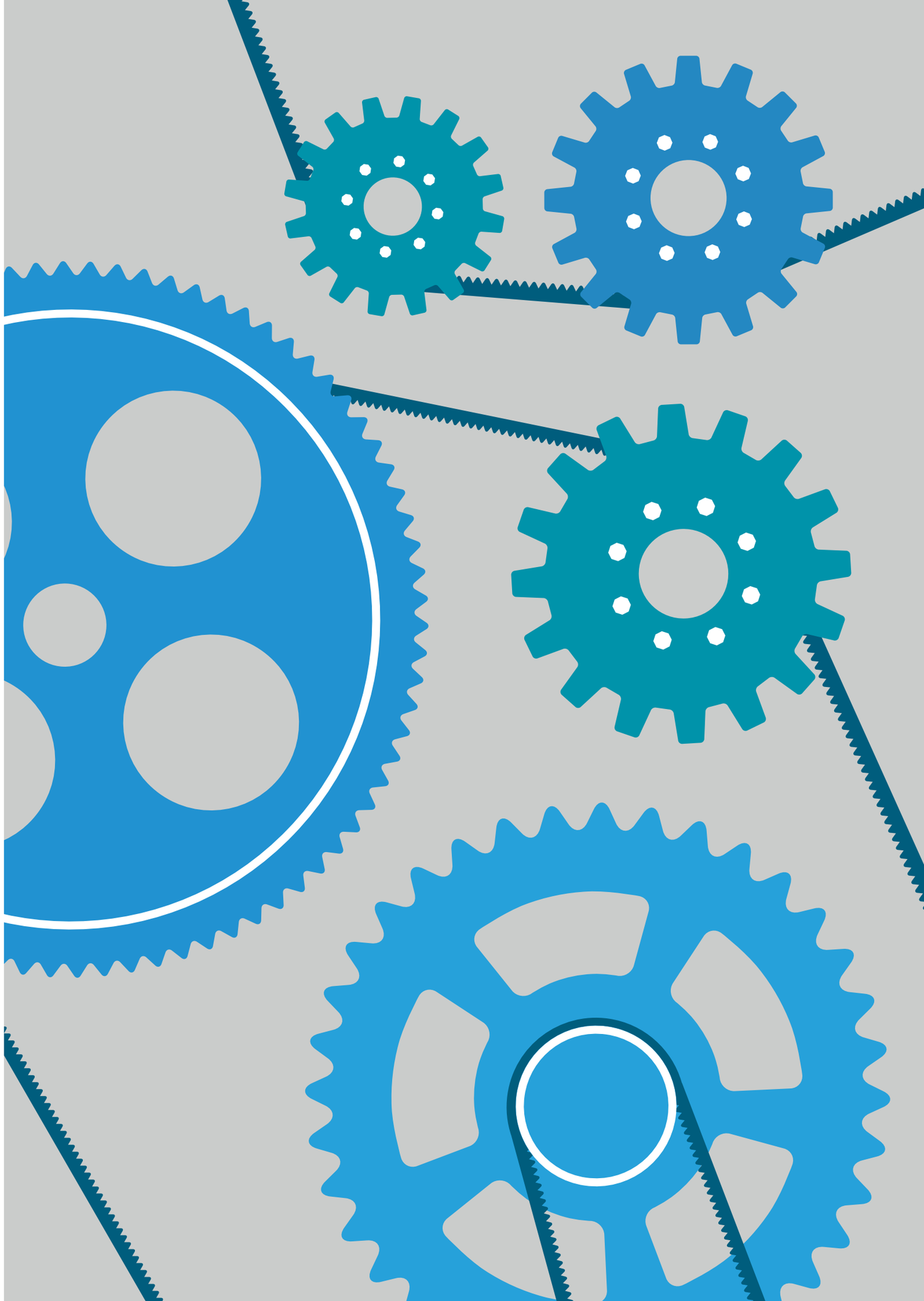
Government should work towards improving and increasing financial investment in the UK remanufacturing industry.

Recommendation 19

Government should raise awareness in the financial sector about how low cost lending can support remanufacturing start-ups with various alternative business models.

