Research Paper

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An Inclusive Circular Economy

Priorities for Developing Countries

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Contents

Executive Summary

Radical transformation in the way we use natural resources is central to meeting the needs of future generations. Current trends in global resource extraction are incompatible with internationally agreed targets to limit the rise in global average temperature to below 1.5°C above pre-industrial levels. Diverting to a sustainable growth pathway will require both substantial improvements in the efficient use of primary resources and a significant degree of displacement of primary resources with secondary materials – those recovered from waste streams and repurposed or remanufactured for further use.

The 'circular economy' (CE) concept is fast becoming a new model for resilient growth. A circular economy is one in which products and materials are recycled, repaired and reused rather than thrown away, and in which waste from one industrial process becomes a valued input into another. Creating and optimizing resource 'loops' along value chains could help meet the material needs of growing populations through drastically lower rates of per capita primary resource use. The CE is now a core component both of the EU's 2050 Long-Term Strategy to achieve a climate-neutral Europe and of China's five-year plans. Japan has tabled the CE as a priority for the 2019 G20 summit.

Insufficient attention has been paid to CE pathways in developing countries, despite considerable innovation and policy progress. Structural and political conditions, and the rapid pace of growth and industrial development, will require different solutions to those adopted in developed countries; for example, the agricultural sector has been afforded minimal attention in global CE discussions to date, but will need to take a central place in developing-country CE pathways. Innovation is already under way in developing countries, in the agricultural sector and beyond, and developing-country governments are beginning to adopt ambitious strategies for more resource-efficient and circular patterns of industrial growth.

The CE offers a promising alternative strategy for industrial development and job creation to the traditional manufacturing-led growth pathway. The CE continues to be understood primarily as a waste management and recycling strategy, but the economic opportunities are far broader and more diverse. With the right enabling conditions, the CE could provide new opportunities for economic diversification, value creation and skills development. Developing countries are in a strong position to take advantage of the new economic opportunities. Their large informal sectors already practice 'circular' activities – in areas such as electronic waste (e-waste) and phone repairs, for example – and could engage in higher-value CE supply chains. Moreover, with enough investment, developing countries can 'leapfrog' developed countries in digital and materials innovation to embed sustainable production and consumption at the heart of their economies.

A transition to a CE brings certain trade-offs that require careful management. In the absence of a coordinated and strategic approach to the CE at national or international level, there is the risk that companies will adopt tokenistic – or, at worst, harmful – activities under the umbrella of the CE which preclude more sustainable or higher-value material use. Waste-to-energy initiatives using sub-standard incineration practices, for example, may bring environmental and human health risks and may also be drawing on waste streams better suited to second-life products. Trade-offs may

also arise where circular solutions imply significant shifts in industrial policy: in resource-intensive economies, for example, circular approaches can support value addition but may also risk job losses among those employed in resource extraction and primary processing.

The success of the CE in developing countries will be critical to global efforts to ensure sustainable growth. Developing countries are already global centres of production and are set to become the global drivers of consumption. Success now in embedding circular principles in industrial growth and infrastructural development strategies can help to meet the needs of growing and urbanizing populations while mitigating against a continued rise in primary resource use, associated emissions and environmental pollution. For example, in adopting modular, adaptive and resilient design principles, the CE can help to deliver quality housing and infrastructure at low economic and environmental cost.

Greater focus is needed on circularity in international value chains, and on the governance and investment frameworks required to enable a global CE. In 2015, East African countries proposed a ban on imports of secondary textiles to protect their domestic industries, concerned about large volumes of cheap second-hand clothes from China entering the market. After the US threatened retaliation, the ban was replaced with an import tax, but the episode highlighted how the trade in secondary materials, if not carefully managed, can lead to tensions with traditional sectors and between countries. And in 2018, China's imposition of a de facto ban on solid waste threw light on the importance of developing integrated, transparent supply chains in waste and secondary materials if harmful waste-dumping practices are to be avoided and CE value chains are to emerge at scale. Greater cooperation is needed at the global level to agree on common rules and standards for international circular value chains, particularly where they risk displacing traditional workers or are associated with environmental or health risks, as is the case with e-waste.

There is an urgent need to widen the global CE conversation to include developing countries and to invest political and financial capital in promoting the development of an inclusive, global CE. Developed-country governments have an important role to play in facilitating a meaningful dialogue on how the international dynamics of CE policies may best be managed. Support from international agencies such as the UN Industrial Development Organization (UNIDO) and the UN Environment Programme (UNEP) will be critical to facilitating the piloting of CE solutions among small and medium-sized enterprises (SMEs) in developing countries and along international value chains to demonstrate the viability of cross-border circular value chains at scale. And proactive engagement by multinational companies with suppliers in developing countries – including SMEs and those operating in the informal sector – will be necessary for circular activities to be scaled up in a manner that is inclusive and avoids the displacement of vulnerable workers.

The next two years present a moment of opportunity to develop a global vision for the CE aligned with climate action and the broader sustainable development agenda. There is much scope for aligning CE strategies with climate action and sustainable development commitments at the national and international level. Key international milestones in global climate change talks, in the delivery of the UN's Sustainable Development Goals (SDGs) and in the agreement of a global treaty on biodiversity protection in 2019 and 2020 present a unique opportunity to integrate the CE into existing global political and environmental agendas and catalyse increased public and private investment in the roll-out and scale-up of CE solutions in developing countries.

Action is required on three fronts:

1. **Aligning the CE with existing policy priorities** in developing countries. To integrate the CE within high-level industrial strategies and investment planning, decision-makers need confidence that CE approaches are consistent with sustainable development objectives, including driving resilient economic growth and providing opportunities for the most vulnerable people. National governments in developing countries should identify synergies between the CE and existing national plans, and undertake an assessment of the scale of opportunity in transitioning to a CE across key sectors of the economy. Donor governments should support the CE as an industrial development strategy in developing countries, mobilizing funds to support the pioneering and scaling up of CE activities.

2. **Investing in the fundamentals** to support the transition to the CE in developing countries. Robust governance frameworks, inclusive policies and partnerships at national, regional and international level will be needed to create an enabling environment for the testing and rolling out of CE activities, and to mitigate potential environmental and health risks from poor waste management. National governments in developing countries should identify priority reforms to domestic policy in support of CE activities; investors should develop cooperative and blended finance mechanisms to support and de-risk early investment in CE value chains; and intergovernmental organizations such as UNIDO and UNEP, with the support of G20 governments, should launch a global 'circular economy accelerator network' to pilot innovative policy interventions and build capacity among developing-country private-sector suppliers.

3. **Supporting an inclusive global CE agenda** that promotes partnership and collaboration. Trade and cooperation are key ingredients for accelerating the CE in developing economies, and harnessing opportunities for innovation will depend on leveraging foreign investment. As important as financial and material flows will be the exchange of knowledge and lesson-learning between those implementing the CE and those looking for evidence of effective strategies and interventions. Developed-country governments should identify early opportunities for 'triple-win' collaboration with developing countries to deliver on trade, the CE and broader sustainability goals; while multilateral development banks should align investments in climate resilience, biodiversity protection and sustainable development with the CE.

   The EU and China, as global CE front-runners, should commit to deeper dialogues with developing countries. Regional forums, such as the Regional 3R Forum in Asia and the Pacific and the African Circular Economy Alliance, should engage proactively in knowledge- and lesson-sharing at an international level. G20 governments should demonstrate leadership in cooperative action in support of the CE. Global trade bodies should spearhead the development of common standards for internationally traded waste and secondary materials.

1. Introduction

In 2015, with the signing of the Paris Agreement on climate change and the establishment of the Sustainable Development Goals (SDGs), the international community recognized that a transformation in the way we use natural resources is a precondition for achieving prosperous, secure and resilient societies. Resource-intensive growth has come at huge environmental cost. Delivering the infrastructure and services needed to support growing economies and populations – above all in developing countries – while addressing climate change and maintaining ecosystem stability will require a revolution in models of resource use.

Excitement is growing around the potential for more 'circular' – and sustainable – models of development to deliver this revolution and to unlock economic, social and environmental benefits. Visions for what is known as the 'circular economy' (CE) rest on a systemic approach to resource efficiency in which 'end-of-life' products and materials – that is, those at the end of their original service lifespan – are not discarded but are instead recycled, repaired or reused through circular value chains. The CE also implies changes to business models, with an emphasis on shared use and rental in preference to independent or single use; as well as changes to consumer preferences, with buyers valuing 'second-life' products (i.e. those recycled or adapted for new uses) and asset sharing over individual ownership.

More often than not, even in rich countries, discussion of sustainability has tended to emphasize reform of specific supply chains rather than full-economy transformation. Over the past decade, advocacy of the CE has come primarily from high-profile transnational corporations in consumer industries, such as Philips and Unilever, and from waste management groups such as Veolia. In part due to the CE's focus on new business models for supply chain management, as well as on industrial regeneration and jobs, the focus of attention around the CE has been on developed countries (above all in the European Union) and China, where CE strategies are most advanced. Less well explored is the role that developing countries other than China can play in a global CE, and the importance of fostering international collaboration and the development of global governance frameworks to support circular value chains at scale.

1.1 The circular economy: a new development paradigm?

Against this backdrop, international organizations including the United Nations (UN), the Organisation for Economic Co-operation and Development (OECD) and the World Economic Forum (WEF) have increasingly called for a new development paradigm: one that prioritizes pathways for poverty reduction and improved standards of living, while promoting resource efficiency and easing pressure on natural resources and the environment. Two milestone agreements in 2015 – the creation of the SDGs and the signing of the Paris Agreement – heralded a radical shift in thinking on growth and development. They placed sustainable production and consumption at the forefront of global efforts to achieve equitable economic growth and tackle climate change.

Investments in emerging and developing economies in the next few years will be critical to delivering on these two global agreements and to shaping natural resource demand, pollution control and waste

management pathways for the coming decades. To meet the SDGs, a scaling up of critical infrastructure will be required in low- and middle-income countries to provide economic opportunity and access to modern services. Yet industries essential to this process – cement, steel, energy, for example – demand significant quantities of water, land and minerals. To meet the provisions of the Paris Agreement, infrastructure expansion will need to be founded on low-carbon technology and circular systems that are climate-friendly and climate-resilient.

In recognition of the limits to current resource-intensive models of development, policymakers are paying increasing attention to the CE concept as an alternative development paradigm that can deliver on the SDGs and Paris Agreement.[1] In principle, the shift to a CE would allow countries to reap the benefits of industrialization, increase well-being and reduce vulnerability to resource price and environmental shocks, without depleting stocks of finite natural resources and contributing to environmental degradation (see Box 1).

Much of the interest in the CE centres on its potential to deliver simultaneously on four major political priorities: job creation, balance-of-payments support, supply chain resilience, and climate change mitigation and adaptation. Estimates of the scale of opportunity largely address developed-country settings but have significant bearing for developing countries:

- **Job creation.** Through capturing the value of materials previously lost to the economy and generating jobs to harness and capitalize on this value, the CE is expected by many to drive job creation and economic growth.[2] Most macroeconomic models find that such a shift will have a positive economic effect,[3] and that many CE activities will offer opportunities for employment at a range of skill levels and across different geographies.[4] A Waste and Resources Action Programme (WRAP) study in 2015 suggested that shifting to a CE could create up to 3 million extra jobs in Europe by 2030.[5] In developing countries where large numbers of young people are entering the labour market each year, ensuring adequate employment opportunities will be key to fostering economic growth and political stability.
- **Balance-of-payments support.** As imports increase to meet rising demand for goods from growing populations, developing-country governments will need to identify opportunities to avoid balance-of-payments deficits. A series of studies estimates the potential scale of savings from shifting to a CE to be in the multi-billions and trillions of dollars in developed countries. A McKinsey analysis for the Ellen MacArthur Foundation (EMF) projected savings in materials costs of up to $630 billion per year by 2025 in EU manufacturing sectors.[6] Similar benefits potentially apply to developing countries. An Arup study, also for EMF, estimated that a transition to the CE at scale in China could save businesses and households RMB 70 trillion ($10.4 trillion)[7]

[1] Preston, F. and Lehne, J. (2017), *A Wider Circle? The Circular Economy in Developing Countries*, Briefing, London: Royal Institute of International Affairs, https://www.chathamhouse.org/publication/wider-circle-circular-economy-developing-countries (accessed 16 Apr. 2018).
[2] Morgan, J. and Mitchell, P. (2015), *Employment and the circular economy: Job creation in a more resource efficient Britain*, London: Green Alliance, http://www.wrap.org.uk/sites/files/wrap/Employment%20and%20the%20circular%20economy%20summary.pdf (accessed 3 Jul. 2018).
[3] McCarthy, A., Dellink, R. and Bibas, R. (2018), *The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches*, OECD Environment Working Papers, No. 130, doi:10.1787/af983f9a-en, Paris: OECD Publishing.
[4] Preston and Lehne (2017), *A Wider Circle? The Circular Economy in Developing Countries.*
[5] WRAP (2015), *Economic Growth Potential of More Circular Economies*, http://www.wrap.org.uk/sites/files/wrap/Economic%20growth%20potential%20of_more%20circular%20economies.pdf (accessed 3 Jul. 2018).
[6] Ellen MacArthur Foundation and McKinsey Center for Business and Environment (2015), *Growth Within: A Circular Economy Vision for a Competitive Europe*, https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/europes-circular-economy-opportunity (accessed 1 Nov. 2017).
[7] Exchange rate of RMB1:$0.1490 via Reuters as of 9 March 2019, https://uk.reuters.com/business/currencies.

by 2040, equivalent to 16 per cent of China's projected real GDP.[8] Accenture identified a $4.5 trillion opportunity by 2030.[9] In India alone, EMF estimates that the CE could create opportunities worth $218 billion per year by 2030.[10] Harnessing new opportunities for value creation will be critical to supporting continued industrial growth in developing countries, particularly in those that currently depend heavily on natural resource rents.

- **Supply chain resilience.** Fears of resources 'running out' have subsided in line with recent resource price falls, but price volatility continues to provide an important incentive – for resource-importing and -exporting countries alike – to pursue less resource-intensive economic pathways. In recent years, moreover, there have been growing concerns over reliance on critical material inputs for advanced technologies – for example, rare earth elements for smartphones or cobalt for electric vehicles.[11] These resources are concentrated in a handful of producer countries, many of which do not have adequate resource governance frameworks to mitigate the environmental and social risks from mineral extraction. Circular value chains and models of product sharing and reuse are expected to reduce countries' exposure to resource supply risks,[12] but will at the same time bring structural changes to resource-intensive developing economies. As demand for raw materials lessens in line with the transition to a CE, potentially significant structural changes will be required to ensure these countries' continued participation in high-value international supply chains.
- **Climate change mitigation and adaptation.** A recent report by Material Economics, a Swedish consultancy, suggests that shifting towards a CE could reduce EU emissions from heavy industry by as much as 56 per cent by 2050 relative to a baseline scenario.[13] According to the International Resource Panel (IRP), more resource-efficient practices could be critical to achieving the commitments in the Paris Agreement. The IRP projects that resource efficiency approaches could reduce greenhouse gas emissions by 60 per cent by 2050.[14] Savings on individual resources can be even higher: producing aluminium from scrap results in a 90–95 per cent reduction in energy inputs and greenhouse gas emissions.[15] CE practices can also contribute to climate adaptation and resilience, including more efficient use of water and energy resources, improved management of land ecosystems to mitigate climate-induced yield losses, and innovative approaches to disaster-ready building and infrastructure construction. With middle- and lower-income countries expected to experience the worst effects of climate change in the short to medium term, exploiting the synergies between the CE and climate mitigation and adaptation will be key to delivering on global commitments under the Paris Agreement while lowering the costs of building climate-resilient infrastructure and industry.

