This briefing explores the challenges associated with meeting our resource demands; introduces the concept of a ‘circular economy’ where materials are retained in use for as long as possible; considers the opportunities and barriers associated with pursuing such an approach and sets out some approaches and interventions that have been proposed to support the development of a circular economy.

The briefing also provides an update on Scotland’s approach to resource efficiency and waste over the past decade and summarises some of the opportunities in Scotland that could support the development of a more circular approach to resource use in Scotland.
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EXECUTIVE SUMMARY

Natural resources play a central role in the provision of our energy, food and product demands, and absorbing the pollution we generate. Over the past century the use of materials to meet global construction, energy, mineral and food demands has increased 8 fold.

The implications of our resource demands have been the subject of considerable debate for centuries, with concerns around food shortages and associated starvation, the exhaustion of supplies of critical resources and the environmental impacts of resource extraction and use. Recent debate has focused on the challenges and complexities associated with meeting resource demands in the face of multiple constraints including economic, political and environmental considerations.

In seeking to address some of these challenges a number of approaches have been pursued, including efforts to protect the supply of key materials, support sustainable raw material supply and boost resource efficiency and recycling. More recently a number of individuals, organisations, and businesses have been advocating the need to move towards a circular economy - European Commissioner Potocnik has set out his strong support for such a move. In a circular economy, rather than natural resources being extracted, transformed into components, assembled into products and then discarded, resources would be kept in use for as long as possible. This approach is supported by designing waste out so that materials and energy are optimised and goods and components reused, repaired and remanufactured.

Benefits and opportunities associated with adopting a circular economy range from financial savings associated with using resources more efficiently, labour opportunities arising from reuse, remanufacture and refurbishment of goods and environmental benefits resulting from a reduction in landfill and in climate emissions associated with raw material extraction, processing and transport. A number of barriers and challenges have also been identified. These include the potential impact for those companies with a business model that is predicated on producing disposable goods, limitations on the leverage that smaller companies may have in seeking to influence their suppliers, procurement processes that favour products with a lower initial capital and are discounted over shorter time periods, and the extent to which external environmental costs are reflected in the price of a product or service.

Much of Scotland’s focus on resource use over the past decade has been directed at increasing levels of recycling and reducing Scotland’s reliance on landfill. Since the publication of Scotland’s Zero Waste Plan in 2010 the Scottish Government have consulted on further measures to reduce waste and use materials more efficiently. In 2013 the Resource Efficient Scotland Programme was established to provide advice and support to businesses, third sector and public sector organisations on resource efficiency. The Scottish Government have also set out their support for moving towards a more circular model of resource use and commissioned a study to explore the challenges and opportunities associated with pursuing a circular economy in Scotland.
RESOURCE USE AND THE ECONOMY

Our economies depend on a range of natural resources to make products, meet our energy needs, provide our food and absorb our pollution. In the past century an 8 fold increase in material use (Figure 1) has accompanied a quadrupling of the world population and 20 fold increase in GDP (Maddison 2001).

![Figure 1 The growth in global demand for materials since 1990 (Giga tons per year)](source: Kraussman et al 2009)

The implications of our resource demands have been the subject of considerable debate for a long time. As far back as 1798 Thomas Malthus suggested that unchecked population growth would undermine the ability of the world to provide sufficient food and ultimately result in starvation (Malthus 1798). More recently in 1972 the Club of Rome ‘Limits to Growth’ report used computer models to explore tensions between rapid population and income growth and natural resource and pollution limits. The authors suggested that continued growth of population and resource use would lead to planetary limits being exceeded sometime in the 21st century and that without technical, policy or behaviour changes the economy and population would collapse (Meadows et al 1972). According to the Club of Rome the issues which were the focus of the ‘Limits to Growth’ report are even more urgent and more severe today.

Other studies have warned about the challenges associated with declines in supply of particular resources, for example oil. In 2005 the United States Department of Energy published a report on peaking oil production (Hirsch 2005). The report identified that:

“The peaking of world oil production presents the U.S. and the world with an unprecedented risk management problem. As peaking is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented. Viable mitigation options exist on both
the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking."

"In summary, the problem of the peaking of world conventional oil production is unlike any yet faced by modern industrial society."

