Smart Growth: 
the economic case for the circular economy

Research conducted by
wrapt
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INTRODUCTION

This paper summarises the findings of desk research led by WRAP, as a member of Business in the Community’s Circular Economy Taskforce, on the economic case for moving towards a circular economy in the UK. The paper should be read alongside the Taskforce’s paper ‘Resource Productivity and the Circular Economy: The Opportunities for the UK Economy’ which sets out key areas where the Taskforce would like to see collaboration and intervention to accelerate this transition and reap the benefits of a more circular approach.

The Taskforce, including participating companies, is described on page 13.
EXECUTIVE SUMMARY

Data from WRAP shows that from 2000 to 2014, the UK improved the circular use of materials through the economy whilst achieving economic growth. There is further to go to avoid the loss of valuable materials in waste disposal, reduce environmental impacts, and to exploit opportunities in higher value product re-use or remanufacturing, rather than lower value material re-use.

It is difficult to estimate the size of existing circular economy activity. Proxy data techniques suggest it could be approximately £40 billion in the UK at present. A number of studies have assessed or modelled the potential benefits of developing a more circular economy, including:

- Enhancing productivity and economic growth: Modelling at the EU economy level for 2050 estimates that the circular economy could increase GDP by 8%. This includes growth in GDP per employee of between 10% and 15%.

- Encouraging investment and innovation: Estimates of the capital required to make the transition are around 3% of GDP. The key for Government is to identify areas where incentives can help unlock the required private sector investment. Application of digital, machine learning and robot technologies could increase innovation and investment in the companies selling products and services, in addition to those in waste and material management sectors.

- Improve the balance of trade: The cost of components and materials are typically 40% to 60% of total costs, and many of these are imported to the UK contributing to the current UK deficit in goods and services of around 7%. A recent study suggests that a materially efficient circular-based economy could improve the country’s trade balance by 1 to 2% of GDP.

- Generating additional jobs and wider societal benefits: Analysis suggests that a circular economy could generate over 200,000 jobs (gross) in the period to 2030 across regions in the UK where there are higher rates of unemployment.

- Helping to ensure a prosperous and resilient economy: Our dependence on imported raw materials and products means that the UK is at risk of disruptions to critical business supply chains, while exposure to volatile commodity prices presents a risk and an uncertainty to both UK business and the economy at large. More circular use of materials has the potential to reduce the exposure of companies to this uncertainty while reducing supply chain risk.

- Reducing greenhouse gas emissions and helping meet the UK’s carbon budgets: Modelling at the EU level suggests that circular economy measure will reduce carbon emissions. The scenarios used in the most recent modelling show large reductions in EU emissions. In the best scenario, the EU achieves an 80% reduction in emissions by 2050, although the scenario applies a mixture of greenhouse gas reduction and material efficiency measures. If these results are replicated on a UK level, this could help meet forthcoming challenging carbon budgets.
Examples of circular business models include designing products to last longer, which can lead to greater reuse and greater ability to repair/refurbish and re-sell products to support growth in the remanufacturing industry and allow for easy recovery of materials when a product is eventually recycled. Service models, including product maintenance and take-back schemes as well as rent/lease and peer-to-peer sharing models, also hold much potential.

Just how circular is the UK? It’s an important question to ask in helping to understand how much further the UK can progress. Considering the materials and products which are going into long term use, and materials that are chemically transformed in their use (e.g. fossil fuels or food consumed), WRAP estimates that circular use of those materials that can be recycled or reused grew by around 20 percentage points between 2000 and 2014.

Whilst this represents strong progress, there are opportunities for even greater improvements in the degree to which the UK is circular and the associated environmental and economic benefits. Measures of circularity based on the material mass flows do not account for the relative economic value of the loss of small amounts of high value material. Nor do they account for the fact that some materials have a much higher impact than others.

It is important to note that this growth in UK circularity has happened in a 14-year period where GDP grew by over 25% and the population grew by 10%. Some of the economic “decoupling” from resource constraints described is likely to be structural (the decline in manufacturing and rise in service sectors for example) and some is likely to be cyclical (for example, the fall in minerals extracted at the end of the decade because of the economic downturn, which particularly affected the construction sector).

