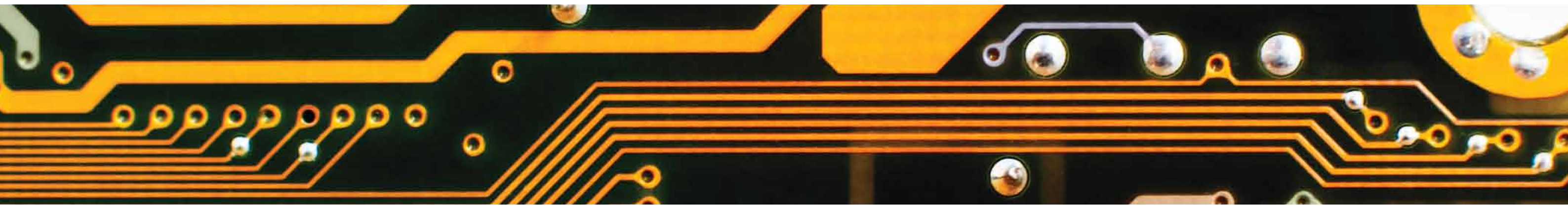
CHATHAM HOUSE

briefing paper



A Global Redesign? Shaping the Circular Economy

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Summary points

- A fundamentally new model of industrial organization is needed to de-link rising prosperity from resource consumption growth – one that goes beyond incremental efficiency gains to deliver transformative change.
- A 'circular economy' (CE) is an approach that would transform the function of resources in the economy. Waste from factories would become a valuable input to another process – and products could be repaired, reused or upgraded instead of thrown away.
- In a world of high and volatile resource prices, a CE offers huge business opportunities. Pioneering companies are leading the way on a CE, but to drive broader change it is critical to collect and share data, spread best practice, invest in innovation and encourage business-to-business collaboration.
- Policy-makers should focus on accelerating transition to a CE in a timescale consistent with the response to climate change, water scarcity and other global challenges. Smart regulation can reward private-sector leadership and align incentives along the supply chain – for example, to deliver a step-change in remanufacturing rates.
- Resource consumption targets that reflect environmental constraints should be considered at a global level. Coordination of national policies would help create a level playing field across major markets, easing competitiveness concerns and reducing the costs of implementation.

Introduction

In the run-up to the United Nations Conference on Sustainable Development (Rio+20) in June 2012, there has been a renewed focus on pursuing meaningful action to reduce resource and environmental pressures. Even though many countries, including emerging economies, can point to impressive environmental improvement in the past two decades, the overriding global patterns of production, consumption and trade remain dangerously unsustainable.

There is increasing recognition that resource efficiency and security are critical to future economic competitiveness and resilience – for countries and companies alike. This requires a fundamental rethink on the role and function of resources in the economy. According to McKinsey, cheap resources underpinned economic growth for much of the 20th century, but in the last eight years prices have returned to heights not seen since the 1900s – and barring a major macroeconomic shock, they are expected to remain high and volatile for at least the next 20 years.[1] To meet this new resource price reality, new forms of value creation must be developed if the world is to maintain and increase prosperity.

This paper explores the potential of a circular economy (CE) as a model for industrial organization that will help de-link rising prosperity from growth in resource consumption. Central to the CE is the idea that open production systems – in which resources are extracted, used to make products and become waste after the product is consumed – should be replaced by systems that reuse resources and conserve energy. The paper explores the concept of a CE, its key components, challenges and opportunities, and the importance of international cooperation.

Moving towards the CE will require a paradigm shift in the way things are made – putting sustainability and closed-loop thinking at the heart of business models and industrial organization. This has profound implications for society, since 'how we make things dictates not only how we work but what we buy, how we think, and the way we live'.[2]

The 20th century witnessed two great shifts in systems of production. After the First World War, Ford Motor Company and General Motors led global manufacturing away from centuries of craft production into the age of mass production. After the Second World War, Toyota and other Japanese firms pioneered 'lean manufacturing' systems and the just-in-time business model: the 'flexible production' approach that rapidly became a defining characteristic of the globalized economy.[3]

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One lesson from the shift to mass and flexible production is that companies – and countries – can reap enormous first-mover advantages. Mass production is closely associated with the rise of the US economy in the early 20th century, and flexible production with the emergence of Japanese companies in the 1970s. A second lesson is that systemic changes in the economy can happen much faster than expected, once the benefits

1 Dobbs, R., Oppenheim, J., Thompson, F., Brinkman, M. and Zornes, M. (2011), 'Resource Revolution: Meeting the World's Energy, Materials, Food, and Water Needs', McKinsey Global Institute, www.mckinseyquarterly.com/Energy_Resources_Materials/Environment/A_new_era_for_commodities_2887.

2 Womack, J., Jones, D. and Roos, D. (1990), *The Machine That Changed the World* (Sydney: Simon and Schuster), p. 9.

3 Ibid., p. vii.

of a new approach are successfully demonstrated by pioneering firms. A third lesson is that a wide range of factors influence – and are affected by – changes in production systems: from technological pathways,[4] resource prices and regulatory frameworks to the reshaping of norms and values.[5]

At the global level, a CE could help enable developing countries to industrialize and developed countries to increase wellbeing and reduce vulnerability to resource price shocks – but without placing unsustainable pressure on natural resources and breaching environmental limits. For companies, it offers a model of sustainable growth fit for a world of high and volatile resource prices. The economic potential is huge; a McKinsey analysis for the Ellen MacArthur Foundation shows that if a subset of the EU manufacturing sector adopted CE business models, it could realize net materials cost savings worth up to $630 billion per year by 2025.[6]

Defining a 'circular economy'

The notion of a circular economy has its roots in industrial ecology, a theory first developed by environmental academics in the 1970s and still used today.[7] It involves remodelling industrial systems along lines of ecosystems, recognizing the efficiency of resource cycling in the natural environment.[8]

In today's economy, natural resources are mined and extracted, turned into products and finally discarded. While the recycling of waste and measures to improve efficiency can both help to reduce the need for extraction of raw materials, this remains a fundamentally open, linear system, and one likely to place unsustainable demands on the environment in the medium term.

In a CE, the resource loop would be closed,[9] so that large volumes of finite resources (metals and minerals, for example), are captured and reused.[10] Other products can be made from plant-based materials that biodegrade into fertilizer at end of their life. Extending this logic across the economy means a deep change in the basic structures of industrial systems. In terms of energy, redesigning industry at the system level would enable efficiency improvements that 'far outweigh potential savings from improving the energy efficiency of industrial processes'.[11] The remaining energy needed for a CE would be provided by renewable sources.

Despite growing interest in the link between resource efficiency and competitiveness, the term 'circular economy' is applied inconsistently by governments and companies – and awareness of the concept is relatively low. Developing a common understanding of CE and its key components would help to lay the groundwork for wider take-up of the concept, encourage cooperation and avoid confusion.

For example, in China, the CE is defined in legislation as a generic term for reducing, reusing and recycling activities conducted in the process of production, circulation and consumption.[12] In the 12th Five-Year Plan (2011–15), the priority is a shift from the resource (primarily energy

4 Arthur, W.B. (2011), 'The Second Economy', *McKinsey Quarterly*, October, www.mckinseyquarterly.com/The_second_economy_2853.