Many economists have, however, challenged the idea of absolute resource scarcity and resource constraints on economic growth – noting that market mechanisms would largely deal with scarcities through technical innovations and resource substitutions and pointing to predictions of rising commodity prices or forecasts of particular material exhaustion that failed to materialise (Barnett and Morse 1963, Simon 1981).

Recent studies highlight that constraints on resource use are more complex than physical resource availability alone and reflect economic, political and environmental factors. In a report on minerals and metals scarcity in PwC (2011) note that “Major manufacturing companies consider minerals and metals scarcity as an important issue for their business,” however the report identifies that “Economic and political drivers of scarcity are generally seen as much more important than physical drivers.”

Over the last decade greater attention has also been given to environmental constraints on resource use. The International Energy Agency (IEA) report of 2012 (IEA 2012) noted that US oil and gas production is rebounding as a result of new technologies and that as a result the US is set to become the largest global oil producer by 2020. However, the IEA suggested that the challenge is actually how much of the global oil reserve can be used noting that

“No more than one-third of proven reserves of fossil fuels can be consumed prior to 2050 if the world is to achieve the 2°C goal\(^1\), unless carbon capture and storage (CCS) technology is widely deployed.”

THE “PERFECT STORM”

In 2009 the then Chief Scientific Advisor to the UK Government, Sir John Beddington, warned that the world faced a “perfect storm” of events given the challenges associated with ensuring food security to meet a growing population coming out of poverty while tackling climate change and sustainably managing rapid growth in demand for energy and water (Beddington 2009):

“It is predicted that by 2030 the world will need to produce around 50 per cent more food and energy, together with 30 per cent more fresh water, whilst mitigating and adapting to climate change. This threatens to create a ‘perfect storm’ of global events…”

In a recent assessment of the challenges associated with meeting global demands for materials, energy, food and water McKinsey (2011) highlight that although it has been possible to meet dramatic growth in demand for commodities as a result of significant technical improvements in exploration, extraction and cultivation and the identification of new low cost sources of supply to date, this is unlikely to be a viable response for the future as a result of a number of factors:

- an expected increase in middle-class consumers of up to three billion people in the coming two decades (OECD 2012)

\(^1\) The United Nations Framework Convention on Climate Change (UNFCC) have agreed that the global temperature should not exceed 2°C above pre-industrial levels,
the climate impact of carbon emissions associated with resource extraction and the associated awareness that significant changes will be required if global carbon emissions are to be reduced in line with limiting global temperature rise (IPCC 2013)

the challenges of expanding commodity supply associated with more marginal, challenging and costly extraction (G20 Study Group 2011)

the increased linkage between resources resulting in a shortage in one resource rapidly impacting on other resources e.g. water, food production etc (World Bank 2013, G20 Study Group 2011, IEA 2012).

McKinsey (2011) report that commodity price increases in the last decade have wiped out the declines that occurred in the previous century (Figure 2), and on the basis of current trends prices are set to remain high and volatile for the years ahead.

Figure 2 Global commodity price index 1900 – 2011


EMERGING RESPONSES

Over the past few decades a number of countries have pursued specific approaches to protect the supply of raw materials that they rely on. For example, the Japanese government support particular resource acquisition projects and have provided financial support for mineral exploration and development. Recent investments have included copper projects in Peru and Chile, an iron ore project in Australia and a uranium project in Namibia (JOGMEC 2012). The US Geological Survey has co-ordinated an international project to assess undiscovered global mineral resources (USGS 2013).

In 2008 the European Commission published a Raw Material Initiative (European Commission 2008) communication proposing that the EU agree an integrated raw material strategy based on:

- ensuring access to raw materials from global markets
- providing an EU framework that supports the sustainable supply of raw materials within Europe
• increasing resource efficiency and promoting recycling to reduce the EU’s consumption of raw materials.

Subsequently the Commission published an assessment of 14 raw materials deemed “critical” because of the risk of short supply and particularly significant impacts on the economy (European Commission 2010). In this analysis concerns over short supply of these materials were associated with global production being concentrated in relatively few countries, limited opportunities to substitute one material for another and low levels of recycling.