Just how big is the UK’s circular economy? To help understand the potential benefits of the circular economy it is useful to understand where we are currently. WRAP estimate the size of the circular economy through assessing the following factors:

- Re-use activity is proxied by the Gross Value Added (GVA) of the retail of second hand goods sector;
- Repair activity by GVA of the repair of machinery and equipment sectors, repair of electronic and household products sector;
- Closed & open loop recycling activity is proxied by wholesale of waste and scrap sectors and the waste and recycling sector GVA; and
- For circular economy activity relating to servitisation, the GVA in the rental & leasing sectors is taken as a proxy.

The approach outlined clearly has its limitation as, for example, it is not really possible to separately identify remanufacturing or servitisation with any precision. It is an approach which uses the best available information and is useful in that, given a lack of any alternatives, is an attempt to quantify the current level of activity in circular economy activities. Using this approach, the UK circular economy is estimated to be worth almost £40 billion.
Productivity growth is vital for living standards and economic growth in the long term as it allows employers to raise wages (over the long term, trends in real pay growth align with productivity growth). Many countries have suffered a labour productivity slowdown since the financial crisis, but the UK’s experience has been particularly bad. Its workers are now 20% less productive than they would have been if the pre-crisis growth trend had continued. Many economic commentators have offered possible explanations for this, but the UK experience is not fully understood and there is no single convincing explanation.

Although labour tends to be the primary focus of efforts to increase productivity - because of its high cost - the greatest opportunities for improvement, and hence for increasing that rate of economic growth, could be in the way we use materials – so-called resource productivity (Defra 2011). And here, alternative broader measures of productivity are important in understanding the impact that more circular, more resource efficient sectors of the UK economy could have on economic growth. Total Factor Productivity (TFP) is one such measure, and includes all inputs used in production; capital, labour, energy and resources. As such, its level is determined by how efficiently and intensely all inputs are utilised in production.

Research examining almost 50 years of US manufacturing sector data found an inverse relationship between intermediate input intensity and TFP, i.e. sectors that are less intensive in their use of intermediate inputs, but are more intensive in their use of labour tended to have higher TFP. The results in this paper suggest that policies which encourage less intermediate input-intensive sectors or reduce the intermediate input intensity of production may lead to increases in average productivity (as defined by TFP).

IMPACT ON ECONOMIC GROWTH

Several studies have analysed the macroeconomic impact of a circular economy (resource efficiency more broadly) on economic growth, including those conducted by the European Commission (EC), University College London and the Ellen MacArthur Foundation. Note that different studies use different definitions of what exactly constitutes a ‘circular economy’. These range from resource and energy efficiency, to recycling and remanufacturing and to new circular economy business models. The papers also differ markedly as to how such measures are implemented and what causes economic growth to increase, i.e. whether it is the result of a set of policy measures that are introduced or that the circular economy establishes itself organically and it is the increase in TFP that causes the increase in economic growth. On the next page we summarise three of the main studies.
IMPACT ON ECONOMIC GROWTH CONTD.

First, a macro-econometric modelling exercise undertaken for the European Community found that resource productivity improvements of around 2 to 2.5% per annum could be achieved with net positive impacts on European Union (EU) Gross Domestic Product (GDP). Note that the increase in GDP is driven not so much by the increase in resource productivity as by the policy mechanism used to bring it about and the initial investment in resource efficient technology. Beyond a rate of 2.5%, however, the report found that higher resource productivity requires costs that outweigh the saving.\(^{12}\)

Second, a report for the EU funded project Policy Options for a Resource-Efficient Economy (POLFREE) from University College London used a similar model and looked at a range of scenarios from business as usual, to EU and global cooperation and on to a post-consumerist society. Assuming a scenario of global cooperation, the report estimates that resource efficiency measures could potentially increase EU GDP by 8% compared with business as usual in 2050.\(^{13}\)

Finally, a 2015 report by the Ellen MacArthur Foundation found that implementing resource efficiency opportunities in buildings, food waste and transport could increase European GDP by 11% by 2030 and 27% by 2050 in a circular scenario, compared with 4% and 15% under current trends. In this case the result was driven by technical progress leading to cost reductions in the use of resources.\(^{14}\)\(^{15}\)

THE GAINS ARE NOT UNIFORM

It should be noted that, if increased resource efficiency is achieved, there is a danger that the economic growth it has stimulated will increase resource use and environmental impacts through the rebound effect. This arises because money saved through resource efficiency can be spent either on more of the same good or service, or on other goods or services, both of which may increase future resource use.

