

Annex A

Summary of Literature Review

Annex A: Summary of Evidence Review

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>Meeting the UK climate change challenge: The contribution of resource efficiency. Scott, K., Barrett, J., Baiocchi, G. and Minx J. (2009) Available at: http://www.wrap.org.uk/downloads/Final_Report_EVA128_SEI_1_JB_SC_JB3.c03bc484.8038.pdf [Accessed 1 Feb 2010].</p>	<p>Through scenario modelling, the authors estimated different ways that resource efficiency can contribute to GHG emissions reduction targets; Optimising product lifetime formed part of the research of this project.</p>	<p>Estimated that households could save over 47 billion pounds by using products over their full lifetime (life cycle optimisation) and that up to the region of 1.2 billion tonnes of CO₂ could be saved through extending product lifetime via quick wins over the next forty years. Data provided on premature discard rates. Proposed means to extend product lifetimes include avoid premature discard, implement product service systems, reduce food waste and create more durable products</p>	<p>Clothing; glassware and tableware; tools and equipment for house and garden; vehicles; telephone and telefax equipment; audio-visual, photo and information processing equipment; other major durables for recreation & culture; other recreational equipment; household appliances</p>
<p>Environmental Impact of Products (EIPRO): Analysis of the life cycle environmental impacts related to the final consumption of the EU-25. European Commission, Brussels, Belgium. Tukker et.al. (2006) http://ec.europa.eu/environment/ipp/pdf/eipro_report.pdf</p>	<p>Measuring the environmental impacts of products in the European Union</p>	<p>Product impacts data to consider the potential for reducing environmental impacts.</p>	<p>Input-output analysis of range of product categories, estimate for product groups</p>
<p>Smith, V. and Keoleian, G. (2004) The Value of Remanufactured Engines. <i>Journal of Industrial Ecology</i>, 8(1-2), 193-221. Available from Science Direct; Purchasing price (<30 US dollars)</p>	<p>Quantified the economic and environmental benefits of remanufactured gasoline engines</p>	<p>The remanufactured engine could be produced with 68% to 83% less energy and 73% to 87% fewer carbon dioxide emissions, but found that a 1% decrease in efficiency can negate the environmental benefits. Assumed that the remanufactured would last same number of miles as new engine. If it lasted fewer miles, then the reduction in inefficiency could be greater than 1% before the remanufactured engine performs worse than the new engine.</p>	<p>Mid-sized gasoline engine</p>
<p>EU Ecolabels for Personal Computers Atlantic Consulting and IPU (1998) CLA Study (Version 1.2), http://ec.europa.eu/environment/ecolabel/about_ecolabel/reports/lcastudy_pc_1998.pdf</p>	<p>Analyses life cycle impacts of PCs and quantitatively measures the benefits of different improvements in the PC design Replacing key components of a PC can extend first lifetime to reduce first overall environmental impact. The scenario measured was replacing the motherboard</p>	<p>10-15% saving across all environmental impact categories measured and 15-20% saving for all resources except energy carriers. Sensitivity analysis conducted, particularly important was assumption made on lifetime of PC</p>	<p>Generic PC</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>WR0106: Achieving household waste prevention and promoting sustainable resource use through product service systems. Natural Resources Management Centre at Cranfield University (2008) Defra. UK.http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14656</p>	<p>after 3 years and inserting larger hard disk, and using the computer for another 3 years. Exploratory research into potential of Product Service Systems (PSS) to prevent waste on new housing developments.</p>	<p>1. Environmental assessment - evidence that PSS reduce waste of all products assessed, but more research required 2. social and economic assessment - evidence of consumer demand for PSS, but concern over cost; all products bar linen show a positive business model 3. eco-labels could help in the uptake of PSS Data in technical annex 3 (not available). The proposed method of extending product lifetime is introduction of product service systems.</p>	<p>Electric drill Lawn mowers Vacuum Washing machines</p>
<p>Environmental Life Cycle Assessment (LCA) Study of Replacement and Refurbishment options for domestic washing machines. ERM. WRAP. Little, M., Thomas, B. and Collins, M. (Unpublished) Little, M., Thomas, B. and Collins, M. (2010, Unpublished)</p>	<p>Full ISO standard peer reviewed LCA comparison of whether it is preferential to immediately replace or refurbish washing machines</p>	<p>Immediate replacement of A to C rated machines with A++ is advised, but very few are currently available in the market. Therefore, with the exception of water use, refurbishment of an A rated machine is environmentally preferential to immediate replacement with an A or an A+ rated machine. Preferential scenarios for C rated machines depends on length of second life and the impact category under consideration.</p>	<p>Washing machines</p>
<p>Product Service systems Ecological and Economic Basics. Goedkoop, M.J., van Halen, C.J.G., te Riele, H.R.M., Rommens, P.J.M., (1999) http://www.pre.nl/pss/download_PSSreport.htm</p>	<p>Authors carried out qualitative analysis of ten product service systems (PSSs) and quantitative analysis of 3 PSSs</p>	<p>Some products scored well on environmental benefit (laundrettes and vegetables), and others did not (Car sharing). Data is provided on an estimate of difference in product lifetime between laundrette and domestic washing machines. Proposed means to extend product lifetimes include introduction of product service systems.</p>	<p>Qualitative: vegetable delivery; hotel office: expanded polystyrene; mobile phone; coffee; laundrette; car sharing; chipper electronic purse; biological pest management Quantitative: car sharing/ renting (not beneficial) laundrette (beneficial) and vegetable delivery (beneficial because of reduction in pesticides)</p>
<p>Eco-efficiency gains from remanufacturing: A case study of photocopier remanufacturing at Fuji Xerox Australia. Kerr, W.; Ryan, C. (2003). Journal of Cleaner Production, 9, 75–81.</p>	<p>First level assessment of environmental benefit of remanufacturing photocopiers to provide indication of benefit, as opposed to precise measurement.</p>	<p>A reduction factor of 3 in CO₂eq emissions from remanufacturing of photocopiers was estimated. Some quantitative data is provided. Proposed means to extend product lifetimes include remanufacturing.</p>	<p>Photocopiers</p>
<p>Lifecycle assessment of ultra efficient</p>	<p>LCA of different efficient lighting systems</p>	<p>The incandescent lamp (lifetime hours 1,000) has</p>	<p>Lamps</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
Iamps. Navigant Consulting Europe (2009) Defra, UK. http://randd.defra.gov.uk/Document.aspx?Document=EV0429_8060_FRP.pdf	including information on lifetime of products.	lowest efficiency and T5 system has most attractive profile (lifetime hours 24,000).	
Remanufacturing in the UK: 2009 survey Centre for Remanufacturing and Reuse: http://www.remanufacturing.org.uk/pdf/story/1p342.pdf	Report examines current UK market for remanufacturing by sector and provides estimates on savings both in terms of economic costs and CO ₂ eq.	No quantitative data is provided related to extended product lifetimes.	
Market Study: Remanufacturing of refrigerated display cabinets Centre for Remanufacturing and Reuse: http://www.remanufacturing.org.uk/pdf/story/1p346.pdf	Report examines the financial and environmental benefits, market potential and hindering factors behind remanufacturing refrigerated display cabinets (RDCs). It compares the manufacturing and disposal of two units compared to the manufacture, transport, remanufacture and disposal of one unit.	Some limited data on the impacts of extended product lifetimes is provided in the sense that % of new material and energy consumption of remanufactured is assumed. The work concludes that remanufacturing saves 2,100 kg CO ₂ e. It considers tax relief system that only applies to new purchases, despite the fact that remanufactured purchases can be as energy efficient.	Refrigerated display cabinets (RDCs)
Carbon Impact of Remanufactured Products: End Mill Cutting Tools Centre for Remanufacturing and Reuse: http://www.remanufacturing.org.uk/pdf/story/1p262.pdf	Manufacturing and disposal of five tools compared to the manufacture, transport, remanufacture (5x) and disposal of one unit.	Report estimates the carbon savings from remanufacturing a cutting tool up to five times. Remanufacturing can save between 50% (end-mill remanufactured once) and 83% (end-mill remanufactured five times)	Cutting tools
Carbon Impact of Remanufactured Products: Toner cartridges Centre for Remanufacturing and Reuse: http://www.remanufacturing.org.uk/publications/6/Carbon-Benefits/index.html	Manufacturing and disposal of two toner cartridge units compared to the manufacture, transport, remanufacture and disposal of one unit.	Report estimates the carbon savings from remanufacturing toner cartridges and compares the difference between including and excluding the use phase in the model. Carbon impact of remanufactured cartridges was 22.8 kgCO ₂ eq compared to 35 kgCO ₂ eq for new cartridges when the use phase was excluded - 35% reduction. When the use phase was included, the benefit reduced to 8%.	Toner cartridges
Carbon Impact of Remanufactured Products: Photovoltaic panels Centre for Remanufacturing and Reuse:	Manufacturing and disposal of two PV units compared to the manufacture, transport, remanufacture and disposal of one unit.	Report estimates the carbon savings from remanufacturing PV modules. New PV modules have a carbon impact of 417kg CO ₂ eq compared to 152kg CO ₂ eq that of remanufactured ones	Photovoltaic cells
Carbon Impact of Remanufactured Products: Gearboxes Centre for Remanufacturing and Reuse:	Manufacturing and disposal of two gearboxes compared to the manufacture, transport, remanufacture and disposal of one unit.	Report estimates the carbon savings from remanufacturing gearboxes. Carbon impact of a remanufactured gearbox is 284.5 kgCO ₂ eq compared to 432.5 kgCO ₂ eq of a new gearbox	Gearboxes