Under the European Commission’s 2020 growth strategy (European Commission 2010b) seven “flagship initiatives” have been developed to boost growth and jobs. One of these initiatives is the development of a Resource Efficient Europe (European Commission 2011). This initiative notes that:

“….intensive use of the world's resources puts pressure on our planet and threatens the security of supply. Continuing our current patterns of resource use is not an option.”

In recent years momentum for more fundamental changes in the approach to resource use has increased. In their report Resilience in the Round (Aldersgate Group 2012), The Aldersgate Group state that:

“The absolute decoupling of economic progress from resource constraints is one of the greatest challenges of the 21st century.”

A recent briefing paper by Chatham House (Chatham House 2012) echoes this sentiment:

“A fundamentally new model of industrial organisation is needed to de-link rising prosperity from resource consumption growth – one that goes beyond incremental efficiency gains to deliver transformational change.”

In June 2013 European Commissioner Potocnik gave a speech in the Scottish Parliament (European Commission 2013a). In this speech the Commissioner set out his views on the need to reform the current approach to resource use and make a transition to a ‘circular economy’:

“But today we see that pressures on the environment are having a real and increasing impact on the economy. The soft laws of economics are coming up against the hard laws of physics as we hit physical resource constraints. We now start to see that tomorrow's growth will depend on making environment part of our economic policy.

Our old resource-intensive growth model is simply not feasible on this scale and on a limited planet. Many of the resources our economies depend on are already scarce (like energy or some raw materials) and others are limited and vulnerable (like clean water, clean air and nature).

In concrete terms the global competition for resources will mean that we will be obliged to increase resource productivity, particularly in Europe where we are so dependent on imports of materials. But resource scarcity will also mean that we will have to move away from our linear model of resource consumption where we consider it normal to ‘take-make-use, then throw away’….The transition to resource efficiency and a circular economic model is inevitable, particularly for Europe.”
CIRCULAR ECONOMY

The Waste Resources Action Programme (WRAP) define a circular economy as follows:

“A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.”

The concept of a circular economy draws on a number of approaches that have been developed and advocated by various academics and business leaders over several decades including:

‘Industrial ecology’: The idea of industrial ecology was developed in the 1970’s and is based on the premise that considering the flow of materials and energy through industrial processes it is possible to optimise the use of energy and resources, reduce pollution and use the waste from one part of the process as the material for another process.

‘Cradle to cradle’: Walter Stahel began using the language of ‘cradle to cradle’ and ‘closed loops’ in the 1970s and 1980s to highlight how goods and components could be reused, repaired and remanufactured and the employment opportunities that such a closed loop model offered.

‘Biomimicry’: The concept of biomimicry has been coined to highlight the opportunities to emulate processes and strategies used in nature (Benyus, 2002). As an example a study of the cooling mounds of a particular type of termite was used to inform the design of an air conditioning system in a new development in Harare, Zimbabwe. This design resulted in a 90% reduction in the energy used for ventilation in comparison to equivalent buildings (Biomimicry 2013).

In recent years a number of individuals, organisations and businesses including the Ellen MacArthur Foundation, BT and Green Alliance have been developing the case for a circular economy to address the resource use challenges set out earlier, in response to concerns that while major strides have been made in improving resource efficiency, boosting recycling and exploring new forms of energy however far less attention has been directed at designing waste out completely to create a “closed loop”.

The Ellen MacArthur Foundation (2012) note that unlike in today’s economy where natural resources are extracted, transformed into components, assembled into products and then discarded, a circular economy would close the resource loop so that resources were captured and re-used. Where products are made from plant-based materials these would be able to biodegrade into fertilizer. Systems would be designed to reflect high levels of energy efficiency, toxic materials avoided and energy demands met from renewable sources.

Chatham House (2012) have identified several particular components that will underpin a move towards a circular economy and group these as:

- redesign of industrial systems

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2 Closed loop systems are a conceptualisation of a sustainable approach to managing the entire lifecycle of a consumer product, whereby all material not safely consumed in the use of the product is designed to be a valuable input into the same or other processes. Thus, waste elements that cannot be eliminated are either: a) recaptured and reused in the process of making the same or other products, or b) bio-degraded/composted to become inputs to the broader biosphere.
• a cradle-to-cradle approach to production
• changes in consumer behaviour.