Recommendation 20

Government should work with industry to create an educational programme and support network to help businesses change their business models to incorporate remanufacturing



Chapter Eight

Moving forward

> *"We need to change the way we produce and consume goods, so we move from a linear to a circular economy. Like this, we will not only become more resource efficient, but we will gain new jobs. For that we need everyone – governments, industry, consumers and producers, to play a part…Valuable materials are leaking from our economies. In a world where demand and competition for finite and sometimes scarce resources will continue to increase, Europe can benefit economically from making better use of those resources"*
> – Janez Potočnik, EU Environment Commissioner from 2010 to 2014[147]

8.1 Resource Security and Resilience

The 7th Environment Action Programme of the European Commission has set out the European Union's environment priorities that will be used to guide environment policy up to 2020. With the aim of enhancing Europe's ecological resilience and transforming the EU into a circular and sustainable green economy, the programme lists nine priority objectives. Of these, three key features are:

1) Protecting natural capital
2) Supporting resource efficiency and turning the EU into a competitive low-carbon economy
3) Tackling environment-related pressures and risks to health and wellbeing.

Protecting natural capital and supporting resource efficiency are directly linked to the circular economy. Remanufacturing could play a substantial role in improving resource efficiency as well as protecting natural capital by reducing the continuous consumption of finite and precious elements and minerals. This potential to save resources does not only contribute to reducing carbon emissions globally, but could also support national resilience and security as the UK aims to keep resources within its economy.

The EC also outlined a Circular Economy Package[148] in July 2014, adopting the communication *Towards a circular economy: a zero waste programme for Europe*, to establish a common and coherent EU policy framework to promote the circular economy. This includes boosting recycling and preventing the loss of valuable materials, creating jobs and economic growth, reducing environmental impacts and greenhouse emissions, as well as showcasing how new business models, eco-design and industrial symbiosis can move Europe towards zero-waste.

According to Janez Potočnik, the three 'I's – Innovation, Incentives and Integration – continue to be key to enabling a shift to a circular economy.[147] The UK Government and industry need to work together and keep these concepts in mind when working towards developing remanufacturing.

147 The Loop (2014). *Closing Remarks: Interview with Janez Potocnik*. The Loop; the Magazine of the Local Authority Recycling Advisory Committee, Issue 48, Autumn 2014, pp. 31 -33.
148 European Commission (2014e) *Moving towards a circular economy: The circular economy package*.

8.2 Skills

The remanufacturing industry provides a true opportunity for growth of skilled and semi-skilled jobs in the UK. Labour plays a major factor in the remanufacturing industry, ranging from 34% to 45% of production cost. Furthermore, research in the United States has indicated that half of the workforce in the remanufacturing industry is classified as skilled labour, 30% are semi-skilled, 10% are salaried or profession and only 10% of the workforce are classified as doing unskilled labour. The remanufacturing industry thus provides the UK with an immense opportunity to develop a strong, skilled and secure work force. Further, remanufacturing remains a very domestic industry, providing long term local employment and training within the UK and reshoring of work opportunities.[149]

Considering the potential for a skilled labour force involved in the remanufacturing industry, a very limited number of apprenticeships, undergraduate degrees, and postgraduate degrees related to remanufacturing are currently available in the UK. Although engineering and design degrees are highly developed, many of these have a very limited focus on remanufacturing, with the exception of the degrees currently available from the University of Strathclyde, Coventry University and Loughborough University. There is a very strong need for remanufacturing practice and research to be recognised as the multidisciplinary topic that it is. Within this, education is essential.

Recommendation 21

Government should invest in developing more apprenticeship in the remanufacturing industry. It should also encourage the development of sustainable design and sustainable engineering modules and courses at universities.

149 Lund, R. T. and Hauser, W. M. (2010) *Remanufacturing: An American Perspective*.

8.3 Research and Development

Moving forward, investing in research and development will be key to developing the full potential of the remanufacturing industry in the UK. Industries with the most potential for remanufacturing need to be identified and knowledge of business models needs to be developed. Some countries have been able to successfully grow their remanufacturing sector in part due to the existence of remanufacturing hubs, research centres, networks of excellence and special interest groups where key actors and stakeholders involved in the industry share knowledge and drive the industry forward. Although in the UK industry is currently moving ahead of policy in this area, there is opportunity for government to support such developments which will provide improved communication and coordination of knowledge, innovation, research and development between the various actors in the remanufacturing industry.