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>Inadequate Life? Evidence of Consumer Attitudes to Product Obsolescence. Journal of Consumer Policy, 27, 421–449. Cooper, T. (2004) Available from Science Direct</p>	<p>Analysis of consumer attitudes to product obsolescence</p>	<p>Includes information on premature discard rates and average life of appliances in household; Consumers expect technology to move rapidly and show lack of consideration for environmental benefits of longer-lasting products; Consumers would also like more information on the expected lifetime of products No quantitative analysis or data on extended lifetimes identified</p>	
<p>Product lifetime optimization: a challenging strategy towards more sustainable consumption patterns. van Nes, N. and Cramer, J. (2006) Journal of Cleaner Production, 14(15-16), 1307-1318</p>	<p>Authors built a model for estimating ecological payback period to determine lifetime optimisation as opposed to lifetime maximisation.</p>	<p>Authors concluded based on scenario modelling that extending product lifetime is desirable in all instances, except where there is a significantly more efficient new product.</p>	<p>No quantitative analysis or data on extended lifetimes identified – no products are modelled.</p>
<p>Innovative approaches to optimising design and use of durable consumer goods. Mont, O. (2008) International Journal of Product Development, 6(3-4), 207-250 http://www.iiee.lu.se/site.nsf/wwwpages/9EAF48D37B1AE1B7C12574DE00472EE7/\$File/IJPD%206(3-4)%20Paper%2002.pdf</p>	<p>Author discusses need to consider product service systems over other ways of extending product lifetime due to the fact the maximising lifetime might not be beneficial for energy-using products.</p>	<p>Product service systems are beneficial because they will ensure that the products are used for much longer or used more intensively. No quantitative data related to extended product lifetimes is provided.</p>	<p>washing machines (Electrolux) DIY tools baby prams</p>
<p>Optimal household refrigerator replacement policy for life cycle energy, greenhouse gas emissions, and cost. Chul Kim, H., Keoleian, G. and Horie, Y. (2006) <i>Energy Policy</i>, 34, 2310-2323. Available from Science Direct. Purchase price 20 US dollars</p>	<p>Developing optimal life cycle model for refrigerators</p>	<p>The optimal lifetime depends on technological innovation over time frame considered between 1985-2020 and a second timeframe of 2004 - 2020 2-7 years from energy perspective 2-11 years from GWP perspective 18 year from economic cost From MTP <i>What if</i> tool, the average lifetime of a fridge is 17.49 years. The proposed method of extending product lifetime is remanufacturing.</p>	<p>Refrigerator</p>
<p>The eco-efficiency of reuse centres critically explored - the refrigerator case, Dewulf W., Willems B., Duflou J., Proc. of the 10th European Round= table on Sustainable and Cleaner Production, Antwerp, 2005. http://www.mech.kuleuven.be/lce2006/to m.pdf Wim.Dewulf@mech.kuleuven.be</p>	<p>Modelling optimal replacement rate of washing machines. Literature review on effect limescale build-up has on energy efficiency, as well as belt and and pulley deterioration; plans were mentioned to carry out fields trials; for production and disposal burden, data taken from literature and for use phase, an internet search</p>	<p>The energy efficiency and water use of the washing machines when new will impact on how many years it is environmentally beneficial to reuse it, as opposed to buying a new machine. It is concluded that reuse centres should not supply B-labelled washing machines at all, while A+ or A-types can be supplied until they reach an initial reuse age of 15 years</p>	<p>Washing machines</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>The Environmental Impact of Disposable Versus Re-Chargeable Batteries for Consumer Use. Parsons D (2007): <i>International Journal of Life Cycle Analysis</i> 12 (3) 197–203 http://www.springerlink.com/content/r104g3640u736674/fulltext.pdf</p>	<p>Measuring the difference in environmental impact of disposable versus rechargeable batteries.</p>	<p>Rechargeable batteries more beneficial out of three scenarios assessed (nickel metal hydride, nickel cadmium and disposable alkaline battery)50 cycles of discharge/recharge showed overwhelmingly in favour of rechargeable batteries in LCA analysis.</p>	<p>Batteries</p>
<p>The Centre for Sustainable Design http://www.cfsd.org.uk/Professor Martin Charter +441756711363 The Surrey Institute of Art & Design</p>	<p>A network that facilitates discussion and research in eco-design and broader sustainability considerations in product and service development.</p>	<p>No findings related specifically to extended product lifetime.</p>	
<p>Demand and Dematerialization Impacts of Second-Hand Markets: Reuse or More Use?. Thomas, V. (2003) <i>Journal of Industrial Ecology</i>, 7(2), 65-78.Available from Science Direct</p>	<p>Effect of second-hand market on purchasing new items - evidence of rebound effect</p>	<p>Increased demand for products with a high second-hand value does not lead to reduced sales of new corresponding products. Decreased demand for products with zero second-hand price, such as markets for electronics, furniture, clothing, will lead to a decrease in the demand for new goods.</p>	
<p>An economic analysis of electronic secondary markets: installed base, technology, durability and firm profitability. Arunkundram, R. and Sundararajan, A. (1998) <i>Decision Support Systems</i>, 24, 3-16. Available from Science Direct</p>	<p>Economic analysis of secondary electronics market.</p>	<p>In a number of cases, the presence of the second-hand markets has a primary positive effect on the profitability of a new good. It included developing a model to understand effect of second-hand market on rate of new product purchased</p>	<p>Electronics</p>
<p>Remanufacturing and Product Design – Designing for the 7th Generation, The Centre for Sustainable Design, University College for Creative Arts, Gray, C., Charter, M. (2007), Farnhamhttp://www.cfsd.org.uk/CfSD/Remanufacturing%20and%20Product%20Design.pdf</p>	<p>Discussion of principles on designing for remanufacture</p>	<p>Amongst design principles, case studies are provided of remanufacturing industries in the UK. No quantitative data is provided in the study.</p>	<p>Xerox photocopiers; Perkins diesel engines; Milliken carpets; Info team electronics;</p>
<p>‘Reducing life cycle environmental impacts through systems of joint use’ Mont, O. (2004b) Special issue on ‘Life Cycle Management’ of Greener Management International, Spring, No. 45, pp.63–77. Available from Science Direct:</p>	<p>Estimates economic and environmental benefits of product service systems for garden and DIY equipment because they are long-lasting, used infrequently and with low innovation.</p>	<p>Community based sharing is environmentally preferential, but the rental scenario was not. No quantitative data is provided.</p>	<p>Lawnmowers Battery-powered drills</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
http://greenscm.org/Articles/Reducing%20Lifecycle%20Environmental%20Impacts%20Through%20Systems%20of%20Joint%20Use%20Mont%202004.pdf			
Evaluating the Sustainability of Passenger Cars: Interventions and Trade-offs. Avery, K. L., Myers, D.N., Cordell, B. and Harris, B.J. (2009) Transport Research Laboratory. Defra, http://randd.defra.gov.uk/Document.aspx?Document=EV0424_8158_FRP.pdf	A literature review of the environmental, social and economic impacts of cars with reference provided to a report investigating the environmental impact of different replacement intervals.	The study referenced (Spitzely et al, 2005) concludes that long replacement intervals (18 years) are favourable for CO2 emissions and energy use, but short replacement intervals are favourable for CO, NOx and NMHC.	Cars
WR0113:Refillable packaging systems. Lofthouse, V. (2009) Defra http://randd.defra.gov.uk/Document.aspx?Document=WR0113_8684_FRP.pdf	Primary research into feasibility of refillable packaging system conducted in conjunction with Boots on its skincare range	All three packaging prototypes led to a reduction in packaging waste in the focus groups over the 6 month period measured. Report includes quantitative analysis on extended product lifetimes.	Packaging
Do LCD TVs really last longer then PDP TVs?. Weber, L. (2004) <i>Information Display</i> , 8, 10 to 17. http://www.eic.com.pl/layout/nec/pliki/Display%20Aug%2004.pdf	Comparing the lifetimes of LCD and PDP TVs with information on energy consumption as well.	The author argues against the conventional view that LCD screens last longer than PDP screens when focusing attention on the quality of the luminosity of the picture. Trial data on two different types of televisions screens (it is not an entirely straightforward case)	Televisions
Contribution to resource conservation by reuse of electrical and electronic household appliances. Truttman, N. and Rechberger, H. (2006) <i>Resources, Conservation and Recycling</i> , 48, 249–262. Available from Science Direct; Purchase price 31.00 US dollars	Using an extensive model based on assumptions, two extreme scenarios for eight electrical and electronic products were built to determine whether reuse is environmentally beneficial compared to efficient recycling	Efficient recycling achieves a higher contribution to resource conservation than reuse of electronic household appliances No quantitative analysis or data on extended lifetimes identified.	Assumed extended lifetime 50%: washing machine, dish washer, refrigerator, microwave, TV Assumed extended lifetime 75%: monitor, DVD player
When to buy new electrical/electronic products? Kiatkittipong, W., Wongsuchoto, P. Meevasana, K. and Pavasant, P. (2007) <i>Journal of Cleaner Production</i> , 2007, 1-7. Available from Science Direct	Environmental criterion for the determination of the usage pattern of electronic products are proposed	Computer monitors: buy LCD screen, but after full lifetime of less efficient technology CRT (due to periodic use) Refrigerator: possibly more beneficial to replace before end of life (due to constant use) light bulbs: replacement of incandescent with CLD before end of life highly recommended	Computer monitors Refrigerators Light bulbs Induction motors