Furthermore, the benefits of a circular economy are not likely to be uniform across the UK economy – there will be relative winners and losers. The impact of circular processes on individual sectors of the UK economy’s performance (from the perspective of competitiveness, GVA, output and employment) is likely to vary considerably depending on the characteristics of the sectors concerned, including the:

- Positioning of the industry regarding final product supply chains;
- Import intensity of the resources whose demand is reduced;
- Types of resource efficiencies (the extent of the intra-industry feedbacks);
- Price elasticities of demand (and trade demand);
- Degree of influence of the business cycle on demand for the sector;
- Cost pass-through rate; and
- Labour market interactions influenced by the business cycle.
ENCOURAGING INVESTMENT AND INNOVATION

The previous section demonstrates that the circular economy has the potential to raise TFP and in turn to increase the sustainable rate of economic growth in the UK. One aspect of economic activity is investment and innovation. Indeed, investment in circular economy infrastructure as well as the innovation that occurs across products and supply chains could prompt a multiplier effect, boosting other parts of the UK economy.

A transition to the circular economy will involve considerable investment. A recent report from the Club of Rome estimated that the level of investment (in addition to business as usual) required to deliver a circular economy is in the order of 3% of GDP per annum (equivalent to £55bn\(^6\)) until 2030. According to the report, investment would primarily be needed in the following sectors:\(^7\):

- Agriculture, forestry, timber, pulp and paper to promote biofuels and to develop new bio based products;
- Installation services and construction/renovation to promote energy-efficiency and renewable energy sources;
- Sustainable infrastructure concerning especially energy and transport, for instance mass-transit transport systems and electric vehicles and ways to charge them; and,
- Maintenance and repair, recycling and development to promote material-efficiency.\(^8\)

The longer-term requirement is for investment in education and vocational training that will enable the UK to meet the increased demand for new competencies in areas like product design, recycling and remanufacturing as well as new business models. The labour force must be ready to take on a set of new tasks required in the emerging circular economy (see section 5 for more discussion of the benefits of the circular economy to the labour market).

Since the recession, many UK companies have been cutting back on capital investment, apparently preferring to hoard cash or spend it on equity buybacks instead. If companies are not seeing enough demand for their products to justify large investments then they may become stuck in a low productivity, low growth trap.

The growth of business models such as Uber and Airbnb are just two examples of high profile, high value companies that allow scarce resources to be utilised more effectively. These business models exemplify how consumer preferences have changed, enabling demand for circular economy products and services to grow. By investing in similar circular economy business models of their own, companies may be able to increase their productivity while benefitting from pent up consumer demand.

Other perhaps more mundane business models also offer the potential for growth in consumer demand and investment. For example, refurbishment is an increasingly important and growing sector which could allow UK companies to get closer to their customers.

Tapping into this rising demand could encourage companies to invest in making their products easier to disassemble and the skills and equipment to repair and refurbish the products. Consumers have a strong preference for buying and owning new products. However, WRAP research found that there is a strong appetite for repair and rental services, trade-in and purchasing second-hand when delivered by trusted, major retailers.\(^9\)

The investment required to deliver the circular economy (for example improving the UKs collection infrastructure) as well as demand for more circular products may, in turn give companies the confidence to increase their investment spend still further – a circular economy multiplier.

Anglian Water’s ‘Nutri-bio’, developed from the final product of used water treatment.
IMPROVING THE UK’S BALANCE OF TRADE

Intuitively, the importance of material costs for the manufacturing industry to the success of firms competing domestically or in export markets is likely to be a strong driver to become as resource productive as possible. Today, materials and components constitute 40% to 60% of the total cost base of manufacturing firms in Europe and often create a competitive cost disadvantage.

Analysis published by the Ellen MacArthur Foundation sought to quantify the potential annual costs savings for the EU across the three sectors (food, transport and the built environment) based on a range of circular economy measures. The report estimated that costs at the EU level could decline by €0.9 trillion per annum by 2030 – on a UK weighted basis this would equate to £110 billion per annum.