5 For example, economic historians and institutional economists have emphasized the differences in the organization and dynamics of social systems of production in the United States, Germany and Japan. See Hollingsworth, J.R. and Boyer, R. (eds) (1997), *Contemporary Capitalism: The Embeddedness of Institutions* (Cambridge University Press).

6 Ellen MacArthur Foundation (2012), 'Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition', www.thecircu-lareconomy.org.

7 These academics also drew on parallel developments in ecology, systems theory and the nascent global environment movement in that period. The systems theory dimension to CE has even earlier roots, going back to the 1950s. For example, Von Bertalanffy noted that 'a system is characterized by the interactions of its components and the nonlinearity of those interactions': Von Bertalanffy, L. (1950), 'An Outline of General System Theory', *British Journal for the Philosophy of Science*, Vol. 1, pp. 139–64.

8 See, for example, Graedel, T.E. and Allenby, B.R. (1995), *Industrial Ecology* (Englewood Cliffs, NJ: Prentice Hall).

9 The terms 'closed loops' and 'cradle to cradle' were used as early as 1976 by Walter Stahel, considered one of the key industrial ecology thinkers. See for example Stahel, W. (1981), *Jobs For Tomorrow: The Potential for Substituting Manpower for Energy* (New York: Vantage Press).

10 Huber, J. (2000), 'Towards Industrial Ecology: Sustainable Development as a Concept of Ecological Modernization', *Journal of Environmental Policy and Planning*, October–December 2000, Vol. 2, No. 4, pp. 269–85.

11 Clift, R. and Allwood, J. (2011), 'Rethinking The Economy', *The Chemical Engineer*, March.

12 This translation is via the China Environmental Law website, www.chinaenvironmentallaw.com/wp-content/uploads/2008/09/circular-economy-law-cn-en-final.pdf.

and water) efficiency of heavy industries to recycling of metals and minerals and remanufacturing of products, especially the exchange of materials between companies.[13] This is intimately linked to the upgrading and reorganization of China's industry to boost competitiveness, and to its wider development strategy.[14]

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Other countries have generally not used CE terminology to date, but it is important to note that China's approach is partly derived from policies and approaches adopted in other countries, notably Germany and other European countries, as well as Japan. For example, China puts 'cleaner consumption and production' principles and the '3Rs' of reduce, reuse and recycle at the heart of its CE policy. These terms are widely applied in other countries.

Implementing circular economy concepts

Three decades on, several factors lie behind the resurgence of optimism around the circular economy. First, as noted above, the CE offers new forms of value creation appropriate for a world of high and volatile resource prices. Second, innovation in key areas such as information technology and advanced materials have opened up avenues that were previously unavailable, including the ability to track and optimize the use of resources along global supply chains. Third, many governments have become more active in their support for high-tech manufacturing industries and in policies related to resource efficiency.

Yet in practice, scaling up the concept of a CE raises political economy questions that were not historically the focus of thinking in this arena and are only starting to be explored. For example, which types of firms, sectors and regions stand to gain from the shift to a circular economy? Crucially, what are the immediate opportunities for countries seeking to stimulate their economies in a time of crisis? And how can countries ensure that the circular economy remains open and competitive?

The EU has agreed a strategy for 'a resource-efficient Europe' under its 'Europe 2020 Strategy'[15] and introduced an initiative to address raw-materials security.[16] Relevant country strategies include the National Resource Efficiency Programme in Germany[17] and the proposed 'materials roundabout' – a hub for the high-grade recycling of materials and products – in the Netherlands.[18] In the United Kingdom, the environmental think tank Green Alliance has produced one of the most detailed studies of the CE to date, focusing on economic instruments and raw-materials security. It proposes, for example, product standards and a 'recovery reward' for metals.[19]

13 See the report of the Low Carbon Industrialization Task Force (2011), established under the China Council for International Cooperation on Environment and Development.

14 See Guo Qimin, Circular Economy Development Division, Department of Resource Conservation and Environmental Protection, NDRC China, 'The Ideas of the Development of a Circular Economy in the "Twelfth Five-Year Plan" of China', presentation given at the United Nations Centre for Regional Development (Third Meeting of the Regional 3rd Forum in Asia), www.uncrd.or.jp/env/spc/docs/3rd_3r/PS5-2_NDRC-China_Guo%20and%20Li-new.pdf.

15 European Commission (2011), 'A Resource-efficient Europe – Flagship Initiative under the Europe 2020 Strategy', http://ec.europa.eu/resource-efficient-europe/pdf/resource_efficient_europe_en.pdf.

16 See European Commission website, http://ec.europa.eu/enterprise/policies/raw-materials/.

17 Press release on BMU website: 'Röttgen: Germany aims to become world champion in resource efficiency', 12 October 2011, www.bmu.de/english/current_press_releases/pm/47870.php.

18 Han van de Wiel (2011), 'The Netherlands as materials roundabout', Waste Forum special edition, January, http://www.wastematters.eu/uploads/media/The_Netherlands_as_materials_roundabout.pdf.

19 Hislop, H. and Hill, J. (2011), 'Reinventing the Wheel: A Circular Economy for Resource Security', Green Alliance, www.green-alliance.org.uk/grea_p.aspx?id=6044.

The use of the term 'circular economy' by companies has naturally tended to emphasize the engineering and design challenge for the relevant industry. For example, it is widely adopted by large waste-management companies based in the EU, including SITA UK,[20] Veolia Environment[21] and the van Gansewinkel Groep.[22] Many companies and organizations have implemented policies that are consistent with a CE, often using different terminology.

The next three sections set out the components that will help shape progress towards the CE. The first tackles the redesign of industrial systems at the system level, and particularly the role of heavy industries. The second covers the principle of 'cradle to cradle' production, focusing on the need to redesign products. The third considers how changing patterns of consumer behaviour might help determine future resource pathways.

Redesigning industrial systems

A major reorganization of global industrial systems will not happen overnight. In the meantime it is critical to avoid further lock-in to resource-intensive industrial systems and infrastructure. Owing to the size and scope of economic transformation in emerging economies, choices made in these countries in the next few years will help shape global resource and carbon pathways for decades.[23] There is a window of opportunity to avoid replicating the resource-intensive production models of developed countries and 'leapfrog' to a more sustainable mode of development.

To reach higher levels of resource productivity, the deployment of efficient technology needs to be complemented by systemic and structural changes in industry.[24] For heavy industry, part of the solution is to use the 'waste' stream from one factory as a resource for other companies or consumers,[25] resulting in a local system based on multiple closed loops – sometimes called the 'waste equals food' principle.[26]

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For this to work, physical co-location of factories is often required so that linking infrastructure becomes practical. For example, using waste heat for district heating systems is most cost-effective where the heat source is close to the customer, minimizing the cost of pipes and insulation as well as heat loss. Proximity can also produce significant positive effects on the rates of formation of new firms and firms' productivity, innovation, profitability and growth, according to the Organisation for Economic Co-operation and Development (OECD).[27]

20 SITA UK (2011), 'Achieving the vision of no more waste: engaging in the circular economy'. www.sita.co.uk/downloads/SITAUK-nmw-vision-web.pdf.