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>Environmentally improved product design- Case studies of the European electric and electronic industry. Ferrendier, S., Mathieux, F., Rebitzer, G., Simon, M. and Froelich, D. (2002), Technical report of the European thematic network Ecolife, 133. http://www.sph.umich.edu/riskcenter/jolliet/Ferrendier%202002.pdf</p>	<p>Presentation of product design principles that reduces environmental impacts of electrical and electronic products</p>	<p>induction motors: recommended to rewind or replace rather than continue using an old one until its end of life</p> <p>Amongst case studies presented, two are cited for remanufacturing potential. Proposed means to extending product lifetime is through remanufacturing.</p>	<p>Siemens SIMOREG DL MASTER 6RA70 Control Module; XEROX photocopiers</p>
<p>A distributed Design Methodology for Extensible Product Life Cycle Strategy, Li, J et al (2004) IEEE, 214 - 219 Available from Science Direct: http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01299718</p>	<p>Design principles provided to extend lifetime of particular components of electrical and electronic products.</p>	<p>Comparison provided of number of years electronic and electrical products can theoretically be functional compared to its actual performance. Possible means to extend the lifetime of product is the introduction of recoverable and reusable components.</p>	<p>Desktop computer, LCD monitor, CD - recordable, audio system, TV, cordless phone, washing machine</p>
<p>Economic Sustainability of Reuse and End-of-life Management tool for Computers and Televisions, Rubinstein, L (2004) IEEE, 1 - 6 Available from Science Direct</p>	<p>Economic analysis of secondary electronics market</p>	<p>Real economic challenges in extending this sector to include advanced electronics. No quantitative analysis or data on extended lifetimes identified</p>	
<p>Reuse and Lifetime Extension Strategies in the Context of technology Innovations, Global Markets and Environmental Legislation, Griese, H; Poetter, H (2004) IEEE, 173 -178 Available from Science Direct; http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01299710</p>	<p>A discussion of the current economic environment for the reuse and the main technological obstacles of three product groups: medical equipment, PCs and automotive electronics</p>	<p>Model built to calculate ecological break even points for components of PCs</p>	<p>Medical equipment: oxymat 3 and Siemens Medical Solutions PCs: floppy disk drives, CD-ROM drives, hard disk drives, soundcard, power supply unit</p>
<p>Environmental life-cycle impacts and benefits of secondhand CRT TVs exported from Japan to the Philippines. A. Yoshida, T. Tasaki, A. Terazono, pp.1-6, 2009 IEEE International Symposium on</p>	<p>Second-hand EEE trade from developed to developing countries</p>	<p>A significant percentage of exported used TVs are damaged in transit. The authors use this data to model the environmental cost-benefits.</p>	<p>Televisions - - provides estimates on lifetime of second-hand TVs exported to East Asia</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
Sustainable Systems and Technology, 2009 To view abstract (article costs 19 US dollars) http://www.computer.org/portal/web/csdl/doi/10.1109/ISSST.2009.5156764			
New concepts in product use for sustainable consumption. Hirschl, B., Konrad, W. and Scholl, G. (2003) Journal of Cleaner Production, 11, 873-881 Available from Science Direct	Analysed benefit of use intensification and useful life extension, as well as analysis on consumer attitudes towards product service systems.	Suggested that use intensification and useful life extension beneficial in case studies analysed. Also, the consumer uptake of sustainable product use is dependant on prior socio-structural characteristics and frequency of which a product is used. No quantitative analysis or data on extended lifetimes identified. Proposed means of extending product lifetime are introduction of product service systems.	Ski rental and launderettes
The use of 1-methylcyclopropene (1-MCP) on fruits and vegetables. Watkins, C. (2006) Biotechnology Advances, 24, 389-409.	There are examples of new substances and methods for extending the shelf-lives of food stuffs, and this report analyses the substances 1-MCP	1-MCP has had commercial success in apples, and there is evidence that it can be used in other food products to extend their lifetime as well. - the number of days the shelf life of fruit is not provided; just an indication of whether decay is slowed down	Food
Information inspiration Ecodesign http://www.informationinspiration.org.uk/ http://www.hp.com/hpinfo/globalcitizenship/environment/recycling/refurbished-products.html	A resource developed to support designers who want create environmentally and socially responsible products	Case studies are provided on product design for extending product lifetime, as well as key principles for designing for optimal life No quantitative analysis or data on extended lifetimes identified	White goods: Miele and Electrolux design products with upgradeability in mind Electrical & Electronic: Philips Master PL Electronic Lamp (longer lifetime), Xerox Photocopier (product service system), Cartridge swap shop (product service system), HP remanufactured products Furniture: Herman Miller's Aeron Chair, Blueline office furniture, Gammer AG Natura Chair. HP remanufactured products:
The Design Council http://www.designcouncil.org.uk/Case-Studies/All-Case-Studies/Vitsoe/A-sustainable-future/	The Design Council is a leading information source on design in the UK.	Case studies in sustainable design are provided, including the Vitsoe chair. Its designed to last a lifetime and its form can change shape according to the customer's changing needs. No quantitative analysis or data on extended lifetimes identified	Chair
Maximising Reuse and Recycling of UK Clothing and Textile.	Report analyses opportunities to increase the recycling and reuse of textiles from a	Standards could be useful to incentivise reuse and recycling, and quality protocols for textiles are more	Uniforms