The UK’s trade deficit in goods averaged 6.9% of nominal gross domestic product in 2016. Although the recent fall in sterling may improve the UK’s trade balance evidence from previous periods of currency weakness suggests that sterling can only provide some support. More fundamentally the UK may be able to improve its balance of trade by improving its competitiveness in export markets and by importing less.

The circular economy offers a way to achieve both. By introducing more resource efficient, more circular products there is an opportunity to reduce costs across supply chains. UK manufacturers competing in export markets may use this advantage to reduce the price of their products or boost profitability and increase investment, that will, all else being equal result in a more competitive UK economy. Meanwhile, by introducing a more circular economy in the UK through greater recycling, remanufacturing and reuse we reduce our dependence on the import of commodities and semi-finished products from abroad. In doing so the circular economy also offers an opportunity to develop valuable skills and expertise in the UK.

UK businesses may also be able to gain a crucial first mover advantage ahead of overseas competitors. Here network effects related to establishing that first mover advantage could be important for any UK circular economy business. The aftermath of the financial crisis and the new business parameters may create the opportunity for the reinvention of existing businesses and the growth of new business models. Several companies around the world have begun to seize these opportunities – creating first mover advantage for them. Consider, for comparison, the companies that similarly began and flourished in economic downturns thanks to their innovation in a time of change, including GE (1890), General Motors (1908), FedEx (1973), and Microsoft (1975).

What is the potential size of the benefit to the UK’s trade balance? A recent report published by the Club of Rome found that, combined with efforts to increase energy efficiency and the use of renewable energy, organising manufacturing along the lines of a materially efficient circular/performance-based could improve a country’s trade balance in the order of 1-2% of GDP.

As with other economic benefits of the circular economy, the impact is likely to vary on a sector level. Modelling work carried out by Cambridge Economics on behalf of Defra examined examples of resource efficiency measures introduced by the food, drink and tobacco (FDT) and in turn its impact on the UK’s balance of trade. The analysis assumes that resource-efficiency measures undertaken in the UK lead to price reductions that make domestically-produced goods relatively cheaper than imports (domestic production becomes preferable to imports). UK-produced goods are also cheaper overseas when compared to other countries domestic production while reducing the attractiveness of imported products, overall resulting in an increase in net UK exports (from the FDT sector). The report shows that the impact on trade is likely to vary by sector, being dependent on the degree of import demand intensity of those commodities consumed by a particular sector, the price elasticity of demand for exported and imported goods and the sectors cost pass through rate.
The UK labour market faces several important challenges. It exhibits significant regional and occupational mismatch in employment, meaning that available opportunities are not necessarily well aligned, either with where the unemployed live, or with the skills they acquired in previous occupations. Labour market mismatches are thought to account for around three percentage points of the unemployment rate and are likely to have played a significant role in the rise in unemployment since the start of the financial crisis.

A transition towards a circular economy may help alleviate some of the labour market challenges that the UK currently faces. A review of 65 academic studies on the relationship between the circular economy and employment found that, while more research is needed, “existing studies point to the positive employment effects occurring in the case that a circular economy is implemented.” This impact on employment is largely attributable to increased spending fuelled by the lower prices expected across sectors and to the labour-intensity of recycling activities and higher skilled jobs in remanufacturing. Indeed research from WRAP estimates that based on the current rate of development, the circular economy could create over 200,000 gross jobs and reduce unemployment by about 54,000 in the period to 2030. More extensive expansion of circular economy activities could more than double these figures, creating around half a million jobs (gross), reducing unemployment by around 102,000.

An expansion in the circular economy may help correct structural unemployment in the UK. WRAP analysis suggests that dealing with structural mismatch will require new employment opportunities in high unemployment regions, such as the north of England, that are suitable for low to intermediate skilled workers, perhaps with previous experience in manufacturing, retail or service industries (see Figure 1). In addition, the UK, in common with many other countries, faces a significant challenge with the trend of declining mid-level occupations, through a combination of technological progress and competition from emerging economies.