INDUSTRIAL SYSTEMS

To achieve high levels of resource productivity requires both efficient technology and structural changes for example to enable the ‘waste’ stream from one factory to be used as a resource elsewhere and to source inputs from sustainable sources.

Such an approach would build on the concept of an eco-industrial park where businesses co-operate with each other to reduce waste and pollution, share resources and link up waste and feedstock. The UK National Industrial Symbiosis Programme (NISP) is an initiative that aims to link up businesses so that a resource that is under used or under-valued by one can be used as an input by a business elsewhere (NISP 2013).

Examples

Kalundborg eco-industrial park, Denmark
In Kalundborg, Denmark waste heat from a coal-fired power station provides heating for 3500 local homes and a fish farm. The sludge from the fish farm is sold as fertiliser. Steam from the power plan is sold to a local pharmaceutical and enzyme manufacturer and the gypsum as a by-product of the power station sulphur dioxide emissions scrubbing system is sold to a plasterboard manufacture (IISD 2013).

Binn Eco Park, Scotland
In Scotland Binn Eco Park in Tayside has been established as Scotland’s first eco-innovation park and plans to be based on three industries – waste and resource use, renewable energy and food production. The site aims to maximise the synergies available for example using organic materials as a feedstock for anaerobic digestion to supply energy and waste heat from different technologies able to provide heating to the businesses on the park and controlled environments for food production.

Fact: Processing food waste in Scotland through anaerobic digestion could produce 1.1 million tonnes of fertiliser (WRAP 2011)

CRADLE-TO-CRADLE PRODUCTION

The aim of a cradle-to-cradle approach is to create products that not only boost the economy but also have a positive impact on environment and society. In a cradle-to-cradle approach materials are viewed as nutrients to be maintained within a closed loop, and are often classed as either biological (e.g. food and wood) or technical (e.g. metals or plastics). Biological nutrients are those that can biodegrade safely and restore the soil after use. Technical nutrients are those that can provide high-quality, high-tech ingredients for generation after generation of synthetic products. Examples would include deriving plastics from plants, rather than fossil fuels that could be easily reused or biodegrade or designing products for a cycle of disassembly and reuse. Figure 3 provides a comparison of a linear and closed loop product chain.
In comparison to a linear model of design and resource use the Ellen MacArthur Foundation describe how more circular approaches can ensure materials are used more efficiency through:

- minimising the amount a product has to be changed in order for it to be reused, remanufactured or refurbished
- maximising both the length of time that a product functions for, and the number of times it can be reused, remanufactured or refurbished
- optimising how materials that have degraded beyond being able to be reused as a feedstock in one system can be used as a feedstock in another process or supply chain
- minimising contamination and maximising the purity of material chains to increase collection and value of materials.

Figure 3 A model of linear and closed loop manufacturing chain

Source: World Economic Forum 2010
According to the European Commission (2012) over 80% of the environmental impact of a product is determined at the design stage. Ecodesign requires the environmental impacts of a product to be considered at the earliest stages of design. The EU Ecodesign Directive (European Commission 2009) provides a framework for mandatory ecodesign standards to be set for specific products (e.g. limit values for maximum energy consumption of appliances in standby mode or the use of minimum quantities of recycled material).

**CONSUMER APPROACHES**

Significant opportunities exist to change our approach to the ownership of goods and products and the relationship between producer and consumer and in doing so reduce the resources consumed. Access to the facility can be provided without necessarily requiring ownership whether by renting (e.g. car clubs), lending (e.g. Streetbank), swapping or gifting goods and this is hugely supported by smart and real-time technologies which can now facilitate this. In effect manufacturers and retailers could increasingly retain the ownership of their products and act as service providers.

Some businesses have also pursued approaches based on selling a service or function rather than product. In such instances the manufacturer has a strong incentive to maximise the durability and reliability of the product and ensure that it can be refurbished or remanufactured. As examples, Rolls Royce offer airplane engines and accessory replacement services on a fixed-cost-per flying-hour or ‘power by the hour’ basis and Michelin offer a pay-per-kilometre tyre management service for vehicle fleets.