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
Morley, N.J., Bartlett, C., and McGill I. (2009). Defra. http://www.defra.gov.uk/environment/business/scp/evidence/theme2/products0809.htm	technological and economic perspective	useful for carpet recycling. A case study on whole lifecycle service for uniforms is cited from Finland. Proposed means to extend product lifetime are introduction of product service systems.	
WR0504: Establishing the behaviour change evidence base to inform community-based waste prevention and recycling. Brook Lyndhurst (2007) Defra. http://randd.defra.gov.uk/Document.aspx?Document=WR0504_5409_FRP.pdf	Report consolidating evidence from literature and stakeholder interviews on community-based waste prevention and recycling	No conclusions related to extending product lifetime	Community waste organisation groups particularly concerned with the reuse of existing goods including furniture, bicycles, scrap tyres; refurbishing of waste electrical and electronic equipment; promoting the use of reusable nappies.
Integrated Product Policy Pilot Projects: Mobile Phones http://ec.europa.eu/environment/ipp/pilot.htm	Life cycle analysis on mobile phones that has informed a series of steps to reduce the environmental impact of mobiles	As part of the project, a take back scheme is being investigated. No evidence that an environmental impact assessment has been undertaken. No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetime include reuse and remanufacturing.	Mobile phones
Windows: Environmental Impacts and Initiatives. Hobbs, G. (2009) Defra. http://www.defra.gov.uk/environment/business/products/roadmaps/window.htm	A report consolidating evidence on the lifecycle environmental impacts of windows - references provided to LCAs analysed	Descriptions provided on the lifecycle impacts of windows and research gap analysis conducted for each lifecycle stage including maintenance. No specific data but qualitative discussion on initiatives and gaps in analysis on extending lifetime of windows Proposed means to extend product lifetimes include: 1. raise awareness on maintaining timber frames - reference given to work by BRE on increased service life for timber and coatings 2. Better engineering to improve seal longevity to reduce moisture build up 3. Replacing windows without removing the outer frame 4. Replacing components of windows as opposed to entire window 5. Further research required into designing longer lifetimes or designing for easier deconstruction	Window systems
Helping Consumers Reduce Fruit and Vegetable Waste: Final Report.	Primary research into best storage options for	More often than not, storing fruit and vegetables in	Fresh fruit and vegetables

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
Johnson, D., Hipps, N. and Hails, S. (2008) WRAP, http://www.wrap.org.uk/downloads/WRAP_RTL044-001_Final_report.e9c593b0.7193.pdf	fruit and vegetables	the fridge and in a bag made the food last longer. Best scenarios identified for food storage. Proposed means to extend product lifetimes include optimising storage techniques	
Good Practice Guide 295 'Cleaner product design: Examples from Industry' . Envirowise (2001) Didcot, UK.	Analysis of case studies that cover all aspects of reducing environmental impacts of products through better design.	Two case studies mentioned: Electrolux's Eco Save Guide developed for consumers to use in-store so that they can consider lifetime costs (including financial) and Xerox's design to maximise reuse potential of developer rolls No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include customer engagement and reuse	Household appliances and imaging equipment
Life Cycle Management of Industrial Product-Service Systems. Aurich, J. C.; Schweitzer, E.; Fuchs, C. (2007) In: Takata, S.; Umeda, Y. (Hrsg.): Advances in Life Cycle Engineering for Sustainable Manufacturing Businesses, London: Springer, 171-176. http://books.google.com/books?id=FSCqH5aBmiwC&printsec=frontcover&dq=advances+in+Life+Cycle+Engineering+for+Sustainable+Manufacturing+Businesses&cd=1#v=onepage&q=&f=false	Many sources of information on sustainable product design principles	In terms of extending product lifetime, a case study is analysed on product service systems for commercial vehicles; No quantitative data is provided. Proposed means to extend product lifetimes include introduction of product service system	Commercial vehicles
Product-Service Systems: Panacea or myth? , The International Institute for Industrial Environmental Economics, Lund: Mont, O. (2004a). Lund University, pp.146. http://www.iiiee.lu.se/Publication.nsf/\$webAll/D375F6813A2C460CC1256EF9002D15C0/\$FILE/mont.pdf	Analyses the potential for different types of products to be developed as product service systems.	Discussion is provided on the type of product characteristics that would make a product suitable for a product service system. No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include product service systems.	Carpets; baby prams; furniture; lawnmowers, DIY tools; cleaning equipment; refrigerators and freezers; washing machines; cars; photocopiers
Making functional sales environmentally and economically beneficial through product remanufacturing. Sundin, E.; Bras, B. (2005). Journal of Cleaner Production 13, 913-925. Available from Science Direct	Qualitative analysis of the benefits of not selling a product, but instead selling its function, i.e. creating product service systems.	Functional sales give suppliers a better understanding of their product and incentivise designing the product for durability and easy disassembly for remanufacturing. No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include product service systems.	BT Industries - forklifts Electrolux AB - fridge/freezer and washing machine refer to Sundin's thesis below for more detail on case studies
Product and process design for successful	Thesis research into environmental and	Based on level of analysis, author could not	Toner cartridge, gasoline engine, single