[8] Arup and Ellen MacArthur Foundation (2018), *The Circular Economy Opportunity for Urban & Industrial Innovation in China*, https://www.ellenmacarthurfoundation.org/assets/downloads/The-circular-economy-opportunity-for-urban-industrial-innovation-in-China_19-9-18_1.pdf (accessed 7 Apr. 2019).
[9] Lacy, P. and Rutqvist, J. (2015), *Waste to Wealth: Creating advantage in a circular economy*, New York: Palgrave Macmillan; Ellen MacArthur Foundation and McKinsey Center for Business and Environment (2015), *Growth Within* (accessed 1 Nov. 2017).
[10] Ellen MacArthur Foundation (2016), *Circular Economy in India: Rethinking Growth for Long-Term Prosperity*, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Circular-economy-in-India_5-Dec_2016.pdf (accessed 10 May 2017).
[11] Mathieux, F., Ardente, F., Bobba, S., Nuss, P., Blengini, G., Alves Dias, P., Blagoeva, D., Torres De Matos, C., Wittmer, D., Pavel, C., Hamor, T., Saveyn, H., Gawlik, B., Orveillon, G., Huygens, D., Garbarino, E., Tzimas, E., Bouraoui, F. and Solar, S. (2017), *Critical Raw Materials and the Circular Economy – Background report*, Luxembourg: Publications Office of the European Union, doi: 10.2760/378123 (accessed 3 Jul. 2018).
[12] European Commission (2015), *Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Closing the loop – An EU action plan for the Circular Economy*, 2 December 2015, COM(2015) 614 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614 (accessed 29 Jul. 2018).
[13] Material Economics (2018), *The Circular Economy – a Powerful Force for Climate Mitigation,* http://materialeconomics.com/publications/the-circular-economy (accessed 3 Jul. 2018).
[14] Ekins, P. and Hughes, N. (2017), *Resource Efficiency: Potential and Economic Implications*, UN Environment Programme (UNEP), https://europa.eu/capacity4dev/unep/documents/resource-efficiency-potential-and-economic-implications (accessed 19 Oct. 2017).
[15] Gardner, J. (2017), 'Circular economy & decarbonisation: lessons from industry', Hoffmann Centre for Sustainable Resource Economy, 4 September 2017, https://hoffmanncentre.chathamhouse.org/article/circular-economy-and-decarbonisation-lessons-from-industry/ (accessed 29 Jul. 2018).

Box 1: What is the circular economy?

The idea of having some 'circularity' of resource use in an economy is hardly a new one. Activities such as recycling, remanufacturing and reusing products are already part of most industrialized waste management systems. The novelty of the 'circular economy' (CE) as a unifying concept is that it is comprehensive. It brings different elements together into a single framework to enable a more systemic and cohesive approach – in theory, allowing policymakers and businesses to better manage trade-offs associated with resource efficiency practices. Where the CE is successfully deployed, it not only reduces waste and resource needs but also unlocks additional value from natural resources. As such, the CE is about more than conserving resources: it implies the development of an ecosystem in which innovations in sustainability support whole new areas of economic activity.

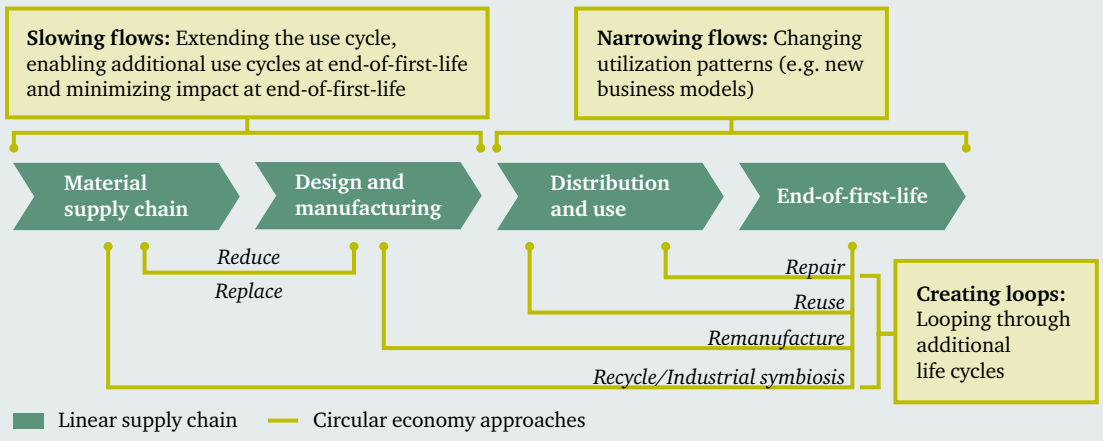
There is no standardized definition of the CE. Some definitions include a set of new business models that can extract more value from resources while reducing their overall use. For instance, there is the 'sharing economy', which involves physical assets such as cars and homes being shared between multiple people. This can increase the 'utilization rate' of products but may also decrease the total number of products needed. Alternatively, 'product-as-a-service' models involve companies leasing products to consumers. Such approaches may provide a greater incentive for manufacturers to make products more durable and easier to repair.

The definition used in this paper falls at the broader end of the spectrum. A circular economy is one in which products are recycled, repaired or reused rather than thrown away, and in which waste from one process becomes an input into other processes.

In practical terms, the CE can be broken down into three types of activities (also see Figure 1):

1. **Creating loops** – when a product reaches the end of its designed operational life, it is reused, repaired or recycled rather than thrown away.
2. **Slowing flows** – shifting to new ways of designing and making products ensures that they remain in use for as long as possible, thereby decreasing demand for new products.
3. **Narrowing flows** – this involves shifting to more efficient ways of using products, e.g. sharing products or adopting product-as-a-service models.

Figure 1: Circular economy activities



Source: Authors' own analysis adapted from a diagram by InnovateUK.

1.1.1 Slow progress in achieving the circular economy at scale

For all of the excitement around the CE as a new development paradigm, progress in its implementation has been slow. Although many countries have shown improvements in energy efficiency and resource productivity, these gains have not translated into a reduction in absolute resource use at the global level. Indeed, recent trends indicate a possible 'recoupling' of GDP growth to resource use.[16] An analysis of materials use in the global economy suggests that of the 19.4 billion tonnes of waste produced in 2015, only 9.1 per cent was recycled.[17]

Even in countries generally perceived to have advanced waste management systems, a CE is taking time to take shape. In Sweden, where the share of materials collected for recycling is relatively high, only a small percentage of such materials are converted into secondary materials, and an even smaller percentage of their original value is captured.[18] In the UK, there has been growing criticism of waste management companies and councils collecting vast quantities of materials for which there is no market.[19] These issues have been thrown into sharp relief by China's de facto ban on the import of secondary plastic and paper: the sudden disappearance of a destination for the majority of globally traded waste has drawn attention to inadequate waste management systems in the US and Europe, which are failing to cope with the increased volumes of materials requiring domestic processing.

The sudden disappearance of a destination for the majority of globally traded waste has drawn attention to inadequate waste management systems in the US and Europe, which are failing to cope with the increased volumes of materials requiring domestic processing.

The CE is rising up the international policy agenda (see Box 2), but there is currently no global agreement to steer implementation, align the CE with existing frameworks, and facilitate cooperation and rapid lesson-sharing. A collaborative agenda at the global level that aligns the CE with existing policy priorities around sustainable development and trade cooperation is needed to accelerate the development of circular value chains both in developed and developing countries. Amid rising tensions over international trade and rules-based governance, the CE will understandably be seen by some governments as an appealing alternative: a way to generate economic value and jobs while reducing dependence on imports of raw materials and products. But an inclusive approach to the CE requires examination not only of national strategies but also of the cross-border effects of alternative development strategies. It also requires scrutiny of the role of regional and international circular value chain development in delivering the transition to a CE at scale.

[16] Ekins and Hughes (2017), *Resource Efficiency: Potential and Economic Implications*.
[17] De Wit, M., Hoogzaad, J., Ramkumar, S., Friedl, H. and Douma, A. (2018), *The Circularity Gap: An analysis of the circular state of the global economy*, https://docs.wixstatic.com/ugd/ad6e59_c497492e589c4307987017f04d7af864.pdf (accessed 4 Jun. 2018).
[18] Material Economics (2018), *Retaining Value in the Swedish Materials System*: *English Summary,* http://materialeconomics.com/me_rapport_eng_summary.pdf?cms_fileid=4aba8bbdd943ddc6fe8298ba70784eee (accessed 4 Jul. 2018).
[19] Peake, L., Brandmayr, C. and Klein, B. (2018), *Completing the circle: Creating effective UK markets for recovered resources*, London: Green Alliance, https://www.green-alliance.org.uk/completing_the_circle.php (accessed 3 Jul. 2018).

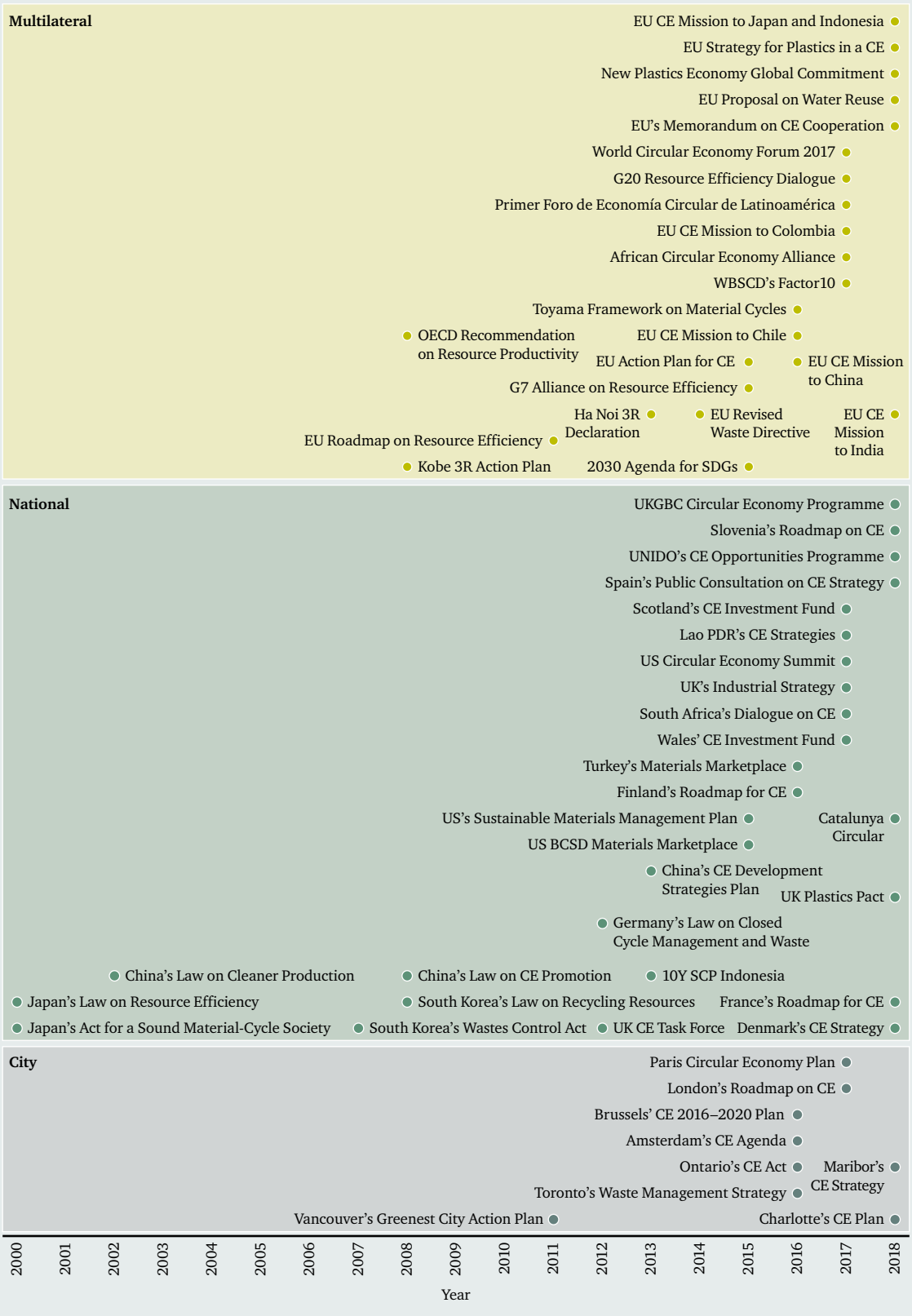
Box 2: Growing interest in the circular economy

The CE policy landscape has expanded noticeably over the last two decades. Although CE-type thinking has been around since the 1970s, policies that explicitly refer to the 'circular economy' started to be introduced only in the 2000s. The EU and China have been the global front-runners in this process. China introduced its Circular Economy Promotion Law in 2009 and has since developed a series of supporting policies, including the State Council's Circular Economy Development Strategy and Near-Term Action Plan, issued in 2013; and the Promotion Plan of Extended Producer Responsibility, introduced in 2016.[20] In Europe, high-level discussions on the CE began in 2011 in the context of concerns around high commodity prices. The EU announced its highly ambitious Action Plan for the Circular Economy in 2015. This has been followed by a slew of policy announcements, dedicated CE strategies and action plans from ambitious member states and European cities.

There has also been a dramatic increase in business engagement, as companies increasingly see their profitability and long-term success as dependent on more sustainable development.[21] A growing range of companies – including major players such as Google, Unilever and Renault – have been exploring circular approaches, spurred on by the potential for cost savings from adopting more resource-efficient supply chains. For instance, Ricoh – a multinational electronics company – collects, disassembles and reuses the component parts of printers, scanners and other office equipment. Philips, a multinational technology company, has launched a 'lighting as a service' business. Some firms are finding new value in waste streams that previously went untapped: for example Newlight Technologies, a California-based company, has developed a technique for turning captured methane and carbon dioxide into plastic.

[20] Li, W. and Lin, W. (2016), 'Circular Economy Policies in China', in Anbumozhi, V. and Kim, J. (eds) (2016), *Towards a Circular Economy: Corporate Management and Policy Pathways*, Economic Research Institute for ASEAN and East Asia (ERIA) Research Project Report 2014–44, Jakarta: ERIA, pp. 95–111 (accessed 25 Apr. 2019); and Pauliuk, S., Wang, T. and Muller, D. B. (2012), 'Moving Toward the Circular Economy: The Role of Stocks in the Chinese Steel Cycle', *Environmental Science & Technology*, 46(1): pp. 148–54, doi: 10.1021/es201904c (accessed 24 Apr. 2019).
[21] OECD (2016), *Private Sector Engagement for Sustainable Development: Lessons from the DAC,* Paris: OECD Publishing, doi: 10.1787/9789264266889-en (accessed 6 Jul. 2018).

Figure 2: Circular economy initiatives over time



Source: Authors' analysis.

