

# Designing a Circular Economy



Circular economies recover resources at their highest quality and keep them in circulation for longer. Shifting to this model could alleviate concerns arising from current approaches to material use, such as resource insecurity and pollution. This POSTnote outlines what a circular economy could look like and summarises some of the benefits of, and challenges to, creating one.

## Background.

Current approaches to product use are largely linear (make, use and dispose) resulting in valuable materials being wasted. In contrast, a circular approach uses restoration and recovery processes to increase the lifespan of products, components and materials. This goes beyond current recycling, which has largely focused on ‘easy wins’ in waste streams, such as paper,<sup>1</sup> as end-of-life circular products are designed to be an input for new industry. Circular supply chains seek to decouple economic growth from resource consumption. This could help overcome pressures on finite natural resources arising from the estimated growth of the global middle class, from 1.8 bn in 2009 to 4.9 bn by 2030.<sup>2</sup> For example, the European Commission has identified 20 critical raw materials, which have both high economic importance to the EU and high supply risk.<sup>3</sup> These include rare earth elements in modern technologies, less than 1% of which are recycled despite limited supplies (POSTnote 368).<sup>4</sup> The circular economy could also reduce energy use and have environmental benefits (Box 1).

New circular business models may lead to a larger service economy, with a focus on access to product use rather than ownership, such as Philips’ selling of ‘lighting as a service’

## Overview

- In a circular economy, reusing products, components and materials keeps them at their most useful and valuable. As a result waste is minimised.
- Moving to this model could create new economic and employment opportunities and provide environmental benefits through improved materials and energy use.
- Changes to product design and ownership, as well as focusing on access to services, are key to enabling circular businesses.
- Establishing a circular economy will require voluntary action, government intervention and international co-operation.
- Strategies differ across the UK, as policy areas are split between government departments and devolved administrations.
- Barriers to this economic transition have been identified, such as achieving economies of scale in recovery processes

rather than selling fixings.<sup>5</sup> Although there is broad consensus that a circular economy is desirable there is debate over how it can be achieved.<sup>6</sup> Some nations have adopted strategies to encourage a transition, but there is no formal UK wide strategy. However, the Government has recognised the need for intervention to deliver a circular economy.<sup>7</sup> The creation of the Department for Business, Energy and Industrial Strategy (BEIS) provides an opportunity to address resource challenges and integrate circular economy principles into the new UK industrial strategy.<sup>8</sup>

## Economic Value

The World Economic Forum estimates that the circular economy could contribute \$1 trillion a year to the global economy through reduced material use by 2025.<sup>9</sup> Largest benefits would be seen in Europe (which relies on imports)<sup>10</sup> and materials-intensive sectors like the automotive industry.<sup>11</sup> A more circular UK economy could be worth £9-29bn a year,<sup>8,12</sup> and create 10,000-175,000 jobs across skills levels by 2030, depending on the initiatives adopted.<sup>12,13</sup> This largely reflects the emergence of new business models with an increased focus on human capital and skills training.

**Box 1. Energy and Environmental Benefits of a Circular Economy***Energy Opportunities*

- **Embedded energy:** reuse of materials preserves energy invested during production.<sup>11</sup> For example, plastic recycling could require as little as 5% of the energy needed for new plastic production.<sup>14</sup>
- **Energy from waste:** incinerating non-recyclable or contaminated waste (like food packaging) generates energy. Bio-waste can also be used to make gas—anaerobic digestion is the most efficient method, generating both gas and liquid nutrients ([POSTnote 387](#)).

*Environmental Benefits*

- **Carbon emissions:** The EU has a target to reduce CO<sub>2</sub> emissions by 80-95% by 2050 compared to 1990.<sup>15</sup> Circular systems are low carbon: recycling all household plastics in 2013/14 would have saved 400,000 tonnes (125,000 cars worth) of emissions.<sup>14</sup>
- **Renewable energy:** a circular economy would cease to use fossil fuels and would transition to more renewable (circular) sources.<sup>11</sup>
- **Reduced resource extraction:** reuse protects the environment from resource extraction, for example, mining damage.<sup>16</sup>
- **Reduced pollution:** resource reuse and renewable energy would prevent many harmful materials leaching into the environment, such as marine plastics ([POSTnote 528](#)) and air pollutants.<sup>11</sup>