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
remanufacturing , Sundin, E. (2004), Department of Mechanical Engineering, Linköping University, Linköping. liu.diva-portal.org/smash/get/diva2:20932/FULLTEXT01	economic benefits of remanufacturing; analysed remanufacturing operations of a number of companies (see pgs 55 - 80).	conclude whether remanufacturing was environmentally preferable from a whole lifecycle perspective. No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include remanufacturing.	use camera, Electrolux household appliances
Product recovery with some byte: an overview of management challenges and environmental consequences in reverse manufacturing for the computer industry. White, C.D.; Masanet, E.; Rosen, C.M.; Beckman, S.L (2003) Journal of Cleaner Production, 11, 445-458. Available from Science Direct	Article relevant only to understanding components of a computer, not in regards to extending product lifetime.	No quantitative analysis or data on extended lifetimes identified	
Contribution to Design for Adaptation: Method to Assess the Adaptability of Products (MAAP) Willems, B.; Seliger, G.; Duflou, J.; Basdere, B. (2003): Proceedings of EmDesIgnW: Third International Symposium on Environmentally Conscious Design and Inverse. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01322740	Methodology developed to assess the adaptability of products to different management options: remanufacturing, maintenance, repair, upgrading and downgrading.	The methodology involves assessing a product based on a number of criteria that each management option would require the product to fulfil. No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include remanufacturing and downgrading.	Mobile phones
Integrated design of remanufacturable products based on product profiles. Zwolinski, P.; Lopez-Ontiveros, M.A.; Brissaud, D. (2006) Journal of Cleaner Production, 14, 1333-1345. Available from Science Direct	Design principles provided to enable product remanufacturing	A list of 25 products successfully remanufactured is provided, along with a criteria list for remanufacturing. Main case study: shopping trolley. Household appliances: washing machines, refrigerators, television Medical equipment: portable x-ray, bed Car components: engines, alternators, starters, gear boxes, universal joints Office materials: photocopiers, phones, mobile phones, faxes, printers, toner cartridges Computer materials: computers Machines: textile machines, floor cleaning machines, tractors, pallet-trucks, steam machines Other: tyres, office furniture, pallets	Various
		Example of scenario development to understand best way to remanufacture shopping trolley.	

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>Review of Life Cycle Impacts of WCs. Gandy, S., Smith, S., Paton, W., and Aumônier, S. (2009) ERM. Defra. http://randd.defra.gov.uk/Document.aspx?Document=EV0415_7968_FRP.pdf</p>	<p>Measures life cycle impacts of ceramic toilets and analyses the market for new toilets.</p>	<p>Proposed means to extend product lifetimes include remanufacturing.</p> <p>Environmental impacts of toilets dominated by use phase and plastic and concealed cisterns likely to become more dominant in market No quantitative analysis or data on extended lifetimes identified</p>	<p>WCs</p>
<p>Energy Using Products (EuP) European Initiative http://ec.europa.eu/enterprise/policies/sustainable-business/sustainable-product-policy/ecodesign/product-groups/index_en.htm</p>	<p>Ecodesign Directives for energy-using products have specific design requirements that manufacturers must meet.</p>	<p>Of the nine products that have an EU ecodesign Directive passed, only domestic lighting and office/street lighting have lifetime specifications. A minimum lifetime specification for lighting is provided</p>	<p>TVs</p> <p>Standby & off mode</p> <p>Set-top boxes</p> <p>Domestic lighting</p> <p>Office & street lighting</p> <p>External power supplies</p> <p>Electric motors</p> <p>Circulators</p> <p>Domestic refrigeration</p>
<p>Preparatory studies on Ecodesign for EUP http://efficient-products.defra.gov.uk/cms/eup#prepstudies</p>	<p>LCA studies on energy using products, including indication of lifetime.</p>	<p>Findings of studies include base case data, design options as well as social and economic studies; for the majority of products, there is no indication of designing to extend product lifetime or how design options extend product lifetime. Data provided for some products.</p> <p>Transformers</p> <p>Sound and imaging equipment</p> <p>Industrial and laboratory furnaces and ovens</p> <p>Machine tools</p> <p>Air conditioning and ventilation systems</p>	<p>Boiler</p> <p>Water heater</p> <p>Computers - lifetimes of different computers are provided as estimated by manufacturers, as well as estimates of second life</p> <p>Office imaging equipment</p> <p>Televisions</p> <p>Office/outdoor lighting - very useful data for product category 'technology development'</p> <p>Motors - final reports show comparison of power and total operating hours</p> <p>Fridges</p> <p>Dishwashers & washing machines</p> <p>Chargers</p> <p>Air conditioning</p> <p>Standby and off mode devices</p> <p>Commercial freezers</p> <p>Domestic fridge/freezers</p> <p>Laundry dryers</p> <p>Vacuum cleaners</p> <p>Set-top boxes (cable satellite)</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
			Set-top boxes (digital) Domestic lighting Projects still to complete: Small solid fuel combustion machinery Local room heating products Central heating products using hot air Domestic and commercial ovens Domestic and commercial grills and hobs Professional washing machines, dryers and dishwashers Non-tertiary coffee machines Networked standby losses of EuPs Domestic uninterruptible power supplies Refrigerating and freezing equipment
Integrated Product Policy Pilot Projects: Tropical Wooden Garden Chair http://ec.europa.eu/environment/ipp/pilot.htm	Life cycle analysis on teak furniture that has informed a series of steps to reduce their environmental impact.	No findings or projects related specifically to extended product lifetime No quantitative analysis or data on extended lifetimes identified	Tropical wooden garden chair
Who pays for the 'beer fridge'? Evidence from Canada. Young, D. (2008) Energy Policy, 36, 553-560	Measuring the impact of buying a more energy efficient fridge, but turning the old fridge into a second 'beer fridge'.	Data collated on number and models of 'beer fridges' in Canada that was used to inform a use phase LCA on how much GHG emissions are released from Canada's 'beer fridges' No specific lifetimes data- - data comparing energy efficiency of different fridge models	Domestic fridges
Durable consumption: reflections on product life cycles and the throwaway society. Cooper, T. (2002) In Hertwich, E. Lifecycle Approaches to Sustainable Consumption: Workshop Proceedings, 22. http://www.iiasa.ac.at/Publications/Documents/IR-02-073.pdf#page=15	Summary of available conceptual debates on designing products that are more durable.	Points out lack of literature on product longevity, and that increasing product lifespan is essential, but the balance between durability and energy efficiency needs to be determined. Provides an estimate of the ages of household appliances at disposal.	Various household products considered in discussion. Limited quantitative and no life cycle data
Enhanced product design facilitating remanufacturing of two household appliances – a case study. Sundin, E. (2001a), Proceedings of the International Conference on Engineering	Investigates design options to help remanufacturing of household appliances.	Presents design options for two case studies and has presented the design to Electrolux to see potential	Electrolux washing machine and fridge/freezer