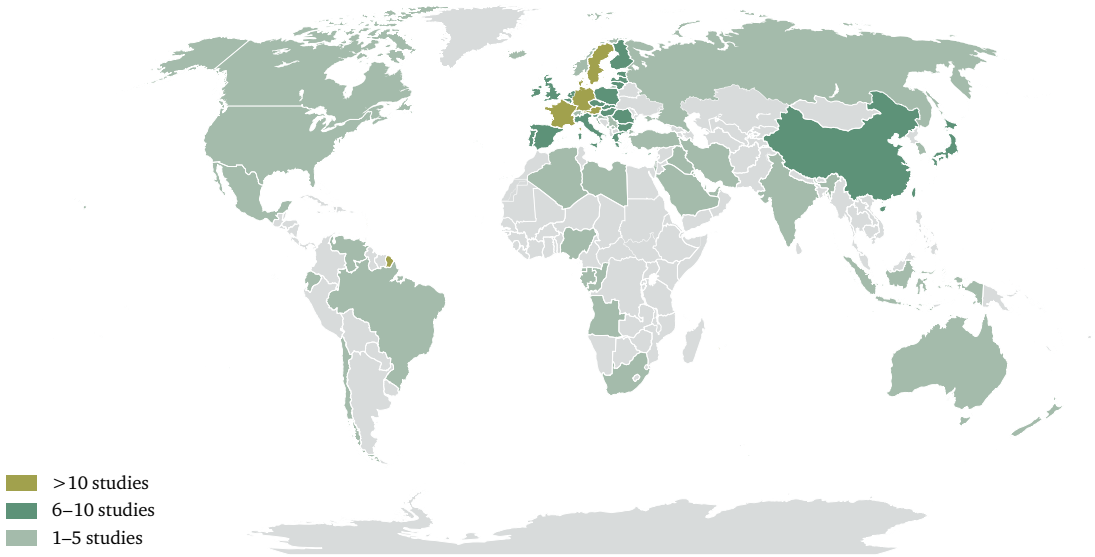
1.2 The circular economy in developing countries

Until now, discussions on the CE have paid minimal attention to developing economies other than China. This is despite the many opportunities for circular activity that already exist in such economies, and the important role that developing countries will play in future global circular value chains. Analyses of the CE, its development and implications have focused overwhelmingly on the EU and China,[22] which have the most advanced legislative frameworks in this area.

The scant focus on developing economies in part reflects the paucity of detailed data at the country and subnational level in these settings. Of the top cited papers on the CE, 42 per cent focus on China, one focuses on Europe, and the rest deal with the evolution of the concept and do not have a specific regional lens.[23] Very few other developing countries are included in existing macroeconomic models of the effects of shifting to a CE (see Figure 3).

At the same time, national-level assessments have been undertaken for only a handful of high-income countries: Austria, France, Germany, Japan, South Korea, Sweden and Turkey.[24] More granular data on a larger set of countries are available in input–output models.[25] However, these data are often aggregated to just a few economic sectors, limiting the effectiveness of the process for CE monitoring.[26]

Figure 3: Geographic coverage in existing CE-related macroeconomic models



Source: Authors' analysis of studies included in McCarthy, A., Dellink, R. and Bibas, R. (2018), *The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches*, OECD Environment Working Papers, No. 130, doi:10.1787/af983f9a-en, Paris: OECD Publishing.
Note: This analysis includes both single- and multi-region analyses. When a study included a larger non-specific region such as 'rest of world' or 'western Europe', the countries within these broad categories were not included.

[22] Turkeli, S., Kemp, R., Huang, B., Bleischwitz, R. and McDowall, W. (2018), 'Circular economy scientific knowledge in the European Union and China: A bibliometric, network and survey analysis (2006–2016)', *Journal of Cleaner Production*, 197: pp. 1244–1261, doi: 10.1016/j.jclepro.2018.06.118 (accessed 6 Jul. 2018); and Kalmykova, Y., Sadagopan, M. and Rosado, L. (2018), 'Circular economy – From review of theories and practices to development of implementation tools', *Resources, Conservation & Recycling,* 135: pp. 190–201, doi: 10.1016/j.resconrec.2017.10.034 (accessed 9 Jul. 2018).
[23] Authors' analysis of Google Scholar search results on 6 July 2018. The search term used was 'circular economy'. Only hits with more than 100 citations were included, resulting in a dataset of 26 articles, papers and reports.
[24] McCarthy, Dellink and Bibas (2018), *The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches*.
[25] WIOD, GTAP, EXIOBASE and Eora cover a broader set of regions, 43, 140, 43 and 190 respectively.
[26] Kalmykova et al. (2018), 'Circular economy – From review of theories and practices to development of implementation tools'.

The lack of data and analysis on the CE in most developing countries belies important opportunities for accelerating a transition to circular activities and value chains. Certain developing countries are actively pursuing national CE policies. Nigeria, Rwanda and South Africa launched the African Circular Economy Alliance in 2017, while India has set out a strategy for resource efficiency which recognizes the role of the CE in achieving this.[27]

Waste remains a major environmental and public health challenge in many developing countries: of the top 20 countries ranked by mass of mismanaged plastic waste in 2015, 12 were low-income.[28] Middle-class citizens in the developing world are already starting to consume more and reuse less.[29] That said, in many middle- and lower-income countries a wealth of circular activity is already happening. Currently this activity is not being captured in analyses, but it could provide a starting point for broader CE strategies at a national, regional or global level (see Table 1).[30]

Developing countries are the current dominant centres of production and the future centres of consumption in the global economy. An increasing share of the global 'consuming class' now lives in emerging and developing countries, with a vast concentration in India and China. McKinsey estimates that by 2025 the global consuming class will have an additional 1.8 billion people, of which 1 billion will live in the emerging world.[31] If there is to be a fundamental shift in consumption and production patterns, the success of CE models in these countries will be key.

> Developing countries are the current dominant centres of production and the future centres of consumption in the global economy.

Following the pathways to the CE that will be established and implemented in developed countries is unlikely to be fruitful. Many of the challenges faced by proponents of the CE in these settings – access to finance to support innovative technologies, for example, and a narrow understanding of the CE among stakeholders as primarily a waste management concept – are common to developing countries. Yet other structural and economic conditions make the scaling up of the CE in developing countries particularly challenging: institutional capacity is often limited, access to technology is not equitably distributed, the private sector is often fragmented, and the dominant strategies for industrial growth and economic development are, in many cases, founded on resource extraction-led models.

The outlook for the CE in developing countries may also depend on the global appetite for international trade and regional cooperation. For many developing countries, participation in CE value chains will only be possible if there are regional remanufacturing, reprocessing and material recovery hubs that import used products and repair them ready for resale to consumer markets. However, robust regulations will be needed to avoid the exploitation of such hubs for waste dumping by exporting countries. Waste reduction measures in agricultural supply chains also present new export opportunities through the bio-economy, for example in the form of sustainable construction timber. Ultimately, harnessing the economic opportunities of the CE will not only be a function of trade and regional

[27] NITI Aayog (2017), *Strategy on Resource Efficiency*, https://eeas.europa.eu/sites/eeas/files/na_eu_restrategy_nov2017.pdf (accessed 20 Mar. 2019).
[28] Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R. and Law, K. L. (2015), 'Plastic waste inputs from land into the ocean', *Science*, 347(6223): pp. 768–71, doi: 10.1126/science.1260352 (accessed 20 Mar. 2019).
[29] Cooke, K. (2016), 'Rising middle class threatens China's climate targets', Climate Home News, 29 December 2016, https://www.climatechangenews.com/2016/12/29/rising-middle-class-threatens-chinas-climate-targets/ (accessed 20 Mar. 2019).
[30] Schroeder, P., Dewick, P., Kusi-Sarpong, S. and Hofstetter, J. S. (2018), 'Circular economy and power relations in global value chains: Tensions and trade-offs for lower income countries', *Resources, Conservation & Recycling*, 136: pp. 77–78, doi: 10.1016/j.resconrec.2018.04.003 (accessed 19 Jul. 2018).
[31] McKinsey & Company (2016), *Urban World: The Global Consumers to Watch*, McKinsey Global Institute, https://www.mckinsey.com/~/media/McKinsey/Featured%20Insights/Urbanization/Urban%20world%20The%20global%20consumers%20to%20watch/Urban-World-Global-Consumers-Full-Report.ashx (accessed 14 Nov. 2018).

cooperation. It will also rely on knowledge-sharing with front-runner regions, the ability to attract foreign investment to support the roll-out of emerging innovations and supply chains, and the forging of partnerships across borders that will allow for regional and international CE value chains to evolve.

Cooperative approaches will be needed to develop common rules and standards for the governance of global CE value chains. Discussions are under way on how international governance frameworks such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (the 'Basel Convention') may be strengthened to manage the significant environmental and health impacts associated with global flows in electronic waste (e-waste).[32] Parallel frameworks will be needed to mitigate the risk of trade disputes as global trade in secondary materials across other sectors increases. In 2015, several East African countries proposed a ban on the import of secondary textiles in order to protect domestic industry from the large volumes of cheap second-hand clothes flowing in from third countries, particularly China.[33] While the proposed ban was diluted to an import tax when the US threatened retaliation,[34] the dispute indicates the political economy challenges to be managed as cross-border flows in secondary goods and circular services increase in volume and complexity.

Table 1: Examples of circular economy approaches in developing countries

	Shelter	Mobility	Food	Waste
Extending the use cycle	El Salvador – a housing NGO partnered with the government to use more durable earthquake-resistant building technologies in social housing.[35]	India's Tata Steel set up an Advanced Materials Research Centre along with the Indian Institute of Technology to develop lightweight, high-strength materials for automotives.[36]	Vietnam's government is working with the World Bank on the supply chain for frozen food, to reduce losses and improve food quality.[37]	In Nigeria, about 70 per cent of all imported e-waste is functional – it is now sold to consumers after testing.[38]
Enabling additional use cycles	Modular construction is being used for low-cost housing solutions in New Delhi, India, enabling more efficient disassembly at product end of life.[39]	In Brazil, a number of companies are active in the market to replace car parts through the National Association of Auto Parts Remanufacturers.[40]	In Nigeria, tractor sharing among smallholder farmers is being used to improve agricultural productivity.[41]	In India, a new e-waste extended producer responsibility (EPR) system requires companies to set targets for collection and repairs.[42]

[32] Khan, S. A. (2016), 'E-products, E-waste and the Basel Convention: Regulatory Challenges and Impossibilities of International Environmental Law', *Review of European, Comparative & International Environmental Law*, 25(2): pp. 248–60, doi: 10.1111/reel.12163 (accessed 15 Nov. 2018).
[33] Krauss, S. M. (2018), 'East Africa pushes second-hand clothing ban', Deutsche Welle, 26 February 2018, https://www.dw.com/en/east-africa-pushes-second-hand-clothing-ban/a-42747222 (accessed 14 Nov. 2018).
[34] John, T. (2018), 'How the US and Rwanda have fallen out over second-hand clothes', BBC, 28 May 2018, https://www.bbc.co.uk/news/world-africa-44252655 (accessed 14 Nov. 2018).
[35] Institution of Structural Engineers (2017), 'Housing for Low-Income Communities in El Salvador', https://www.istructe.org/structuralawards/2017-winners/sustainability-award/2015/housing-for-low-income-communities-in-el-salvador (accessed 30 Oct. 2017).
[36] Tata Steel (2016), 'Tata Steel Advanced Materials Research Center now at IIT MADRAS', 22 August 2016, https://www.tatasteel.com/media/newsroom/press-releases/india/2016/tata-steel-advanced-materials-research-center-now-at-iit-madras/ (accessed 20 May 2019).
[37] Vu, H. (2016), 'Vietnam Agriculture: challenges in supply chain and logistics management', Vietnam Business Forum, 14 October 2016, http://vccinews.com/news_detail.asp?news_id=34023 (accessed 30 Oct. 2017).
[38] Basel Convention Coordinating Centre for Training & Technology Transfer (2011), *Measuring e-waste – results from country studies: Nigeria*, 8 December 2011, https://www.itu.int/ITU-D/ict/wtim11/documents/cont/024-E.pdf (accessed 30 Oct. 2017).
[39] Hans, P. (2012), 'Factory-made homes', *Business Today*, 1 February 2012, http://www.businesstoday.in/moneytoday/real-estate/house-building-modern-methods-brick-mortar-steel-frame/story/21878.html (accessed 30 Oct. 2017).
[40] Hesselbach, J. and Herrmann, C. (2015), *Globalized solutions for sustainability in manufacturing*, London: Springer, p. 471.
[41] Schiller, B. (2015), 'An affordable smart tractor for African farmers and their tiny farms', *Fast Company*, 21 July 2015, https://www.fastcompany.com/3048780/an-affordable-smart-tractor-for-african-farmers-and-their-tiny-farms (accessed 30 Oct. 2017).
[42] Bhaskar, K. and Turaga, R. (2017), 'India's e-waste rules and their impact on e-waste management practices', *Journal of Industrial Ecology*, pp. 1–13, doi: 10.1111/jiec.12619 (accessed 30 Oct. 2017).

	Shelter	Mobility	Food	Waste
Minimizing impact	In Ho Chi Minh City, Vietnam, materials made from rice husks are used in the construction of more fire-resistant, heat-insulated and sound-insulated buildings.[43]	Fiat cars for Brazil contain polyurethane seat foams with 5 per cent soy polyol. [44]	An entrepreneur in Indonesia is experimenting with bioplastic food packaging to cut down on plastic waste in Jakarta.[45]	In India, EnviGreen has created a 100 per cent organic, biodegradable and eco-friendly plastic bag.[46]
Changing utilization patterns	In India, new digital platforms such as Airbnb and OYO are allowing users to share rooms and homes.[47]	In India, the introduction of UberPOOL in Bangalore and Delhi may have cut 7 million km worth of driving.[48]	In Tanzania, the government is working with the World Bank to develop more water-efficient practices among smallholder farmers.[49]	In India, the government has passed new e-waste handling rules to divert waste from local scrap merchants.[50]
Looping an asset through additional use cycles	In Haiti, debris from natural disasters has been converted into concrete building blocks for use in the construction of affordable homes in Port-au-Prince.[51]	In India, trials are under way to evaluate the potential to bury shredded plastic in roads, both reducing amounts of waste sent to landfills and increasing the durability of roads.[52]	In Brazil, Procomposto, an SME start-up, provides waste collection and composting services to generators of organic waste in cities.[53]	In Tanzania, BORDA, ISWA[54] and the Dutch government have given technical and financial support to municipal governments to improve municipal waste management processes.[55]

1.3 Scope of this research paper

In recognition of the critical role that developing countries will play in regional and global circular value chains, this research paper explores three principal questions:

1. How well aligned are the principles and practices of the CE with existing policy priorities in developing countries?
2. Under what conditions can CE activities expand and thrive in developing countries?
3. How might greater collaboration at the regional and global level facilitate the scaling up of circular value chains, both in developing and developed countries?