Special interest groups and research networks for remanufacturing already exist in other countries where remanufacturing is taking place, although these interactions are often fluid and no common method of setting up such collaborations has been identified. Encouraging further collaboration between remanufacturing industry members would prompt UK economic growth, encourage the opportunity to provide skilled jobs to local communities and demonstrate the significant domestic environmental benefits that remanufacturing can have.

Since the last APSRG report on remanufacturing was published in March 2014, and as discussed in Chapter 2 of this report, there have been some developments for greater collaboration between remanufacturing industry members in the UK.

As previously mentioned, Scotland's Environment Secretary, Richard Lochhead, announced that funding will be attributed towards the development of a Scottish Institute of Remanufacture based at the University of Strathclyde[150]. Alongside this, a UK-wide special interest group on remanufacturing has been taking shape over the year 2014.

This fledgling SIG has involved organisations such as the HSSMI, The Centre for Remanufacturing and Reuse (CRR), the University of Strathclyde, the KTN, The Centre for Process Innovation (CPI) (part of the High Value Manufacturing Catapult), The Carbon Trust, University College London (UCL) and Coventry University. These organisations are already starting to collaborate and discuss the potential for remanufacturing in the UK. For example, a workshop bringing together a number of different actors involved in various aspect of remanufacturing in the UK was organised by the above mentioned partners at Coventry University in October 2014.

Continued collaboration by this fledgling special interest group on remanufacturing would foster several indirect benefits to the UK, including foresting world leading innovation in remanufacturing and creating new business opportunities by guiding

150 Verrinder, J. (2014) *Scotland to launch remanufacturing institute*. MRW Magazine.

businesses in adapting more circular business models (Chapter 7), organising new training within the manufacturing industry and improving the resilience of the UK manufacturing industry. Encouraging remanufacturing will also contribute to the UK CO2 emissions reduction targets and will establish the UK as a remanufacturing leader.

Recommendation 22

A more formal Special Interest Group should be established to support industry in the development of a comprehensive, inclusive mechanism to drive remanufacturing forward, utilising all expertise and excellence present in UK institutions.

8.4 Recycling Policy

As noted above,Government support for recycling in the UK has led the industry to grow by 300% since 2005, whereas without government support, the remanufacturing sector has only grown by 15-20%. To maximise carbon reduction efforts, and address rising unemployment and resource security issues in the near future, Government and industry need to work together to support the remanufacturing industry in a similar fashion to the way it has encouraged the growth of recycling over the past decade.

Some evidence gathered during our research suggested that in some areas government policies to promote recycling has been almost too successful and this is to the detriment of remanufacturers. WRAP has, after being instructed by Government to do so, been very successful in promoting recycling. In 2012/13 for example, 43.2% of household waste in England was recycled or composted. This is more than three and a half times the rate of recycling in 2000/01 (12%) when WRAP was created and shows the value of Government initiatives in driving change. This same Government support is now needed for remanufacturing.

Recommendation 23

Government should work across departments to review relevant legislation and remove perverse incentives.

8.5 Placing the UK in Global Remanufacturing

It is difficult to rank the UK in a list of global remanufacturing leaders as facts and figures on how big the remanufacturing sector is remain largely unavailable. However, other countries actively involved in remanufacturing continue to have more Government support and are therefore developing more rapidly than the UK.

China devotes substantial sums to research on remanufacturing. In the most recent Five-Year-Plan-Period, the NDRC has supplied funding for pilot enterprises and research in car component, construction machinery and tyre remanufacturing.[151] The sector is growing exponentially, and is expected to be treble that of the UK by 2015.[151]

The EU has also seen a growth of remanufacturing activity over the past several decades, notably in Scandinavia, the Netherlands and Germany, with considerable amounts of funding provided for research.

Research on the remanufacturing industry in the United States has confirmed that 3,844 establishments are currently practicing remanufacturing in the country, with 2,434 further establishments having been identified as possible remanufacturers although their status has not yet been confirmed.[152] Remanufacturing occurs in 113 product areas within the United States and each of these is likely to be remanufacturing many different product lines. Although remanufacturing in the United States is most commonly being practiced for motor vehicle parts, electrical motors, pumps, transformers, and laser toner cartridges, these figures suggest that remanufacturing is taking place in more industries within the United States[152].