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
Design - ICED01, Glasgow.			
Mapping the environmental impacts, interventions and evidence requirements for the TV roadmap. Maxwell, D. (2007) Defra. http://www.defra.gov.uk/environment/business/scp/documents/eiitv-report.pdf	Overview of available literature on environmental impacts of TVs.	References provided to available LCA studies and also ecodesign information for TVs (such as EuP and MTP studies), but nothing on extending product lifetime.	Televisions
Plasterboard: Sustainability Impacts and Initiatives. Hobbs, G. (2009) Defra, London, UK. http://www.defra.gov.uk/environment/business/products/roadmaps/documents/plasterboard0909.pdf	A report consolidating evidence on the lifecycle environmental impacts of plasterboard - references provided to LCAs analysed.	Only discussion of recycling plasterboard, not reuse/remanufacturing/extending lifetime	Plasterboard
Defra's Product Roadmap Studies: electric motors http://www.defra.gov.uk/environment/business/products/roadmaps/motors.htm	No environmental assessment carried out due to number of sources already available.	No quantitative analysis or data on extended lifetimes identified	Electric motors
Sustainable Production and Consumption of fish and shellfish: Environmental Impact Analysis. Cappell, R., Wright, S. and Nimmo, F. (2007) Haskoning UK Ltd. Defra, London, UK. http://www.defra.gov.uk/environment/business/products/roadmaps/documents/seafood-scp-haskoning.pdf	An environmental impact analysis of fish production and consumption.	No evidence regarding extending product lifetime of fish products. No quantitative analysis or data on extended lifetimes identified	Fish
The Environmental, Social and Economic Impacts Associated with Liquid Milk Consumption in the UK and its Production: A review of Literature and Evidence. Foster, C., Audsley, E., Williams, A., Webster, S., Dewick, P. and Green, K. (2007) Defra. http://www.defra.gov.uk/foodfarm/food/industry/sectors/milk/pdf/milk-envsoecon-impacts.pdf	A literature review of the environmental, social and economic impacts of milk production.	No evidence regarding extending the lifetime of milk .No quantitative analysis or data on extended lifetimes identified	Milk
EU Ecolabel http://ec.europa.eu/environment/ecolabel/ecolabelled_products/product_categories_en.htm	EU ecolabels have been created for a number of energy-using and non energy-using products	Standards on product durability and availability of spare parts for a certain number of years are required.	Footwear: durability requirements (not measured in time) PCs: memory, hard disk, graphic cards and CD/DVD drive where available

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
			<p>must be accessible and can be changed; take-back and recycling requirements as well</p> <p>Portable computers: availability of parts guaranteed 3 years after production ceases; memory and hard disk (and CD/DVD where applicable) are accessible and can be changed</p> <p>TVS: commercial guarantee that product will function for 2 years; parts must be available for 7 years after production ceases; design for disassembly</p> <p>Floor coverings/ furniture: durability requirements; easily recyclable</p> <p>Lighting: under review, but original had lifetime hrs and lumen maintenance criteria</p> <p>Heat pumps: parts be made available for 10 years</p> <p>Mattresses: durability tests</p>
<p>U.S. Environmental Protection Agency Energy Star initiative http://www.energystar.gov/index.cfm?c=products.pr_find_es_products</p>	<p>The Energy Star is awarded to energy-using products that meet energy efficiency standards</p>	<p>No criteria for product lifetime or durability. Assumptions in cost savings models useful for modelling efficient vs. conventional products. No quantitative data available.</p>	
<p>Nordic Swan initiative Product Category Rules http://www.environdec.com/pageId.asp?id=214&menu=4,10,33 http://www.svanen.nu/Default.aspx?tabName=CriteriaEng&menuItemID=7056</p>	<p>An ecolabel created by EU Nordic countries for a number of energy-using and non energy-using products</p>	<p>Standards on product durability and availability of spare parts for a certain number of years are required. Includes design requirements which could be modelled as part of scenario analysis</p>	<p>Over 60 product categories are included as part of the Nordic Swan scheme</p>
<p>The Product-Life Institute Walter Stahel +41787656794 http://www.product-life.org/</p>	<p>A leading research and consultancy institution advancing the idea of a Functional Service Economy.</p>	<p>The website provides an introduction to Stahel's work on why and how to create a 'loop economy', which involves extending the lifetime of products through remanufacturing.- case studies provided in book 'Performance Economy' No quantitative analysis or data on extended lifetimes identified</p>	<p>Cannot access book to view case studies</p>
<p>The Network on Product Life-spans Tim Cooper</p>	<p>An interdisciplinary, research-based</p>	<p>Open forum with some examples of good practice</p>	<p>Case studies on website could not be</p>

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
Centre for Sustainable Consumption at Sheffield Hallam University http://extra.shu.ac.uk/productlife/	community comprising over 400 industry and policy specialists.	from manufacturers. No quantitative analysis or data on extended lifetimes identified	accessed because website has been taken down for maintenance
OSRAM http://www.osram.com/osram_com/About_Us/Society_and_the_Environment_-_Global_Care/Products_and_the_environment/Product_Life_Cycle/EPD/EPD_CFLi/index.html	EPD of CFLi lightbulb	Lasts up to 15x as long as ordinary lightbulbs and consumes 80% less	Lighting
Environmental Product Declaration (EPD) Initiative http://ec.europa.eu/environment/ipp/pdf/epdstudy.pdf www.gednet.org http://www.environdec.com/pageId.asp?id=123	No evidence of duplicate EPDs on two similar products regarding environmental difference resulting from lifetimes between them. Only one UK manufacturer is listed	Environmental data on range of products	
An in depth study of the effects of socio-economic conditions on household waste recycling practices. Emery, A., Griffiths, A. and Williams, K. (2003) Waste Management & Research, 21, 180-190. Available from Science Direct	Consumer behaviour in recycling	No quantitative analysis or data on extended lifetimes identified	
Personal Factors Related to Consumer Product Disposal Tendencies. Harrell, G. and McConocha, D. (1992) The Journal of Consumer Affairs, 26(2), 397-417. Available from Science Direct	Discussion on consumer behaviour relating to product disposal	Nothing of direct relevance to product lifetime	
Design, Lifestyles and Sustainability: Aesthetic Consumption in a World of Abundance. Dobers and Strannegard (2005) Business Strategy and the Environment, 14(5), 324-336. Available from Science Direct	Discussion on designing for aesthetics as essential to reduce environmental impact of consumerism	Consumers will become more attached to the product therefore keeping it for longer. No quantitative analysis or data on extended lifetimes identified	
CIMdata (2002). Product Lifecycle Management: Empowering the Future of Business, www.cimdata.com.http://www.cimdata.com/publications/pdf/PLM_Definition_0210.pdf	Discussion provided on product lifecycle management principles	Nothing specifically on extending product lifetimes	
Product development performance: strategy, organization and management in the world	Discussion provided on product lifecycle management principles	Nothing specifically on extending product lifetimes	