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**Examples**

**Desso carpet manufacturer**
In 2010 Desso – a Dutch carpet manufacturer announced that it would become a cradle-to-cradle company by 2020 – with all raw materials used free of toxic chemicals, designed to be disassembled and able to be reused or recycled.

FACT: each year 400,000 tonnes of carpet waste is buried in UK landfill (carpetrecyclinguk 2013)

**Patagonia clothing company**
As part of their ‘Common Threads Partnership’ Patagonia clothing have worked with their manufacturers to reduce the energy, water and toxic chemicals used in their manufacturing processes, alongside this they provide a repair and buy-back service for their clothing to re-sell and a recycling service for worn out clothing. In July 2013 Patagonia announced that working with a company called PLUSfoam they have crated 100% recyclable flip-flops and that all the waste used in the creation of the product can be recycled back into creating new products and the flip flops can be recycled into new flip-flops with no reduction in performance.

FACT: one third of textiles in the UK are recovered for re-use or recycling (Defra 2009)
BENEFITS, OPPORTUNITIES AND BARRIERS

The adoption of a circular economy has been advocated by many as an opportunity to address some of the key challenges around resource availability, as set out earlier, and provide environmental, economic and social benefits. Table 1 summarises some of the benefits and opportunities associated with a circular economy.

Table 1 Benefits and opportunities of a circular economy

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<thead>
<tr>
<th>Heading</th>
<th>Context</th>
<th>Examples</th>
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<tr>
<td>Resource use and competitiveness</td>
<td>High levels of resource efficiency, re-use and refurbishment offers potential for considerable reductions in the amount of raw materials and energy consumed, with financial savings associated with this.</td>
<td>Europe: Designing and using durable goods (cars, furniture, washing machines etc) to reflect the principles of a circular economy offers energy and material savings worth between $380 bn and $630 bn per year in Europe (depending on ambition) for the manufacturing sector alone by 2025 (Ellen MacArthur Foundation 2012)</td>
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<td>Alongside the material cost savings further benefits for companies have been identified including those associated with fostering innovation, providing competitive advantage, reducing exposure to volatile prices and reducing warranty costs have been suggested (Ellen MacArthur Foundation 2012).</td>
<td>UK: Businesses could save £23 billion per year with zero or low investment by using material, energy and water more efficiently (Defra 2011a).</td>
</tr>
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Examples
City car clubs
The use of car clubs across the UK has grown significantly over the past decade. One of the operators, Zipcar, report that every car club vehicle takes at least 20 personally-owned cars off the road. Not only does this therefore constitute a significant reduction in resource use but Zipcar report that a typical member saves around £3,000 per year in comparison to the cost of owning their own vehicle.

Fact: average car parked for 95% of the time (Barter 2013)

Streetbank resource sharing facility
Streetbank enables people to share skills and resources – for example borrow a ladder or diy tools. Sharing such resources makes considerable economic and material sense.

Fact: The average diy drill is reportedly used for 15 minutes in its entire lifetime (DirectScot 2013)
## Job opportunities

A circular economy provides labour opportunities associated with the re-use, remanufacture and refurbishment of goods. The Aldersgate Group note the benefits of this approach as follows:

“Most of the value in the circular economy comes much further up the chain (or loop); recycling is the last resort. It is the componentisation, remanufacture, refurbishing and reselling of goods that is of most value to the economy and, in doing so, creates the most high value jobs.” (Aldersgate Group 2012).

**UK:** The roll out of anaerobic digestion technology to treat food waste in the UK is estimated to offer 35,000 new jobs (Defra 2011b).

**Germany:** A study of the jobs associated with bottle reuse found that switching from the current system which involves reuse of nearly three quarters of bottles to a one-way bottle disposal would result in a loss of 53,000 jobs and increasing the share of reusable bottles to 100% would provide 27,000 additional jobs (PWC 2011b).

## Environment

Reduced waste to landfill – reduction in associated climate emissions.

Reductions in climate change emissions associated with extraction, processing and transport of raw materials.

Reduction in toxicity of materials used to support greater re-use/remanufacture.

**Global:** Potential to divert 340 million tonnes of waste from landfill associated with clothing, food waste and packaging.

