# **The Circular Economy:** A perspective from the technology sector

**September 2015**

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# Contents

# Executive Summary

The term “circular economy” has become a very familiar one over the last few years. Although not a new concept, it has been promoted as an alternative to the traditional “make-use-dispose” approach that applies - predominantly though not exclusively - to manufacturing and commerce.

Circular economy principles are attracting growing attention from many other stakeholders. These include policy makers in Whitehall, Brussels and further afield, where the agenda is moving away from an almost exclusive focus on waste to accommodate more geopolitical concerns about resource scarcity and resource security. The circular economy is a hot topic in Europe at the moment and the Commission is proposing an extensive package of circular economy measures.

These factors are particularly compelling for the technology sector where circular business models are already well-established. The technology sector is very positive about the circular economy and strongly supports moves to implement circular economy practices and thinking.

We are proud that circular economy practices and thinking are already well established within the technology sector, especially in the business-to-business market. Moreover, technology is a key enabler of the circular economy in the retail and service sectors, especially in peer-to-peer transactions. However, implementing a circular economy is a major undertaking and not without risk.

**The Three Ps: Principles, processes, products**

We believe that policy should focus on principles and processes as well as products and we take the view that the successful development of a circular economy depends on a robust business case; a coherent policy framework and good consumer engagement.

Circular economy thinking should prioritise principles over processes and prioritise processes over products in parallel with the more familiar “reduce, re-use, recycle” hierarchy[1]. By this we mean that we should keep in mind what we are trying to achieve and how we are trying to achieve it rather than just focussing on the physical characteristics of products.

## Recommendations

This paper includes a number of recommendations for the technology industry and policy makers in order to take forward circular economy thinking:

**For the technology industry:**

1. Adopt innovative business models: An opportunity for technology businesses to be as innovative in their business models as they are with their devices and systems.
2. Provide consumers with easily accessible information regarding repair and recycling options: Scope for technology businesses to do more to ensure that consumers can repair their devices easily, or at least make them aware of the options available to them.

**For policy makers:**

3. Focus on re-use, not just waste: Give equal consideration to encouraging re-use and therefore creating a market for both second hand and remanufactured devices and for recyclates.

4. Remember the consumer: Include consumers in policy dialogue and take into account consumer preference and consumer behaviour.

5. Use government procurement to promote the circular economy: Where reasonable, use environmental and social criteria in public procurement as a way to achieve market transformation towards the circular economy.

6. Overcome inertia in policy implementation: Understand inertia at the point of policy implementation and seek to overcome it without imposing burdensome policy on businesses.

7. Encourage market pull for non-virgin products and materials: Focus on positive incentives and tackle the disjointed approach which adds complexity to the policy landscape and generates perverse incentives that discourage the right behaviours.

8. Ensure regulation does not inhibit the circular economy: Ensure regulations do not prevent the legitimate movement of materials and recognise testing, repair, refurbishment and re-use to be essential practices in circular economy.

9. Broaden the agenda to include commercial considerations: Recognise that the vast majority of examples of successful implementation of circular thinking have been driven by commercial opportunity rather than by environmental constraints.

10. Recognise the opportunity for reform: An opportunity for EU policy makers to implement significant reform of current policy measures – many of which create a significant burden – and therefore introduce a truly joined up approach.

11. Do not turn the circular economy into an end in itself: Focus on the positive environmental and economic outcomes that a circular economy delivers, rather than on the circular economy concept itself.

12. Ensure a more robust dialogue with the technology industry: A more robust dialogue with the technology industry to ensure policy making is properly informed, and recognition of how far the industry has come on circular economy.

As a sector we are truly excited about the environmental and economic benefits that a circular economy can deliver: we see it as a really positive development that we welcome. We also see it as an invaluable opportunity to align and harmonise a large part of the environmental policy landscape.

We look forward to providing the technical and market information about the sector that policy makers will need to make informed choices looking ahead. We also look forward to working with stakeholders from business, academia, government and customers, to help make circular economy practices a reality.

# Introduction

The technology sector strongly supports the circular economy: an economic and social system in which there is no such thing as waste, which is regenerative and restorative by design. While the terminology and the policy emphasis on circularity are relatively new, circular economy practices are well established within the technology industry. Technology businesses are agile, fast developing and quick to exploit the market opportunities presented by disruptive digital technologies. A movement away from product based business models to service delivery over the last decade is a typical example of this trend. In such areas, business opportunity is closely aligned with the move to greater sustainability and it would be surprising, in such a dynamic industry, if these new models were not being welcomed and adopted.

Indeed, this transition has not been driven by an evangelical desire to achieve circularity. In reality it has been fuelled by the realisation that such approaches are commercially attractive and present the prospect of economic as well as environmental sustainability for companies operating in a global marketplace where differential labour and energy costs render them unable to compete on prices for manufacturing output alone. It has also been driven by the availability of the enabling technologies on which such business models frequently depend.

But the service delivery model is not the only approach:  while it provides greater visibility and control of the supply chain (in particular the disposal supply chain) when compared to the dominant consumer purchase model, the industry is no stranger to the make-use-re-use-recycle approach. In response to resource constraints, CSR (corporate social responsibility) concerns and recycling obligations, the sector continues to improve the efficiency of that route.

Despite the presence of these drivers, a strong policy focus and clear thought leadership, the opportunities for implementing circular economy thinking are underexploited. A circular economy is clearly desirable from an environmental point of view and we support objectives that foster and facilitate this approach. However, implementing circular thinking presents some unexpected problems and challenges for the sector and we identify market, technical, policy and cultural barriers that we need to overcome: unless we acknowledge them, we are unlikely to be in a position to address them effectively.

For the technology sector in particular, these barriers include lack of market pull, elusive return on investment (ROI), the speed of technology development, consumer preferences and the inherent difficulty of predicting market trends in an industry characterised by disruptive technologies. How do we address these barriers? Some of them will be eroded by time and technology but others may require intelligent policy intervention.

The circular economy policy agenda is changing rapidly and at European level the focus appears to be moving away from a specific concern with waste to a more holistic approach that will include resource efficiency, ecodesign, and market drivers for re-use.

We also need to maintain perspective. The circular economy construct has taken shape and is now a very large entity, with its own thought leaders, language and delivery bodies, supported by a growing body of literature and academic research. We need to remain focused on achieving economic and environmental outcomes through practical implementation as opposed to the pursuit of a perfect, and probably unachievable, economic model.

We very much look forward to assisting policy makers by providing the technical and market information that will help to inform their future decision making on this important topic.

## Who are we?

For the purposes of this document, the technology sector comprises the Information and Communications Technologies (ICT) and Consumer Electronics (CE) sectors. Businesses that make up this sector include IT hardware manufacturers, software developers, IT services companies, data centre operators, telecommunications providers, consumer electronics manufacturers, system integrators and a huge range of associated service providers and consultancies.

## Scope of this paper

This report is not intended to define or redefine the circular economy or develop new thought leadership on circular economy frameworks or implementation.

This paper gives us an opportunity to explore the specific implications of the circular economy for the technology sector, an assessment that we think is somewhat overdue. It acknowledges the degree to which our businesses have already adopted circular economy models; articulates some of the barriers that are preventing wider deployment of circular thinking in the technology sector, and tries to find ways to address them. It is important to be aware where a circular approach has limitations and also where it could, if badly managed or too ideologically applied, compromise innovation within this rapidly changing sector. It also looks at some successful examples of circular thinking by technology companies.