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>auto industry, Clark, K.B., Fujimoto, T (2001) Harvard Business School Press. http://books.google.com/books?id=DdNZ8wvXprEC&printsec=frontcover&dq=Product+development+performance:+strategy,+organization+and+management+in+the+world+auto+industry&source=bl&ots=W0wmEfzgKM&sig=j4tdfgE3EfrKwRHOC55U_nQWFug&hl=en&ei=z-JqS-DmOdW6jAeW3uTqBg&sa=X&oi=book_result&ct=result&resnum=3&ved=0CA8Q6AEwAg#v=onepage&q=&f=false</p>			
<p>Total Life Cycle Management - An Integrated Approach Towards Sustainability. Herrmann, C., Bergmann, L., Thiede S., Halubek, P. (2007) 3rd International Conference on Life Cycle Management. University of Zurich at Irchel, Zurich. http://www.lcm2007.org/paper/466.pdf</p>	<p>Discussion provided on product lifecycle management principles</p>	<p>Nothing specifically on extending product lifetimes</p>	
<p>Institute for Ecological Economy Research Dr. Gerd Scholl Tel. +49 (30) 884594-20, gerd.scholl@ioew.de http://www.ioew.de/no_cache/projekt/Neue_Nutzungskonzepte_fuer_Produkte/?tx_t3ukioew_pi1%5Bpointer%5D=4&cHash=7c40baa629</p>	<p>Many research papers available from a policy and consumer perspective on sustainable product systems, but nothing specific on quantitative analysis on extending product lifetime.</p>		
<p>Innovative Approaches in European Sustainable Consumption Policies. Insitute for Ecological Economy Research, Frieder Rubik, Gerd Scholl, Katja Biedenkopf, Harri Kalimo, Franziska Mohaupt, Ólöf Söebeck, Eivind Stø, Pål Strandbakken, Bruno Turnheim (2009) Berlin, Germany. http://www.ioew.de/uploads/tx_ukioewdb/IOEW-SR_192_Sustainable_Consumption_Policies_01.pdf</p>	<p>A report published by the Institute for Ecological Economy Research consolidating evidence and providing analysis on sustainable consumption policies in Europe</p>	<p>All relevant policy initiatives analysed in report that have a research programme are listed below</p>	
<p>Market Transformation Programme “What if?” database.</p>	<p>This holds assumptions about the average life use and diistribution of lifetimes of a vast</p>	<p>Some product data available.</p>	

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
http://whatif.defra.gov.uk/D100 .	range of energy using products beginning from 1980 onwards.		
Alexander, C; Smaje, C (2008) Evaluating third sector reuse organisations in the UK: Case-studies and analysis of furniture reuse schemes . Resources, Conservation and Recycling, 52(5), 719-730. Available from Science Direct	Analysing benefit of furniture reuse schemes using cost-benefit analysis and primary data (economic case).	Nothing of direct relevance to	product lifetime
ACR+ (2009) Bulky Waste Reduction Cluster http://www.acrplus.org/-kgtechnicalinfodatabulky	Data provided on bulky waste collection and what is available for reuse.	Nothing of direct relevance to	product lifetime
Stahel W. (1994) The Utilization-Focused Service Economy. Resource Efficiency and Product-Life Extension . In: Allenby B, Richards D, editors. The Greening of Industrial Ecosystems. Washington D.C., 178-190. http://books.google.com/books?id=Y1EZAAAYAAJ&printsec=frontcover&dq=the+greening+of+industrial+ecosystems&client=safari&cd=1#v=onepage&q=&f=false	Theoretical justification to shift current linear economic structure to a loop economy	Nothing of direct relevance to	product lifetime modelling.
Rowledge L.R., Knowledge Management for Sustainable Value Creation, EKOS International . http://www.ekosi.com/samples/km.pdf	Theoretical discussion on value of pursuing sustainability objectives in Knowledge Management Systems	Nothing of direct relevance to	extending product lifetime.
Nes, N. And Cramer, J. (2005) Influencing Product Lifetime through Product Design . Business Strategy and the Environment, 14, 286-299 http://www3.interscience.wiley.com/cgi-bin/fulltext/111082150/PDFSTART	Report provides theoretical analysis behind product lifetime optimisation and product design with arguments based on consumer behaviour analysis on product replacement	Consumers want well functioning and up to date products, therefore products should be designed for future repair and upgrade to avoid discard. No quantitative analysis or data on extended lifetimes identified	
Sustainable Design Network : Dr Vicky Lofthouse +441509222777 Loughborough University http://www.sustainabledesignnet.org.uk/	Research network which addresses the issues of sustainable design (particularly the methods, tools and techniques to aid its implementation)	A list of references provided on theoretical background to sustainable design, but nothing on extending product lifetime specifically.	
Saaksvuori, A., Immonen, A. (2004). Product lifecycle management , Springer, Berlin. http://books.google.com/books?id=CiHbLm	Principles of product lifecycle management	Nothing specifically on extending product lifetimes	

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
6twJMC&printsec=frontcover&dq=Product+life cycle+management&client=safari&cd=1#v=onepage&q=&f=false			
Stark, J., (2005). Product lifecycle management: 21st century paradigm for product realization , Springer, London http://books.google.com/books?id=PiVri4OyU7AC&printsec=frontcover&dq=Product+life cycle+management&client=safari&cd=2#v=onepage&q=&f=false .	Principles of product lifecycle management	Nothing specifically on extending product lifetimes	
Waste Watch (2007) WR0105: Project REDUCE Monitoring and Evaluation - Developing tools to measure waste prevention . Defra http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14655	Primary research into waste minimisation messaging campaigns	No conclusions related to extending product lifetime	
WR0116: Household Waste Prevention Activity in Dorset . Dorset County Council (2008) Defra http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14710	Primary research into effective monitoring of waste prevention activities	No conclusions related to extending product lifetime	
AEA (2006) WR0107: Modelling the Impact of Lifestyle Changes on Household Waste Arisings . Defra. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14661#Description	A model was developed to measure the impact on waste arisings from different changes in lifestyles	A scenario was modelled on the basis that all product categories double in lifetime; Authors estimate that increasing the lifetime of non-electrical appliances will bring greatest benefit out of four categories (food, electrical, non-electrical and paper). No quantitative analysis or data on extended lifetimes identified	
Brook Lyndhurst (2008) WR0104: Lifestyle Scenarios: the Futures for Waste Composition . Defra. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14615	Report builds various scenarios to model and estimate the impact on waste arisings and composition	Premature discard of products are included as part of the scenarios modeled, but nothing relevant to this project.	
Hogg, D., Wilson, D., North, J., Errey, O., Astley, M., Buchert, M., Hermann, A., Tukker, A. and Johnson, E. (2007) WR0103: Household	Report aimed to investigate and identify waste prevention policies with the greatest potential in the UK	With regard to product lifetime, the authors recommended extended product warranties and extended producer responsibility. No quantitative	