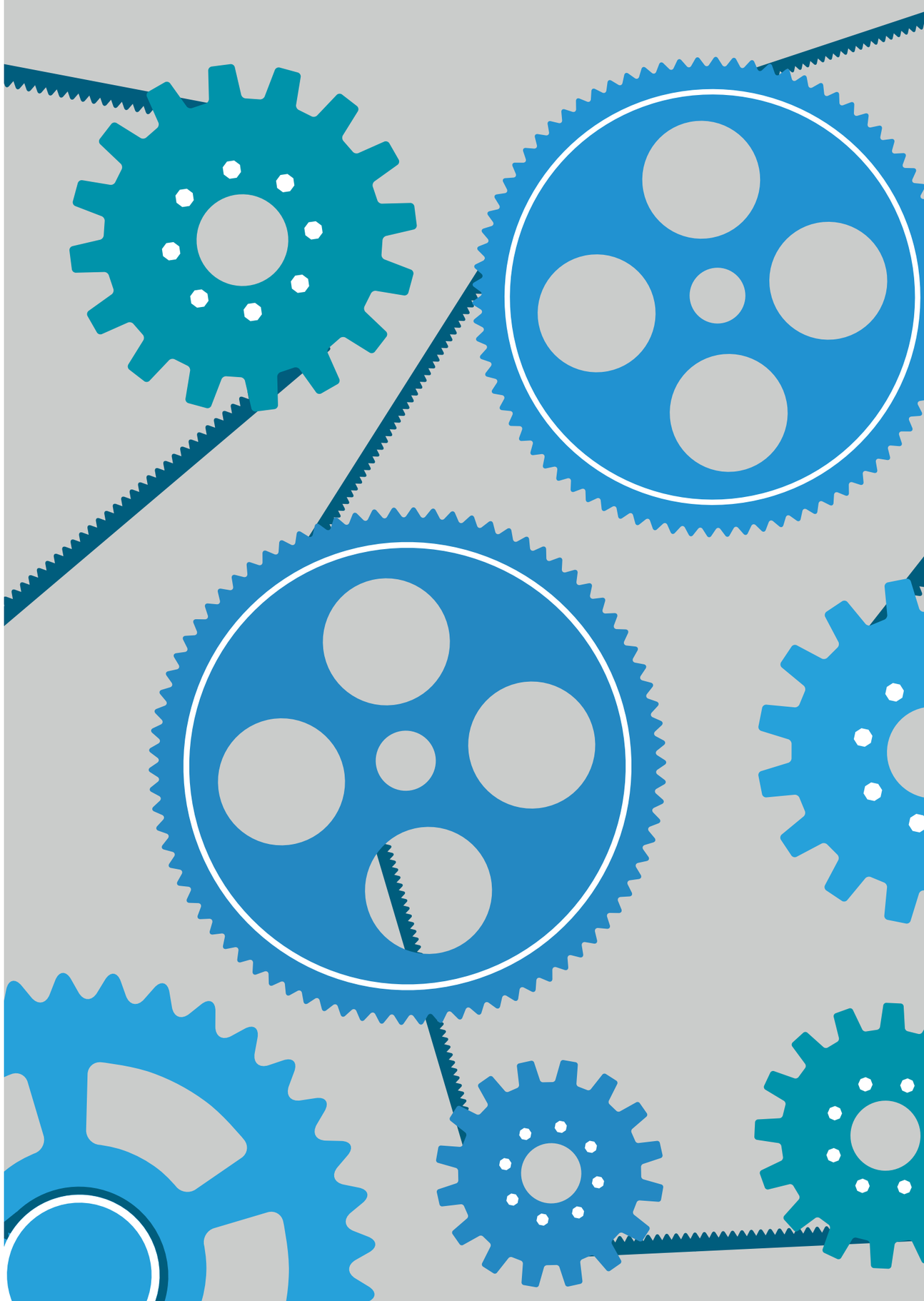
Moving forward, the UK should acknowledge that remanufacturing can be profitable and viable in a number of industries beyond those commonly known. Government should meet with and support not only companies that are already remanufacturing, but also those that have the potential to remanufacture.

The UK also needs to take advantage of developments that are currently taking place in other countries so as not to fall behind. Research funds such as those provided by the European Union or subsidies for remanufacturing companies such as in China have the potential to be successful in encouraging remanufacturing in the UK. Government needs to begin investing in research, identifying which support mechanisms would be most successful within the UK.