**UK:** Emission savings of 7 million tonnes of CO2e resulting from the use of food waste-derived biogas (Ellen MacArthur Foundation 2013a)

## Users/consumers

A circular economy presents opportunities to reduce the costs and hassle associated with the disposal of products that break or are not economically repairable after relatively short lifespans and purchase of replacements.

The Apple iPhone is not designed for the user to replace the battery. Apple currently charge £55 for a battery replacement.
A broad range of challenges and barriers have been identified in taking forward the concept of a circular economy. These span barriers faced by industry, business and consumers and can be summarised as follows (Table 2).

### Table 2: A summary of barriers to a circular economy

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Explanatory note</th>
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<tr>
<td><strong>Business models</strong></td>
<td>Some companies have a business model that is predicated on the production of disposable goods. As such these companies may be resistant to new approaches that challenge this in order to avoid losing their market share to more innovative companies.</td>
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<tr>
<td><strong>Consumer acceptance</strong></td>
<td>Challenges associated with a shift in culture towards access rather than ownership.</td>
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<tr>
<td><strong>Infrastructure</strong></td>
<td>Larger companies may have the leverage to influence the approach of their suppliers but many smaller ones may not have such influence. In addition some infrastructure may only be viable at a particular scale and require co-ordination to join up demands for inputs and outputs of such infrastructure. Similarly challenges exist around access to finance to develop the necessary infrastructure and support end of life recovery.</td>
</tr>
<tr>
<td><strong>Procurement</strong></td>
<td>Procurement rules have the potential to favour products that have a lower initial capital outlay and are discounted over relatively short periods rather than those that have a greater upfront cost but much lower lifetime operation costs/remain operational for much longer.</td>
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<tr>
<td><strong>Environmental externalities</strong></td>
<td>Where external environmental costs are inadequately reflected in the costs of a product or service the ‘one use’ product may be favoured over those produced on a more circular economy basis.</td>
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<tr>
<td><strong>Inertia</strong></td>
<td>Some companies can be slow or resistant to adapt. A recent survey found that two-thirds of waste management companies didn’t feel a need to adapt or adjust their business model in any way to take advantage of the changing dynamics around waste flows.</td>
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<tr>
<td><strong>Metrics</strong></td>
<td>The Aldersgate group identifies that work is required to identify metrics that would best support the move towards a circular economy e.g. post-consumer recycled content or embodied carbon.</td>
</tr>
<tr>
<td><strong>Data and knowledge gaps</strong></td>
<td>Gaps have been identified relating to the collaboration between “start-of-life” and “end-of-life” industries.</td>
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In their report ‘Shaping the Circular Economy’ Chatham House identify the challenges associated with overcoming such barriers, noting that

“… if circular economy practices are to be rapidly scaled up, a major push will be needed to overcome barriers, not least the dominance of the existing resource- and energy-intensive growth models. Governments have a key role to play in reshaping obstructive regulations and setting a smarter regulatory framework that incentivizes the reuse of resources.”

CRITICAL COMMENT

Beyond identification of some of the challenges and obstacles that exist in achieving a circular economy there is relatively little analysis critical of the concept. A number of reports do, however, note that there will be winners and losers (Chatham House, 2012 Aldersgate Group 2012), for example relating to job losses in businesses that fail to innovate or in traditional waste disposal practices and resource extraction industries. In addition products that are designed for a longer life may have a greater upfront purchase cost.

The Green Alliance (2011) also advocate that the stewardship of resources used must also be an important aspect of a circular economy:

“We envisage a ‘circular economy plus’ where all extraction of all materials, both renewable and non-renewable, as well as water and energy production, are achieved under a flexible but powerful ethos of stewardship by the companies concerned.”

SCOTLAND’S APPROACH TO RESOURCE USE

Over the past decade Scotland’s understanding of, and approach to, resource use has developed through a number of initiatives. Some of the most significant developments are set out below.

With a focus to boost municipal waste recycling Scotland’s National Waste Strategy:

- set targets to boost municipal waste recycling and composting levels to 25% by 2006, and 55% by 2020 (from 10% in 2003)
- committed to stop the growth in municipal waste by 2010.

2008: New Recycling Targets established
In 2008 the Scottish Government announced new household waste recycling targets of 40% by 2010, 50% by 2013, 60% by 2020 and 70% by 2025.