Figure 1: Potential net job creation in a UK circular economy
Growth in the circular economy, whether modest or transformational, can create a wide variety of employment opportunities that directly tackle these challenges in the following ways:

- Regional unemployment disparities may be reduced by a broad geographical spread of employment opportunities in circular economy activities.

- More extensive development of the circular economy, involving more remanufacturing, servitisation and repair, could create employment near existing manufacturing sites where unemployment tends to be higher. This may also draw on the large pool of unemployed, former employees of manufacturing industries in these areas.

- The circular economy can also contribute to offsetting the decline in mid-level occupations. Sectors that provide mid-level employment, such as remanufacturing and closed loop recycling, offer potential routes to addressing the decline in mid-level occupations.

- A transition towards a circular economy can also link to other regional redevelopment initiatives. For example, WRAP analysis shows that a circular economy has the potential to make a real contribution to mainstream employment in London. With the right investment and policy interventions, this transition could create up to 12,000 incremental jobs and deliver lasting reductions in unemployment, especially in low-skilled to mid-skilled occupations, whilst simultaneously driving resource efficiency.

If the circular economy is to be developed extensively then there needs to be adequate skills to deliver it. Skills in repair and maintenance need to be developed for the circular economy to grow. Feedback from industry suggests that even now there is a lack of workers with the right skills. Once the circular economy grows this skills gap will only widen unless action is taken now to support this transition.

The circular economy is an industrial revolution that can make the UK more competitive, but it could also have wider societal benefits too. Discontent among many UK families has been fuelled by feelings of a lack of social inclusion, concern over the pace of technological change as well as fears that globalisation has removed control over their lives. The circular economy may offer a means to abate this trend. The previous section shows how the circular economy may help to correct structural unemployment in the UK, in turn increasing the income and opportunity of those who may have traditionally been left out of the labour market. Meanwhile, establishing more ‘local’ re-manufacturing, developing skills in repair and maintenance and by providing stable employment the circular economy may serve to reduce feelings of discontent, and instead engender a sense of cohesion and wider purpose.

However, care needs to be taken when introducing policies to encourage the growth of the circular economy to ensure that it doesn’t increase income inequality. For example, if by trying to reduce food waste, policies are introduced that lead to higher food prices then this could increase inequality - lower income groups tend to spend a higher proportion of their income on food.
Section 3 showed how the circular economy can help improve the UK’s balance of trade, by increasing exports of our products and services and reducing our dependence on imported raw materials and semi-finished and finished products. The circular economy can help ensure that UK economic growth is robust, yet sustainable. In particular, by reducing our dependence on imported raw materials and products the UK may reduce the risk of supply disruptions.

While higher stock levels for many commodities may have reduced the perception of supply risk, the reliance on the import of commodities from certain parts of the world is still as fraught with risk (whether it be producer, transport or logistical) as when commodity prices were much higher. The risk of supply disruption is still a prime motivator towards a circular economy and this is likely to remain whatever the overall price of commodities does.

UK companies in sectors with the greatest variations in exposure to commodity costs stand to gain most from becoming more resource efficient than their competitors, while those less dependent on resources to generate earnings will be more stable financially. Analysis by Trucost estimated the impact of a 10% change in commodity prices on earnings for almost 200 FTSE 350 companies. Of the top 5 most exposed sectors, a 10% change in commodity prices equated to a 6% change in earnings, however for the food and drink sector (the most exposed) a 10% change in prices equates to a 13% change in earnings.

Uncertainty about the future price of commodities, particularly oil can also affect the stability of the UK’s economy. Analysis carried out by the European Central Bank (ECB) found that underestimating future oil and food prices were two of the main factors contributing to errors in projecting Euro area inflation and GDP growth. If our dependence on imported commodities fell, then the impact on the UK economy from a proportionate change in commodity prices would be reduced. In turn the cost in terms of monetary and policy uncertainty may also decline.
Developments in global steel markets are an example of how the circular economy can help today to insulate the UK economy from external shocks (whether resulting from a change in price or a supply disruption to the UK). The drop in global steel prices (resulting from Chinese over-capacity and weak demand) has highlighted the UK’s lack of competitiveness in steel production by supplying relatively lower value steel products. UK steel industry assets, mainly owned by Tata Steel, were largely constructed in the 1960’s and are configured to produce steel from (imported) iron ore.