21 Veolia Environment (2010), 'Recycling: between market regulations and environmental imperatives', www.veolia-environmentalservices.com/veolia/ressources/files/1/912,Galileo5_Anglais_KQ-1.pdf.

22 Van Gansewinkel Groep (2011), Company press release: 'CEO Ruud Sondag: Give products a raw materials passport', 1 October, www.vangansewinkelgroep.com/en/company/news/sonda_scarcity_recycling.aspx.

23 Lee, B., Froggatt, A. et al. (2007), *Changing Climates: Interdependencies on Energy and Climate Security for China and Europe* (Chatham House/E3G).

24 See the report of the Low Carbon Industrialization Task Force (2011), established under the China Council for International Cooperation on Environment and Development, www.cciced.net.

25 Frosch, R. A. and Gallopoulos, N. E. (1989), 'Strategies for Manufacturing', *Scientific American*, Vol. 189, No. 3, p. 152, www.is4ie.org/resources/Documents/Strategies_For_Manufacturing_Sci_American_1989.pdf.

26 Hawken, P. (1994), *The Ecology of Commerce* (New York: HarperCollins).

27 Davis, C., Arthurs, D. et al. (2006), 'What Indicators for Science, Technology and Innovation Policies in the 21st Century?' (Ottawa: OECD), www.oecd.org/dataoecd/22/18/37443546.pdf.

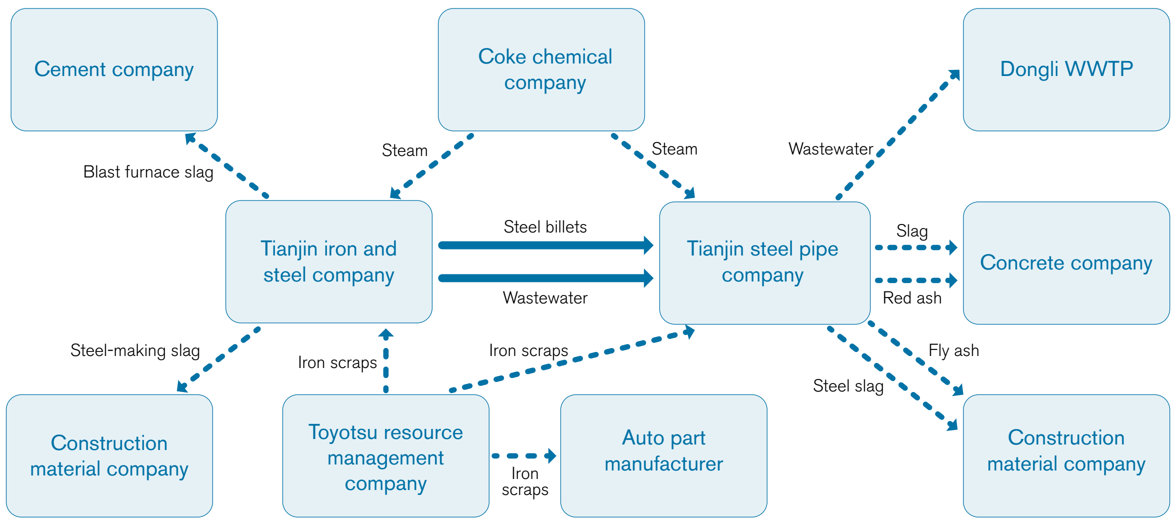
Along these lines, eco-industrial parks were developed in North and South America, Southeast Asia, Europe and southern Africa during the 1990s, often drawing on the example of Kalundborg in Copenhagen.[28] At Kalundborg, heat and other waste from a coal power station is used as a feedstock for fertilizer and plasterboard as well as heating local homes. The economic, resource, cultural and regulatory environment that led to success at Kalundborg has been much studied but has often proved difficult to replicate.

Today, China is giving a renewed boost to the eco-industrial park concept. The 12th Five-Year Plan states that China will 'plan, construct and renovate various kinds of industrial parks according to the requirements of the circular economy.'[29] Figure 1 shows how steel companies in Tianjin have formed an intricate network with other local companies ranging from cement to automobile manufacturing.

Some aspects of integrated process design are already well established in large process industries such as petrochemicals and integrated iron and steel works. In these circumstances, the process design, although complex from an engineering perspective, is relatively simple from an organizational perspective because the processes are often on a single (albeit large) site, and often under the ownership of one or only a few companies. Spreading this type of practice to a more diverse set of industrial sectors involving many different companies may in principle be only slightly more challenging from an engineering point of view, but can be much more challenging from an organizational perspective.[30]

Up to now, most eco-industrial parks have exhibited energy and resource efficiency savings, but they have rarely challenged the fundamental patterns of production and consumption. The next generation of eco-industrial parks could move beyond industrial symbiosis towards a

Figure 1: Industrial ecosystem in Tianjin



Source: China Joint Research Center for Industrial Ecology (2008), 'Uncovering Industrial Symbiosis in Tianjin Region' (Yale University), http://is4ie.org/resources/documents/tianjin%20IS%20Spring%202008.pdf.

28 Lowe, E. (2001), *Eco-industrial Park Handbook for Asian Developing Countries* (Asian Development Bank); Desrochers, Pierre (2001), 'Eco-Industrial Parks: The Case for Private Planning', *The Independent Review*, vol. V, no. 3, pp. 345–71.

29 Guo, Q. and Li, J. (2011), 'The Ideas of the Development of a Circular Economy in the "Twelfth Five-Year" Plan of China' (Department of Resource Conservation and Environmental Protection, NDRC, China), www.uncrd.or.jp/env/spc/docs/3rd_3r/PS5-2_NDRC-China_Guo%20and%20Li-new.pdf.

30 Blyth, W. (forthcoming), 'Systems Change and Innovation for Low-Carbon Industrial Transformation', Chatham House.

Table 1: Types of material reuse

Structural Change	Description of recycling process	Examples	Type of recycling
No change	The product is transferred from one application to another.	Reuse of bottles, second-hand sales of books and clothing, modular construction/deconstruction.	Direct reuse
Superficial	Changes are made to the surface of the product only.	Toner removal from paper, refurbished cardboard boxes (label/print/tape removal), molten-salt processing, thermal cleaning, ultrasonic sound waves, non-abrasive blasting media.	
Deformative	Alterations are made to the form of the product without addition or subtraction of material.	Bending metal beams, reforming steel columns, re-folding of cardboard boxes, re-rolling of steel plate (Indian ship salvage).	Non-destructive recycling
Subtractive	Material is removed from the original product.	Dye-cutting of used cardboard, removal of oxide coating, cutting new shapes from used steel plate.	
Additive	Products are joined together e.g. by welding or gluing.	Cold bonding of aluminium, welding processes (selective recasting, friction welding, laser cladding, wire-arc spraying), gluing of plastics/paper.	
Destructive	Breaking down a material so it can be used as feedstock in conventional production processes.	Melting of plastics and metals, re-pulping of paper/board.	Conventional recycling

Source: Allwood, J., Ashby, M., Gutowski, T. and Worrell, E. (2011), 'Material Efficiency: A White Paper', *Resources, Conservation and Recycling* 55, Table 3.3, www.fraw.org.uk/files/economics/allwood_2011.pdf.

broader vision of green industrialization, incorporating global supply chains and a network of industrial zones. These parks could also demonstrate the shift away from fossil fuels and towards sustainably sourced inputs. The opportunities for heavy industries in the CE could be demonstrated not just through efficiency savings, but through providing high-value products for use in clean-technology manufacturing and associated infrastructure.