Furthermore, it explains the important role that technology plays in facilitating and delivering some of the most often cited examples of circularity at work: these may be advanced logistics systems that track the movement of resources through supply, manufacturing, use and disposal or software applications that enable leasing models or websites that promote re-use, either for free or commercially.

# Our key messages

## A robust business case

A robust business case is critical for the circular economy to work. Commercial opportunity has generally been the catalyst for successful circular economy examples; whether driven by the need for resource security or to create value-add in a low margin market.

## A coherent policy framework

We welcome an ambitious, joined-up policy focus on circular economy thinking and practices. The circular economy has major implications for a multitude of existing environmental policies, including ERP, EcoDesign and WEEE plus a range of energy and chemicals related legislative instruments[2]. In the UK, circular economy policy could benefit from being more coordinated: currently the approach appears to be fragmented across multiple departments and bodies. At EU level, in reconsidering circular economy policy, the European Commission has an invaluable opportunity to deliver more coherent and harmonised environmental policy.

Policy needs to recognise the need for commercial drivers, reduce the disproportionate focus on waste, encourage re-use and drive the market for recycled content.

## The consumer is king

Policy approaches that do not engage or accommodate the consumer are unlikely to be successful: Businesses will not develop products or services for which there is no demand.

Many of our members are directly consumer facing and are sensitive to and cognisant of consumer attitudes and preferences, particularly relating to digital devices and services. Their knowledge can help ensure that policy is properly informed.

## Implications for the technology sector

- Circular economy practices are already well established within the technology sector and are successfully creating business opportunities and generating growth and employment.
- With respect to digital devices, circular economy practices are more readily applicable to the business-to-business market and are harder to apply successfully in the business-to-consumer market.
- The technology sector already provides the infrastructures and platforms that support circular economy approaches especially in the retail and service sectors: eBay, GumTree, ZipCar, Freecycle, etc. and will continue to do so.
- We must examine many of the assumptions associated with the circular economy: not all of them stand up to scrutiny.
- techUK is wholly supportive of circular economy approaches that make sense from a business perspective: in addition to the obvious resource and efficiency considerations it is an opportunity for technology companies to differentiate their brands on the basis of customer service and sustainability.

## Some words of caution

- While there is an unprecedented opportunity for the European Commission to deliver a dramatic improvement in regulatory coherence, the opposite is also possible: a fragmented, complicated, restrictive and burdensome array of individual policy instruments disproportionately focused on products rather than on processes and on production rather than on consumption.
- At European level a more robust meta-policy dialogue is needed – on the quality of the consultation process itself. The 2015 European Commission stakeholder consultation was inadequate and included a questionnaire that seemed predicated to create an artificial mandate for Commission activity.
- Finally, the circular economy should not become an ideology in its own right: policy objectives should focus on the positive environmental and economic outcomes that a circular economy delivers, rather than on the circular economy concept itself. We need to recognise that there is a gap between policies that “look circular” and policies that encourage circular innovation without restricting it.

# What IS the circular economy?

## Definitions

Broadly speaking, a circular economy is one in which there is no such thing as waste. In the natural environment we have examples like the nutrient, carbon and water cycles: minerals are released from rocks, taken up by plants and other organisms, released with the help of detritivores after death and taken up again, or laid back down as sediment which then returns to rock. Proponents of the circular economy seek to learn from and mimic this seamless, waste-free approach to resource management. The Ellen MacArthur Foundation report provides a useful definition:

There are powerful drivers for pursuing a circular economy: although a circular approach may not be a feasible solution in every circumstance, the conventional take, make, use, dispose route cannot continue to be the dominant economic model – not just from a waste management point of view but also because of the growing issue of resource scarcity. A burgeoning global middle class can only add more pressure at both ends.

*"A circular economy is an industrial system that is restorative or regenerative by intention and design... it replaces the "end of life" concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair re-use, and aims for the elimination of waste through the superior design of materials, products, systems and within this, business models. Such an economy is based on few simple principles. First, at its core, a circular economy aims to design out waste. Waste does not exist – products are designed an optimised for a cycle of disassembly and re-use. These tight component and product cycles define the circular economy and set it apart from disposal and even recycling where large amounts of embedded energy and labour are lost. Secondly, circularity introduces a strict differentiation between consumable and durable components of a products. Unlike today, consumables in the circular economy are largely made of biological ingredients or "nutrients" that are at least non-toxic and possibly even beneficial and can be safely returned to the biosphere – directly or in a cascade of consecutive uses. Durables such as engines or computers, on the other hand, are made of technical nutrients unsuitable for the biosphere, like metals and most plastics. These are designed from the start for re-use. Thirdly the energy required to fuel this cycle should be renewable by nature, again to decrease resource dependence and increase system resilience...."* See Towards the Circular Economy (Ellen Macarthur, 2012 and 2013) Reports 1 and 2.

## Key players in the circular economy

Circular economy terminology was brought to prominence by the work of the Ellen MacArthur Foundation, following the "cradle to cradle" concepts established by William McDonough and Michael Braungart. The Foundation articulated the environmental and economic benefits of the concept in 2012 with follow-up reports in 2013 and 2014 and has been very effective in alerting policy makers, businesses and other stakeholders to the urgent need for a more circular approach - in particular more joined-up policy thinking on waste and resource issues. The Foundation has also developed a compelling proposition for implementing circular economy thinking in practice, together with supporting models and standards to help make it a reality.

At the same time the RSA and InnovateUK are supporting a joint initiative. The Great Recovery and Friends of the Earth are orchestrating a high profile Make it Better campaign. WRAP is running an Electrical and Electronic Equipment Sustainability Action Plan (esap) and is heavily engaged in the REBus project – both of which identify commercial opportunities through circular economy practices. Other contributors include the Aldersgate Group, EEF, the European Commission, Green Alliance and IEMA. Green Alliance run the Circular Economy Task Force which brings together business, government and NGOs. There is a bibliography at the end of this document covering some of the main publications on the circular economy.

Many contributors see the circular economy not as an end in itself but as a framework that brings together different elements into a coherent landscape and accommodates existing practices such as lifecycle thinking, ecodesign and resource efficiency alongside new approaches. Some observers see the circular economy as simply a new means of describing ways of working that are already well-established – such as cradle-to-cradle, closed loop, service delivery and leasing models.

Policymakers need to understand where breaks in this cycle occur, why they occur and whether policy instruments can be effective in bridging them, either temporarily or permanently. They also need to understand and acknowledge where policy instruments are actually creating or exacerbating breaches in the cycle or where they pose a risk of doing so.

Businesses need to understand the opportunities that a circular approach presents and it is clear that many already do and have taken or are taking steps to deliver business offerings that accommodate circular economy thinking and practice.

Over the last couple of years the focus has moved away from purely a consideration of how we perceive resources and "design out" waste to how we derive economic value from a more circular approach. There is a rapidly growing body of literature on the economic opportunities presented by circularity (see the below box), including figures for job creation. InnovateUK (previously the Technology Strategy Board), is very actively involved in this agenda. Some initiatives have focused on the market opportunities for businesses, others are trying to quantify the macro-economic contribution that a more circular approach might contribute to national and regional economies. This change in emphasis is also explicitly supported by NGOs and business groups.