Recommendation 24

Government should continue to facilitate the setting up of stakeholder meetings between the UK remanufacturing industry and Governmental departments such as Defra, BIS and DECC.

151 China Daily (2011) *Remanufacturing stress in Circular Economy Boost.*
152 Lund, R. T. and Hauser, W. M. (2010) *Remanufacturing: An American Perspective.*



Acronyms

APEC	Asia-Pacific Economic Cooperation
APMG	All-Party Parliamentary Manufacturing Group
APSRG	All-Party Parliamentary Sustainable Resource Group
BCF	British Coatings Federation
BIS	Department for Business, Innovation & Skills
BSI	British Standards Institution
CE	Conformité Européene (European Conformity)
CPI	Centre for Process Innovation
CRR	Centre for Remanufacturing and Reuse
CSR	Corporate Social Responsibility
DECC	Department of Energy & Climate Change
Defra	Department for Environment, Food & Rural Affairs
EC	European Commission
ELV	End of Life Vehicles
EuP	Energy using Products
ETIRA	European Toner and Inkjet Remanufacturers Association
EU	European Union
FOI	Freedom of Information
GDP	Gross Domestic Product
HDOR	Heavy-Duty Off-Road
HGV	Heavy Goods vehicle
HSSMI	High Speed Sustainable Manufacturing Institute
HWRC	Household Waste Recycling Collection
IP	Intellectual Property
KTN	Knowledge Transfer Network
MDD	Medical Devices Directives
MHRA	Medicines and Healthcare products Regulatory Agency
NHS	National Health Service
NDRC	National Development and Reform Commission (China)
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
REACH	Registration, Evaluation, Authorisation and restriction of CHemicals
RoHS	Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
SCAP	Sustainable Clothing Action Plan
SIG	Special Interest Group
SME	Small and Medium Enterprise
SoGA	Sale of Goods
STEM	Science, Technology, Engineering, mathematics
SVHC	Substance of Very High Concern
TDA	Trade Descriptions Act
UCL	University College London
USITC	United States International Trade Commission
USP	Unique Selling Proposition
WEEE	Waste Electrical and Electronic Equipment
WRAP	Waste & Resources Action Programme

Methodology, steering group and secretariat

Methodology

This research project was conducted between June 2014 and November 2014. A range of steering group sessions were held between June and November 2014 to explore issues raised by the research.

The findings and policy recommendations in this report are based on evidence collected from steering group sessions, extensive in-depth interviews and written submissions to a call for evidence involving the waste sector, reprocessors, manufacturers, remanufacturers and other stakeholders.

Steering group sessions

The findings from the research was scrutinised in a series of meetings led by the inquiry co-chairs Rt Hon Caroline Spelman MP, former Secretary of State for the Environment and Barry Sheerman MP.
The sponsors, HVM Catapult, have supported this work with valuable expertise on the remanufacturing sector. The recommendations provided by this inquiry are those of the APSRG and do not necessarily reflect the opinions or positions of the sponsor or individual steering group members.

Steering group members

Suzanne Baker	EEF, the Manufacturer's Organisation
Simon Barnes	HSSMI
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David Fitzsimons	Oakdene Hollins
Dr Clive Hickman	Manufacturing Technology Centre
Dr Greg Lavery	Lavery Pennell
Patrick Mahon	WRAP
Ben Peace	Knowledge Transfer Network
Alan Wheeler	Textile Recycling Association

Secretariat

The All-Party Parliamentary Sustainable Resource Group and the All-Party Parliamentary Manufacturing Group are powered by Policy Connect, the think tank that works with parliamentarians, businesses and the public sector to help improve policy in the health, education and skills, sustainability, design and manufacturing sectors.