Cradle-to-cradle production

In their book *Cradle to Cradle*, William McDonough and Michael Braungart make the case for turning the industrial economic model that 'takes, makes and wastes' into a sustainable system that can be a 'creator of goods and services that generate ecological, social and economic value'.[31] The aim of cradle-to-cradle approaches is highly ambitious: to create products that make money and not only avoid harming the environment and society but have a positive impact on both.

The CE would mean a radical shift in how materials are used throughout the economy. With the right incentives, innovation will deliver more sustainable materials – plastics, for example, would increasingly be derived from plants rather than fossil fuels. Nanotechnology and biotechnology have the potential to deliver materials with increased strength, reduced weight and other useful properties. At the end of the product's life these materials would biodegrade or could be easily separated so that they could be reused.

Key strategies for increasing the 'circularity' of resource flows include switching to longer-lasting products, modularization and remanufacturing, component reuse, and designing products with less material.[32] Under these processes, products can undergo a variety of changes. Table 1 presents the options for reuse and recycling.

31 Mcdonough, W. and Braungart, M. (2002), *Cradle To Cradle: Remaking The Way We Make Things* (San Francisco, CA: North Point Press).

32 Allwood, J., Ashby, M., Gutowski, T. and Worrell, E. (2011), 'Material Efficiency: A White Paper', *Resources, Conservation and Recycling* 55, pp. 362–81, www.fraw.org.uk/files/economics/allwood_2011.pdf.

Making a radical change to product design and business models is a big step for any company, and one that will only be widely replicated if it leads to commercial success. There are few examples of companies that have fundamentally shifted their approach to value creation, but many firms are experimenting with cradle-to-cradle practice, some examples of which are provided in Box 1.

> McKinsey have argued that the most profitable opportunities lie in products with a medium life span – longer than a single use but short enough for reuse and remanufacturing to be attractive

The private sector provides the majority of investment in innovation in many countries, but the policy environment set by governments can be critical in accelerating the time it takes for breakthroughs in materials science and product design to reach the mass market. More evidence is also needed on how the transition to CE practice affects company performance, investment decisions, innovation and employment. McKinsey have argued that the most profitable opportunities lie in products with a medium life span – longer than a single use but short enough for reuse and remanufacturing to be attractive.[33]

Desso, a major Dutch carpet manufacturer, announced in 2010 that it would transform itself into a cradle-to-cradle company by 2020 – meaning that all the raw materials it uses should be free of toxic chemicals, designed for easy disassembly and capable of being recycled or composted. According to Desso's CEO, the strategy has delivered increased profit margins despite the global economic crisis, indicating that customers are already willing to pay a premium for the greener product lines. Moreover, in three years the price premium will be no more than 5% over the traditional approach, down from 15% today.[34]

The Japanese electronic firm Kyocera was an early pioneer of refillable toner cartridges. The company says that conventional cartridges can have over 60 parts made from numerous materials – and are typically thrown away at the end of their life. Instead, it produces much simpler cartridges that can be easily refilled. Over the lifetime of the product this saves money because the materials cost is reduced by 50% (while waste is down by 90%). However, despite its efforts over the past two decades, Kyocera admits it has struggled to displace the conventional business model. The reason is that buying decisions are often determined by the retail price of a printer and not the lifetime cost, which includes the cost of toner and maintenance.[35]

Such approaches require systemic changes that go beyond the individual firm. They must be embedded in partnerships and networks of companies operating at different points in the supply chain.[36] Collaboration can be important because companies need to synchronize investments in innovation or new machinery and logistics infrastructure, or because knowledge and skills need to be brought together. It is not uncommon for companies to have a clear understanding of how their direct suppliers and customers operate, but a much weaker understanding of points further down or above in the supply chain. To address this key challenge, full use of new and emerging technologies that enable information collection, analysis and sharing between companies will be required.

33 Ellen MacArthur Foundation (2012), 'Towards the Circular Economy' (note 6 above).

34 Desso website, http://www.desso.com/Desso/EN; *The Guardian*, 'Cradle to cradle: how Desso has adapted to birth of new movement', 1 September 2011, www.guardian.co.uk/sustainable-business/cradle-to-cradle-desso-carpet-tiles-innovation.

35 Rawling-Church, T., Director of Brand at Reputation at Kyocera, talk given at conference on 'Building Resilience: Resource Security and the Role of the Circular Economy', held at CBI, London on 12 December 2011.

36 Socolow, R. et al. (1994), *Industrial Ecology and Global Change* (Cambridge University Press).

Major global companies have considerable influence over their suppliers, sometimes thousands of them, who can be affected by a change in policy. If such companies took a serious step towards cradle-to-cradle approaches the impact would be felt across the economy. Walmart, for example, has over 100,000 suppliers and has a long term goal of creating zero waste, selling products that sustain people and the environment, and being supplied 100% by renewable energy.[37]

Box 1: Companies and products engaged in cradle-to-cradle activities

Electronics: Philips has a target for 2012 that 30% of its revenue should come from green products. The next phase of its innovation programme aims to 'close the materials loop', with a target of doubling global collection, recycling amounts and recycled materials in products by 2015 compared with 2009.

Carpets: Desso is aiming to fully implement cradle-to-cradle processes by 2020. The company already processes old tiles, separating the yarn, which goes to one of its suppliers. This supplier has itself invested in a de-polymerization facility and then makes new yarn from the waste. For tiles that still include bitumen, that material is separated and goes into road repairs and cycle paths, or serves as raw material for the cement industry.[a]

Construction: The industrial equipment provider Caterpillar has for 30 years offered remanufacturing for a range of industrial products from earth-moving machines to water pumps. The company claims that remanufacturing saved 59,000 tonnes of steel, 91 metric tonnes of cardboard and over 1,500 tonnes of wood products in 2010. End-of-life parts have a return rate of over 90%.[b]

Automobiles: Renault vehicles with the eco^2 mark are designed so that 95% of their mass can be recovered at end-of-life to be reused or recycled. In 2004, Ford introduced a concept car called the Model U that showed the opportunities for modular, layered design, simplified engineering processes and other techniques that help enable remanufacturing and repairs.

Clothing: Patagonia has established its 'common threads initiative'. The company promises to make durable products and to repair faults quickly but also enables customers to fix minor damage. Franz Koch, CEO of clothing manufacturer Puma, says that his company will be the first to bring to market training shoes, T-shirts and bags that are either compostable or recyclable.