In Growth Within: A circular economy vision for a competitive Europe (2015), the Ellen MacArthur Foundation estimated that by adopting circular economy principles, Europe can take advantage of the impending technology revolution to create a net benefit of €1.8 trillion by 2030, or €0.9 trillion more than in the current linear development path. This would be accompanied by better societal outcomes including an increase of €3,000 in household income, a reduction in the cost of time lost to congestion by 16%, and a halving of carbon dioxide emissions compared with current levels. Previous calculations by the Ellen MacArthur Foundation has estimated this opportunity as US$1trillion per annum in cost savings globally by 2025 and in Europe at US$380bn in savings during the transition and US$630 billion with full adoption; See Towards the Circular Economy reports 2 and 3.

# Policy context

Until recently it seemed that the strategic policy process was focused almost exclusively on eradicating or at least reducing waste. However, this is changing and the policy agenda has broadened considerably.

## European developments

At the time of writing, the much-publicised circular economy package[3] proposed by the Barroso Commission[4] has been withdrawn by the new incumbents who promise a much more comprehensive approach that will be announced later in 2015. As yet there is still considerable uncertainty regarding the form that these new measures will take and a number of commentators have expressed concern over the inevitable delay. However, indications from the current Juncker Commission seem to signal that policy makers wish to take a much more holistic view of the circular economy and, as mentioned above, want to avoid a package dominated by waste related issues. Instead they prefer to try and ensure that such considerations are fully integrated with other relevant issues such as resource efficiency, sustainable production and consumption, markets for recycled materials, product policy and ecodesign. If the intention is to make EU policy more joined - up in this area then that would be a very welcome development.

It also seems evident that the current objective is to bring the circular economy proposals within the investment plan with DG GROWTH[5] providing the policy lead. This signals that the package will no longer have a purely environmental remit and the revised agenda will include a strong focus on the opportunities for employment and growth generated by circular thinking. We take the view that this is a vital broadening of stance:  an exclusive focus on environment without taking into account any commercial considerations is less likely to achieve its policy objectives than a more holistic approach.

Interest in the circular economy is also growing both at EU level and in nation states for another reason: In an attempt to retain control of valuable or rare raw materials by keeping them within state boundaries the agenda is increasingly being influenced by geopolitical concerns over resource scarcity and resource security. This reflects business concerns about commercial risks from price volatility, but the emphasis and objectives are different:  businesses want the raw materials (whether virgin or secondary) to be directed to where the manufacturing processes take place[6], which may well be the Far East. Governments want the raw materials to be retained within nation state boundaries or at least within “friendly” states so that they can be confident that they will retain access to them in the medium to long term. While such concerns are completely valid and must be accommodated, we operate within a global market place and unilateral approaches by individual nation states or regions will most probably add barriers, constraints or complexity unless they are very carefully thought through.

## Domestic policy landscape

Policy relating to the circular economy in the UK is fragmented. Although DEFRA[7] is the nominal lead, responsibility is spread between a number of departments, agencies and organisations. There have also been structural and organisational changes within some of the bodies responsible for delivery.

The following points provide a brief summary:

- DEFRA and BIS[8] both have policy roles regarding the circular economy. DEFRA is in charge of waste and the departments were jointly responsible for the Resource Security Action Plan.
- WRAP - the Waste and Resources Action Programme, which was established in 2000 to help join up the ends of the supply chain, has been very effective in identifying and implementing ways in which waste materials or by-products can be repurposed as resources. WRAP has recently become a charity which enables the organisation to diversify funding streams. WRAP underpins ESAP – the Electrical and Electronic Equipment Sustainability Action Plan. This is a collaborative initiative to catalyse action to improve sustainability and share good practice on delivering economic and environmental benefits. WRAP maintains a focus on commercial opportunities (sometimes identifying a business case that nobody was aware of or addressing obstacles that prevent potential opportunities being capitalised). The rationale is that unless there is a solid business case it cannot be scaled up beyond a pilot or persist into the long term. WRAP is also engaged in the REBUS project.
- The Environment Agency (EA), an agency of DEFRA and other Departments, is responsible for delivering a number of waste management services relevant to the circular economy and runs a number of relevant operations such as waste enforcement and the end-of-waste initiative among others. Reduced funding and a major reorganisation have placed limitations on the EA.
- InnovateUK funds, supports and connects innovative businesses within a range of technology disciplines. They are investing in circular economy projects and recently ran a call for feasibility studies into the business case for retaining value in durable goods through re-use, remanufacture or leasing/maintenance.
- UK Parliament, through the Environmental Audit Committee, has also taken a strategic interest in progress towards a circular economy and published a report[9] in November 2014 that criticised the government for failing to tackle the UK's "throwaway society".

The UK needs to commit to a more coherent policy stance on the circular economy along the lines of the changes we expect to see at EU level. All the elements are present in the UK but it needs to be a less piecemeal and more ambitious approach that can provide a greater focus on resources and on commercial opportunities. This will also allow the UK to engage proactively and pragmatically in this debate at European level.

## Accommodating the consumer

Whether domestic or European, policy making must accommodate the consumer. In the past there has been reluctance to engage with consumers on environmental issues and we know from the experiences of consumer facing advisory groups like the Energy Savings Trust that many consumers are resistant to any messaging that they believe places constraints on their behaviour. This observation is supported by studies conducted by NESTA, DEFRA and the CBI over the last decade. The result has been that policy makers have tended to place the responsibility on businesses rather than consumers whose behaviour and preferences have sometimes been ignored. While placing constraints on business - such as excluding hazardous materials from the supply chain - does indeed deliver obvious benefits, ignoring the consumer altogether is not a viable option.

A policy focus that accommodates commercial and market considerations is more likely to lead to positive outcomes where sustainability and commercial objectives are aligned and we start to see positive outcomes like unconscious environmentalism – where the sustainable approach is the obvious approach for the consumer and does not involve difficult decision making, additional cost or sacrificing performance.

techUK represents a number of consumer electronics manufacturers who are both sensitive to and knowledgeable about consumer attitudes and preferences. They can help inform aspects of the policy process that relate to the consumer interface.

# What are the implications for the technology sector?

The issues that underline the need for a circular economy include resource scarcity, pollution, constraints on energy use and an explosion in demand. These factors are particularly compelling for the technology sector. The rapid evolution of digital technologies is driving change in the networks, systems and devices that deliver them and this in turn can lead to rapid obsolescence - particularly in end-user device[10]. Technology is becoming more and more pervasive, more and more accessible and more and more affordable. The inevitable result of this, combined with the emergence of a global middle class, is proliferation. Then we add the issue of all the electronic waste that has to be collected, handled appropriately and recycled. Finally, when we throw in the fact that, for the technology sector in particular, many key resources are extremely limited, it starts to take the shape of a perfect storm.

## To what extent has the technology sector adopted a circular economy approach?

The technology sector is fast moving, adaptable and innovative, in terms of products, routes to market and business models. Service delivery approaches have long been adopted across the technology sector: aircraft manufacturers provide flying hours instead of planes for training purposes, engine manufacturers like RollsRoyce also charge by engine flight time[11], lighting suppliers provide illumination in terms of lux or lumens instead of light bulbs, car manufacturers "sell" a large proportion of cars on a monthly leasing basis (which reduces consumer risk and helps with budgeting), printer manufacturers provide managed print services, cloud computing companies provide utility computing at any level – infrastructure as a service, platform as a service, software as a service, etc. Instead of trying to sell more planes or printers or servers, these longer term, more customer-focused business models work on the basis that the interests of both customer and supplier are closely aligned.