**Box 2. Ecodesign and EPR in the EU**

To export into the single market the UK must adhere to a number of EU directives.<sup>27</sup> Members of the European Economic Area (Norway, Iceland and Liechtenstein) and Switzerland typically introduce the same or similar requirements for this reason.<sup>28</sup>

- The **Ecodesign Directive**<sup>29</sup> set rules on products environmental performance (particularly energy efficacy) and the **Energy Labelling Directive**<sup>30</sup> made energy rating labels mandatory.
- The **WEEE Directive**<sup>31</sup> set targets for collection, recycling and recovery of electronics the **Restriction of Hazardous Substances Directive**<sup>32</sup> (RoHS) requires toxic materials, like heavy metals, be substituted for safer alternatives.
- The **End-of-Life Vehicles Directive**<sup>33</sup> (ELV) sets similar rules to WEEE and RoHS above, but focuses on vehicles.
- The **Battery Directive**<sup>34</sup> sets chemical content and waste-management requirements.

**What is a Circular Economy Approach?**

Circular systems are either technical or biological.<sup>11</sup> Both incorporate a range of activities that reduce the demand for material inputs and recover/reuse materials already in the system. For example, in a technical cycle a car can first be fixed, then components reused and finally materials like alloys recovered. This extracts the highest quality and value at each stage in the products' life cycle. Biological cycles focus on bio-waste, for example agricultural and food waste, where opportunities exist for chemical production (like biofuels and fertilisers) and energy generation (Box 1).<sup>17</sup> London food waste could generate £11m worth of savings a year through energy production.<sup>18</sup> More circular beer, fish and whisky sectors in Scotland could save £500m a year.<sup>19</sup>

**Product Design**

Ecodesign (making products more resource efficient over whole life cycles) and coordinating across supply chains could reduce waste at end-of-life. Various strategies exist, such as building modular products and designing for more efficient disassembly and reuse. Around 80% of a product's environmental impact is determined by decisions made at the design stage,<sup>20</sup> where choices are currently largely based on aesthetics and economics. For example, gluing together smartphone cases makes them thinner but harder to reuse compared to using screws.<sup>21</sup> Recent EU eco-design regulations have focused on energy efficiency (Box 2), though areas like durability are also being developed.<sup>22</sup> Expanding eco-design to encourage greater resource efficiency could include regulatory reuse requirements or market incentives for secondary material use. For example, variable VAT based on recycled content or pricing externalities (like emissions) into raw materials.<sup>11,23,24,25</sup>

*Extended Producer Responsibility (EPR)*

As the cost of waste management is borne by stakeholders other than producers, there is little incentive to design for better product reuse and disassembly. EPR can change this as it shifts the practical or economic burden of end-of-life goods, partly or fully, from local authorities to producers.<sup>26</sup> There are two approaches, collective (CPR) and individual (IPR) producer responsibility. While CPR spreads costs and

responsibilities between brands, IPR makes producers responsible for their own products.<sup>35</sup> Some commentators argue that the more direct cost of IPR will encourage better eco-design and should be the focus of future legislation. For example, Apple's experimental Liam robot can disassemble and sort the components of an iPhone 6S in 11 seconds.<sup>36</sup> When combined with take-back schemes, this allows Apple to keep hold of all aspects of its products, from hardware to intellectual property. Both CPR and IPR approaches are included in EU EPR obligations under the Waste electrical and electronic equipment (WEEE), End-of-Life Vehicles and Battery Directives (Box 2), though implementation has been inconsistent across member states.<sup>37</sup> EPR rules vary for other products,<sup>38</sup> with calls for wider coverage by groups like the Local Government Association (LGA).<sup>39</sup>

**New Business Models**

New service based businesses could arise through changes to product ownership and the emergence of a more sharing economy. Recent ONS data shows more UK spending on renting and services than on buying to own,<sup>40</sup> indicating that desired customer benefits come from use not ownership. Businesses focusing on access over sales could gain from longer relationships with customers, individuals could access products beyond their means to own and inefficient products could be taken out of circulation. 'Product service systems', where consumers pay for performance not products, is a proven model.<sup>41,42</sup> Examples include Rolls Royce's 'Power by the Hour' aircraft engine maintenance<sup>43</sup> and Michelin's 'pay-per-km' tyres.<sup>44</sup> Another is Xerox take-back—by selling copies not printers, more than 90% of equipment is reused or recycled.<sup>45</sup>