2010: Zero Waste Plan established
Scotland’s Zero Waste Plan set out a vision where all waste is seen as a resource that has a value and should be preserved, captured and used again. The plan:

- proposed that the recycling and composting targets of 70% by 2025 would applied to all waste
- established a target to dispose of a maximum of 5% of Scotland’s waste to landfill.
2011: SNIFFER Critical raw materials for Scotland
Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) published a report identifying the top 12 materials that are critical to the Scottish economy and are likely to be subject to supply shocks in the short to medium term, as well as the seven sectors of the economy which may be vulnerable. Based on consideration of consumption levels, availability of alternatives, scarcity, supply distribution, geopolitical influences, technology change, and public attitude the report identified the following materials as the most critical:

<table>
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<th>Material</th>
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<tr>
<td>Aggregates</td>
<td>Indium</td>
<td>Phosphorous</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Lead</td>
<td>Rare earth elements</td>
</tr>
<tr>
<td>Copper</td>
<td>Lithium</td>
<td>Timber</td>
</tr>
<tr>
<td>Fish</td>
<td>Palm oil</td>
<td>Tin</td>
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The report concluded that:

- the key biological resources used throughout the supply chain of a number of Scottish industries (e.g. food and drink, construction) are produced in either Scotland or elsewhere in the UK
- opportunities for low- or zero-carbon growth could be constrained by the scarcity of certain resources including rare-earth elements
- Scotland’s agricultural sector is heavily reliant on the importation of phosphorus
- volatile prices and increases in the costs of most resources should be expected for most resources.

The authors also reported that they “found little evidence that Scottish industry is planning for a resource-constrained future.”

2012: Zero Waste Regulations
The Scottish Parliament passed the Waste (Scotland) Regulations 2012 that set out a range of measures aimed at boosting recycling and improving resource efficiency. The regulations include:

- a requirement for businesses to present dry recyclables and food waste for collection
- a ban materials collected separately for recycling going to landfill or incineration (from 1 January 2014)
- a ban on biodegradable municipal waste going to landfill (from 1 January 2021).

2013: Resource Efficient Scotland Programme launched
The Scottish Government launched the Resource Efficient Scotland Programme to simplify advice and support to businesses, third sector and public sector organisations on energy, material resource and water efficiency.

2013: Safeguarding Scotland’s Resources Programme
Safeguarding Scotland’s Resources is the Scottish Government’s programme to reduce waste and create a more productive and circular economy. The programme includes:

- targets to reduce Scotland’s waste by 7% by 2017 and 15% by 2025
• the establishment of a resource efficiency pledge system for companies
• a commitment to explore the viability of business models for consumer products that would support leasing or hiring, rather than purchase, of some products
• collection trials for small waste electronic and electrical equipment
• a requirement on retailers to charge for carrier bags from October 2014.

PROGRESSING A CIRCULAR ECONOMY IN SCOTLAND

In ‘Low Carbon Scotland Meeting the Emissions Reduction Targets 2013-2027’ the Scottish Government (2013a) advocate a “shift toward a more circular model of resource use and economic growth that ultimately designs waste out of our economy”. The document notes that this “isn’t simply about using less and recycling more. It’s about supporting new forms of manufacturing, redesigning products and packaging, reshaping supply chains and stimulating innovative new ways to transform recyclables into new, higher value materials.”

Figure 4, taken from Safeguarding Scotland’s Resources (Scottish Government 2013b) sets out how materials can circulate around the economy through reuse, refurbishment, remanufacture and recycling with organic materials used as a source of fertiliser and energy.

Figure 4 A more circular approach to resource use

![Circular Economy Diagram]

Much of the emphasis in Scotland over the past decade has focused on the recycling element shown in Figure 4, however examples of initiatives aimed at boosting the remanufacture,
refurbishment, reuse and organic waste components include trials of deposit return schemes\textsuperscript{3} and the deployment of anaerobic digestion plants\textsuperscript{4}. Alongside this Scotland is already home to a number of companies where circular economy approaches are deployed as part of their operation. AG Barr operate one of the longest running glass bottle deposit return schemes in the world. The scheme enables empty bottles to be returned to the manufacturer via retailers that sell the product and the deposit (currently 30 pence) is returned to the consumer. In 2012 Hewlett Packard (HP) opened a technology centre in Erskine that reconditions, rebuilds and remarkets IT equipment.