In 2008 we pointed this out in our publication High Tech: Low Carbon: *"The concept of service provision is becoming increasingly important in the technology industry and is replacing traditional, more specific offerings like particular items of hardware or software. What this really means is that instead of a utility company selling gas, for instance, they sell the service of keeping people warm, so they take care of all domestic heating aspects including supply, efficiency and insulation. Document management services could be seen as an example within the technology sector..."*

But there are some important qualifications to make here. Firstly, with a few exceptions, the leasing or service delivery model tends to work most successfully in the business to business (B2B) and business to government (B2G) markets and is much more rarely seen in the business to consumer (B2C) market. Technology tends to play a rather different role in the B2C (and indeed consumer to consumer (C2C)) market by enabling the sharing economy (see below). While we don't know for sure, we think that this is because businesses are more likely to make financially motivated decisions based on total cost of ownership (TCO) with service level agreements (SLAs) in place to ensure that any devices are supported and maintained adequately.

Government is also  moving towards a greater emphasis on TCO with the help of schemes to encourage sustainable procurement like the DEFRA-led Government Buying Standards (GBS). On the other hand, it seems that consumers are currently more likely to purchase technology equipment on more emotional or cultural grounds and that owning the actual device is still important to many. Studies of consumer behaviour by the CBI, by NESTA and by DEFRA regarding the purchase of electronic equipment suggest that environmental performance is still low on the priority list at point of sale.

Secondly, the many examples of circularity existing in the technology sector (and widely cited in the literature) are not the result of a desire to achieve more circular business models. They are usually the result of pursuing commercial opportunities opened up by the emergence of new technologies. The need to compete in a global marketplace is an additional driver: companies in regions with relatively high manufacturing costs cannot compete on commodity prices alone and therefore have to provide value-add - for instance in the form of "service wrap"[12]. So while they provide excellent examples of circular thinking and best practice, the initial driver may have been more economic than environmental.

## Barriers to re-use

Moving to a leasing or service delivery model is not the only answer. In some cases the best approach remains make-use-re-use-recycle followed by re-make. There has been a very strong policy focus on recycling but a much weaker focus on re-use.  In fact the policy emphasis on measuring recycling input (the volume or weight of "waste" collected, rather than the amount and quality of recyclate created) can discourage re-use as producers are obliged by legislation to meet their recycling targets or make up the difference. Some observers report that these targets result in perfectly reusable appliances being dismantled and the materials shredded in order to make up the required recycling weight[13]. This compares poorly with practices in other regions (see box below).

### Learning from Japan: recycling value rather than volume.

In the UK we are very accomplished at recycling volume rather than value. WRAP have identified that few UK companies are exploiting the handful of niche domestic markets (such as single polymers from WEEE derived plastics). Furthermore, whilst recovery of the key material streams is very effective in terms of the proportion of materials recovered UK costs are higher than overseas. There are interesting variations in approach to WEEE recovery across the globe. For example the focus in Japan is more on recovering embedded value rather than churning volume.
The Japanese system has seen considerable investment in recycling infrastructure. This is driven by the need to capture strategic materials rather than meet weight-based targets.  Through improvement of recycling techniques Japan expects to cut annual demand for dysprosium by 200 tones and neodymium by 1,000 tons. This approach is well suited to an economy that produces high value, low volume goods. This approach would serve the UK well particularly given our high-end manufacturing base. Source: Kyocera, Project Recover and Unbuild: February 2014

While online auction sites such as eBay have been very effective in creating a thriving re-use market and Freecycle allows goods to be distributed to where they are needed rather than being sent for disposal, these offerings are not the result of policy direction or policy measures – they have evolved because digital applications have made a low cost, peer-to-peer market viable.

## A refurbishment market

There is a commercial opportunity in the UK for refurbishment and remanufacturing that is not being fully exploited. While the vast majority of ICT equipment is manufactured in the Far East, it does not necessarily follow that remanufacturing should take place at the point of manufacture. The circular economy has the potential to re-boot the UK's manufacturing sector. For those global brands that have no domestic manufacturing in the UK, repair and remanufacturing services can be outsourced to a partner.

## Creating a market for recycled material

Despite the strong policy focus on recycling there is not enough emphasis on creating a viable market for recycled material. This has been a particular problem recently for plastics recyclers. The fall in oil prices has made the recycled market temporarily unviable because the commodity price for virgin plastics has dropped so significantly. Companies have also explored the use of biodegradable alternatives but early experiments demonstrated that in hot or humid environments the rate of biodegradation was such that the life expectancy of the device was severely truncated. Potential problems have also been identified when biodegradable plastics are introduced into the waste stream where it may be difficult to separate them from other recovered plastics. Another example relates to waste heat, where re-use policies are actually in place: planning regulations now require data centre operators in Docklands to make their waste heat available for community or district heating schemes. Operators have complied but as yet no demand has been identified for the waste heat.

## Regulatory barriers to using recycled content (secondary raw materials)

The number of restricted chemicals (banned or strictly limited in products placed on the European market) is growing all the time as the scope of EU chemicals regulation increases. This presents a significant challenge for recycling or reusing products manufactured before the restrictions were put in place because they cannot legally be sold.

These regulatory approaches also prevent the widespread use of recycled plastic in products. This is because the chemical constituents of virgin feedstock can be carefully controlled but the same is not true for recycled feedstock, and it is prohibitively costly to test plastics for chemical content at point of recycling. For manufacturers to be confident that new products comply with chemicals legislation, it is safer to exclude recycled materials from the manufacturing process.

In the past some plastic material makers developed recycled material feedstock (i.e. new plastic raw material from plastic derived from end of life electronics and other products) and promoted this as 'RoHS compliant certified' recycled material. While this in theory should be a desirable, high-grade product for component and device manufacturers, the compliance is only valid at time of sale. This is because new SVHCs (Substances of Very High Concern) are added every six months under REACH[14] regulation which makes it impossible to supply and guarantee a grade of raw material that will meet future industry demands. Manufacturers are effectively having to try and hit a moving target.

The issues are not limited to regulation. Several observers commented that the requirements of the (voluntary) EU Ecolabel for TVs have forced them to stop using recycled plastic if they wish to retain the label.

## Case Study: Panasonic and PETEC – leading the way in high quality recycling

In Japan, Panasonic directly owns and operates a recycling facility, Panasonic Eco Technology Centre (PETEC for short). http://panasonic.net/eco/petec/ PETEC was opened by Panasonic in 2001 to meet the requirements of the Japanese equivalent of WEEE (Home Appliance Recycling Law). The facility aims to achieve high quality recycling and operates more as a reverse factory than a traditional recycling facility. Since starting operations PETEC has recycled over 11 million products, producing enough steel to make 228,000 new cars, and enough aluminium to make 140 new aeroplanes.

Plastics have been particularly challenging as European legislation provides no exemption from chemical regulations for recycled materials. For this reason, shredder residues have historically been discarded or used as fuel. PETEC has been able to develop technology capable of sorting three major types of resins: polypropylene (PP), polystyrene (PS), and acrylonitrile butadiene styrene (ABS) with an accuracy of at least 99%. This is achieved using Panasonic's original near-infrared identification technology which not only enables the sorting and recovering of single resins but also detects specific hazardous substances and removes them during sorting. This keeps the substance content significantly lower than regulated by stringent European legislation.