Investment in upgrading UK steel plants to electric arc furnaces could result in greater use of scrap steel, helping to insulate manufacturers from higher raw material costs and the risk of a disruption to supply. It also provides a domestic end market for some of the 7Mt of steel that the UK collects, but that is currently exported (See Figure 2).

Meanwhile, UK steel mills could be upgraded to supply either higher value exports as intermediate goods, or converted into final goods for domestic use or export. More broadly, investing and innovating in steel up-cycling and in integrating steel producers with downstream users, offers much greater opportunity for adding value, while creating the conditions for innovation that can then be exported. With today’s mix of electricity supply in the UK, the total greenhouse gas emissions from making steel from recycled metal are around half those when making the steel from iron ore. If the supply of low-carbon electricity expands as well, the emissions associated with recycled steel could drop further.

Although commodity prices have, in general, fallen sharply since 2011, eventually commodity prices will rebound as demand growth increases and supply fails to catch-up. Based on an analysis of previous commodity cycles there could be an extended period of lower prices, although this cannot be guaranteed. Investing in the circular economy now will help to create a more resilient UK economy, in turn reducing the impact that a future supply disruption and/or hike in commodity prices could have on UK prosperity.
In mid-2016 the UK announced the fifth carbon budget, setting a target that by 2030 UK emissions will be 57% below what it was in 1990. The target is part of a series of budgets designed to ensure the UK meets the Act’s commitment of bringing emissions down 80% by 2050. The circular economy is one of the options to reduce emissions over this period.

However, the relationship between the circular economy and carbon emissions is complex, but in general implementation of circular economy strategies will reduce carbon emissions. There are complicating factors to this relationship such as:

1. Understanding the links – This can be complex and assessing the impact of emissions is difficult.

2. Trade-offs – Where energy using products are improving quickly, then there is a trade off between prolonging life and reducing emissions.

Despite these issues there are tools that can be used to assess greenhouse-gas (GHG) benefits from circular economy measures at the company and economy level. These are life cycle assessment and environmentally extended input output modelling. There are some limitations to these data sets, but these techniques can be expanded to assess the emissions benefits from the circular economy.

The Polfree project modelled circular economy policy impacts on the greenhouse gas emissions. The global emissions would fall by 60% for the Global Co-operation scenario and by 27% in the EU Goes Ahead scenario. In the EU Goes Ahead scenario, EU emissions would fall by just over 60%, although the impact on global emissions is smaller.

In Figure 4 below we have plotted the GHG intensity of the economy for each scenario against the study’s reference case. The results indicate that in the presence of these policy measures, emissions per GDP fall by 34-39% more than the reference scenario.

The policy mix use to generate these results combines measures to reduce greenhouse gas emissions and measures to increase more efficient use of other resources. The relative contribution of each policy to the results has not been published to date.

**Figure 3: Scenario assumptions**

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<td>- All nations share EU targets</td>
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<td>- Global warming restricted to 2°C</td>
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<td>- “Everything but hard market interventions”</td>
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<th>EU Goes Ahead</th>
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<tr>
<td>- Non-EU countries adopt some climate measures</td>
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<tr>
<td>- Taxes / subsidies change on supply side</td>
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<tr>
<td>- Consistent with RCP 4.5</td>
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Change in CO2 Emissions per GDP per capita

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<th>Year</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
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CONTRIBUTIONS

We would like to thank PwC and our partner organisations – Accounting for Sustainability and the Cambridge Institute for Sustainability Leadership – for contributing their views to this report.

ABOUT THE CIRCULAR ECONOMY TASKFORCE

Business in the Community’s Circular Economy Taskforce brings together a group of CEOs and other senior executives committed to delivering a high impact programme to bring the circular economy to life. The Taskforce is Chaired by Andrew Bester. Its members include: Amey, Anglian Water, Anthesis, Arup, Interface, JLL, Lloyds Banking Group, PwC, Recycling Lives, Ricoh, Unilever, Veolia, Viridor, Walgreens Boots Alliance and WRAP.