Waste: Waste management companies Veolia Environment, SITA UK and the van Gansewinkel Groep have introduced strategies that aim to enhance source-separation of materials. TerraCycle, a company that organizes the collection of waste from households and 'upcycles' them into more valuable products, grew by over 100% per year since its inception in 2001 to $16 million revenue in 2010, the year in which it also started to turn a profit.[c]

a Centre for Remanufacturing and Reuse, www.remanufacturing.org.uk/reuse-repair-recycle.lasso?-session=RemanSession:3EFDC4B21b3fb0D8DCoSY32D3BF1.

b Caterpillar (2010), 'Sustainability Report', http://www.caterpillar.com/cda/files/2838620/7/2010SustainabilityReport.pdf.

c Szaky, T. (2011), 'Choosing between profits and growth', *New York Times,* 25 August, http://boss.blogs.nytimes.com/2011/08/25/choosing-between-profits-and-growth/.

Sources: company websites.

37 Walmart website, http://walmartstores.com/Sustainability/.

Although in general it makes sense to prioritize the reduction in the use of resources and the reuse of products, in some cases it will remain more practical and efficient to recycle or compost the product after one or more uses. Experience in China suggests that using waste steel in steelmaking requires 60% less energy than making primary steel from iron ore.[38] One key issue is how to extract relatively small amounts of key materials such as metals and minerals from electronic goods. Even if the component containing this material cannot be directly reused, with good product design and an appropriate waste stream it can be extracted and recycled without significant degradation of its material quality.

The opportunities are huge if technical barriers could be overcome. For example, a tonne of ore from a gold mine produces just five grams of gold on average, whereas a tonne of discarded mobile phones can yield up to 150 grams.[39] Tailings ponds (containing the waste from metal processing) and landfill sites are similarly rich in useful material.

Today, the recycling of many materials does not occur because it is uneconomical relative to the production of virgin material. With incentives that encourage careful planning all the way from the product design stage to the consumer, the economics of recovery and reuse could be transformed. Jane Jacobs predicted in 1969 that 'cities will become huge, rich and diverse mines of raw materials'.[40] Such approaches could allow companies to sustain large high-grade ore deposits in the 'urban mine' practically indefinitely – a fact that is highly relevant in a world where the discovery of large ore bodies is becoming increasingly rare and ore grades have been declining for decades.

Towards collaborative consumption

According to the UN Environment Programme, the amount of minerals, ores, fossil fuels and biomass consumed globally per year could triple between today and 2050 unless a way is found to decouple economic growth from the rate of consumption of natural resources.[41] Global energy consumption doubled between 1800 and 1900 but grew over twenty times in the 20th century, according to BP;[42] it is set to grow by a further 50% by 2030 under business-as-usual scenarios, according to the according to the International Energy Agency. Global growth in water demand is also set to increase by 50% over the same period compared with current demand.[43]

While developed countries remain responsible for the lion's share of global consumption, the increases in demand in recent years have been fuelled by changing lifestyles and population growth in industrializing countries. In addition, these countries are going through a highly resource-intensive phase of infrastructure development.

There is growing interest in changes to consumption patterns that could help shift global resource trajectories away from 'business as usual'. In terms of the CE, a key demand-side issue is the extent to which resource efficiencies can be achieved by the sharing and recycling of products by consumers. Concepts such as 'collaborative consumption' or the 'sharing economy'[44] are based on the observation that conventional ownership is being replaced in some parts of the economy by 'sharing, bartering, lending, trading, renting [and] gifting'.[45] Companies such as Ebay and Craigslist and

38 See the report of the Low Carbon Industrialization Task Force (2011), established under the China Council for International Cooperation on Environment and Development, www.cciced.net.

39 Yoshikawa, M. (2008), 'Urban miners look for precious metals in cell phones', Reuters, www.reuters.com/article/2008/04/27/us-japan-metals-recycling-idUST13528020080427.

40 Jacobs, J. (1969), *The Economy of Cities* (New York: Random House).

41 Fischer-Kowalski, M. et al. (2011), 'Decoupling Natural Resource Use and Environmental Impacts from Economic Growth', UNEP, www.unep.org/resourcepanel/decoupling/files/pdf/decoupling_report_english.pdf.

42 BP (2011), *Energy Outlook 2030*.

43 2030 Water Resources Group (2009), 'Economic Frameworks to Inform Decision-making', available at www.mckinsey.com/App_Media/Reports/Water/Charting_Our_Water_Future_Exec%20Summary_001.pdf.

44 Benkler, Y. (2004), 'Sharing Nicely: On Shareable Goods and the Emergence of Sharing as a Modality of Economic Production', 114 *Yale Law Journal* 273, http://yalelawjournal.org/the-yale-law-journal/content-pages/sharing-nicely:-on-shareable-goods-and-the-emergence-of-sharing-as-a-modality-of-economic-production/.

45 Botsman, R. and Rogers, R. (2010), *What's Mine is Yours: The Rise of Collaborative Consumption* (New York: Harper Business), p. xv.

organizations such as Freecycle were early enablers of these processes, but now thousands of organizations and companies are involved. Collaborative approaches are also emerging in the design and production of products, posing a potential challenge to orthodox manufacturing practices (see Box 2).

According to Lisa Gansky:

> For now, most businesses… stick to various twists on a single tried and tested formula: create a product or service, sell it and collect money... [but] a new model is starting to take root – one in which consumers have more choices, more tools, more information, and power to guide those choices… [Such approaches] deploy physical assets more efficiently. That boosts the bottom line, with the added advantage of lowering pressure on natural resources.[46]

A switch away from standard ownership models can fundamentally alter the relationship between producer and consumer. Rental or pay-as-you-go contracts are now an option for customers in sectors and activities where a few years ago they barely existed. The 'Collaborative Consumption' website[47] provides hundreds of examples in music and other media, household DIY equipment, toys, textbooks, fashion and art. The proliferation of these approaches is enabled by the internet, but it is also driven by the desire to save money, by convenience, and by environmental and social awareness. The model can be for-profit, non-profit or a mixture of the two. These approaches are also often associated with a specific community or location even if they are part of a larger network.

Car-sharing is one example: there are now half a million members of car-sharing schemes in North America (up from 2,500 in 2000), who drive about 30% less than when they owned a personal vehicle. In addition to dedicated car-sharing companies such as Zipcar, automobile manufacturers BMW, Volkswagen and Peugeot have launched pilot schemes directly with consumers.[48]

In addition, the shift to digital services in some sectors is creating many opportunities for savings in resources and energy. Examples include the streaming of music and films, teleconferencing and remote working.

A major incentive for companies to engage in all these novel approaches is that they have the opportunity to build a much closer and direct relationship with the consumer. Customers may have a single account with a company that allows them to access services, or they may sign long-term contracts on a repair-or-replace basis (for example, for a washing machine). In the latter case, this creates a set of incentives for the company to supply more reliable, durable and repairable goods.

'A switch away from standard ownership models can fundamentally alter the relationship between producer and consumer. Rental or pay-as-you-go contracts are now an option for customers in sectors and activities where a few years ago they barely existed'

Despite these interesting developments, resource consumption continues to grow rapidly in areas that may prove resistant to sharing models, especially where these are linked to lifestyle, status and consumer fashion. For example, personal electronic devices – which have a key role in the sharing economy by facilitating online exchange – themselves require ever-growing volumes of metals and minerals to produce and energy to operate.