The successful establishment of PETEC depended on the enlightened approach to waste electrical equipment legislation in Japan, aided by strong industry-government cooperation. The resulting legislation recognised the resource potential of WEEE in terms of both commercial and societal benefits and is an example of how closed loop manufacturing can be achieved, and one that European legislators could learn from.

One solution might be to grant an exemption for recycled material from chemical content provided that it is below a certain percentage. This might facilitate the increased use of recyclates and avoid any risk of the very undesirable consequence of creating a loophole for avoiding chemical regulations.

## Limitations of WEEE on IT Asset Recovery:

The development of the IT asset recovery industry demonstrates that there is commercial value in end of (first) life B2B ICT equipment that is not realised by the WEEE compliance system. B2B compliance schemes incur costs for both the "producer" for membership (of the scheme) and recycling and the end-user for transport to the recycling centre. Yet IT asset recovery companies manage to either pay the user for the redundant kit or collect it free and generate sufficient revenue from the sale of second life devices, viable parts and discrete materials recovered through disassembly to either generate profit or contribute to a charity or social project. As a result, the amount of equipment processed through B2B compliance schemes is falling to unsustainable levels as users consider them inferior from a cost perspective. Considering that they also operate further down the waste hierarchy begs the question of whether such schemes are necessary and why B2B EEE is counted in setting a member state's WEEE targets.

## Circularity: a constraint on innovation?

While there are plenty of examples of circularity creating new opportunities for innovation there are certain circumstances when the reverse could happen. For instance, while in general greater modularity and standardisation are good things, in areas where technology is developing rapidly, standardising too early can act as a barrier to innovation. Batteries are a case in point – a few years ago there were moves within SG5 of the ITU (International Telecoms Union – a UN derived standards body) to standardise mobile phone batteries. These were resisted on the basis that competition on battery performance was driving relevant R&D which in turn was very effective in improving efficiency. Standardising batteries at too early a stage effectively freezes that all-important technological evolution and constrains innovation. In fact, had these moves been carried out, batteries would be a generation behind their current iteration. It is a very tricky balance to maintain.

# Applying circular economy thinking: digital device case studies

Let's have a look at how circular economy applies  to different digital technologies and the degree to which a circular approach has already been adopted, the scope for applying circular economy thinking and some of the implications. We focus on five areas: printers, mobile phones, TVs satellites and servers. The particular hardware devices that have been chosen represent a range of characteristics both in terms of size and complexity and in terms of customer or user.

## Printers

Printers make a particularly interesting case study because printers span both the business and consumer markets, with very different types of device and business model applied respectively. Although there is an area of overlap, simplistically speaking, printers aimed at the business market are large, complex, multifunctional devices that lend themselves well to being provided under a service delivery model where the manufacturer or service provider retains ownership of the device and provides consumables and maintenance under a service level agreement. At the consumer end the picture is very different, both in terms of printing technology and business model, where products tend to be discounted at point of sale in order to compete on price points and leasing is not a recognised route to market.

A number of printer manufacturers provide a complete remanufacturing service where they strip the machine and re-fit it. Current legislation creates a Catch-22 situation because a printer cannot be issued onto the market as an "as-new" device unless it meets current ROHS[16] requirements and remanufactured devices then have to be listed under their original serial numbers as second hand, when in fact they present all the same technical and physical capabilities – and guarantees - as new devices. In the past some government procurements have actually excluded the use of such devices, but the situation is improving.

## Business models

It is worth mentioning that service delivery models within the printer market are themselves evolving. While the most familiar model is a movement from the supply of printers to providing the service of printing – or "managed print services" with guaranteed service level agreements, this has for some evolved into document management and for others it has evolved yet another stage into information management. The result is a spectrum of services in which the product itself plays a smaller and smaller commercial role. At the same time the incentives to make that product reusable are becoming stronger because it remains the property of the manufacturer or provider.

As mentioned above, the printer manufacturing industry includes a full range of business models: some companies are still focused almost exclusively on manufacture and others have undergone a business transformation into information management providers.

## Printer cartridges[17]

There are several observations to make on printer cartridges. Some laser printer companies like KYOCERA Document Solutions have moved away from the composite cartridge and designed its key components permanently into the print engine so that the consumable contains only toner. In general, though, large print cartridges for business laser printers have long been cycled between customer and provider.

At the consumer end, dominated by inkjet technology, cartridge recycling is a purely voluntary affair, although the inherent value in the cartridge remanufacture market has generated incentives for consumers to send their used inkjet cartridges for recycling. While cartridge remanufacture can extend the life of an inkjet cartridge, the cartridge itself can only withstand a couple of remanufacturing cycles before it becomes unusable. Cartridges cannot be cycled indefinitely and the remanufacturing industry, therefore, relies on a steady stream of new cartridges coming on the market from the original equipment manufacturers, so this business model can never be truly circular.

### Case Study: HP Closed Loop Cartridge Recycling

HP, a major print cartridge manufacturer, has implemented a closed loop approach to cartridge manufacture and is now making cartridges from recycled PET (RPET) and recycled polypropylene (RPP). Polypropylene is used in a significant percentage of HP's inkjet supplies. This new initiative became fully commercialised in early 2014, having started in 2010. The RPP programme combined with the existing RPET initiative has led to more than 75% of original HP cartridges containing recycled plastic. In addition, 24% of HP LaserJet toner cartridges contain recycled plastic. Through this process, HP has kept 566 million cartridges, 498 tonnes of polypropylene hangers and 2.5 billion post-consumer bottles out of landfill. See: www8.hp.com/us/en/hp-information/environment/hp-closed-loop-ink-cartridge-recycling.html#.VWOm-e9FBMs

## Mobile phones

Mobile phones have not yet moved to a full service delivery model to the extent that we might have expected (in which the phone remains the property of the company supplying it, and not the consumer). And while there is clearly a demand for "second life" mobile phones there are some significant barriers to cross before we area likely to see a seamless circular market. The most problematic, though perhaps not the most obvious, is that if a phone is intended to be retained by the manufacturer or supplier at the end of contract and then refurbished and re-issued, for that business model to work the provider has to be able to anticipate the price that the second life phone will attract up to two years ahead. At the moment it would be challenging to predict prices as little as two months ahead and a change in just a single factor – such as market, technology or fashion – could make a nonsense of any predictions. To deliver a fully service based business model the manufacturer's relationship with the consumer will also have to accommodate new aspects such as the credit rating of that consumer.

A second problem is that there is frequently an intermediary between the manufacturer and the phone user. The phone has value so a market has been created and this means that the manufacturer loses control of the device. A number of other practical barriers are cited by manufacturers, including the tendency for consumers to take less care of devices that they don't own. This ongoing debate is attracting considerable attention from stakeholders.

### Case Study: Mazuma Mobile

Mazuma Mobile is an online mobile phone re-use and recycling service allowing consumers to unlock the cash value of their mobile phones – offering same day payments. If necessary, the handsets are refurbished by an external partner, and then sold to emerging markets and to insurance dealers and retailers in the UK. The majority of phones received can be re-used, provided they are refurbished. Phones that do not work are recycled for secondary raw materials.