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
<p>Waste Prevention Policy Side Research Programme. Defra. http://www.conservatives.com/pdf/secretbinreport1.pdf</p>		analysis or data on extended lifetimes identified	
<p>Proposed work by Defra, WRAP and Food Standards Agency on sell-by dates http://defra.gov.uk/news/latest/2009/food-0615.htm</p>	Work ongoing between Defra, FSA, WRAP and food industry about how to make labelling clearer on dates	No findings from research published as of yet.	
<p>Brook Lyndhurst (2009) WR1204: Household Waste Prevention Evidence Review. Defra. http://randd.defra.gov.uk/Document.aspx?Document=WR1204_8346_OTH.pdf#3</p>	Report is a synthesis review to draw together the reports of the Waste and Resource Evidence Programme (WREP)	Two reports from WREP are of particular relevance: WR0106 and WR0113. These reports are included in the evidence review.	
<p>Tucker, P. and Douglas, P. (2007) WR0112: Understanding Household Waste Prevention Behaviour. Defra. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14681</p>	Report consolidating evidence on consumer behaviour and attitudes towards waste prevention	Ways to motivate consumers on reducing waste are provided, but nothing included on purchasing products with extended product lifetime.	
<p>Global Action Plan (2008) WR0114: Building greater understanding of the techniques and processes required to promote sustainable waste management through behaviour change programmes. Defra. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14692</p>	Primary research into behaviour change programmes	No conclusions related to extending product lifetime.	
<p>Hampshire County Council (2008) WR0117: Developing a programme of practical waste minimisation schemes to take forward recent research on consumer behaviour and behavioural change. Defra. http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14719</p>	Primary research into waste minimisation programmes	No conclusions related to extending product lifetime.	
<p>Avfall Sverige (2008) Vart tar smått el-avfall från hushåll vägen? Studie av plockanalyser samt hushållens attityder och agerande</p>	Resource efficiency and extended product lifetime	In order for extended product use lives to result in increased material efficiency, and thereby waste prevention, the product use life extension needs to result in reduced consumption of new products. In many cases, household appliances are not discarded	

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
		when a replacement appliance is purchased. Instead, the old appliance finds a new area of use in the same household, such as a beer fridge or a TV set for the children's' room. No quantitative analysis or data on extended lifetimes identified.	
De Keulenaer, H., Herrmann, C. and Parasiliti, F. (2006) ' Ecosheet: 22 kW induction motors with increasing efficiency '. Leonardo Energy. http://www.leonardo-energy.org/webfm_send/359	Measuring the environmental benefit of improved efficiency of a 22 kW induction motor	The three motors that were compared all have the same lifetime, and as such there are no findings related to extending product lifetime. No quantitative analysis or data on extended lifetimes identified	
Ferriera, S. (2006) ' Eco-sheet: 15 kW induction motor - impact of efficiency increase varies according to electricity mixes '. Leonardo Energy. http://www.leonardo-energy.org/webfm_send/378	Measuring the different levels of emissions by country for two different efficiencies of 15 kW motors	No findings related specifically to extended product lifetime.	
Sundin, E. (2001b), " Product properties essential for remanufacturing ", Proceedings of the 8th International Seminar on Life Cycle Engineering, Varna, .	Discusses design principles essential for remanufacturing	No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include remanufacturing.	
UNEP, Product Service Systems and Sustainability: Opportunities for Sustainable Solution . France http://www.unep.fr/scp/design/pdf/pss-imp-7.pdf	A booklet to explain the concept and benefits of product service systems. Detergent: case study system reduces packaging; virtual office service system; toy library	Product service systems have the potential to bring environmental benefits, but needs to be considered on a case by case basis. No quantitative analysis or data on extended lifetimes identified. Proposed means to extend product lifetimes include product service systems.	
Resource Recovery Forum Kit Strange (Tel) +441756711363 http://www.resourcesnotwaste.org	An international non-profit network of more than 300 organisations interested in sustainable waste management.	No database of findings	
LCA discussion lits. http://www.pre.nl/discussion/default.htm	Nothing specific to extending product lifetime came up in search		
LCA Search tool. http://www.pre.nl/LCAsearch/default.htm	Nothing specific to extending product lifetime came up in search		
European commission LCA resource website http://lct.jrc.ec.europa.eu/eplca and its	Nothing specific to extending product lifetime came up in search		

Title	Subject	Principal findings relevant to product lifetimes	Product(s) examined (if any)
information Hub http://lct.jrc.ec.europa.eu/eplca			
Institute of Electrical and Electronics Engineers. Proceeding of Electronics and the Environment. http://ieeexplore.ieee.org/xpl/RecentCon.jsp?punumber=1099	Any articles of relevance have been included in the specific research reviews		
SETAC Europe LCA Case Studies Symposium. http://www.setac.org/node/32	Nothing specific to extending product lifetime came up in search		
University of Bath - Innovative Design and Remanufacturing Centre http://www-edc.eng.cam.ac.uk/kim/publications/?month=11&year=2008&mode=summary&action=view	The programme on Extended Product Models forms part of the KIM Grand Challenge Project. Therefore, reviewed list of over 200 publications from this programme.	No case studies could be found that would be possible to model in this project. The focus is on much larger systems and how to build lifecycle management systems.	
Ekvall, T., Gottberg, A., Ljunggren Söderman, M., Green, J., Larsson, C. & Rydberg, T. (2009) Avfallsprevention och giftfri miljö . IVL-rapport B8161, Stockholm. www3.ivl.se/rapporter/pdf/B1861.pdf	http://www3.ivl.se/rapporter/pdf/B1861.pdf	Swedish reference concerning and environmental toxicity of waste prevention measures	

Other references briefly reviewed include:

- Rodgers, C. (1995). **From 'start-up' to 're-boot': product life cycle strategies and competitive advantage in the computer industry**. Business Strategy and the Environment, 4 (3)p128-135.
- Fabrice Mathieux, Gerald Rebitzer, Sophie Ferrendier, Matthew Simon and Daniel Froelichelling (2001) **Ecodesign in the European Electronics Industry: An analysis of the current practices based on cases studies**. The Journal of Sustainable Product Design, 233-245.
- Kostecki M. (1998) **Marketing and the durable use of consumer goods: a framework for inquiry**. In: Kostecki M, editor. The durable use of consumer products. Dordrecht, The Netherlands: Kluwer.
- Box, J.M. F. (1983). **Extending Product Lifetime; Prospects and Opportunities**. European Journal of Marketing, 17 (4), p34-49.
- Bohoris, G. A. (1996) **Trend testing for complex repairable systems**. International Journal of Quality & Reliability Management, 13 (6), p18-29.

- Dewulf, W., Willems, B., & Duflou, J. R. (2005). **The eco-efficiency of reuse centres critically explored-the refrigerator case-**, Proceedings of European Roundtable on Sustainable and Cleaner Production, Antwerp, 5-7 October. (CD-Rom)
- Sun, J.; Han, B.; Ekwaro-Osire, S.; Zhang, H-C. (2003). **Design for Environment: Methodologies, Tools and Implementation**. In: Journal of Integrated Design and Process Science.
- van Hemel, C. (1998) **Eco Design empirically explored. Design for environment in Dutch small and medium sized enterprises**. Delft, The Netherlands: Delft University of Technology.
- Barry, J, Cavinato, J.L., Green, A., and Young, R.R (1996) **A development model for effective MRO (maintenance, repair and operating) procurement**. International Journal of Purchasing and Materials Management (USA) Vol: 32 (3)p35-45.
- **Eternally Yours Foundation**
- Websites of large manufacturers: Siemens (EPD), Baxter (EPD), BT, Sony, Panasonic, Nokia, Samsung, Bosch, LG, Beko, Philips and any of their Environmental Product Declarations. CECED