[43] Santiaguel, A. (2013), 'A second life for rice husk', IRRI, 1 April 2013, https://www.irri.org/rice-today/a-second-life-for-rice-husk (accessed 30 Oct. 2017).
[44] Biron, M. (2016), *Industrial applications of renewable plastics: environmental, technological and economic advances*, New York and Oxford: Elsevier.
[45] Monks, K. (2017), 'Plastic you can drink: a solution for pollution', CNN, 17 January 2017, http://edition.cnn.com/2017/01/16/world/cassava-plastic/index.html (accessed 30 Oct. 2017).
[46] Doshi, V. (2017), 'Burn it, dissolve it, eat it: is the solution to India's waste problem in the bag?', *Guardian*, 2 March 2017, https://www.theguardian.com/global-development/2017/mar/02/burn-dissolve-eat-solution-india-waste-problem-plastic-bags-ashwath-hegde (accessed 30 Oct. 2017).
[47] Russell, J. (2016), 'Airbnb focuses on India's growing travel market', TechCrunch, 18 April 2016, https://techcrunch.com/2016/04/18/airbnb-focuses-on-indias-growing-travel-market/ (accessed 30 Oct. 2017).
[48] Uber (2016), 'Get pooling India!', 1 July 2016, https://newsroom.uber.com/india/get-pooling-india/ (accessed 30 Oct. 2017).
[49] World Bank (2016), 'New project to link farmers to agribusiness in Tanzania', 10 March 2016, http://www.worldbank.org/en/news/press-release/2016/03/10/new-project-to-link-farmers-to-agribusiness-in-tanzania (accessed 30 Oct. 2017).
[50] India Environment Portal (2018), 'E- Waste (Management) Amendment Rules, 2018', 22 March 2018, http://www.indiaenvironmentportal.org.in/content/453310/e-waste-management-amendment-rules-2018/ (accessed 20 May 2019).
[51] Dawson, S. (2015), 'Disaster debris can become building blocks for a new life', Reuters, 14 July 2015, http://www.reuters.com/article/us-aid-housing-quake/disaster-debris-can-become-building-blocks-for-a-new-life-idUSKCN0PO2LW20150714 (accessed 30 Oct. 2017).
[52] Subramanian, S. (2016), 'Plastic roads: India's radical plan to bury its garbage beneath the streets', *Guardian*, 30 June 2016, https://www.theguardian.com/sustainable-business/2016/jun/30/plastic-road-india-tar-plastic-transport-environment-pollution-waste (accessed 30 Oct. 2017).
[53] Raworth, K. (2017), *Doughnut economics: seven ways to think like a 21st-century economist*, Vermont: Chelsea Green Publishing, p. 192.
[54] BORDA = Bremen Overseas Research & Development Association; ISWA = International Solid Waste Association.
[55] Stegmann, P. and Tisza, K. (2017), *CCAC work plan for Dar Es Salaam*, International Solid Waste Association, http://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=4925 (accessed 30 Oct. 2017).

The analysis and findings in this paper are based on a survey of development stakeholders and on a series of multi-stakeholder workshops held over the course of this 18-month project. Six workshops focusing on the CE in developing countries were held in India (Kolkata and New Delhi), Indonesia (Jakarta and Bandung), Tanzania (Dar es Salaam) and the US (New York) respectively. A seventh workshop, focusing on trade and the CE, was held in collaboration with the OECD in France (Paris).

In collaboration with the UN Industrial Development Organization (UNIDO), Chatham House surveyed 39 stakeholders from 25 emerging and developing economies[56] and three advanced economies,[57] representing a range of national 'cleaner production' centres, business associations, non-governmental organizations and businesses operating in the CE. The Chatham House–UNIDO survey posed a series of questions on the CE, its central activities and components, key challenges around transitioning to the CE, and the opportunities the CE presents to promote industrial and sectoral strategies (see Appendix 1 for the full survey).

1.3.1 Outline of the paper

Chapter 2 presents some of the key challenges to scaling up the CE in developing countries, taking into consideration capacity and finance constraints, economic and structural conditions, and infrastructural deficits and urbanization.

Chapter 3 discusses the extent to which the CE aligns with existing policy priorities in developing countries, including industrial development, sectoral strategies and 'green growth' strategies.

Chapter 4 considers the conditions required if circular activities are to thrive in developing countries. It explores factors ranging from policy architecture to innovation and investment to equitable development strategies.

Chapter 5 then explores the principal ways in which the CE can support the wider UN-led 2030 Agenda for Sustainable Development and vice versa. It discusses the role of multilateral and bilateral collaboration and trade in supporting the development of international circular value chains that link developing- and developed-country markets.

The paper concludes in **Chapter 6** with a set of recommendations for national policy actors and bilateral and multilateral development actors to support the scale-up of a global, inclusive CE.

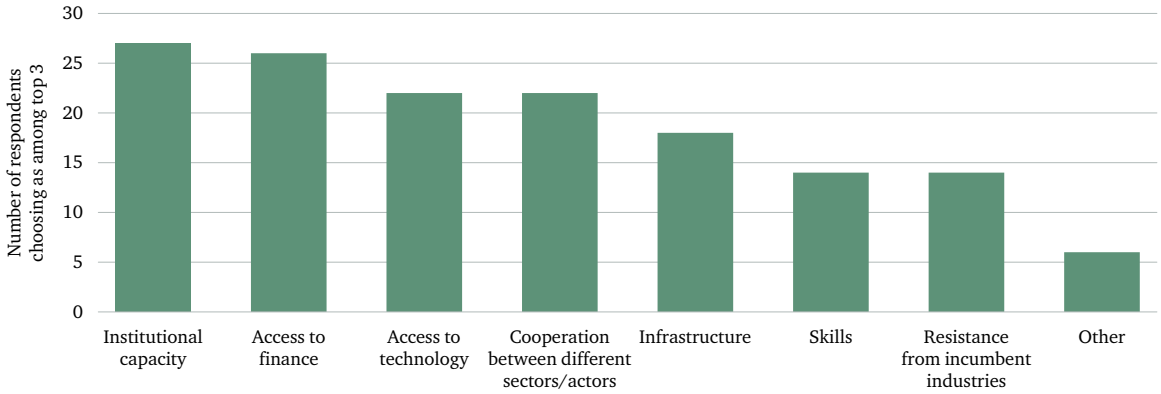
[56] Algeria, Argentina, Bosnia and Herzegovina, Cambodia, Colombia, Costa Rica, El Salvador, Georgia, Honduras, Hungary, India, Jordan, Laos, Montenegro, Nicaragua, North Macedonia, Palestine, Romania, Russia, Rwanda, Serbia, Tanzania, Uzbekistan, Vietnam and Zimbabwe.
[57] Austria, Finland and the United Kingdom.

2. Challenges to Scaling up the Circular Economy in Developing Countries

As CE policies in developing countries are rolled out, it will be crucial for policymakers and development actors to understand and address challenges specific to these economies. The challenges include varying degrees of institutional capacity to implement CE strategies, an often undeveloped and fragmented private sector, and an active informal economy beyond the reach of market interventions. Across most developing countries, a growing and urbanizing population will require significant investments in critical infrastructure, including housing stock, for which primary materials – including concrete – will be needed.[58] Unlike in developed countries, there will not be an existing stock of materials available for reuse, and circular approaches to construction are unlikely to be viable in the near term. In developing economies that rely heavily on extractive industries, growth models predicated on circular value chains and secondary material use are likely to meet resistance from vested interests among public and private actors.

Respondents to the Chatham House–UNIDO survey indicate that they expect the greatest challenges to implementing the CE in developing countries to be limited institutional capacity and a lack of access to the requisite finance and technology (see Figure 4). Low institutional capacity may constrain the use of punitive measures such as taxes on poor waste management, for example, and limited access to investment capital can act as a brake on innovation.[59] A large and active informal sector offers opportunities for capitalizing on existing circular approaches, but this will make it challenging to support and regulate private-sector initiatives in a coordinated way.

Figure 4: What are likely to be the most significant barriers to implementing circular economy approaches in your country?



Source: Authors' analysis of Chatham House–UNIDO survey responses.
Note: Concerns cited under 'Other' included a lack of consumer awareness, the absence of a stronger legal definition of waste, and a scarcity of adequate CE-related policies.

[58] Lehne, J. and Preston, F. (2018), *Making Concrete Change: Innovation in Low-carbon Cement and Concrete*, Chatham House Report, London: Royal Institute of International Affairs, https://www.chathamhouse.org/publication/making-concrete-change-innovation-low-carbon-cement-and-concrete (accessed 20 Mar. 2019).
[59] Deloitte (2018), *Survey of Global Investment and Innovation Incentives*, https://www2.deloitte.com/us/en/pages/tax/articles/global-survey-of-investment-and-innovation-incentives.html (accessed 20 Mar. 2019).

Below we consider in turn challenges relating to institutional capacity and access to finance and technology; economic and structural conditions; and persistent infrastructural deficits and a growing urban population. All of these factors are likely to have a bearing on the ease and pace with which circular practices may be implemented and scaled up in developing countries.

2.1 Capacity and finance constraints

2.1.1 Institutional capacity

The speed of urbanization in many developing countries has led to problems with the establishment and enforcement of appropriate regulations and mandatory standards to govern circular activities. In India, for example, more than 95 per cent of e-waste is processed in urban slums by untrained workers who lack adequate protective equipment and are exposed to a wide range of toxins.[60] In Agbogbloshie, Ghana, large quantities of e-waste are burned, notably insulated copper wire, the valuable metal from which is easily recycled for trade (once the insulation is burned off). The burning of plastics such as this insulation exposes workers to dangerous levels of carbon monoxide and other hazardous substances.[61] A recent report found record levels of brominated and chlorinated dioxins – two highly toxic chemicals – in free-range chicken eggs in Agbogbloshie, linked to the dismantling and burning of e-waste.[62]

> Without strong governance frameworks, there is a risk that developing countries will install cheaper but limited-quality technologies and equipment, including those mis-sold under the guise of a CE.

Without strong governance frameworks, there is a risk that developing countries will install cheaper but limited-quality technologies and equipment, including those mis-sold under the guise of a CE. There is evidence, for example, that waste-to-energy technologies reliant on incinerators are regularly sold in developing countries that lack proper testing facilities or oversight for the use of such equipment. In some cases, these technologies would not be approved for use in the countries in which they are made. Some stakeholders in the EU, meanwhile, have expressed concerns that dramatically increasing recycling and creating downstream markets for secondary materials could mean that toxic and hazardous materials that might otherwise be banned from consumer markets will be kept in circulation.[63] The use of recycled plastics can bring health risks, for example via plastic waste streams that contain harmful pollutants such as brominated diphenyl ether (BDE) flame retardants,[64] while water reuse is only beneficial for health if sufficient standards are in place.[65]

[60] Schroeder, P., Anggraeni, K. and Weber, U. (2018), 'The Relevance of Circular Economy Practices to the Sustainable Development Goals', *Journal of Industrial Ecology*, doi: 10.1111/jiec.12732 (accessed 16 Jul. 2018).
[61] Minter, A. (2016), 'The Burning Truth Behind an E-Waste Dump in Africa', Smithsonian.com, 13 January 2016, https://www.smithsonianmag.com/science-nature/burning-truth-behind-e-waste-dump-africa-180957597/ (accessed 15 Nov. 2018).
[62] Petrlik, J., Puckett, J., Bell, L. and DiGangi, J. (2019), *Weak Controls: European E-Waste Poisons Africa's Food Chain*, IPEN and Basel Action Network, https://ipen.org/sites/default/files/documents/final_ghana-egg-report-v1_6-web_copy.pdf (accessed 26 Apr. 2019).
[63] Hervey, G. (2018), 'Europe's plastic paradox', *Politico*, 12 February 2018, https://www.politico.eu/article/circular-economy-goals-clash-with-chemicals-safety-rules/?utm_source=POLITICO.EU&utm_campaign=3b77fc41c6-EMAIL_CAMPAIGN_2018_02_16&utm_medium=email&utm_term=0_10959edeb5-3b77fc41c6-189934665 (accessed 17 Jul. 2018).
[64] Leslie, H. A., Leonards, P. E. G., de Boer, J. and Jonkers, N. (2016), 'Propelling plastics into the circular economy – weeding out the toxics first', *Environment International*, 94: pp. 230–34, doi: 10.1016/j.envint.2016.05.012 (accessed 31 Mar. 2019); and Sanchez, W. and Egea, E. (2018), 'Health and environmental risks associated with emerging pollutants and novel green processes', *Environmental Science and Pollution Research,* 25(7): pp. 6085–6086, doi: 10.1007/s11356-018-1372-0 (accessed 16 Jul. 2018).
[65] Voulvoulis, N. (2018), 'Water reuse from a circular economy perspective and potential risk from an unregulated approach', *Environmental Science & Health*, 2: pp. 32–45, doi: 10.1016/j.coesh.2018.01.005 (accessed 16 Jul. 2018).

Weak regulation is also resulting in substandard practices in construction, a sector in which the design and governance of new building stocks and assets will be critical to enabling longer asset lifetimes and the future refurbishment and reuse of materials (see Section 2.3).[66] For instance, almost 90 per cent of residential built stock in the informal building sector in India is free from regulation, resulting in an increase in unplanned growth and settlements.[67] Even when regulations are in place, such as in Ghana, Kenya, Nigeria and South Africa, persistent non-compliance has been reported, with lack of enforcement cited as a prominent cause.[68] Tragedies including the collapses of a factory in Bangladesh in 2013, a 24-storey apartment building in Colombia in the same year and, most recently, a four-storey building in Nigeria in 2019 have increased awareness of the poor construction quality of many buildings in certain developing countries, and have strengthened demands for improved regulations.[69]

CE policymaking is also likely to demand a level of centralized or distributed coordination across multiple ministries that is often difficult to achieve in developing countries. Governments are still largely organized along sector lines, with ministries focusing on specific areas. In most of these countries, environment ministries are often among the weakest departments in government, with limited influence over the industrial and innovation strategies needed to succeed in a CE. Those responsible for fostering more sustainable resource use will need to work closely with ministries of finance or industry to generate political buy-in and cross-government ownership.

Some of the most ambitious and radical CE-related policymaking is occurring in middle- and lower-income countries. Rwanda and Kenya have imposed total bans on plastic bags in an attempt to stem growing waste crises. Burundi, South Sudan, Tanzania and Uganda are reported to be considering similar measures.[70] Yet even these positive examples have highlighted the impact of limited institutional capacity on policy implementation and regulatory enforcement. In both Rwanda and Kenya, plastic bags are still smuggled into the country,[71] and retailers, manufacturers and consumers are struggling with the lack of cheap and good-quality alternatives.[72] In Kenya, the ban has affected exports of food and flower products as there is a lack of adequate alternative packaging.[73] Developing countries are by no means alone in experiencing these challenges: examples from higher-income countries include a growing illegal waste dumping problem in the UK;[74] and the continued export of e-waste from several EU countries to Nigeria, in contravention of the Basel Convention and the EU's waste shipment directive.[75] Such cases point to the universal risk of weak governance undermining ambitious CE policies.

[66] Windapo, A. O. and Rotimi, J. O. (2012), 'Contemporary Issues in Building Collapse and Its Implications for Sustainable Development', *Buildings*, 2(3): pp. 283–99, doi: 10.3390/buildings2030283 (accessed 20 Mar. 2019).
[67] Jawaid, M. F., Pipralia, S. and Kumar, S. (2018), 'Review of environment responsiveness of building regulations in Jaipur', *Journal of Urban Management,* 7(2): pp. 111–20, doi: 10.1016/j.jum.2018.06.001 (accessed 20 Mar. 2019).
[68] Arimah, B. and Adeagbo, D. (2000), 'Compliance with urban development and planning regulations in Ibadan, Nigeria', *Habitat International*, 24(3): pp. 279–94, doi: 10.1016/S0197-3975(99)00043-0 (accessed 20 Mar. 2019).
[69] Asante, L. A. and Sasu, A. (2018), 'The Challenge of Reducing the Incidence of Building Collapse in Ghana: Analyzing the Perspectives of Building Inspectors in Kumasi', *SAGE*, doi: 10.1177/215818778109 (accessed 20 Mar. 2019); and BBC (2019), 'Nigeria school collapse: Lagos building disaster leaves 10 dead', 13 March 2019, https://www.bbc.co.uk/news/world-africa-47555373 (accessed 20 Mar. 2019).
[70] Dan Nielsen, T., Holmberg, K. and Stripple, J. (2019), 'Need a bag? A review of public policies on plastic carrier bags – Where, how and to what effect?', *Waste Management,* 87: pp. 428–40, doi: 10.1016/j.wasman.2019.02.025 (accessed 1 Apr. 2019); and Watts, J. (2018). 'Eight months on, is the world's most drastic plastic bag ban working?', *Guardian*, 25 April 2018, https://www.theguardian.com/world/2018/apr/25/nairobi-clean-up-highs-lows-kenyas-plastic-bag-ban (accessed 1 Apr. 2019).
[71] Pilgrim, S. (2016), 'Smugglers work on the dark side of Rwanda's plastic bag ban', Al Jazeera America, 25 February 2016, http://america.aljazeera.com/articles/2016/2/25/rwanda-plastic-bag-ban.html (accessed 29 Jul. 2018); and UN Environment (2018), 'How smuggling threatens to undermine Kenya's plastic bag ban', 16 May 2018, https://www.unenvironment.org/news-and-stories/story/how-smuggling-threatens-undermine-kenyas-plastic-bag-ban (accessed 28 Jan. 2019).
[72] Watts (2018), 'Eight months on, is the world's most drastic plastic bag ban working?'.
[73] Ibid.
[74] Dalton, J. (2018), 'Government to announce beefed-up measures to tackle fly-tipping', *Independent*, 10 June 2018, https://www.independent.co.uk/news/uk/home-news/government-gove-crackdown-illegal-flytippers-waste-dumping-a8391351.html (accessed 29 Jul. 2018).
[75] Odeyingbo, O., Nnorom, I. and Deubzer, O. (2018), 'Person in the Port Project: Assessing Import of Used Electrical and Electronic Equipment into Nigeria', United Nations University, 19 April 2018, https://www.scycle.info/person-in-the-port-pip-study/ (accessed 28 Jan. 2019).