## Cloud based service delivery

That said, the trend towards cloud services may change all this. If all content is stored and accessed through the cloud, the device itself becomes much less important in its own right. The consumer's individual log-in will be much more important in terms of accessing services than the type of device he or she uses. This has far reaching implications – in theory it should encourage longevity because older devices can be used to access content and services, so the upgrade cycle is broken, and devices will also have much more value for second use, because they will not be obsolete.

## Service support

In the past customers have sometimes struggled to repair devices easily and often do not want to send their phone off for repair because it has become such an integral part of their daily life. Companies are now setting up on-the-spot repair and service centres so that consumers can have their device repaired while they wait (see case study).

### Case study: Samsung Repair Centres and Smart Tutor app

Samsung UK has the strategy to bring customer support interaction closer to our customers by providing strategically placed face to face, Support Centre locations across the UK within easy reach of our customers. These repair centres offer full-on site repair facilities for all Samsung smartphones and tablets and are open for business customers and the general public. All repairs are carried out by fully trained engineers, technicians and support staff using genuine Samsung parts, which are both in and out of warranty, hardware and software faults. All repairs are tested to Samsung standards and issued with a 90 day warranty. However, increasingly a large number of repairs can be fixed remotely. Samsung research found that 30% of all repairs in support centres could have been fixed by remote management support. The innovative Samsung Smart Tutor app was developed to give customers dedicated support from a qualified expert who can check devices remotely to examine and improve performance. It also provides a great opportunity to educate customers on the devices new features.

## Modularity

There has also been a lot of focus on the scope for reusing mobile phones (Ellen MacArthur foundation reports 1 and 3, and the 2015 Green Alliance report on Smart phones – see bibliography). In January 2015 Google announced that it will be launching a modular smartphone later in 2015 which has garnered attention (see www.projectara.com). It will be very interesting to monitor how this product is received and whether it can drive the market. Some manufacturers are concerned that moves to modularity will encourage a grey market in inferior parts and counterfeiting that could compromise performance and invalidate guarantees. There are also concerns that a more modular approach might result in small items of WEEE being disposed of through household waste instead of via the appropriate recycling routes. As yet, there is little evidence that consumers want greater modularity - consumer demand is currently still driving premium quality, slim-design products across the bulk of the market. Smaller companies such as a Finnish firm called Circular Devices have produced modular phones like the Puzzlephone – www.puzzlephone.com which is designed to last at least ten years and the FairPhone is another approach that aims to place control and choice in the hands of the device owner - www.fairphone.com. However, these are relatively minor players in the market at the moment and it is important to emphasise that initiatives by global scale manufacturers are still in the project phase.

## TVs

TVs present an interesting conundrum for circular economy thinkers. 20 or 30 years ago, TV hardware was usually accessed via leasehold agreements and rented from companies like RadioRentals on the basis of monthly payments. Content was all delivered as broadcast on a "one-to-many" basis. Now the situation has reversed. Consumers usually own their TV hardware and the TV rental market seems to be largely a historical artefact. Moreover, a TV is a more emotional purchase than, say, a fridge or a washing machine, and environmental credentials usually rank below performance. When it comes to content, far more TV content is now delivered through an "on demand" model with much being accessed over the internet. This is what consumers demand but the transition is worth exploring further because delivering video content on an individual basis over internet or wireless is less energy efficient than broadcast. In this specific circumstance the service delivery model may not lead to energy savings.

That said, service delivery can drive circular practice through the provision of "bundled service packages". WRAP is exploring models where a single supplier, who manufactures across both white and brown goods ranges, can offer a complete service package of all household electrical and electronic equipment: washing machine, fridge, TV, etc. The consumer pays a monthly hire charge that covers all aspects of servicing, repair, replacement and upgrade. This bundled approach may include advisory services: communications providers like O2 have "O2 Gurus" in their retail outlets freely available to help people understand and make best use of their devices and the same can apply to household devices. Over time the supplier builds up an understanding of the consumer's unique needs and the advice becomes more bespoke.

## Satellites

Service delivery models are being rolled out successfully in the space industry, for instance the provision of a secure satellite communications service to Government (Skynet 5). However, applying circular economy thinking to satellite hardware is a major challenge for the space industry. On the one hand the potential benefits are significant:  once in orbit a satellite has access to free, unlimited solar power. Compared to terrestrial equivalents, satellites are exceptionally energy efficient - a satellite launcher emits less CO2 than a single transatlantic flight[18], and is a one-off cost – once the satellite is in orbit, it runs almost entirely on solar power – only requiring fuel if its position needs to be adjusted. Moreover, some large launchers burn (liquid) hydrogen generated from solar power and at launch sites such as Kourou, the energy required to reform ethanol into hydrogen and oxygen and its refrigeration to liquid fuel is from a hydroelectric source and the ethanol is produced from sugar cane. When compared to terrestrial alternatives, satellites can deliver orders of magnitude energy savings particularly in the areas of communications and broadcast. On the other hand, some materials are lost during launch (about 10% of a single aircraft by mass) and while the satellite may well last for 20 years, at the end of its life the hardware is currently not recovered - it is placed in a relatively harmless orbit known as the “satellite graveyard” where it will remain indefinitely. That said, the industry is currently investigating ways to reclaim spent satellites, so this situation is likely to change.

## Servers

Servers are computers that provide IT functions that are remote from the user. Servers may form part of a “distributed” computing environment where they are within an office network located on the business premises, or they may be consolidated or “co-located” in purpose built data centres and provide IT services from anywhere in the world. Servers are usually a business to business purchase and purchasing decisions are likely to be made on the basis of computing performance and energy consumption. Because Moore’s Law applies to the energy performance of chips as well as processing power, (essentially this means that the energy used to process a given amount of data halves about every 18 months) the energy performance of servers changes very rapidly and because they are active constantly it makes economic and environmental sense to upgrade or “refresh” them at regular intervals.

Companies that run ultra large, highly commoditised and very efficient data centres tend to refresh their servers more frequently – anecdotal evidence suggests as often as every 12 months in a few cases, in order to save energy. This does not mean that they recycle their entire server estate at this frequency:  their servers are bespoke so that only the core components need to be replaced and the shell and longer lasting components are re-used. Some computer manufacturers are implementing closed loop recycling. See the Dell case study.

There has been a tendency, particularly in government contracts, to sweat assets and try to extend the life of servers in government owned or leased data centres. For the reasons given above this tends to be counterproductive[19]. However, one of the most frequent problems associated with the government server estate is data security and data removal:  it is frequently the case that government material has to be shredded and destroyed rather than being disassembled and recycled because of the associated legal and procurement constraints. Sometimes this is necessary; sometimes it is not.

### Case Study: Crown Hosting:  Data centres as a service to the public sector

Crown Hosting Data Centres Limited is a joint venture between the Cabinet Office and Ark Data Centres that delivers increased efficiency, improved value and transparency of data centre hosting utilisation across all of the UK public sector. The Crown Hosting Data Centres catalogue of simple-to-buy services substantially reduces the operational risk and overall cost of public sector departments and organisations. The service based approach, where government customers can buy secure data centre hosting, connectivity and other services on demand on a pay-as-you-go basis, will deliver significant environmental and cost benefits. There is no longer any need for public sector bodies to maintain multiple individual sites that are frequently underutilised and inefficient.

## Case study:  Closed Loop recycling:  Dell computers

When something gets recycled, a common misconception is that it gets easily and immediately turned right back into the same thing it was. The reality is many materials are “downcycled,” meaning they are converted into new materials that are usually of a lesser quality or reduced functionality. Closed-loop systems, however, recycle and re-use materials repeatedly. This reduces the need for virgin materials while avoiding the creation of waste.