**Industrial Symbiosis (IS)**

IS allows waste from one industry to be used as an energy or material input for another.<sup>46</sup> Kalundborg Symbiosis in Denmark was the first full example of IS, where by-products from eight organisations (some of Denmark's largest) are traded in a closed system.<sup>47</sup> China also benefits from this model, largely due to the top-down organisation of industrial parks like the Suzhou New District, which contains over 16,000 enterprises and 4,000 firms.<sup>48</sup> A number of UK companies have adopted IS principles. For example, British Sugar uses by-products from its Wigginton factory in Norfolk to produce a range of products, such as animal feed, biofuels and tomatoes.<sup>49</sup>

## Circular Economy Strategies

Dedicated national strategies have increased resource efficiency in some countries (Box 3). This is largely because markets cannot deliver a circular economy through 'business as usual' and government help or mediation is required. However, with global supply chains it may be necessary to coordinate strategy internationally. The new EU package is the most advanced example of this (Box 4).

### The Circular Economy Within the UK

Some companies like Unilever,<sup>50</sup> Kingfisher<sup>51</sup> and M&S<sup>52</sup> have integrated circular concepts into their business models. The British Standards Institution (BIS) is also writing a voluntary *Framework for implementing the principles of the circular economy in organizations*.<sup>53</sup> Calls have come from groups like the UNEP,<sup>41</sup> Environmental Audit Committee (EAC)<sup>25</sup> and LGA<sup>39</sup> for the public sector to lead by example and include circular requirements into public procurement. However, different approaches have emerged across the UK as result of key policy areas being divided between different bodies, including: Defra, BEIS, the Treasury, local authorities and devolved administrations:

- **England:** While there is no formal strategy, supporting measures have been implemented, including: funding for research and business; waste prevention and reuse criteria within central government procurement; and the Built Environment Commitment (2014) for low carbon, resource efficient construction.<sup>7</sup> WRAP (Waste and Resources Action Programme) delivers much of England's circular economy initiatives.
- **Northern Ireland:** While there is no formal strategy,

#### Box 3. The Circular Economy Abroad

International examples of circular economy strategies include:

**Germany's Closed Substance Cycle and Waste Management Act** (1996) promotes multi-use, low-waste, long-life and repair-friendly products.<sup>54</sup> It sets producer, market and consumer obligations, as well as making trade and industry responsible for recovery and disposal ('polluter pays principle'). There are also more targeted schemes: Dresden was the first European city to use electronic identification and charging for municipal waste ('pay-as-you-throw')<sup>55</sup> and there are nationwide deposit-refund schemes for glass and plastic bottles.<sup>56</sup>

**Japan's** lack of landmass and natural resources has led to many 3R (reduce, reuse, recycle) policies.<sup>57</sup> The *Law for Promotion of Effective Utilization of Resources* (2000) covers ten industries and 69 product categories, outlining requirements and voluntary actions for:

- **Businesses**, which must justify raw resources use, increase the use of recyclables and reduce waste and other by-products. Failure to comply will result in a warning followed by financial penalties.
- **Consumers**, who are encouraged to use products for longer and aid business and government meet their requirements.
- **Government**, which must enforce the law; promote research; provide funding; conduct public education activities; and account for the aims of the law during procurement of goods and services.

Their *Home Appliance Recycling* law obliges industry to finance product collection and recycling, with a trade group responsible for those products that outlast their manufacturers. Consumers also pay a recycling fee, though this has led to illegal dumping.<sup>58</sup>

**China** has promoted circular tax, fiscal, pricing and industrial policies in its 11<sup>th</sup>, 12<sup>th</sup> and 13<sup>th</sup> Five-Year Plans (2006-present). This was in response to the economic and environmental risks of China's high resource use. The *State Council's National Strategy for Achieving a Circular Economy* (2013) was the first of its kind in the world.<sup>48</sup>

Prosperity Agreements have supported businesses to move beyond minimum compliance in energy use and resource management.<sup>7</sup> However, moving to a more circular economy could create an estimated 13,000 new jobs (net) and see unemployment reductions of 21,000.<sup>59</sup>