46 Gansky, L. (2010), *The Mesh: Why the Future of Business is Sharing* (New York: Portfolio Penguin), p. 6.
47 The examples used here are set out in detail on Rachel Botsman's Collaborative Consumption website, http://collaborativeconsumption.com/.
48 Ibid.

Box 2: A shift to collaborative production?

Sitting at the interface of information technology, machining and advanced materials-related innovation, 'collaborative design and production' approaches have the potential to change the relationship between designers, producers and consumers – and challenge the dominance of production-line manufacturing.

In the last few years it has become possible to 'crowd-source' the design process, harnessing the input of multiple contributors in arrangements that can be relatively informal. A range of technologies and systems has emerged to support crowd-sourcing, such as collaborative virtual environments, online software design tools and open-source forms of intellectual property. Open innovation approaches that were first developed in software are now being applied to the design of physical products.

Breakthroughs in digital design, automated manufacturing and materials innovation have opened up the landscape of sustainability for designers, but they are part of an ongoing process. The linked evolution of digital and information technology, computer-aided design and automation of machine tools revolutionized production processes in the 1960s, as the costs of computing started to fall. Rapid prototyping became possible in the 1980s, accelerating the design process. Photography, scanning and other forms of remote sensing have enabled designers to model, mimic and reshape designs observed in the environment more quickly and with greater accuracy. Automated machining today allows complex 3D structures to be produced with relative ease.

3D printing, which produces physical objects by laying down multiple layers of powder, is one technology that could take collaborative design to the next level. Already, it is being used by businesses for a range of applications – for instance, to produce parts for Formula 1 racing vehicles, architectural models and surgical instruments. In the near future it will be affordable to print objects in a matter of hours in the home or small enterprises – the most inexpensive models are now priced at under $2,000. As the technology moves into the mainstream over the next few years, the time and cost of prototyping and production at small volumes is likely to fall dramatically, accelerating and increasing the scope for collaborative design. Goods could also be produced on demand in near real time and with much greater flexibility than a conventional production line. A change in product size and colour, for example, requires only a couple of clicks on a computer.

Much more work is needed on the broader implications of these new forms of production. Are they destined to be a niche market, to produce parts that slot into existing lean manufacturing systems, or to pose a genuine challenge to just-in-time mass production in the medium term? What are the implications for employment and competitiveness if they start to gain traction? How should innovation policy evolve to reflect the new challenges and opportunities – and what does collaborative production mean for intellectual property rights? The environmental implications of mass uptake of 3D printing versus traditional approaches, in terms of resource, water and energy use, are currently unclear. The additive approach of 3D printing wastes very little material compared with traditional methods, but it lacks economy of scale and involves a switch in raw materials.

Measuring progress

Measuring progress towards a circular economy will involve much more detailed mapping of how resources move within the economy than there is now. Just as important are the economic impacts of the CE along value chains at company and sector level. Information technology has significantly enhanced the ability to track both resource and value flows, enabling companies to identify wasteful processes along the supply chain and model new approaches. But at national level – and for many smaller companies and organizations – poor availability, quality and consistency of resource-related data remain significant obstacles.[49]

For heavy industry, adopting (and going beyond) best available standards for resource consumption would achieve huge savings. Energy intensity standards have been proposed for China, for example, that would bring the country in line with the most efficient developed countries over the next ten years in key sectors.[50] Similarly, one way to capture progress towards a circular economy is the use of 'resource intensity' targets: the total flows of resources and total inputs and waste (adjusting for imports and exports) divided by GDP.[51] The link with GDP recognizes that developing countries face different challenges as they industrialize. However, one issue is how to reflect patterns of consumption and production across different countries.

A number of key questions on the CE should be considered when developing indicators at the national level. First, what is the maximum volume of resources that can be circulated sustainably – i.e. within safe environmental limits? What are the key resources to focus on? How fast should circulation occur? Slower resource flows – with very durable products – might have a lower environmental impact in the short term, but faster flows might enable growth and encourage green innovation. Does a CE imply an ultimate limit to growth in the economy, or can value addition continue indefinitely? In some cases circulation would occur at the local and regional scale, while in other cases the optimization of global systems may be necessary.

Towards international cooperation

At the 2002 World Summit on Sustainable Development in Johannesburg, the world's leaders recognized that 'changing consumption and production patterns, and protecting and managing the natural resource base for economic and social development are overarching objectives of, and essential requirements for sustainable development.'[52] Since then, the resource intensity of the global economy has decreased, but rising population and changing lifestyles mean that overall resource consumption continues to rise.[53] What is now required is transformative and systemic change, rather than just incremental efficiency gains.

Negotiations on a 10-Year Plan of Action on Sustainable Consumption and Production (SCP) did not produce an agreement at the meeting of the UN Commission on Sustainable Development in May 2011, despite significant areas of agreement on SCP between key countries and a number of useful proposals.[54] There remains an appetite for practical action and cooperation on resources that can demonstrate the economic benefits and growth potential of SCP.

Governments in crucial countries have already introduced policies and strategies on resource efficiency – driven by concerns over energy and resource security, but also by escalating problems in managing waste and pollution. The shared roots of policy frameworks for resource efficiency in many countries suggest that a degree of common understanding of some of the key principles may already exist. China became the first country to adopt specific legislation on the CE in 2002 and the concept features prominently in its 12th Five-Year Plan. China's approach was in turn greatly influenced by Japanese and German legislation on the 'recycling economy' in the last two decades, such as Japan's Basic Law for Establishing the Recycling-based Society in 2000,[55] and Germany's Closed Substance Cycle Waste Management Act of 1994.[56]

49 For more on different types of critical information flows, see Tierry, M., Salomon, M., Van Nunen, J. and Van Wassenhove, L. (1995), 'Strategic Issues in Product Recovery Management', *California Management Review*, Vol. 37, No. 2, Winter.

50 See the report of the Low Carbon Industrialization Task Force (2011) (note 38 above).

51 See Fischer-Kowalski et al. (2011).

52 Johannesburg Declaration on Sustainable Development, adopted at the 17th plenary meeting of the World Summit on Sustainable Development, 4 September 2002, www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POI_PD.htm.

53 See Fischer-Kowalski et al. (2011).

54 According to analysis by IISD: 'differences over references to new financial resources or rights of peoples under foreign occupation' were responsible for the lack of agreement on SCP. 'Earth Negotiations Bulletin, Monday 7th March 2011', p. 13, http://www.iisd.ca/download/pdf/enb05304e.pdf.

55 Japan's Basic Law for Establishing the Recycling-based Society, an update of an earlier 1991 law, www.env.go.jp/recycle/low-e.pdf.

56 Gordon Davis, G. J. D. and Hall, J. A. (2006), 'Circular Economy Legislation: The International Experience' (Washington, DC: World Bank), http://siteresources.worldbank.org/INTEAPREGTOPENVIRONMENT/Resources/CircularEconomy_Legal_IntExperience_ExecSummary_EN.doc.