A key component of closed-loop systems is the idea that recycling comes from the same product or same industry. In the case of Dell, this means recycling computers back into new computers. The Dell closed-loop system uses plastics derived from the computers that the company takes back.

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For further information see bibliography.

### How Dell does closed-loop recyling

# Avoiding pitfalls

## How do we identify and avoid potential pitfalls?

Moving to a circular economy will require commitment from all stakeholders and a vigilant outlook for pitfalls.  With the exception of work from Green Alliance, most recent circular economy publications have a strong emphasis on how a circular economy can work and only a very limited focus on identifying, assessing and overcoming barriers to delivery. In reality potential pitfalls are legion and fall across many categories:  if they weren't, then faced as we are with the combined factors of resource constraint and business opportunity, we'd be there already. We think that the following three will be an interesting place to start:

1. Assumptions about technology

2. Culture and social norms

3. Policy frameworks

## Assumptions about technology

We are in an era of disruptive technological development, highly complex devices, systems and networks and astonishingly dynamic and complicated supply chains. While business models are more agile and adaptive than they have ever been, it is easy to make assumptions. We have so far come across the following unhelpful assumptions:

- Technology companies can afford to make leaps of faith into new business models.
- Digital devices can be treated in the same way as white goods.
- What has been true for digital devices over the last five years will continue to be true over the next five.
- Modular devices will automatically appeal to consumers.
- Digital technology businesses are impervious to changes in commodity pricing.
- Innovation in technology works best when artificially constrained by policy.

## Culture and social norms

Behavioural change takes a long time – usually a generation. Tackling environmental challenges requires far more rapid and radical behavioural change. Economic incentives are one way to encourage behavioural change but taxes are not always effective and incentives can be expensive (e.g. FITs – Feed-in-Tariffs). Social incentives, however, can be fast and powerful drivers of behavioural change. A social incentive is something that genuinely changes social norms so that a change in behaviour is needed in order to be socially acceptable – and socially acceptable could mean ethical, smart or cool – or all three. So the Zipcar becomes the cool car, instead of the Humvee.

We mentioned the need to overcome inertia in implementing viable solutions and this applies to consumers as well as to businesses. There are currently viable options for consumers to recycle their devices or make them available for second use and at the same time unlock any residual value in them. While a significant number take advantage of these approaches, the majority do not and we need to understand why not. Digital device producers have made some routes available through takeback schemes, others are provided by new market entrants, so the lack of take-up is not due to the absence of a viable business model that would deliver value all round. This problem of inertia is one that we need to work together as stakeholders to solve.

## Policy Frameworks

Getting the policy landscape right is one of our biggest challenges and there are multiple examples of disjointed, over ambitious or poorly implemented policies creating perverse incentives. We currently see a disproportionate focus on waste alone and we need to see policy addressing some of the critical disconnects which include encouraging market pull for second hand devices, whether refurbished or simply re-used and for secondary raw materials (ie recycled materials) and overcoming inertia in implementing circular economy measures.

# Conclusions & recommendations

The circular economy is a relatively new construct but circular economy practices are well established within the technology sector. As mentioned, these have been driven by commercial opportunity and the need to compete in a global market place characterised by variations in labour costs. Nevertheless, the opportunities for implementing circular economy thinking and practices are under-exploited.

This renders the technology sector a useful case study for examining barriers and drivers. Even a cursory look at some successful approaches reveals some interesting patterns. Circular economy business models are applied most successfully in business to business transactions, where decisions are made objectively on total cost of ownership, where service delivery approaches work well and the producer can remain in control of the device throughout its life, and where the interests of supplier and customer are aligned.

Individual consumers tend to be more emotional regarding their digital devices and prefer an ownership rather than a leasing model. The speed of technical development results in both fashionable and functional obsolescence which reduces the life expectancy of portable devices. A complex marketplace involving intermediaries tends to take devices out of the control of manufacturers. This may all change: as content is accessed increasingly from the cloud, the device itself may become less important. Moreover, some of the most disruptive new circular business models where access is replacing ownership do involve consumers, through the sharing economy.

## What can technology businesses do?

The successful implementation of a circular economy is a change management programme of truly seismic proportions. However we do not have to look at many circular economy case studies before a common theme emerges: the use of digital technologies underpins many of them. The most obvious is the provision of an electronic platform or portal that aggregates demand or can process multiple low value transactions cost effectively. Other platforms such as those that enable Zipcars are entirely dependent on innovative software applications. Advanced tracking and logistics enable resources to be traced and tracked through the supply chain, the use phase and right through to disposal. RFID and sensor technologies allow maintenance teams to detect wear and they predict component failure intelligently so that parts can be replaced when necessary.

### Recommendation 1: Adopt innovative business models

Many commentators suggest that technology is a critical enabler of more widespread moves to circular practices across the wider economy and is leading the way in many areas by exploiting circular economy opportunities. However, what is often surprising is that while established technology companies are extremely innovative when it comes to devices, the physical characteristics of the supporting infrastructure and digital technology, some observers have commented that they are sometimes less innovative when it comes to business processes. It is frequently newcomers to the market who exploit business opportunities within a single supply chain – for instance Mazuma Mobile or Cartridge World. This suggests that in some cases the original equipment manufacturer is missing an opportunity and has either been more cautious or less agile in adopting new business models. If an external organisation can identify and monetise value from a third party supply chain then an even better opportunity should exist for that third party. So there is exciting scope for technology businesses to be as innovative in their business models as they are with their devices and systems.

### Recommendation 2: Provide customers with easily accessible information regarding repair and recycling options

There is also scope for technology businesses to do more to ensure that consumers can repair their devices easily – or at least make them aware of the options open to them. Many companies already provide on-the-spot repair and maintenance for digital devices but this service is not provided industry-wide and in some cases consumers are simply not aware of these services. Much could be learned from the way these approaches are implemented in Japan and Korea. Many companies also operate take-back schemes but adoption is patchy. There is also the opportunity for manufacturers to help consumers understand how to use their devices in an environmentally appropriate way.

## What can policy makers do?

### Recommendation 3: Focus on re-use, not just waste

The policy focus is currently inconsistent and the disproportionate focus on waste is in some cases hampering the implementation of circular thinking. Policy makers must therefore give equal consideration to encouraging re-use and in creating a market for both second hand and remanufactured devices and for recyclates. Policy makers need to ensure that geopolitical concerns about retaining raw materials within nation state boundaries do not run counter to the obvious need for resources to be directed to the point of manufacture.

### Recommendation 4: Remember the consumer

Most importantly, policy makers must not forget the consumer as a critical stakeholder in any dialogue regarding the circular economy. Digital technology businesses, especially those providing consumer electronics, are extremely focused on and responsive to consumer demands and requirements. Leaving the consumer out of the circular economy debate and failing to take account of consumer preference and consumer behaviour are omissions that are likely to be fatal to its successful implementation. Consumer facing businesses can help here because they have invested significant resource in understanding their customers.