**OPPORTUNITIES AND CHALLENGES IN SCOTLAND**

In 2013, working in collaboration with Zero Waste Scotland and Scottish Enterprise, the Ellen MacArthur Foundation produced a report for the Scottish Government to review the opportunities for a circular economy in Scotland. The report estimated that improved resource and energy use in the manufacture of goods like computers, electronic products, motor vehicles, and furniture sector alone offers estimated annual cost savings of between £0.8 and £1.5 billion (Ellen MacArthur Foundation 2013b).

The report also identified the following supply chains as those with the biggest opportunities:

- food and drink – organic by products and food waste offer significant energy and fertiliser opportunities
- energy – opportunities to cut energy use, increase reliance on renewables and also to progress recovery and reuse of materials associated with the end-of-life oil, gas and renewable infrastructure
- construction – significant volumes of construction and demolition materials are discarded
- chemical and life sciences – for example research opportunities for example in the replacement of fossil fuels with biological feedstocks.

Alongside those barriers that all economies face in making a transition to a circular economy two specific barriers that Scotland faces, and a number of opportunities to progress a more circular economy have been identified (Ellen MacArthur Foundation 2013b). The specific barriers identified were:

- concerns that the dominance of smaller enterprises in Scotland may result in a greater reluctance to take risks
- limitations on the availability of data in Scotland that hinder understanding of the potential impact of a circular economy.

The opportunities identified for Scotland included:

- political and industry-led leadership to build an understanding of the opportunities and inspire others

\textsuperscript{3} Deposit return (also known as ‘reverse vending’) schemes reward people for returning bottles and cans so that they can be reused or recycled. In 2013 the Scottish Government commenced trials of these schemes across Scotland.

\textsuperscript{4} Anaerobic digesters enable organic waste streams (e.g. sewage, food) to be used to generate renewable energy (gas) and fertiliser. In Scotland a number of anaerobic digestion plants are already in operation.
- public procurement approaches that incentivise new approaches to product and service supply and support collaboration
- market incentives and signals that favour re-use, remanufacture and closed loop recycling
- education approaches that support knowledge transfer and build business capability.
- establishment of a circular economy hub to support innovation and research in product manufacturing and design
- innovative financial tools and services that support the sale of services rather than ownership of goods.

**NEXT STEPS**

The implementation of a circular economy is currently a feature of discussions at an international, European and national level. Globally, a circular economy is being proposed as an approach that should inform the development of Rio+20 Sustainable Development Goals. In Europe, building on support of the European Commission, the Commission’s European Resource Efficiency Platform recently put forward a set of policy recommendations designed to deliver progress towards a circular economy (European Commission 2013b). In Scotland organisations including the Scottish Government, Zero Waste Scotland and Scottish Enterprise are actively engaged in exploring and implementing activities that could help build a more circular economy.

During a speech to the Scottish Parliament in June 2013 (European Commission 2013a) Commissioner Potočnik noted that a broad range of actors are required to progress a circular economy:

> “Implementing the resource efficiency agenda and moving to a circular economy is not only about policies and legislation, it requires the active engagement from all economic actors.

> Legislation will still be important in setting the right framework conditions and investment predictability, and that will be the role of parliaments like this one. Civil society and business will also have to play a key role.”

Establishing a circular economy for Scotland would require the engagement of many different stakeholders and deployment of a range of levers spanning public and private investment, land use planning, procurement, accounting and reporting systems and skills development.


Ellen MacArthur Foundation. (2013a) Towards the Circular Economy – Opportunities for the Consumer Goods Sector. Available at:


PWC. (2011b) Reuse and Recycling Systems for Selected Beverage Packaging from a Sustainability Perspective. Available at:


RELATED BRIEFINGS

SB 13-41 Treatment Options for Residual Waste  June 2013
SB 12-18 The Waste (Scotland) Regulations 2012  March 2012
SB 09-04 Climate Change (Scotland) Bill: Waste Provisions  January 2009

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