2.1.2 Access to finance

Activities associated with 'linear' (i.e. non-circular) resource extraction and processing often account for the bulk of financing, foreign exchange earnings and foreign investment in lower-income countries (see Section 2.2.2). Resource-led development – which focuses on leveraging the potential investment in, and revenue and jobs from, natural resource sectors – has been a popular theory among major donors and international organizations in recent years. International partners have often been significant supporters of resource-led development: between 2008 and 2015, multilateral development banks (MDBs) provided over $83 billion in public financing for fossil fuels alone.[76] OECD analysis of private-sector resources mobilized for development reveals that almost half of these resources are focused on energy, industry, mining and construction.[77]

Restructuring economies to accommodate more 'circular' activities will require a major shift in infrastructure, industrial processes and innovation priorities. Developing countries are already facing a major infrastructure investment gap in the order of $1 trillion a year between now and 2030;[78] many lower-income countries lack even basic solid-waste management infrastructure.[79] Yet current investment in modernizing solid-waste management processes and establishing the 'reverse logistics systems'[80] needed to scale up the reuse of materials and products is inadequate: the European Investment Bank (EIB), for instance, invests relatively little in solid-waste-related activities.[81] Access to finance for existing industry may also be needed to support the transition to CE activities. Without careful planning, many facilities and sites will struggle to function in the move to more resource-efficient economic activity.

MDBs face a number of challenges in scaling up finance for CE activities. For one, MDBs are reactive in their financing: they respond to specific requests for support from public- and private-sector clients, among whom awareness of the potential of the CE is lacking. Investments in unproven business models and new technologies may be seen as too high-risk by many MDBs, while the scale of funding required may be too small. MDBs are often mandated to work with national agencies and are less able to offer smaller-scale funding for subnational or municipal projects. At the same time, traditional project-based finance provided by MDBs is not well suited to the systemic and multi-stakeholder approaches often inherent to CE solutions.

Upfront investment costs for CE solutions may be unattractively high for certain buyer groups in developing countries, particularly in the case of technology-intensive solutions. Vertical farming systems, for example, offer a means of radically reducing the land footprint of agricultural production; crops are grown in layered containers rather than on land. But a vertical farm with the capacity to grow 1 million kg of produce a year can cost between $80 million and $100 million to establish, not counting the investments in research and development (R&D) first needed to build

[76] Oil Change International (2018), 'Shift the Subsidies: Public Energy Finance Still Funding Fossils', http://priceofoil.org/shift-the-subsidies/ (accessed 13 Jul. 2018).
[77] OECD (2016), 'Results of the 2016 DAC Survey on mobilisation, 2012-2015, USD million', https://public.tableau.com/views/Mobilisation3/Dashboard1?:embed=y&:display_count=yes&:showTabs=y&:toolbar=no?&:showVizHome=no (accessed 13 Jul. 2018).
[78] Humphrey, C. (2018), *Channelling private investment to infrastructure: What can multilateral development banks realistically do?*, ODI Working paper 534, London: Overseas Development Institute, https://www.odi.org/publications/11119-channelling-private-investment-infrastructure-what-can-multilateral-development-banks-realistically (accessed 12 Jul. 2018).
[79] World Bank (2018), 'Solid Waste Management', http://www.worldbank.org/en/topic/urbandevelopment/brief/solid-waste-management (accessed 15 Nov. 2018).
[80] The collection, recycling, reuse or environmentally appropriate disposal of products from the original supply chain.
[81] Authors' analysis of data provided by the European Investment Bank. See European Investment Bank (undated), 'Financed projects', https://www.eib.org/en/projects/loan/list/index.htm (accessed 7 Apr. 2019).

know-how among the local population.[82] To date, lack of access to finance has been a major challenge for smaller firms and individuals seeking to implement innovative business models and practices in low-income countries: around 1.7 billion adults in developing countries do not have a personal bank account,[83] let alone access to complex financial products, although digital technology is starting to transform access to finance in some areas.

2.1.3 Access to technology

Significant progress has been made on the technological foundations for CE activity. A growing range of data and information technologies are making CE solutions practical for the first time in a range of sectors. There has also been a step-change in the technology available to improve supply chain traceability: satellite-based GPS technology, the rise of the 'Internet of Things' (IoT), low-power wireless technology, advances in big data and 'distributed ledger' blockchain technology, and developments in artificial intelligence and machine learning – all are transforming companies' ability to track and trace commodities and products and monitor environmental conditions in real time.

In many developing countries, however, the 'digital divide' remains a very serious problem, with more than 4 billion people still without access to the internet, and 2 billion people without a mobile phone.[84] Many CE approaches do not require costly technology investments and are already widely accessible in developing countries.[85] Household-level and farm-waste composting, for example, are well proven, low-cost and non-technology-intensive means of tackling food waste and reducing the need for fertilizer. 'Sharing economy' business models – whereby physical assets, such as cars and homes, are shared between multiple people – often only require the ownership of a single physical asset and a mobile phone. But other approaches depend on technological innovation. In agriculture, closed-loop production methods such as hydroponics and aeroponics, 3D printing and innovations in waste processing have the potential to transform traditional growing methods, dramatically reducing the resource inputs required and enabling fundamental changes to the spatial patterns of food supply chains (see Section 3.2). At a more fundamental level, asset-sharing frameworks often require digital platforms to link suppliers to consumers, as well as a stable energy supply. In the absence of reliable energy sources or government mechanisms to support universal access to basic digital and communications networks, the roll-out of CE activities risks excluding already marginalized communities.

E-waste imported by developing countries can act as a source of cheap hardware to help close the digital divide. In Ghana, the import and reuse of vast amounts of e-waste have been key to meeting demand for laptops among the student population.[86] Similarly, refurbished phones are helping to expand connectivity, bringing welfare effects. But, under current practices, e-waste is also a far from perfect solution to the lack of access – as the fastest-growing waste stream in the world, it presents serious health and environmental risks, often for the most vulnerable groups.

[82] Ngumbi, E. N. (2017), 'Africa needs its own version of the vertical farm to feed growing cities', *The Conversation*, 22 March 2017, https://theconversation.com/africa-needs-its-own-version-of-the-vertical-farm-to-feed-growing-cities-74929 (accessed 24 May 2018).
[83] Demirgüç-Kunt, A., Klapper, L., Singer, D., Ansar, S. and Hess, J. (2018), *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution*, Washington, DC: World Bank Group, https://globalfindex.worldbank.org/ (accessed 2 May 2019).
[84] World Bank (2016), *World Development Report 2016: Digital Dividends,* Washington, DC: World Bank, doi:10.1596/978-1-4648-0671-1 (accessed 1 Nov. 2017).
[85] Williams, M., Schroeder, P., Gower, R., Kendal, J., Retarnal, M., Dominish, E. and Green, J. (2018), *Bending the Curve: Best practice interventions for the circular economy in developing countries: A Synthesis of Five Literature Reviews*, London: Tearfund, https://learn.tearfund.org/~/media/files/tilz/circular_economy/2018-tearfund-bending-the-curve-en.pdf?la=en (accessed 12 Jul. 2018).
[86] Williams et al. (2018), *Bending the Curve*.

2.2 Economic and structural conditions

2.2.1 Informal-sector employment

The vital role played by informal labour is one of the most important areas of divergence when comparing CE approaches in developing and developed countries. Developing economies typically have a more fragmented private sector, with considerably higher shares of informal-sector employment, than advanced economies.[87] Almost 70 per cent of the employed population in developing regions is in informal employment,[88] and waste management is among the principal activities of the informal sector. While reliable data are scarce, estimates suggest that waste management provides income opportunities for millions of the poorest people around the world.[89] As many as 0.5 per cent of urban residents are estimated to be working in informal-sector recycling.[90] In India, 1.5 million people are involved in informal waste management.[91]

Informal waste-picking is rarely the most effective means of processing waste, however. Where previously waste-pickers may have been well equipped to process simpler industrial materials, increasingly they are dealing with e-waste – often made up of complex composites – and lack the skills and technology to optimize recycling and repair processes. With the informal sector capturing a large share of material flows, more formalized processes that may be better suited to recycling e-waste cannot source enough feedstock to recycle these products in an economical way. For example, numerous formal facilities in China have been unable to compete with the informal sector due to the latter's established network, low operating costs and convenience of collection.[92]

2.2.2 Resource-intensive economies

For many developing countries, natural resources – defined broadly here to include both extracted minerals and agricultural goods – account for a large proportion of GDP, employment or both. For countries with large hydrocarbon and mineral reserves, models of extractives-led growth have long been promoted by national governments, multilateral organizations and donor agencies.[93] Resource revenues have been a key driver of development gains and economic growth to date: the majority of low-income countries depend on natural resource rents for at least 10 per cent of their GDP.[94] For many countries, moreover, agriculture continues to be the single largest source of domestic employment: in least developed countries, it accounts on average for 60 per cent of employment, compared with 26 per cent in middle-income countries and 5 per cent in OECD countries.[95]

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[87] International Labour Office (2018), *Women and men in the informal economy: a statistical picture (third edition)*, Geneva: International Labour Office, http://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/documents/publication/wcms_626831.pdf (accessed 13 Jul. 2018).
[88] Ibid.
[89] Navarrete-Hernandez, P. and Navarrete-Hernandez, N. (2017), 'Unleashing Waste-Pickers' Potential: Supporting Recycling Cooperatives in Santiago de Chile', *World Development,* 101: pp. 293–310, doi: 10.1016/j.worlddev.2017.08.016 (accessed 16 Jul. 2018).
[90] Velis, C. (2015), 'Circular economy and global secondary material supply chains', *Waste Management & Research*, 33(5): pp. 389–91, doi: 10.1177/0734242X15587641 (accessed 1 Nov. 2017).
[91] Women in Informal Employment: Globalizing and Organizing (WIEGO) (2010), *Organizing Informal Waste Pickers: A Case Study of Bengaluru, India,* http://www.wiego.org/sites/default/files/resources/files/Chengappa-Organizing-Informal-Waste-Pickers-India.pdf (accessed 12 Sep. 2017).
[92] Park, J. K., Hoerning, L., Watry, S., Burgett, T. and Mattias, S. (2017), 'Effects of Electronic Waste on Developing Countries', *Advances in Recycling and Waste Management,* 128, doi: 10.4172/2475-7675.1000128 (accessed 20 Mar. 2019).
[93] Lahn, G. and Bradley, S. (2016), *Left Stranded? Extractives-Led Growth in a Carbon-Constrained World,* Research Paper, London: Royal Institute of International Affairs, https://www.chathamhouse.org/sites/default/files/publications/research/2016-06-17-left-stranded-extractives-bradley-lahn-final.pdf (accessed 7 Apr. 2019).
[94] Authors' analysis of data from World Bank (2018), 'Total natural resources rents (% of GDP)', https://data.worldbank.org/indicator/NY.GDP.TOTL.RT.ZS (accessed 11 Jul. 2018).
[95] World Bank (undated), 'Employment in agriculture (% of total employment) (modelled ILO estimate) – 2018', https://data.worldbank.org/indicator/sl.agr.empl.zs (accessed 7 Apr. 2019).

While the CE has the potential to create new opportunities for value addition and employment – many of them local (see Section 3.1) – the fundamental decoupling of economic growth from resource use nevertheless implies significant changes to industrial strategy. This is likely to meet resistance from governments and industry. Without meaningful dialogue at the national and international level around future growth pathways, there is a risk that natural resource-exporting countries will see the CE not as an opportunity for economic diversification but as a threat to continued growth.

2.3 Infrastructural deficits and urbanization

Key to visions for a CE in developed countries has been the opportunity to tap into an economy's existing stock of materials – through the dismantling and recycling of e-waste, organic waste and construction materials, for example – and so displace primary production and its associated energy requirements and greenhouse gas emissions. Resources available in unused assets and products, and in abandoned buildings and infrastructure, can be brought back into circulation in a number of ways. Governments may incentivize the reuse of existing buildings over new builds: for example, the UK could remove the 5 per cent value-added tax (VAT) charged for converting buildings into housing,[96] or introduce fiscal measures such as 'landfill taxes' to encourage remanufacturing over waste disposal.

Box 3: The circular economy and smart building design

A huge opportunity to reduce material consumption lies in maintaining buildings for the full duration of their design life. Connectivity, embedded sensors, intelligent machines and data analytics are enabling a host of changes in how buildings are managed, which can extend their useful operational lifetimes. Drones and robots can provide maintenance and retrofitting services. Sensors embedded throughout a building can deliver data to a central management system, reporting on structural integrity, energy use and operational health to raise issues as they crop up, such as the need to replace or refurbish a particular component. The use of tracking technologies such as building information modelling (BIM) or radio frequency identification (RFID) can help to optimize the performance of materials, support design for disassembly and enable preventative maintenance. These technologies also support the use of buildings as effective 'material banks' – identifying materials for potential reuse after a building is decommissioned or demolished, and enabling the capture of still viable materials for reuse.[97]

The digital revolution under way in developing countries opens the door for such technologies to be harnessed as a means of moving swiftly to more resource-productive business models. Thriving start-up scenes are cropping up in Bangalore, Nairobi and São Paulo, for example,[98] and companies such as Alibaba, Tencent and Huawei in China, or Safaricom in Kenya, are leading the way on digital innovation and new business model deployment.[99]

In addition to smart design, innovation in materials can transform the resource footprint of urban development. Selecting regionally appropriate, renewable, non-toxic materials for new builds and retaining construction materials at their highest value can reduce demand for non-renewable, virgin material.[100] Engineered clay, for example, offers opportunities to replace resource-intensive materials. Wienerberger, a major brick producer, is manufacturing economical, perforated clay bricks in India, optimizing the use of clay from non-agricultural land and offering an alternative to concrete – an alternative that uses up to 15 per cent less material, requires less energy to produce and can be recycled after use.[101]

[96] GOV.UK (2019), 'VAT for builders', https://www.gov.uk/vat-builders (accessed 20 Mar. 2019).
[97] Lehne and Preston (2018), *Making Concrete Change*.
[98] Rasagam, G. (2016), 'How start-ups can turbocharge global productivity growth', World Bank, 16 November 2016, http://blogs.worldbank.org/psd/how-start-ups-can-turbocharge-global-productivity-growth (accessed 16 Aug 2018).
[99] Schroeder, Anggraeni and Weber (2018), 'The Relevance of Circular Economy Practices to the Sustainable Development Goals'.
[100] Lehne and Preston (2018), *Making Concrete Change*.
[101] Wienerberger (2019), 'About Wienerberger India', https://wienerberger.in/contact (accessed 20 Mar. 2019).