In the wake of the international financial crisis and economic downturn there is also renewed interest in green manufacturing as a driver of economic growth. This is reflected in strengthened industrial strategies in, for example, the United States, the EU, Japan and China.[57] The EU's resource efficiency strategy states that it should be a central element of EU external relations. It also notes that key partners are making major steps in this area and that the EU must further increase its work to bolster its competitive advantage.[58] For its part, China has proposed cooperation with South Korea and Japan on the green economy and CE.[59] These could be the building blocks for developing a way forward.

> 'International cooperation is important for progress on the CE because trade in waste and resources is rising and supply chains for many products today involve multiple countries'

Further international cooperation is important for progress on the CE because trade in waste and resources is rising and supply chains for many products today involve multiple countries, so that separate domestic policies can only address part of the problem. Key technologies will need to spread across borders and be adapted to local needs. Coordination of national policies in key areas and standardization could help to create a level playing field across major markets, easing competitiveness concerns and reducing the costs of implementation for business. It would also create larger markets and investment opportunities.

Barriers to implementation

Widespread implementation of circular-economy approaches would require profound changes in industrial practice and patterns of consumption. This will inevitably create winners and losers, not least in areas where heavy industries and resource production are concentrated. Some of the greatest barriers to implementing a circular economy are set out below.

Lock-in to resource-intensive infrastructure and development models

The traditional development model is driven by heavy industrial growth and resource-intensive infrastructure. While governments in the emerging economies recognize that a less resource-intensive model of development is needed, there are no off-the-shelf models for them to follow. The physical infrastructure of international production, consumption and trade is highly dependent on fossil fuels and geared to once-through manufacturing models.

Political obstacles to putting an appropriate price on resource use

For the market to respond effectively, subsidies that encourage excessive use of resources will need to be removed and all 'externalities' should be incorporated into the price of resources and energy.[60] China, for example, is introducing a range of measures on resource pricing under its 12th Five-Year Plan. But experience from environmental policy-making over decades suggests that regulations with deep systemic impacts – notably carbon pricing – can be frustrated and weakened by special-interest groups.

57 The United States launched a 'Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs' in September 2009; the EU adopted 'Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth' in June 2010; Japan announced details of its 'New Growth Strategy by 2020' in June 2010 and approved it in January 2011; China's 12th Five-Year Plan was launched in 2011.

58 European Commission (2011), 'A Resource-efficient Europe' (note 15 above).

59 Xinhua (2011), 'Wen presents proposal for economic cooperation with Japan, S. Korea', 23 May, http://news.xinhuanet.com/english2010/china/2011-05/23/c_13888422.htm.

60 Hawken, P., Lovins, A. and Lovins, L.H. (1999), *Natural Capitalism: Creating the Next Industrial Revolution* (New York: Little, Brown and Company).

High up-front costs

At the macro level, a successful CE would foster growth and reduce vulnerability to resource-price shocks. But in the short term, there will inevitably be significant up-front investment costs and risks for businesses – e.g. retooling machines, relocating whole factories, building new distribution and logistics arrangements, and retraining staff. Attempting to transform a company's core business model is a risky task in itself and a strong business case will be needed. Clear, strong and predicable policy frameworks will be crucial to encourage investment and experimentation.

Complex international supply chains

Production and consumption often take place in different countries with inputs from multiple companies around the world. In a CE, supply chains may have to be reorganized so that information and material flow in both directions to facilitate reuse and remanufacturing. A key question is how to align incentives throughout the supply chain so that, from the design stage to customer engagement, companies actively consider the use of sustainable materials and features such as durability and reparability at the core of their product strategy.

Lack of consumer enthusiasm

For companies to benefit from the green premium associated with cradle-to-cradle products, consumers will need to understand and value what the concept represents. To reach the mass market, a product certification or labelling system may be needed, like those which have been introduced for energy and carbon. Key barriers include the lack of standardization of methodologies applied in different countries, the cost of assessing resource consumption for individual firms, and the absence of a widely recognized, independent organization to award certification on resource efficiency or a CE.

Challenges for company-to-company cooperation

Incorporating CE practices can require multiple companies to adjust their operations. This may entail a complicated network in which suppliers are ready to provide all the necessary inputs and ensure that infrastructure requirements are in place for logistics, with a diversified set of end markets for recovered materials.[61] Companies face several hurdles in going down this route. There are potentially large transaction costs and delays in negotiating with partner companies. Some larger retailers are already well-practised in pushing norms and standards down supply chains; in other cases companies have longer-term relationships with suppliers.

These cooperative arrangements may touch on fundamental commercial concerns such as the choice of business models, market intelligence and brand positioning. Paradoxically, these pressures could become more acute in the transition to a CE, since the resource would increasingly be associated with the core business model. As John Barton has observed, businesses are more likely to collaborate where they do not directly compete (for instance, electricity distribution companies that operate in separate areas) or if they focus on different sectors.[62]

The innovation challenge

Technology has been at the centre of the dramatic change in manufacturing and industry in the 20th century.[63] It is critical that new breakthroughs in materials science labs and product design studios rapidly find their way into the mass market, so that transition to the CE can contribute to tackling climate- and water-related goals in the necessary timeframe. To optimize global supply chains, smart infrastructure and tracking technology will need to spread across the emerging economies and other developing countries.

61 WRAP (2010), 'Realizing the Value of Recovered Paper: An Update', www.wrap.org.uk/downloads/WRAP_Paper_market_situation_report_Feb2010.352 64b17.8440.pdf.

62 Barton, J. (2007), 'IP and Climate Technology' (Chatham House), www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20 and%20Development/161107_ipclimate.pdf.

63 Arthur (2011), 'The Second Economy', *McKinsey Quarterly*.

Information-sharing along the supply chain and with other companies can raise questions about information security and competitiveness. In a world with sustained, high resource prices, the management of resource flows is likely to increase the importance of protecting intellectual property related to resource efficiency. In addition, practical arrangements will be needed for the shared intellectual property arising from multi-partner activities.

Practical steps forward

There are several practical steps that could be taken by countries and companies in the pursuit of a circular economy.

Best practice and knowledge-sharing

Companies with commitments to the CE or related concepts are already explaining the benefits to the industry and investors. Industry bodies can play a key role in facilitating dialogue between leaders on a CE and other companies that stand to gain from making the transition. Cross-sectoral hubs and networks are likely to be important since systemic CE solutions, almost by definition, involve multiple sectors. As yet there is little evidence, for example, of discussions between online companies at the cutting edge of collaborative consumption and the major heavy industries.

Companies will take the lead on translating CE concepts into practical and profitable business models, but may need practical support in key areas. For example, clear metrics that are affordable to implement would help to encourage the participation of small and medium-sized businesses. Small businesses will also need guidance in areas such as the recovery, reuse and remanufacture of goods and materials.