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Dr Tim Johnson	Tetronics
Adam Luqmani	Interface
John Mackie	Mackie Automatic Transmissions LTd
Hakan Malmros	Volvo
Rob Maslin	We All Design
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Joe McNamara	Jaguar Land Rover
Mike Morgan	Autocraft Drivetrain Solutions Ltd
Neil Murray	Crossrail
Alex Newson	Design Museum
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Martin Pearse	Resource Futures
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Mike Pitts	Innovate UK
Tracey Rawling Church	Kyocera
Suzanne Reeveley	Honest Inks
Katherine Stanier	Crossrail
Kresse Wesling	Elvis & Kresse
Anne Wilson	Numill Ltd
Chris Woollett	The Bond Group
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Written Submissions

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British Coatings Federation
British Standards Institution
British Tyre Manufacturers' Association Ltd
DS Smith Recycling
Honest Inks
REMS - Centre for Resource Efficient Manufacturing Systems
The High Value Manufacturing Catapult
The Manufacturing Technology Centre
UK Cartridge Remanufacturing Association
Waste and Resources Action Programme

Bibliography

APEC and United States Aid (2013) *Remanufacturing Resource Guide*. [Online] Available at: www.apec.org
All-Party Parliamentary Manufacturing Group (2013) *Reshoring: Bringing Making Back?*
All-Party Parliamentary Sustainable Resource Group (2014) *Remanufacturing: Towards a Resource Efficient Economy*.
Axion Consulting & Waste and Resources Action Programme (2012) *The Impact of Textile Feedstock Source on Value*.
Green Alliance (2013) *Resource resilient UK: A Report from the Circular Economy Task Force*.
British Standards Institution (2009) BS 8887-2:2009. *Design for manufacture, assembly, disassembly and end-of-life processing (MADE), Part 2: terms and definitions*. [Online] Available at: shop.bsigroup.com
Centre for Remanufacturing and Reuse (2008) *Review of Policy Options for Promoting UK Remanufacturing*.
Centre for Remanufacturing and Reuse (2009) *Reuse of Office Furniture – Incorporation into the 'Quick Wins' Criteria. A study of the market potential for reused and remanufactured office furniture in the UK*.
Centre for Remanufacturing and Reuse (2010a) *Remanufacturing in the UK: A Snapshot of the UK Remanufacturing Industry, 2009*.
Centre for Remanufacturing and Reuse (2010b) *Market Failures in Remanufacturing: An examination against major categories*.
Centre for Remanufacturing and Reuse (N/A) *Remanufacture of Medical Imaging Devices*.
China Daily (2011) *Remanufacturing stress in Circular Economy Boost*. China Daily, [Online] 21 April. Available at: europe.chinadaily.com.cn
Construction Shows (2014) *4th China International Remanufacturing Summit 2014*. [Online] 29 May. Available at: www.constructionshows.com
Department of Energy and Climate Change (2014) *2013 UK Greenhouse Gas Emissions, Provisional Figures and 2012 UK Greenhouse Gas Emissions, Final Figures by Fuel Type and End-User*.
Department for Environment, Food and Rural Affairs & Department for Business, Innovation and Skills (2012) *Resource Security Action Plan: Making the most of valuable materials*.
Department for Environment, Food and Rural Affairs (2011) *Government Review of Waste Policy in England 2011*.
Department for Environment, Food and Rural Affairs (2013) *Environmental Reporting Guidelines: Including Mandatory GHG Emissions Reporting Guidance*.
Department for Environment, Food and Rural Affairs (2014a) *Policy Paper: Greening Government Commitment Targets*.
Department for Environment, Food and Rural Affairs (2014b) *Making Sustainable development a part of all Government policy and operations*.
Department for Environment, Food and Rural Affairs (2014c) *Government Buying Standard for Office Furniture*.
EEF (2014) *Materials for Manufacturing: Safeguarding Supply*.
European Commission (2013) *Horizon 2020 Funding - Call for Factories of the Future: Re-use and remanufacturing technologies and equipment for sustainable product lifecycle management*. [Online] Available at: ec.europa.eu
European Commission (2014a) *Report on Critical Raw Materials for the EU*.
European Commission (2014b) *Regulation (EC) No 1013/2006 on shipments of Waste*. [Online] Available at: ec.europa.eu/environment/waste/shipments/legis.htm
European Commission (2014c) *Waste: Review of Waste Policy and Legislation*. European Commission
(2014d) *Press release, 26 May 2014: 20 critical raw materials – major challenge for EU industry*. [Online] 26 May 2014. Available at: europa.eu/rapid/press-release_IP-14-599_en.htm
European Commission (2014e) *Moving towards a circular economy: The circular economy package*. [Online] Available at: ec.europa.eu/environment/circular-economy
The Loop; the Magazine of the Local Authority Recycling Advisory Committee (2014). *Closing Remarks: Interview with Janez Potocnik*. Issue 48, Autumn 2014, pp. 31 -33.
EU-China Low Carbon Economy Platform (2012) *EU-China Eco-design and Green Remanufacturing Seminar*. [Online] Available at: www.chinalce.eu
Fletcher, K. (2008) *Sustainable Fashion and Textiles: Design Journeys*. London: Earthscan.
Xanfeon: Energy & Environmental Services (2008) *Carbon Footprints and Ecodesign of Toner Printer Cartridges*.
Gallo, M., Romano, E., and Santillo L. C. (2012) *A perspective on Remanufacturing Business: Issues and Opportunities*. In: V. Bobek, ed. 2012. International Trade from Economic and Policy Perspective. InTech. Chapter 10.
Gray, C. and Charter, M. (N/A) *Remanufacturing and Product Design: Designing for the 7th Generation*. The Centre for Sustainable Design, University College for the Creative Arts, Farnham.
Green Alliance (2013) *Why we need landfill bands*.
Subramoniam, R., Huisingh, D. and Chinnam, R. B. (2009) *Remanufacturing for the automotive aftermarket-strategic factors: literature review and future research needs*. Journal of Cleaner Production, pp.1163-1174.
Greiner, T., Veleva, V. and Phipps, A. (2004) *A Background Report for the National Dialogue on Paint Product Stewardship*. Lowell, M.A.: Product Stewardship Institute, University of Massachusetts.
Guide, D., Harrison, T. and Wassenhove, L.N.V. (2003) *The challenge of closed loop supply chains*. Interfaces, 33(6), pp.3-6.
Hammond, R., Amezquita, T. and Bras, B. (1998) *Issues in the automotive parts remanufacturing industry – a discussion of results from surveys performed among remanufacturers*. International Journal of Engineering, Design and Automation, 4(1), pp.27-46.
Houshamand, A., Disfani, M. M., Dias, R., Oates, G. and Arulrajah, A. (2013) *End-of-Life Options for Waste Paint in Australia*. Swinburne University of Technology.
HM Treasury (2014) *Budget 2014*.
Hewlett-Packard Company (2013) *Living Progress Report*.
Kerr, W. and Ryan, C. (2001) *Eco-efficiency gains from remanufacturing: a case study of photocopier remanufacturing at Fuji Xerox Australia*. Journal of Cleaner Production, 9, pp.75-81.
Lavery/Pennell (2014) *The New Industrial Model: Greater profits, more jobs and reduced environmental impact*.
Lavery, G., Pennell, N., Brown, S. and Evans, St. (2013) *The Next Manufacturing Revolution: Non-Labour Resource Productivity and its Potential for UK Manufacturing*.
Let's Recycle (2012) *UK diverts 16.5% of carpet waste from landfill*. [Online] 27 February 2012. Available at: www.letsrecycle.com
Lund, R. T. and Hauser, W. M. (2010) *Remanufacturing: An American Perspective*. Presented at the International Conference on Responsive Manufacturing, January 11, 2010 in Ningbo, China. [Online] Available at: www.reman.org