In developing countries, however, the focus remains on investing in new infrastructure and building stock in order to support rapid industrialization and urbanization. Critical infrastructure has not kept pace with rapid urbanization in many developing countries, and city slums have borne the brunt of this expansion: at least 881 million people in the developing world are now living in slums where secure housing and essential services are severely lacking.[102] Between now and 2050, developing countries will have to house an additional 2.7 billion people in cities, many of whom will end up living in slums.[103] By 2060, 75 per cent of the total building stock in developing countries will have been constructed since 2010; by comparison, roughly 65 per cent of the projected building stock in OECD countries by 2060 is already in place today.[104] Meeting demand for new construction and related infrastructure services is expected to push material extraction levels to around 180 billion tonnes per year by 2050, double what is extracted today.[105]

At the same time, developing countries also have far smaller stocks of materials for reuse and recycling than high-income countries do. The International Resource Panel (IRP) estimates that per capita in-use stocks of materials in more developed countries typically exceed those in less developed countries by factors of five to 10.[106] Under current growth conditions, and taking a business-as-usual perspective, domestic materials brought back into use through CE approaches are likely to provide only a small share of developing countries' future materials needs. Studies have nevertheless shown that a 90 per cent reduction in the use of the primary building stock, combined with substantial improvements in global recycling systems (via circular value chains), could support a 42 per cent expansion of the in-use building stock in developing countries. This indicates that improved trading in secondary building materials between developed and developing countries could provide an important pathway to meeting future building needs.[107]

Urbanization is also changing consumer demand patterns. A shift in consumer mindsets will be as important as the technical challenges to scaling up the CE in developing countries. To date, higher income levels have closely tracked higher levels of discretionary spending, consumerism and wastefulness. By 2030, today's lower-middle-income countries, including India, Indonesia and Vietnam, will have consumer markets that are $15 trillion bigger than they are today.[108] The fast-growing middle classes in India and Indonesia have already started to fundamentally shift buying patterns in the direction of those associated with wealthier people in developed countries.[109] In India – projected to have the third-largest consumer market by 2025 – members of the elite and affluent classes spend vastly more

[102] UN-Habitat (2016), *Slum Almanac 2015/2016. Tracking Improvement in the Lives of Slum Dwellers,* Nairobi, Kenya: Participatory Slum Upgrading Programme, https://unhabitat.org/slum-almanac-2015-2016/ (accessed 14 Nov. 2018).
[103] Brueckner, J. K. and Lall, S. (2014), 'Cities in Developing Countries: Fueled by Rural-Urban Migration, Lacking in Tenure Security and Short of Affordable Housing', *Handbook of Regional and Urban Economics*, 5: pp. 1399–1455, doi: 10.1016/B978-0-444-59531-7.00021-1; and Barbiere, C. (2017), 'French urban development expert: 'In 2050, 3 billion people will live in slums'', Euractiv, 6 March 2017, https://www.euractiv.com/section/development-policy/interview/french-urban-development-expert-in-2050-3-billion-people-will-live-in-slums/ (accessed 3 Feb. 2018).
[104] UNEP (2017), *Towards a zero-emission, efficient, and resilient buildings and construction sector: Global Status Report 2017*, https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf (accessed 20 Mar. 2018).
[105] Ekins and Hughes (2017), *Resource Efficiency: Potential and Economic Implications*.
[106] International Resource Panel (2013), *International Resource Panel work on Global Metal Flows*, http://www.resourcepanel.org/sites/default/files/documents/document/media/e-book_metals_introduction_english.pdf (accessed 20 Mar. 2019).
[107] Wiedenhofer, D., Fishman, T., Lauk, C., Haas, W. and Krausmann, F. (2019), 'Integrating Material Stock Dynamics Into Economy-Wide Material Flow Accounting: Concepts, Modelling, and Global Application for 1900–2050', *Ecological Economics*, 156: pp. 121–33, doi: 10.1016/j.ecolecon.2018.09.010 (accessed 20 Mar. 2019).
[108] Kharas, H. (2017), *The Unprecedented Expansion of the Global Middle Class: An Update*, Global Economy and Development, Working Paper 100, Washington, DC: Brookings Institution, https://www.brookings.edu/wp-content/uploads/2017/02/global_20170228_global-middle-class.pdf (accessed 15 Nov. 2018).
[109] Ahmed, M. E., Khan, M. M. and Samad, N. (2016), 'Income, social class and consumer behaviour: a focus on developing nations', *International Journal of Applied Business and Economic Research*, 14(10): pp. 6679–6702 (accessed 16 Jul. 2018).

and shop more frequently than people in other categories.[110] Among the country's growing number of wealthier households, recycling and other environmental activities appear to be culturally associated with a lack of prosperity.[111]

2.4 Summary

- The challenges and opportunities associated with transitioning to the CE will vary according to differences in each country's stage of development, resource endowments and political institutions. In developing countries, capacity and financial constraints, economic and structural conditions, and an infrastructural deficit coupled with continued urban expansion will necessitate tailored policy responses that cannot be easily replicated from developed-country experience.
- If it is to be inclusive and sustainable, the restructuring of economies in accordance with circular value chains will require significant investment in innovation and financial access. It will also require investment in the development of robust governance frameworks to mitigate the health and environmental risks associated with poorly regulated waste management and manufacturing practices.
- Low-income countries will continue to experience rapid rates of urbanization for decades to come, and primary resources will be needed to fill the infrastructure gap. Unlike developed countries, developing countries have minimal stocks of in-use buildings and materials for reuse. Demand for consumer goods is also expected to rise; the experience from developed and emerging countries suggests that new goods and individual ownership are likely to be preferred over 'second-life' goods and asset-sharing.

[110] Singhi, A., Jain, N. and Sanghi, K. (2017), 'The New Indian: The Many Facets of a Changing Consumer', Boston Consulting Group, 20 March 2017, https://www.bcg.com/en-gb/publications/2017/marketing-sales-globalization-new-indian-changing-consumer.aspx (accessed 29 Jul. 2018).
[111] Ellen MacArthur Foundation (2016), *Circular Economy in India: Rethinking Growth for Long-Term Prosperity*.

3. Aligning the Circular Economy with Existing Policy Priorities

If the CE in developing countries is to gain political traction and attract investment, it is crucial that strategies be aligned with the existing priorities of governments and businesses. Opportunities for value creation through a transition to the CE exist across many sectors – from waste recycling and machinery repair in agriculture to remanufacturing in the textiles industry to resilient design in construction. All developing countries are thus in a position to craft appropriate, ambitious CE strategies that harness their respective competitive advantages.

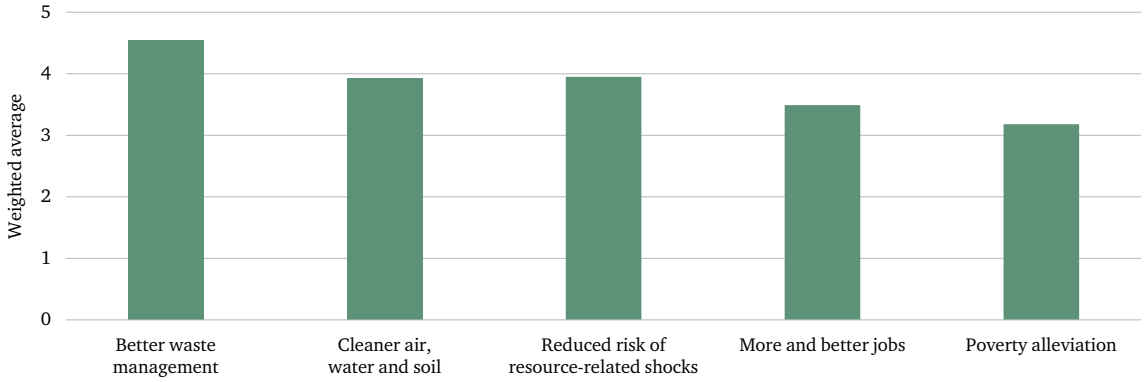
> Improved waste management and reduced waste generation can help to lower the number of premature deaths associated with the open burning of waste – estimated at 270,000 people a year.

There has yet to emerge a compelling narrative on the CE as a strategy for delivering on developing-country policy priorities such as economic diversification, job creation, agricultural development or energy security. Analyses of the CE and the opportunities it presents tend to occur through a developed-country lens that ignores policy priorities specific to lower-income settings. The potential for health benefits, for example, has not generally been the focus of CE strategies in Western countries. But in developing countries, where access to primary healthcare and improved health outcomes are policy priorities, the transition to a CE offers a number of opportunities. Improved waste management and reduced waste generation can help to lower the number of premature deaths associated with the open burning of waste – estimated at 270,000 people a year[112] – while the use of refurbished equipment in healthcare facilities could significantly lower the costs of public procurement. Such equipment can cost up to 60 per cent less than new equipment.[113]

Similarly, understanding of CE practice tends to be narrow relative to the opportunities that the CE opens up. While respondents to the Chatham House–UNIDO survey indicated that the CE could support cleaner air, water and soil, greater resilience to resource shocks, job creation and poverty alleviation (see Figure 5), most respondents saw far greater opportunities for the CE to contribute to waste management strategies and industry rather than to other sectors of the economy such as energy, construction or environmental management (see Figure 6).

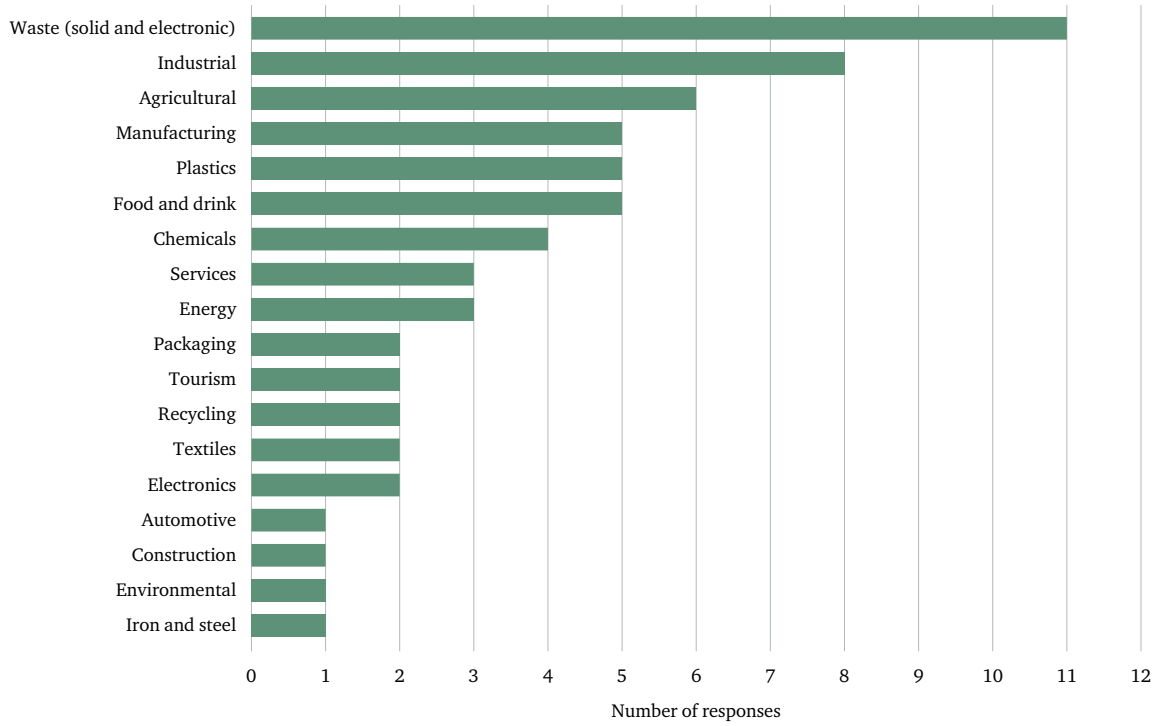
[112] Kodros, J. K., Wiedinmyer, C., Ford, B., Cucinotta, R., Gan, R., Magzamen, S. and Pierce, J. R. (2016), 'Global burden of mortalities due to chronic exposure to ambient PM2.5 from open combustion of domestic waste', *Environmental Research Letters*, 11(12): pp. 1–9, doi: 10.1088/1748-9326/11/12/124022 (accessed 17 Nov. 2017).
[113] Alsford, J., Chapelow, V., Dembele, F. and Zlotnicka, E. (2017), 'Combining the Circular Economy and Affordable Healthcare', Morgan Stanley Research (accessed 20 Mar. 2019).

Figure 5: On which outcomes is the circular economy most likely to help deliver (5 being highly likely, 1 being not at all likely)?



Source: Authors' analysis of the Chatham House–UNIDO survey responses.

Figure 6: What is the most exciting sector for the circular economy?



Source: Authors' analysis of the Chatham House–UNIDO survey responses.

To galvanize buy-in and coordination across ministries, proponents of the CE should use it as an organizing principle that is mainstreamed across government strategies and sectoral plans, highlighting the ways in which CE principles and practice can be employed to accelerate the delivery of existing national development goals as well as the objectives of industrial strategies.

3.1 Delivering on industrial strategy

3.1.1 Job creation

Commitments to increase the number and quality of jobs in the economy are a pillar of development strategies in most lower- and middle-income economies.[114] The potential for the CE to contribute to job creation and economic development is significant, not least because many CE activities centre on local service delivery. While there have been few comprehensive studies of the employment effects of the CE in developing countries, case studies of relevant activities are encouraging. In the Nigerian city of Lagos, for example, where formal collection methods are used for only 40 per cent of the 10,000 tonnes of waste generated daily,[115] entrepreneurs are designing solutions that reflect local skills and capabilities. 'Wecycle', a social enterprise, employs a fleet of cyclists to collect waste from low-income communities. Residents who supply their rubbish are rewarded with vouchers that can be exchanged for household items and common services, including crockery, food and mobile phone airtime.[116] In addition to recycling, other start-ups in the region give this waste a second life as furniture, textiles or lumber.[117]

Meanwhile, in China 1 per cent of all new jobs created in the first half of 2018 were in the bike-sharing industry. The 100,000-strong national workforce in this sector includes those employed in bicycle manufacture, repair and distribution, as well as software development and maintenance (to support user access). In India, car-sharing firms have generated 30,000 new jobs in the state of Tamil Nadu.