- **Scotland:** A comprehensive strategy has been adopted, *Making Things Last: a circular economy strategy for Scotland* (February 2016).<sup>19</sup> Zero Waste Scotland is responsible for delivering much of this. There is also a Scottish Materials Brokerage Service for recycled materials and a Scottish Institute of Remanufacture.<sup>7</sup> Increased remanufacturing alone could generate an extra £620m per year and 5,700 new jobs by 2020.<sup>19</sup>
- **Wales:** Sustainability was written into *The Government of Wales Act* 1998<sup>60</sup> and their 2010 strategy, *Towards Zero Waste*, made a commitment to circularity in global supply chains.<sup>61</sup> *Achieving a More Circular Economy for Wales* (March 2016) highlighted collaboration with academia and WRAP Cymru; recycling; and funding opportunities, particularly for small and medium enterprises (SMEs).<sup>62</sup> Potential benefits of £2bn a year in material cost savings and 30,000 new jobs (gross) have been estimated.<sup>63</sup> Groups like the Green Alliance,<sup>64</sup> trade association techUK<sup>65</sup> and the EAC<sup>25</sup> have called for more consistent UK policies.

#### The Influence of the European Union

EU membership has shaped recent UK waste, resource use and industrial policy. In terms of the circular economy this has mainly been through directives relating to waste. Compliance has seen recycling and recovery rates increase in areas like household waste and packaging and decreases in the landfilling of municipal bio-waste.<sup>66</sup> The EU Circular Economy Package published in December 2015 aims to enable the transition to a more circular economy through a range of measures aimed at increasing resource efficiency and minimising waste (Box 4); this is also applies to members of the EEA. While it remains in the EU, any legally binding measures adopted apply to the UK,<sup>67</sup> but on leaving they cease to be enforceable by the EU's Court of Justice.<sup>68</sup>

## Challenges for the Circular Economy

Barriers to the circular economy have been identified at the level of government, industry and individuals. While some are likely to be overcome in time, such as skills training and technological research, others may require intervention.

### Achieving Economies of Scale

Resources circulate at different geographic scales depending on the sector. Materials used in small quantities, or that require special infrastructure to recover (like the neodymium in some magnets)<sup>69</sup> may need international supply chains. Conversely, glass has to be recycled within 200 miles of its collection point for it to have lower carbon emissions than new production.<sup>70</sup> There also needs to be a sufficient quantity of material collected for an economically viable supply chain. To achieve this, harmonising collection practices and resource management across local authorities has been suggested.<sup>71</sup> The Environmental Services Association has called on funds to be made available to facilitate such harmonisation,<sup>72</sup> which is also supported by the Local Authority Recycling Advisory Committee.<sup>73</sup>

**Box 4. EU Circular Economy Package<sup>74</sup>**

This package contains an action plan and updates to six directives (still subject to negotiation): Waste Framework, Packaging, Landfill, WEEE, ELV and Batteries. Key proposals include:

- **Funding:** to provide over €650 million under Horizon 2020 and €5.5 billion from European structural funds for waste management.
- **Bio-waste:** to halve food waste by 2030 and revise regulations to increase the use of organic and waste-based fertilisers.
- **Recycling:** to set common targets of 65% of municipal waste and 75% of packaging waste by 2030.
- **Terminology:** to harmonise calculations and definitions relating to waste management across legislations and member states.
- **Landfill:** to send no more than 10% of municipal waste into landfill by 2030 and to discourage landfill with economic incentives.
- **Industry:** Develop quality standards for secondary materials and promote initiatives within industry, including: industrial symbiosis; product reparability, durability and recyclability; and ecodesign.
- **Plastics:** increase plastic recyclability and biodegradability. Also, reduce the presence of hazardous contaminants and marine litter.

**Infrastructure**

Product recovery, transport and reprocessing require dedicated infrastructure. Some existing installations can be repurposed,<sup>26</sup> although any transition will incur short-term costs. For example, the cost of turning the Port Talbot Steelworks from a producer of new steel to a producer of high quality recycled steel was estimated at £1-2bn. This was similar to the estimated cost of closing the site or a Government subsidised purchase.<sup>75</sup> However, significant investment and planning is needed in many sectors, with needs varying by industry and product. For example, while over 86% of non-hazardous construction waste is recovered,<sup>66</sup> value is lost because of a geographic mismatch between areas of supply and demand, transport costs, and challenges with multi-material product recovery.<sup>76</sup>