Matsumoto, M. and Y. Umeda (2011) *An analysis of remanufacturing practices in Japan*, Journal of Remanufacturing, 1:2, pp. 1-11.
McMaster, J. (2003) *Household waste paint in Manitoba: an assessment of the feasibility of management alternatives*. MSc Thesis. University of Manitoba, Canada.
Morley, N. (2013) *The contribution of Reuse and Remanufacturing to the Conservation of Raw Materials and to Green Growth Presentation to the 'Business & Raw Materials'*, European Parliament Working Group Meeting, 15 May, 2013. [Online] Available at: www.remanufacturing.org.uk
Oakdene Hollins, *The Salvation Army Trading Company, and Nonwovens Innovation & Research Institute* (2006) Recycling of Low Grade Clothing Waste.
Oakdene Hollins, The Salvation Army Trading Company, and Nonwovens Innovation & Research Institute (2006) *Recycling of Low Grade Clothing Waste*.
Natural Scotland, Scottish Government (2011) *Scotland's Zero Waste Plan: Carbon Metric Guidance*.
NHS Sustainable Development Unit (2014) *NHS Carbon Reduction Strategy*. [Online] Available at: www.sduhealth.org.uk
Oakdene Hollins (2014) *Press Release, September 2014: EU supports €1.5m Project on Remanufacturing*. [Online] Available at: www.remanufacturing.org.uk
Reece, A. (2014) *Picking up the Pieces. Resource: A New Perspective on Waste*, Summer 2014, Number 77, pp. 33-35.
Peralla, M. (2012) *H&M rolls out global 'Shwopping' scheme for textile recycling*. Edie Waste. [Online] 12 December. Available at: www.edie.net
Institute for Public Policy Research (2014) *The Waste Line: Redefining 'Waste' and Improving Resource Management Policy*.
Sahni, S., Boustani, A., Gutowski, T., and Graves, S. (2010) *Textile Remanufacturing and Energy Savings*. MIT Energy Initiative.
Subramoniam, R., Huisingh, D. and Chinnam, R. B. (2009) *Remanufacturing for the automotive aftermarket-strategic factors: literature review and future research needs*. Journal of Cleaner Production, pp.1163-1174.
The Recycler (2013) *EU approves funding for project studying remanufacturing*. The Recycler. [Online] 1 November. Available at: www.therecycler.com
UK Chemicals Stakeholder Forum (2013) *A Guide to Chemical Services*.
UK Government (2005) *The List of Wastes (England) - Regulations*.
United States International Trade Commission (2012) *Remanufactured Goods: An Overview of the United States and Global Industries, Markets, and Trade*.
Vallely, L. (2014) *New Institute of Remanufacture to drive Scotland's Circular Economy*. EdieWaste. [Online] 29 October. Available at: www.edie.net
Verrinder, J. (2014) *Scotland to launch remanufacturing institute*. MRW Magazine. [Online] 29 October. Available at: www.mrw.co.uk
Waste and Resources Action Programme (2011a) *The Construction Commitments: Halving Waste to Landfill*. Signatory Report 2011.
Waste and Resources Action Programme (2011b) *Valuing our clothes: The true cost of how we design, use and dispose of clothing in the UK*.
Waste and Resources Action Programme (2013a) *Textile flows and market development opportunities in the UK*. [Online] Available at: www.wrap.org.uk/content/uk-textile-product-flow-and-market-development-opportunities