Government-backed waste management projects can have a significant short-term impact on employment. An e-waste dismantling and recycling facility opened in Rwanda in 2017. The $1.5 million operation employs 1,000 people and has the capacity to process 7,000 tonnes of electrical and e-waste each year. Similarly, an e-waste recycling facility in Nairobi, established in 2013 through a public–private initiative between Hewlett-Packard, the Kenyan government and other partners, created 2,000 jobs in its first four years of operation.[118]

CE activities may also offer a buffer against increasing automation in industry and manufacturing. Much has been written about the potential for digital technologies, such as robotics and additive manufacturing, to displace low-skilled workers. For developing countries, where manufacturing and services provide only a limited share of employment but are prominent in state development plans, the prospect of increased automation is a strategic concern.[119] The CE may provide a critical part of the response. Many tasks involving disassembly, repairs and remanufacturing are non-routine and involve a high level of knowledge. Compared with manufacturing assembly lines, it will take a long time before these tasks can be widely performed by robots, at least at a cost that can compete with the abundant labour found in many developing countries. The sorting of waste by product type and state of disrepair is difficult enough to automate; more complicated still are tasks involving collection from the streets

[114] Khan, A. (2017), *10 things to know about the global labour force*, ODI Briefing papers, London: Overseas Development Institute, https://www.odi.org/publications/10770-10-things-know-about-global-labour-force (accessed 19 Jul. 2017).
[115] Bakare, W. (2018), 'Solid Waste Management in Nigeria', BioEnergy Consult, 25 July 2018, https://www.bioenergyconsult.com/solid-waste-nigeria/ (accessed 22 Aug. 2018).
[116] Cathcart-Keays, A. (2015), "It's money lying in the streets': Meet the woman transforming recycling in Lagos', *Guardian,* 21 October 2015, https://www.theguardian.com/cities/2015/oct/21/money-lying-streets-meet-woman-transforming-recycling-lagos-wecyclers (accessed 20 Mar. 2019).
[117] EcoPost (2019), 'Welcome to EcoPost', https://www.ecopost.co.ke (accessed 20 Mar. 2019); and Egbejule, E. (2018), 'Nigerian designers put urban waste to sustainable use', *Financial Times,* 30 March 2018, https://www.ft.com/content/5e173f06-17df-11e8-9c33-02f893d608c2 (accessed 20 Mar. 2019).
[118] Fox, N. (2014), 'Hewlett-Packard introduces large-scale e-waste recycling in Africa', *Guardian*, 15 May 2014, https://www.theguardian.com/sustainable-business/sustainability-case-studies-hewlett-packard-ewaste-recycling-africa (accessed 24 Sep. 2018).
[119] Gelb, S. and Khan A. (2016), *Towards a complete jobs picture: A new lens on labour data gaps and on automation*, Overseas Development Institute briefing note, December 2016, https://www.odi.org/sites/odi.org.uk/files/resource-documents/11226.pdf (accessed 29 Jul. 2018).

and redistribution. Yet this will not always be the case. If waste streams become more regular and reliable, robots can play a role in their sorting and management, as demonstrated by Apple's robot, Liam, which disassembles 1.2 million iPhones a year.[120]

3.1.2 Economic diversification

Another common goal in developing-country industrial strategies is the desire to 'move up the value chain', i.e. to gradually move away from agriculture and raw material extraction towards higher-value-added industrial activities such as manufacturing and ultimately a higher-tech, service-led economy. Engagement in circular practices can support value addition and can be supported with minimal investments in infrastructure. Countries with a significant existing manufacturing base, for example, may already have the requisite skills and infrastructure to support product repair and remanufacturing at scale. Remanufacturing can be seen as a complementary rather than competing approach to manufacturing, capable of having a positive impact on employment and economic output.[121] Both China and India (see Box 4) have signalled policy support for remanufacturing and other CE approaches because of the potential for employment creation and value addition.[122]

> In resource-intensive economies, shifting towards a CE may present an opportunity to pursue economic diversification and access higher-value markets. In the medium to long term, however, continued dependence on natural resource extraction will present significant challenges for resilient economic growth.

In resource-intensive economies, shifting towards a CE may present an opportunity to pursue economic diversification and access higher-value markets. In the medium to long term, however, continued dependence on natural resource extraction will present significant challenges for resilient economic growth. Many resource-intensive economies are highly exposed to commodity price fluctuations, with the recent slowdown in growth in African countries closely tied to lower commodity prices.[123] Many resource-rich countries already have ambitious plans to diversify their economies by moving up the value chain. The transformation of industrial assets and resource-processing facilities into regional reprocessing and remanufacturing hubs could support a transition away from quantity-driven resource export strategies towards value-added strategies. Whereas exports of raw, primary or scrap materials will often be relatively low-value, significant value can be added through their processing and remanufacturing into usable goods and materials. The production of car doors from scrap steel sheets is an example.

One notable exception to this model is that economies that export certain metals and minerals will likely feel less pressure to diversify. The central role of digital technologies in many circular activities and sectors will continue to support demand for commodities such as copper, lithium, gold, uranium and rare earth elements. Nonetheless, producers and exporters in the minerals and metals sector can boost their competitiveness in the short and long term through the early adoption of robust environmental

[120] Leswing, K. (2017), 'Apple just revealed how its iPhone-recycling robot 'Liam' works', *Business Insider UK*, 20 April 2017, http://uk.businessinsider.com/apple-liam-iphone-recycling-robot-photos-video-2017-4 (accessed 29 Jul. 2018).
[121] Fatimah, Y. A. (2014), 'Remanufacturing as a Potential Means of Attaining Sustainable Industrial Development in Indonesia', PhD thesis, Curtin University, Australia; and Chaowanapong, J. J., Jongwanich, J. J. and Iojmah, W. (2017), 'Factors influencing a firm's decision to conduct remanufacturing: evidence from the Thai automotive parts industry', *Production Planning & Control,* 28(14): pp. 1139–1151, doi: 10.1080/09537287.2017.1341652 (accessed 20 Mar. 2019).
[122] Binshii, X., Enzhong, L., Handong, Z., Fan, S. and Peijing, S. (2017), 'The Remanufacturing Industry and Its Development Strategy in China', *Strategic Study of Chinese Academy of Engineering,* 19(3): pp. 61–65, doi: 10.15302/J-SSCAE-2017.03.009 (accessed 26 Sep. 2018).
[123] Kharas, H. and Rogerson, A. (2017), *Global development trends and challenges: Horizon 2025 revisited*, London: Overseas Development Institute.

and health standards in (re)processing and (re)manufacturing processes: as buyers and investors increasingly integrate the CE and sustainable business commitments into their business models, high-end materials that perform well against environmental and social governance metrics may attract a premium.

Box 4: Indian Resource Efficiency (InRE) strategy[124]

The Indian Resource Efficiency (InRE) strategy, released by the Indian Resource Panel (InRP) in 2017, details how CE approaches such as recycling, reuse, repair and remanufacture can support improvements in resource efficiency. InRP emphasizes the multidimensional benefits of a more resource-efficient economy in terms of complementing and accelerating existing policy priorities. These priorities include: positioning India as a global manufacturing hub; improving the efficiency of urban infrastructure; creating affordable housing; and reducing domestic pollution and waste. The InRE strategy identifies numerous opportunities associated with a more resource-efficient economy, including the development of industries focused on reprocessing waste (e.g. the reuse of construction and demolition waste in new building products) and job creation in green product certification, eco-labelling and green marketing. The strategy also considers a more formalized waste management sector – supported by government policy to deliver higher wages and improved labour, safety and environmental conditions, as well as new highly skilled jobs in design and manufacturing – with the aim of replicating the success of India's information technology sector and enabling the country to become a global hub for resource-efficient innovation.

3.2 Advancing sectoral strategies

3.2.1 Agriculture and food systems

While the issue has received limited attention in the existing literature, integrating the CE with food security and agricultural development plans could offer an attractive policy avenue for developing countries, particularly those with ambitious targets for the agricultural sector. Tanzania's National Development Vision 2025, for example, sets out to transform the economy 'from a low productivity agricultural economy to a semi-industrialized one led by modernized and highly productive agricultural activities' supported by industrial and service activities.[125]

Opportunities for CE approaches to minimize input requirements while adding value to agricultural outputs and creating new asset loops can be found along the entire food value chain, from production to processing to consumption (see Table 2). Certain practices in this area have long been the focus of policymakers at local and global levels seeking to boost productivity and reduce food loss and waste,[126] while others reflect a departure from more traditional resource management approaches in the food system.

Sophisticated waste processing and treatment technologies – such as anaerobic digestion, the use of waste-eating microbes, and carbon capture and use – provide opportunities for generating value from food and agricultural waste. The technologies are increasingly being promoted in developing and emerging economies. In 2015, the Malaysian government introduced legislation mandating that household waste be separated into organic, recyclable and non-recyclable waste,[127] while in Thailand

[124] NITI Aayog (2017), *Strategy on Resource Efficiency.*
[125] Tanzania Ministry of Finance (undated), *The Tanzania Development Vision 2025*, http://www.mof.go.tz/mofdocs/overarch/Vision2025.pdf (accessed 17 Jul. 2018).
[126] Rood, T., Muilwijk, H. and Westhoek, H. (2017), *Food for the Circular Economy*, The Hague: PBL Netherlands Environmental Assessment Agency, http://www.pbl.nl/sites/default/files/cms/publicaties/PBL-2017-Food-for-the-circular-economy-2878.pdf (accessed 17 Jul. 2018).
[127] Ministry of Urban Wellbeing, Housing and Local Government (2019), #ASINGKAN, http://www.kpkt.gov.my/separationatsource/en/ (accessed 20 Mar. 2019).

the government has set targets under its National 3R Strategy to increase organic waste utilization by 50 per cent on 2012 levels by 2026.[128] In Kenya, modern biodigesters – made from recycled plastic for easy transport and installation – have been distributed to more than 75,000 families. Biodigesters convert manure into biogas, a clean cooking fuel for stoves, and their use in Kenya has helped lower indoor air pollution and reduce emissions.[129] In Kolkata, India, people came together to establish a local bus service that runs completely on renewable biogas,[130] while Mexico has seen some of the biggest local innovations in wastewater management.[131] Such technologies can also be cheaper than large-scale, mechanized production processes. For example, fares on the above-mentioned biogas-fuelled bus service in Kolkata are one-twelfth the price of those on the next-cheapest bus operator.

> Beyond waste collection and reuse, circular approaches are being employed at the point of production to promote greater resource efficiency.

Beyond waste collection and reuse, circular approaches are being employed at the point of production to promote greater resource efficiency. Closed-loop systems such as aquaponics and hydroponics require drastically reduced land, fertilizer and water inputs. Some of the most advanced closed-loop agricultural technologies are being trialled in developing countries. Residents of Ho Chi Minh City in Vietnam have been trialling small-scale closed-loop aquaponic and hydroponic farming systems for growing cassava, tomato and lettuce; the initiative is in part a response to concerns over fertilizer and pesticide use.[132] Lower-tech approaches to vertical farming have also emerged: in Kampala, Uganda, farmers are employing a simple construction of wooden crates – using earthworms to create fertilizer[133] – while sisal sacks are used in a similar way to grow food in the urban slums of Nairobi, Kenya.[134]

For the recycling and reuse of organic waste, robust regulation will be important to mitigate the risk of unintended consequences. Food waste, heat-treated to render it safe for animal consumption, is an important source of animal feed (particularly in pig farming) in many countries: in South Korea and Japan, 43 per cent and 36 per cent respectively of food waste is used as feed for livestock; the process is regulated by laws regarding the treatment, storage and transport of food waste.[135] In Europe and North America, the use of organic waste in animal feed has been strictly regulated since the discovery that the feeding of animal-derived waste to livestock was a contributor to the outbreaks of bovine spongiform encephalopathy (BSE) and foot-and-mouth disease.

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[128] Sharp, A. and Sang-Arun, J. (2012), *A Guide for Sustainable Urban Organic Waste Management in Thailand: Combining Food, Energy, and Climate Co-Benefits*, Institute for Global Environmental Strategies (IGES), https://pub.iges.or.jp/pub/guide-sustainable-urban-organic-waste (accessed 20 Mar. 2019).

[129] Seppala, J. (2016), 'Bringing better biodigesters and clean energy to Africa', World Bank, 29 January 2016, http://blogs.worldbank.org/climatechange/bringing-better-biodigesters-and-clean-energy-africa (accessed 15 Nov. 2018).

[130] Altamirano, J., Maassen, A. and Prieto, O. (2017), 'Moving Beyond "Take, Make, Waste": Developing Cities Show the Possibilities of the Circular Economy', World Resources Institute, 2 October 2017, https://www.wri.org/blog/2017/10/moving-beyond-take-make-waste-developing-cities-show-possibilities-circular-economy (15 Nov. 2018).

[131] World Bank (2018), *Wastewater: From Waste to Resource – The Case of San Luis Potosí, Mexico,* Water Global Practice, http://documents.worldbank.org/curated/en/465541521174377392/pdf/124330-WP-19-6-2018-13-0-30-W.pdf (accessed 15 Nov. 2018).

[132] *Asia Life* (2015), 'Urban Farming', 10 June 2015, https://www.asialifemagazine.com/vietnam/urban-farming (accessed 20 Mar. 2019).

[133] The Observers (2016), 'Ugandans try 'stack farming' as arable land disappears', 8 March 2016, http://observers.france24.com/en/20160803-arable-land-uganda-vertical-farms (accessed 20 Mar. 2019).

[134] Waruru, M. (2010), 'Garden-in-a-sack-for urban poor', *New Agriculturist*, September 2010, http://www.new-ag.info/en/focus/focusItem.php?a=1742 (accessed 24 Apr. 2019).

[135] Salemdeeb, R., zu Ermgassen, E. K. H. J., Kim, M. H., Balmford, A. and Al-Tabbaa, A. (2017), 'Environmental and health impacts of using food waste as animal feed: a comparative analysis of food waste management options', *Journal of Cleaner Production*, 140: pp. 871–80, doi: 10.1016/j.clepro.2016.05.049 (accessed 24 May 2018).

Table 2: Circular economy opportunities along food value chains

Stage	CE strategy	Example initiatives
Production	Reduced resource inputs	Precision agriculture using sensors and data analytics to monitor and apply resource input
	Yield improvements	Breeding strategies to improve yield and resilience to pests, disease and climate impacts
	Reduced on-farm losses	Sensors that monitor and prevent weather or pest damage to harvests and on-farm storage
	Asset sharing	Leasing of agricultural equipment
	Recovery and reuse of agricultural inputs	Closed-cycle production methods, e.g. aquaponics
	Recovery and reuse of waste streams from other sectors	Recycling of wastewater for use in agriculture
	Minimization of food surplus	Subsidy reform to discourage overproduction and promote quality over quantity
	Use of food and agricultural by-products	Production of biochemicals and bioplastics from waste biomass
Processing and distribution	Reduced food loss in storage and transit	Improvements in, and roll-out of, cool-chain technologies
	Reduced inputs	Plastic-free biodegradable packaging
	Reprocessing of food waste into new products	Reprocessing of fruit peels into fabric and paper
	Improvements in traceability for food safety	Product tagging, which can be underpinned by blockchain technology, to monitor environmental conditions as food moves from 'farm to fork'
	Shared logistics	Interconnected storage and transportation system across companies in the food, logistics and cool-chain industries
	Remanufacturing of food retail and storage equipment	Refurbishment and remanufacturing of refrigerated display cabinets
Consumption	Extended food lifetimes	Smart packaging solutions that preserve the quality and safety of foods by absorbing atmospheric compounds – oxygen, ethylene, moisture, etc. – that cause food to perish
	More sustainable consumer behaviour	Nudging tactics to reduce food waste
Post-consumption	Redistribution of food waste	Food surplus redistribution schemes
	Organic waste management	Policies and legislation to encourage separation and differentiated recovery of household waste
	Recovery and refinement of food waste for human consumption	Production of value-added surplus products (VASPs) that make use of food that is safe to eat but generally considered to be waste (e.g. carrot peel that is processed into a powdered soup mix)
	Recovery and refinement of food waste for animal feed and energy	Use of food waste in the production of biofuel and bioproducts, including fertilizer

CE approaches in agriculture could also contribute to improved food security. CE activities along the supply chain – including sensor-assisted approaches to monitoring resource inputs and climatic conditions; leasing models for agricultural equipment; and community-based renewable energy production – can all support productivity gains and improvements to the quality and availability of locally grown food in regions with poor market access. At the same time, the valorization of food and agricultural waste, whether through waste-to-energy projects, fertilizer production or novel circular products such as textiles made from food by-products, can create new markets and new income sources (see Table 2).