**Cooperation and Competition Law**

Standardisation within a sector is required for mass resource recovery. For example, standardising the materials used in milk bottles allows for a single recycling process.<sup>77</sup> This requires data sharing along and between supply chains (Box 5). However, commercial sensitivity may make businesses hesitant to disclose information, requiring oversight by neutral bodies, for example, the WRAP led Courtauld Commitment between supermarkets.<sup>78</sup> The Ellen MacArthur Foundation's 'Circular Economy 100' encourages collaboration by bringing together businesses, policymakers, academics and other stakeholders.<sup>79</sup> Business support schemes like the Netherlands' 'Green Deals' could also be valuable (Box 6). However, a lack of clarity over competition laws and a fear of severe penalties may be hindering dialogue; UK and EU level clarification would be beneficial.<sup>26</sup>

**Investment**

Transitioning to a circular model will incur short terms costs. Some support has been made available, like Innovate UK's 'Circular economy: business models' scheme (£800k; closed)<sup>80</sup> and Zero Waste Scotland's 'Circular Economy Investment Fund' for SMEs (£18m; open until 2018).<sup>81</sup> However, most investment is likely to be private. Market incentives or requirements could encourage bigger firms to invest, while the Centre for European Policy Studies suggest that SMEs would benefit from increased funding and help understanding available opportunities.<sup>82</sup>

**Box 5. Data Sharing Across Supply Chains**

Increased sharing of data across supply chains could help inform strategy and create more stable secondary markets, by making the quality and quantity of material more predictable. Examples include:

- **edoc** (electronic duty of care)—a free to use online system that helps UK businesses meet their waste monitoring obligations and captures data on the content of their waste.<sup>83</sup> This could be used to develop strategies for creating secondary material markets and maximising the value of these materials.<sup>25</sup> There are over 4,500 registrants,<sup>84</sup> with Scotland intending to make its use mandatory<sup>19</sup> and calls for similar action across the rest of the UK.<sup>25</sup>
- **Supermarket loyalty cards** (like Nectar cards) collect data on the purchases of people living in specific areas. This could provide detailed information on the content of municipal waste. If linked with data on manufacturer's material use and local waste management data, comprehensive resource strategies could be developed. Combining information streams like this could also create the infrastructure necessary to track EPR obligations.<sup>85</sup>

**Perceived Value and Behaviour**

Moving to a circular economy will require changes in how people consume products. While the circular economy can be hard to grasp conceptually,<sup>86</sup> translating it into individual benefits can lead to behaviour change, as seen in initiatives like WRAP's 'Love Food, Hate Waste' campaign.<sup>87</sup> However, attitudes towards products are complex. Many act as social indicators and have symbolic value, which can lead to biases against reuse.<sup>88</sup> This varies by product category, socio-economic group and location. For example, people in the North of England are around twice as likely to be embarrassed as people in the South East about buying second hand.<sup>89</sup> However, 'green' activities have emerged as a new signal of status,<sup>90</sup> like the purchasing of hybrid cars.<sup>91</sup> Upcycling can also turn 'waste' into exclusive products, with a material's backstory adding value,<sup>88</sup> such as designer bags made from old fire hoses.<sup>92</sup> The growth of charity shops,<sup>93</sup> platforms like eBay and initiatives like Repair Cafes (where volunteers help fix household items)<sup>94</sup> suggest an acceptance of reuse. However, consumer concerns remain over the quality and durability of secondary materials.<sup>95</sup>

**Access to Information**

Providing greater information to buyers can alter decision-making and encourage ecodesign. A study on lifespan labelling in four EU countries found that people would pay more for 'long-lasting' items.<sup>96</sup> France also passed a law requiring that consumers be informed how long spare parts for a product will be made.<sup>97</sup> Such actions combine circular objectives with consumer benefits, though building longer lasting products will result in higher buy-to-own prices.<sup>96</sup>

**Box 6. Dutch Green Deals**

As part of its strategic approach to supporting the transition to a circular economy, the Dutch government has encouraged eco-innovation through Green Deals with citizens, companies, councils and other stakeholders. These aim to remove barriers like ambiguous or restrictive legislation, legal confusion or a lack of partners.<sup>98</sup> A deal with Circle Economy, MVO Nederland and the Amsterdam Economic Board aims to make the Netherlands a "circular hotspot".<sup>99</sup> A recent international Green Deal between the Netherlands, France, Flanders and the UK may help ease restrictions on the trade of incinerator bottom ash, from which the Dutch firm Inashco can recover metals.<sup>100</sup>

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