The Taskforce’s vision is to deliver a high impact programme to bring the circular economy to life and for the UK to be at the heart of driving a new model of ‘smart’ economic growth that unleashes the opportunities the circular economy and resource productivity bring to:

- Drive innovation;
- Improve productivity and global competitiveness;
- Create new skills and employment opportunities; and
- Achieve broader societal and environmental benefits including contributing to the UN SDG Goals of Responsible Consumption and Production, Decent Work and Economic Growth, Sustainable Cities and Communities and Climate Action.

The Taskforce is drawing on the strength of the BITC network to implement a three-year action plan focused on leadership, collaboration and practical action. The action plan is centred around three core areas of activity:

- Raising awareness and inspiring action;
- Building a programme of practical collaborative action and innovation; and
- Promoting the policy frameworks and support needed to unleash opportunities.
ENDNOTES

1 Chained volume measure, seasonally adjusted.
2 Defined as firms, often manufacturers developing services that replace or complement traditional product offerings.
3 £38.4 billion in 2012
4 https://www.ft.com/content/b6513260-b5b2-11e7-a398-73d59db9e399
6 A secondary analysis of data from South Korea resulted in consistent conclusions, demonstrating that the relationship could apply across countries with very different industry structures.
7 Defined as the share of intermediate inputs of total costs. National accounts typically do not split out materials specifically, and so are included under ‘intermediate inputs’.
9 Delivered through the project Policy Options for a Resource-Efficient Economy (POLFREE)
10 The concept of the circular economy is consistent with the term resource efficiency in that both require resources to be used in a sustainable manner while minimising negative impacts on the environment.
11 As measured by GDP per unit of Raw Material Consumption (RMC), so excluding energy, labour and capital costs.
14 Growth within - July 2015: Ellen MacArthur Foundation and McKinsey Center for Business and Environment
15 It should be noted that the EMF report modelling took no account of the costs incurred in achieving this technical change, or overcoming the barriers to increased efficiency. This report also assumes a substantially higher pace of technology change in the big product and resource sectors going forward compared to what has been observed in the past, whereas most other reports assume a similar pace as witnessed historically.
16 Based on UK nominal GDP, 2015
18 It has been estimated that a fully efficient reuse and recycling system in the UK could cost around £10bn - Environmental Services Association (ESA). Going for growth, a practical route to a circular economy, 2013.
20 Growth within - July 2015: Ellen MacArthur Foundation and McKinsey Center for Business and Environment
21 Based on UK proportion of EU-28 GDP in 2015.
22 The report notes that rebound effects are likely to constrain the potential reduction in costs – identifying a 5%-20% uplift in consumption across the three industry sectors.
24 The trade deficit is ultimately driven by changes in the real exchange rate and domestic versus overseas demand.
25 Next Manufacturing Revolution http://www.nextmanufacturingrevolution.org/
ENDNOTES

27 An interesting side note is to extent to which end-product price competition would happen anyway, without a CE in place to enable it. Since a large proportion of costs borne by manufacturers are in the form of material inputs we assume that price reductions would not be possible to the extent that the CE could deliver.

28 To quantify the impacts of quick-win resource-efficiency measures on competitiveness two distinct modelling approaches were used: the development and application of a sector framework for sector-specific analysis and the application of a more complex whole-economy model (CE’s MDM-E3 model of the UK).


30 Employment and the CE – Job creation in a more resource efficient Britain, WRAP (2015)

31 Jens Horbach et al., CE and Employment, 2015

32 Employment and the CE – Job creation in a more resource efficient Britain, WRAP (2015)

33 Employment and the CE – Job creation in a more resource efficient Britain, WRAP (2015)


35 Coal, oil, wheat and cotton36 Jens Horbach et al., CE and Employment, 2015

36 Including food producers, electricity, gas, water and multi-utilities, chemicals and beverages.

37 Earnings before interest, taxation, depreciation and amortisation (EBITDA).

38 FTSE 350 Commodity Exposure Index, Trucost (2011)


40 2007 flow estimates

41 2007 flow estimates

42 http://www.telegraph.co.uk/news/2016/07/25/a-new-industrial-revolution-is-coming-is-theresa-may-ready-for-t/

43 Previous commodity price super-cycles have tended to sketch a pattern of 10-15 years of broadly rising prices, followed by 15-20 years of broadly falling commodity prices.