### Recommendation 5: Use government procurement to promote circular economy

Government is the UK's single largest customer of ICT and as such can be a powerful instrument for change. Where reasonable, techUK supports the use of environmental and social criteria in public procurement as a way to achieve market transformation towards the circular economy. Green public procurement approaches and Government Buying Standards (GBS) can be helpful here but in many cases implementation is patchy and procurement is still too dominated by initial price rather than whole life costs[21]. Nevertheless there have been some very encouraging moves including the new Crown Hosting approach (see case study). A multitude of purchasing specifications are being developed for the same product categories and so it is important that these measures are introduced with coordination, harmonisation and market assessment.

## Recommendation 6: Overcome inertia in policy implementation

Just as for energy efficiency, implementing circular economy thinking will deliver business benefits and in many cases should be a no-brainer. But there is inertia at the point of implementation just as sometimes there is inertia in implementing efficiency measures in businesses or homes. How we overcome this inertia without imposing burdensome policy on businesses will be an interesting challenge – we would rather not repeat the mistakes of previous policy measures where companies have to spend so much resource jumping through regulatory hoops to ensure compliance with complex legislation that the effort actually erodes the resource they have available for investing in efficiency measures or implementing other best practices. Many businesses cite the CRC (Carbon Reduction Commitment) as a case in point where the carbon tax payment is often made from the very budget that would fund investment in efficiency measures[22]. This needs to change.

## Recommendation 7: Encourage market pull for non-virgin products and materials

A circular economy cannot work unless there is market pull for non-virgin products and materials. Most successful second life markets are entirely voluntary and remanufacturers have been placed at a competitive disadvantage by inappropriate legislation. This disjointed approach not only adds needless complexity to the policy landscape but generates perverse incentives that discourage the right behaviours[23].

## Recommendation 8: Ensure regulation does not inhibit the circular economy

The repair and re-use of electronic equipment is an integral part of the circular economy. To make repair and remanufacturing economically viable electronics companies use regional repair facilities, often co-located with production sites. As the supply and production chains of the electronics industry are global, so is repair and remanufacturing. While the electronics industry agrees that it is vital to take action to stop illegal shipments of e-waste, it is also important that regulations do not prevent the legitimate movement of materials and that they recognise testing, repair, refurbishment and re-use to be essential practices that extend the useful life of products, reduce e-waste generation, conserve material resources and advance sustainable business practices in line with circular economy thinking.

## Recommendation 9: Broaden the agenda to include commercial considerations

Despite the fact that the campaign for a circular economy has to date been largely driven by the environmental agenda, many if not most of the case studies that we see of the successful implementation of circular thinking have been driven by commercial opportunity rather than by environmental constraints. The policy agenda should be framed by opportunity not by constraint.

## Recommendation 10: Recognise the opportunity for reform

It is clear that at European level we are poised at a pivotal moment where the EU has the opportunity to implement significant reform where a truly joined up approach could address and align many of the dysfunctional, duplicative or contradictory policy measures that currently add to the burden of compliance for business without achieving their policy objectives. We are encouraged by the fact that this agenda is now under the leadership of DG GROWTH.

## Recommendation 11: Do not turn the circular economy into an end in itself

Policy objectives should focus on the positive environmental and economic outcomes that a circular economy delivers, rather than on the circular economy concept itself. For instance, materials do not need to flow around a circular economy – a successful outcome would be where materials stay exactly where they are because (even if they are re-purposed) they continue to be valued.

## Recommendation 12: Ensure a more robust dialogue with the technology industry

Observations of the recent European Commission circular economy consultation suggest that there are flaws with the approach and that a more robust dialogue is needed (in other words a transparent exchange of views about the quality of the policy dialogue itself). If consultations ask the wrong questions then policy makers are unlikely to be properly informed. Furthermore, the European Commission and the UK government should recognise the important steps the technology industry has taken to move towards resource efficient business models, and work with the technology industry as a strategic partner.

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1. Principles are things like minimising waste, minimising energy use, optimising materials, minimising material flows, optimising capacity, minimising pollution. Extendinbg product life might seem like a principle but actually it should be an efffect. In some cases a short product life might work equally well. By processes we mean the way we do things. Business models are processes so applying a service delivery model may drive circularity far more effectively (by aligning the interests of customer and supplier) than, say, regulating minimum standards for products. The process of "servitisation" is an important contributor to circularity.
2. ERP is the Energy Related Products Directive (previously EUP), WEEE is the Waste Electrical and Electronic Equipment Directive. Chemicals regulation includes ROHS and REACH (which control use of chemicals in products) among others.
3. The circular economy package under the previous European Commission administration included proposals to increase recycling targets to 70% by 2030, with higher thresholds set for packaging materials, to introduce a ban on recyclable materials going to landfill by 2025 and to reduce the amount of food waste (though proposals to implement the latter in the UK were deemed uneconomic). Recent studies carried out on behalf of the Commission identified sectors in which a move to greater circularity would be beneficial and also identified a role for policy instruments. See: http://ec.europa.eu/environment/circular-economy/pdf/circular-economy-communication.pdf
4. See comment on http://www.euractiv.com/sections/sustainable-dev/eu-tables-circular-economy-package-zero-landifll-goal-303259
5. European Commission Directorate-General (DG) for Internal Market, Industry, Entrepreneurship and SME
6. This is called "closing the material loop"
7. The Department for Environment, Food and Rural Affairs
8. The Department for Business, Innovation and Skills
9. Growing A Circular Economy: Ending the Throwaway Society. See: http://www.publications.parliament.uk/pa/cm201415/cmselect/cmenvaud/214/21402.htm
10. End user devices are things like phones, laptops, TVs – equipment used by consumers and businesses as opposed to the underlying systems that deliver them like communications infrastructures.
11. See http://www.rolls-royce.com/customers/civil-aerospace/services/totalcare.aspx#overview
12. Service wrap just means adding a layer or layers of service to a product. If someone sold you a dog they might add some obedience training classes as an additional service. Buying the dog and classes as a package is a service wrap, which would help you and the dog have a happier life together.
13. See http://kyocerablog.co.uk/category/sustainability
14. Registration, Evaluation, Authorisation and Restriction of Chemicals
15. Waste Electrical and Electronic Equipment
16. Restriction of Hazardous Substances Directive
17. Printer cartridges will come under WEEE legislation in 2016
18. Source, Case4Space, additional data provided from pers. comm., December 2007
19. Servers, or rather the processing chips that do the work, have improved efficiency a million fold in the last 30 years. So the energy used to process a given amount of data has decreased by six orders of magnitude. Since servers are on 24x7 it makes sense to refresh frequently to minimise energy consumption in the use phase, which is very dominant. See: High Tech: Low Carbon or look at relative server efficiencies in: http://www.bcs.org/upload/pdf/eu-coc-best-practices-iso-iec-30134.pdf
20. Zipcar is part of the "sharing" economy where resources are shared and used on demand rather than owned. Individuals or companies join for a modest fee and can then hire cars on an hourly or daily basis. Zipcar currently has over 900,000 members and 10,000 vehicles. Members use a mobile app to reserve cars, locate them using their mobile phones and unlock the car (keys are inside) with a card. Reservation and hire charges cover fuel, parking, insurance, and maintenance.
21. Otherwise known as total Cost of Ownership or TCO
22. See DECC's 2015 report evaluating the CRC where this shortcoming was mentioned several times: https://www.gov.uk/government/publications/evaluation-of-the-crc-energy-efficiency-scheme
23. Because the suitable threshold values of the minimum content of recycled plastic differ very much depending on the product category, such requirements need to be discussed individually as a product-specific measure, not as a horizontal measure.

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