Table 2: Smart regulations

Fiscal measures	Pricing in the externalities associated with resources and encouragement of minimal resource use, waste and pollution.
	Incentives for owners to put materials back into circulation – e.g. land-value taxes, value-extracted taxes and ‘recovery rewards’.[a]
	Removal of distorting subsidies on resources, energy and land.
End-of-life regulations	These are already applied in countries including the EU, Japan and South Korea, especially for consumer electronics, electrical equipment and vehicles. The focus should be on rates of remanufacturing and reuse.[b]
	Just as important will be the removal of any unnecessary regulatory obstacles to the use of ‘waste’, remanufacturing and new business models.[c]
‘Top runner’ standards	Used in Japan since the 1970s and now proposed for China, the ‘top runner’ policy sets minimum average energy performance standards for different product categories that tighten over time, encouraging innovation by manufacturers and removing inefficient goods from the market. For a CE, this approach could be broadened across other resources and adapted to ensure that the reuse and remanufacturing of products are incentivized.
Public procurement	Obligations on public-sector agencies and government departments to purchase resource-efficient and cradle-to-cradle products. In many countries this is a powerful lever for creating markets for more sustainable goods and encouraging innovation.
Public support for innovation	Policy is crucial in setting the framework to encourage private-sector investments in innovation, for example in new materials or supply-chain resource tracking.
Addressing legal frameworks	Review of the legal implications of company-to-company cooperation – e.g. anti-trust frameworks and data protection and security.

a A reward scheme was proposed by the Green Alliance. See Hislop. H. and Hill, J. (2011), *Reinventing the Wheel: A Circular Economy for Resource Security* (Green Alliance).

b Examples include the EU’s Waste Electrical and Electronic Equipment Directive and End-of-Life Vehicles Directive, Japan’s Home Appliance Recycling Law and End-of-Life Vehicles Recycling Law, and South Korea’s 2007 Act for Resource Recycling of Electrical and Electronic Equipment and Vehicles.

c According to the European Commission (2011), ‘a major policy issue is the need for legal clarity for defining when reprocessed waste can be reclassified as a product’: ‘Communication: Tackling the Challenges in Commodity Markets and on Raw Materials’.

More data and analysis on the impacts of transition to a CE are needed. Most of the academic and technical literature on the CE focuses on environmental sustainability rather than on value creation. To develop a powerful business case requires analysis of the economic impact of CE practice and business models at product and firm level. Just as important, failures should be documented as well as successes, to better understand the determinants of company success.

Smart regulation

While much of the investment, innovation and practice related to a CE will be led by the private sector, governments have a crucial role to play in areas such as support for innovation, setting the conditions for investment, and encouraging business-to-business and business-to-university linkages. The right mix of policies will vary according to country and economic conditions – in particular, the extent of market liberalization.

Some of the key options for smart regulation in the CE are set out in Table 2.

Standardization

Technology standards can play an important role in accelerating innovation in an industry, by removing bottlenecks and encouraging economies of scale. Standardization could be important in a number of areas, from common protocols on smart infrastructure to the replaceability of parts. There may be scope for the formation of industry-level technology standards bodies to set increasingly high standards, bring in the laggards and accelerate diffusion.[64]

Technology standards bodies are industry associations administering key technology standards on behalf of the market. Typically the entrants will contribute intellectual property for mutual use, which means cross-licensing agreements are often part of these associations. All members can use intellectual property within agreed boundaries and may be required to pay royalties into a common pool. Examples of such technology standards bodies include the European Telecommunications Standards Institute, which has had an important role around the management of GSM, GPRS, 3G, WiMax and other related standards; and the Continua Alliance, which develops common inter-compatibility standards for medical diagnostics devices.[65]

> ‘A certification or labelling system for CE products would help to build awareness among consumers, encourage rapid uptake by companies and reward leading companies’

The next generation of ideas

The innovators of the next decades are today’s school pupils and university students, so ensuring they are given the opportunity to learn technical and creative skills required is essential.

The Centre for Low Carbon Futures, a university membership organization based in the UK, has recently launched an international Circular Economy Business School Network. The aim is to inform curriculum development in business schools around the world as they seek to educate students in the new thinking surrounding the CE, creating stronger links with the science and engineering technologies required to address the business challenges. One of the network’s members, the University of Leeds, will provide a new executive MBA programme in 2012 focused on the CE.[66]

64 Lee, B. et al. (2009), *Who Owns Our Low Carbon Technology?* (London: Chatham House), p. 61.
65 Ibid., p. 7.
66 For a description of the Circular Economy Business School Network, see the Centre for Low Carbon Futures website, www.lowcarbonfutures.org/projects/circular-economy.

Raising public awareness

A certification or labelling system for CE products would help to build awareness among consumers, encourage rapid uptake by companies and reward leading companies (by allowing them to capture a green premium). A key challenge is how to encourage adoption of consistent or similar methodologies across countries.

Setting credible benchmarks

Targets on resource use could be established at global, national and city levels. At the global level this could be an absolute target. Resource intensity targets may be more appropriate in the short term for the emerging economies. As has been seen with carbon emissions, accounting for resources used in imported and exported products is a key political and methodological challenge when developing national targets.

Countries and companies need metrics for processes that go beyond incremental resource efficiency improvements and capture more transformative actions, including designing out waste and using sustainable materials. While a credible technical approach is crucial, international experience of developing eco-indicators at national and city levels suggests that the process for agreeing approaches will be equally important to encourage widespread adoption of a methodology.[67]

Support for developing countries

Many developing countries will need help with the transition to a CE. Generating 'new and additional' resources from public funds may be challenging given current economic conditions in developed countries, but a range of existing environmental and low-carbon funding facilities could support transformative actions towards a CE. In addition, multilateral development banks could target additional support towards CE investments. Practical cooperation on technology, systems and innovation in emerging markets should be a priority. To this end, demonstration projects on the CE could be established in key production centres involving emerging-market and OECD companies, with complementary regulatory actions in developed countries.

Conclusion

The circular economy offers a transformational agenda that aims to redesign global production and consumption systems. Many of the ideas are decades old, but a combination of environmental and resource price pressures, technological advancements and changes in consumer demand is finally building momentum. Both the private sector and governments increasingly recognize that future competitiveness will depend on leadership in resource-related innovation.

> '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, cities and businesses could put action on moving towards a CE at the centre of their Rio+20 agendas, including considering targets at the global and national levels. The circular economy offers a strategy for value creation, growth and competitiveness that will become increasingly compelling against a backdrop of high and volatile resource prices.

67 Pintér, L. (2006), *International Experience in Establishing Indicators for the Circular Economy and Considerations for China: Report for the Environment and Social Development Sector Unit, East Asia and Pacific Region* (Washington, DC: World Bank), www.iisd.org/pdf/2006/measure_circular_economy_china.pdf.

Individual companies are showing the way by redesigning the way that products are made and what they are made of – and the public is also starting to embrace new forms of consumption. But 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.

Energy, Environment and Resource Governance

The Energy, Environment and Resource Governance research area (EERG) at Chatham House plays an important role analysing and informing international processes, carrying out innovative research on major policy challenges, bringing together diverse perspectives and constituencies, and injecting new ideas into the international arena.

As the largest research area at Chatham House, EERG seeks to advance the international debate on energy, environment and development policy and to influence and enable decision-makers – governments, NGOs and business – to take well-informed decisions that contribute to achieving sustainable development.

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