Waste and Resources Action Programme (2013b) *Refurbishment Resource Efficiency Products, Case Study: Carpets, Reeds*.
Waste and Resources Action Programme (2013c) *Evaluating the financial viability and resource implications for new business models in the clothing sector*.
Waste and Resources Action Programme (2014a) *Alternative Business Model Caste Study: Remanufacturing Office Furniture*. [Online] Available at: www.wrap.org.uk/node/16597
Waste and Resources Action Programme (2014b) *Switched on to Value: Why extending appliance and consumer electronic product lifetimes and trading used products can benefit consumers, retailers, suppliers and the environment*.
Waste and Resources Action Programme (2014c) *Innovative business models*. [Online] Available at: www.wrap.org.uk/content/innovative-business-models-1
Woolridge, A. C., Ward, G. D., Phillips, P. S., Collins, M. and Gandy, S. (2006) *Life cycle assessment for reuse/recycling of donated waste textiles compared to use of virgin material: An UK energy saving perspective, Resources, Conservation and Recycling*, 46(1), pp. 94 – 103.
Xerox (2010) *Nurturing a Greener World through Sustainable Innovation and Development. Our 2010 Environment, Health and Safety Report*.

About the APSRG & APMG

All-Party Parliamentary Sustainable Resource Group

The APSRG is the leading forum informing the debate between parliamentarians, business leaders and the sustainable resource community on the crucial policy issues affecting sustainable resource management in the UK.

Its mission is to provide an objective platform for effective communication between policy-makers, businesses and organisations with an interest in the sustainable resource management agenda and to raise awareness of sustainable resource issues within Parliament.

All-Party Parliamentary Manufacturing Group

The All-Party Parliamentary Manufacturing Group (APMG) is a cross-party coalition of Parliamentarians and manufacturing industry organisations that works to develop new industrial policy ideas, critique existing government decision-making around manufacturing, communicate within Parliament the importance of a well-balanced productive economy, and help the manufacturing community better engage with the policy process.

With renewed political focus on the need to rebalance the UK economy and begin the 'march of the makers', the APMG seeks to ensure that policies and programmes to support the manufacturing sector achieve consensus from all parties, and across industry.

With special thanks to Peter Barrett.

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