3.2.2 Energy access and security

In reducing the need for primary materials and capturing the energy potential in waste, CE approaches can support strategies to deliver energy security and greater energy access. Many CE activities – reducing consumption; reusing, sharing and recycling products; minimizing losses in production – will limit overall demand for primary production and thus reduce the energy requirements of manufacturing. Some examples are as follows:

- Scrap materials can be used in place of primary resources. Producing aluminium from scrap, for example, reduces the use of energy inputs by up to 95 per cent.[136]
- First-generation photovoltaic (PV) panels, with an average lifespan of 30 years, are now being recycled, in some cases with 96 per cent recycling efficiency.[137] While the recycling of solar panels is not yet widely recognized as economically viable – it is estimated that by 2050 there will be 78 million tonnes of waste from solar equipment[138] – legislation is emerging to incentivize their reuse. In the US state of Washington, for example, solar panel manufacturers are required to have in place a recycling plan for their products.[139] France opened the world's first dedicated solar-panel recycling plants in 2018, with the aim of capturing part of an estimated $15 billion in global recoverable value by 2050 and enabling the assembly of 2 billion new solar panels without the need for raw materials.[140]
- Waste can be recovered and refined for energy production through thermochemical processes (using high temperatures to extract energy, e.g. through pyrolysis or gasification), chemical processes (e.g. using a chemical reaction between an alcohol and an acid to extract energy, as in biofuel production from agricultural by-products), and biochemical processes (extracting energy through the decomposition of biowaste, e.g. in the production of biogas through anaerobic digestion or of bioethanol through fermentation).[141]

[136] IEA (2012), 'Aluminium Production', Energy Technology Systems Analysis Programme (ETSAP), Technology Brief I10, March 2012, https://iea-etsap.org/E-TechDS/PDF/I10_AlProduction_ER_March2012_Final%20GSOK.pdf (accessed 24 Apr. 2019).
[137] Veoila (2018), 'Veolia opens the first European plant entirely dedicated to recycling photovoltaic panels', 5 July 2018, https://www.veolia.com/en/newsroom/news/recycling-photovoltaic-panels-circular-economy-france (accessed 20 Mar. 2019).
[138] Chen, A. (2018), 'More solar panels mean more waste and there's no easy solution', *The Verge*, 25 October 2018, https://www.theverge.com/2018/10/25/18018820/solar-panel-waste-chemicals-energy-environment-recycling (accessed 20 Mar. 2019).
[139] Department of Ecology, State of Washington (2019), 'Solar panels', https://ecology.wa.gov/Waste-Toxics/Reducing-recycling-waste/Solar-panels (accessed 20 Mar. 2019).
[140] De Clercq, G. (2018), 'Europe's first solar panel recycling plant opens in France', Reuters, 25 June 2018, https://www.reuters.com/article/us-solar-recycling/europes-first-solar-panel-recycling-plant-opens-in-france-idUSKBN1JL28Z (accessed 20 Mar. 2019); and Greenmatch (2019), 'The Opportunities of Solar Panel Recycling', https://www.greenmatch.co.uk/blog/2017/10/the-opportunities-of-solar-panel-recycling (accessed 20 Mar. 2019).
[141] World Business Council for Sustainable Development (2017), 'Energy recovery', Circular Economy Practitioner Guide, https://www.ceguide.org/Strategies-and-examples/Dispose/Energy-recovery (accessed 18 Jul. 2018).

- Energy storage technologies can be reused: electric vehicle batteries that have degraded through repeated charging and discharging retain between 70 per cent and 80 per cent of their charging capacity,[142] and so can be used in other applications, including as stabilizers in local electricity networks or as back-up energy stores for industrial sites.[143]
- Waste energy can be recovered for use: power stations and large-scale heating systems often generate residual heat that can be captured and used for other purposes. For example, a gas-fired power plant under expansion in Ghana will use heat recovery technology to generate 50 per cent more electricity without increasing greenhouse gas emissions.[144]
- Power-saving technologies can ensure long product lifetimes: low-cost LED lightbulbs have transformed access to lighting in India; made correctly, these lightbulbs can last decades before needing to be replaced.

Box 5: Waste-to-energy technologies

Waste-to-energy projects have received a lot of attention and funding from international development actors and the private sector. They offer a potentially easy solution to energy access issues in remote, hard-to-access areas. They can also relieve the pressure on resource-limited waste management programmes in lower-income countries, where facilities often struggle to handle rising volumes of unmanaged waste. The sector is growing fast: the proposed installed megawatt (MW) capacity in requests for funding for waste-to-energy projects to the Sustainable Energy Fund for Africa (SEFA) went from zero in 2015 to roughly 200 MW in 2016.[145] In 2018, SEFA granted nearly $1 million to a solid-waste-to-energy start-up for a 10-MW power plant in Nairobi's Kibera slum.[146]

However, the gains from such projects are not always clear cut. Burning waste should be considered a last resort, after all options for reuse, refurbishment or recycling have been exhausted. According to some stakeholders, landfilling waste may even be better from a net emissions perspective than burning it in some instances.[147] Waste-to-energy plants often emit dioxins that can be very damaging to humans.[148] And investment in waste-to-energy infrastructure risks lock-in to suboptimal practices: processes dependent on energy from waste in northern and western Europe have, for example, incentivized the practice of burning waste rather than reusing it in more productive ways.[149]

The environmental and health risks are exacerbated in settings where governance is weak and practices are poor. Waste effluent from donor-funded projects has been known to leach into nearby communities or into groundwater sources.[150] Moreover, substandard technologies may escape detection in countries without the technological capacity to test for dioxin levels and other environmental impacts.[151]

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[142] Olsson, L., Fallahi, S., Schnurr, M., Diener, D. and van Loon, P. (2018), 'Circular Business Models for Extended EV Battery Life', *Batteries*, 4(57), doi: 10.3390/batteries4040057 (accessed 26 Mar. 2019).
[143] Brennan, B. and Barder, T. (2016), *Battery Electric Vehicles vs. Internal Combustion Engine Vehicles: A United States-Based Comprehensive Assessment*, Arthur D. Little, http://www.adlittle.de/sites/default/files/viewpoints/ADL_BEVs_vs_ICEVs_FINAL_November_292016.pdf (accessed 24 Sep. 2018).
[144] International Finance Corporation (undated), 'IFC investment in waste heat recovery technology increases power generation in Ghana', https://www.ifc.org/wps/wcm/connect/news_ext_content/ifc_external_corporate_site/news+and+events/news/feature_ghana (accessed 18 Jul. 2018).
[145] Sustainable Energy Fund for Africa (2017), *Annual Report 2016*, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/SEFA_ANNUAL_REPORT_2016.pdf (accessed 18 Jul. 2018); and Sustainable Energy Fund for Africa (2016), *Annual Report 2015*, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/SEFA_ANNUAL_REPORT_2015.pdf (accessed 17 Jul. 2018).
[146] Munda, C. (2018), 'Energy firm gets Sh102 million for Kibera power plant', *Daily Nation*, 1 January 2018, https://www.nation.co.ke/business/Energy-firm-gets-Sh102-million-for-Kibera-power-plant--/996-4248158-5cx93i/index.html (accessed 18 Jul. 2018).
[147] Imbabi, M. S., Carrigan, C. and McKenna, S. (2012), 'Trends and developments in green cement and concrete technology', *International Journal of Sustainable Built Environment*, 1(2): pp. 194–216, doi: 10.1016/j.ijsbe.2013.05.001 (accessed 20 Mar. 2019).
[148] Geronimo, J. Y. (2017), 'Waste-to-energy technologies in PH? 'Go zero waste instead'', Rappler, 26 January 2017, https://www.rappler.com/science-nature/environment/159495-zero-waste-month-waste-energy-technologies (accessed 18 Jul. 2018).
[149] Vahk, J. (2018), 'Renewables law could lock EU into costly burning technologies', Euractiv, 9 April 2018, https://www.euractiv.com/section/energy/opinion/renewables-law-could-lock-eu-into-costly-burning-technologies/ (accessed 18 Jul. 2018); and Corvellec, H., Zapata Campos, M. J. and Zapata, P. (2013), 'Infrastructures, lock-in, and sustainable urban development: the case of waste incineration in the Goeteborg Metropolitan Area', *Journal of Cleaner Production*, 50: pp. 32–39, doi: 10.1016/j.jclepro.2012.12.009 (accessed 18 Jul. 2018).
[150] Wright, C. (2018), 'Blue finance: The Philippines declares war on waste', *Euromoney*, 5 June 2018, https://www.euromoney.com/article/b18hgl08ntqqpx/blue-finance-the-philippines-declares-war-on-waste (accessed 18 Jul. 2018).
[151] Ibid.

3.3 Driving green and resilient growth

It is becoming apparent that even a radical overhaul of current linear patterns of resource extraction and use is incompatible with global climate commitments. Developing countries are increasingly putting in place in place comprehensive 'green growth' strategies to reduce emissions and build their resilience to the impacts of climate change. Vietnam adopted a comprehensive national green growth strategy in 2014, for example, and green growth is one of the six strategies integrated into Malaysia's plan for 2016 to 2020.[152] The Africa Progress Panel has also highlighted the fact that many countries with extractive resources, such as Ethiopia, Ghana, Kenya, Nigeria and South Africa, have made strong progress towards climate-resilient, low-carbon development.

There exist certain trade-offs between the CE and climate mitigation. Approaches generally considered resource-efficient do not always reduce emissions. Primary resource extraction can, in certain circumstances, be less emissions-intensive than recycling and reuse, particularly where recycling is poorly organized or the separation of materials for recycling is inaccurate.[153] Biomaterials sourced from plants or algae can play an important role in displacing non-renewable minerals and metals, but these benefits need to be balanced against the embodied emissions and environmental impacts of the substitute materials, some of which are water- and land-intensive to produce. Nonetheless, a series of recent reports, including ones by Material Economics and the Energy Transitions Commission, have found the CE to be a crucial means of reducing greenhouse gas emissions.[154] The following benefits are of particular note:

- **Avoidance of emissions from primary extraction and production.** Prioritizing secondary materials over primary materials, increasing the utilization of assets, choosing lower-carbon materials and designing products to last longer – all are activities which should reduce both the requirement for extraction and production of primary materials and the emissions associated with such processes.
- **Net sequestration/reduction in emissions from choosing bio-based materials and products.** Beyond opting for lower-carbon materials, CE approaches emphasize the use of biomaterials over abiotic materials. In some cases, the use of **materials made from renewable biomass sources** could create a net sequestration effect, in which wood or crops grown for use as bio-based materials extract and store CO_2 from the atmosphere as they are cultivated. Another impact of choosing such materials could be to reduce emissions from the use of abiotic alternatives. Using organic or waste-based fertilizer rather than synthetic fertilizer could reduce emissions from the fertilizer industry, which is responsible for around 2.5 per cent of global greenhouse gas emissions.[155]
- **Reduced emissions from waste.** Finding alternative uses for waste and reducing the overall amount of waste produced will mitigate emissions from waste management. Under business-as-usual trajectories, these emissions will be substantial: by 2025, dumpsites are

[152] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) (2012), *Viet Nam National Green Growth Strategy*, https://www.giz.de/de/downloads/VietNam-GreenGrowth-Strategy.pdf (accessed 20 Mar. 2019); and Abdullah, H., Jali, M. R. M. and Ibrahim, F. W. (2017), 'The current state of Malaysia's journey towards a green economy: The perceptions of the companies on environmental efficiency and sustainability', *International Journal of Energy Economics and Policy*, *7*(1), pp. 253–58 (accessed 20 Mar. 2019).
[153] McCarthy, Dellink and Bibas (2018), *The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches*.
[154] Hoogzaad, J. and Bardout, M. (2018), *Looking Beyond Borders: The Circular Economy Pathway for Pursuing 1.5 ˚C*, Policy Analysis Brief, Iowa, US: The Stanley Foundation, https://www.stanleyfoundation.org/publications/pab/CircleEconomyPAB318.pdf (accessed 13 Aug. 2018).
[155] Phys.org (2018), 'Changes in agriculture could cut sector non-carbon dioxide greenhouse gas emissions by up to 50 percent', 17 December 2018, https://phys.org/news/2018-12-agriculture-sector-non-carbon-dioxide-greenhouse.html#jCp (accessed 20 Mar. 2018).

projected to account for 8–10 per cent of global greenhouse gas emissions.[156] Methane emissions, some of which are due to ineffective manure management, account for around 15 per cent of global greenhouse gas emissions.[157]

For many developing-country governments, climate-resilient growth is as important as low-carbon growth. Thinking around the contribution of the CE to climate resilience is in its infancy, but there are a number of pathways through which CE activities, if properly implemented, can support climate adaptation across sectors (see Table 3). For example, CE practices can reduce the exposure of communities to climate hazards. In many countries, waste is a contributing factor to flooding in urban settings.[158] Without adequate waste and water management infrastructure, drains and waterways become clogged with rubbish and pollutants; CE practices can lower the amount of unmanaged waste and thus reduce the potential for waste to heighten flood risk. CE practices can also boost the coping capacity of communities affected by climate change. Efficient water use, for example, will be a key strategy in promoting water security for the 3 billion people expected to be living in areas at high risk of water scarcity by 2050.[159]

Table 3: Linkages between the circular economy and climate resilience and adaptation

Priority sectors	Pathways through which the CE may contribute to climate resilience and/or adaptation	Examples from developing countries	Potential trade-offs for consideration by policymakers
Food and nutrition security	More circular agricultural approaches that mimic natural cycles, such as the recycling of nutrients and organic matter, could protect and improve soil fertility and reduce the use of synthetic fertilizers. This could increase the resilience to the negative impacts of climate change on crop yields and reduce dependence on international input supply chains. Closed-loop farming systems could support more local, self-sufficient and decentralized food networks, contributing to reduced exposure to price and supply shocks along international supply chains.	Over centuries, small-scale farmers in Cambodia, China, Indonesia, Laos, the Philippines, Thailand and Vietnam have developed the closed-loop rice/duck farm method, whereby ducks and fish de-pest, weed and fertilize rice paddies.[160] In Malawi, the FAO is working with networks of smallholder farmers to improve soil fertility by diversifying cropping systems, and by adding compost manure or legume residue to their soils.[161] Hydroponic indoor farming systems are being used in Vietnam to grow crops in cities.[162]	Closed-loop urban and peri-urban agriculture systems may disrupt existing trade between rural and urban communities, threatening the resilience of rural livelihoods.

[156] Mavropoulos, A. (2015), *Wasted Health: The Tragic Case of Dumpsites*, International Solid Waste Association, June 2015, https://www.iswa.org/fileadmin/galleries/Task_Forces/THE_TRAGIC_CASE_OF_DUMPSITES.pdf (accessed 26 Oct. 2017).
[157] World Resources Institute (2014), Climate Analysis Indicators Tool: WRI's Climate Data Explorer, http://cait2.wri.org (accessed 25 Sep. 2018).
[158] Lamond, J., Bhattacharya, N. and Bloch, R. (2012), 'The role of solid waste management as a response to urban flood risk in developing countries, a case study analysis', in Proverbs, D., Mambretti, S., Brebbia, C. and de Wrachien, D. (eds) (2012), *Flood Recovery Innovation and Response,* Southampton: WIT Press.
[159] United Nations World Water Assessment Programme (2018), *The United Nations World Water Development Report 2018: Nature-Based Solutions for Water*, Paris: UNESCO.
[160] Furuno, T. (2017), *Greater profits for the farm powered by symbiosis*, https://www.ellenmacarthurfoundation.org/case-studies/ecosystem-inspired-farm-yields-large-profits (accessed 10 Apr. 2019).
[161] Food and Agriculture Organization of the United Nations (2017), *Malawi Farmer to Farmer Agroecology project*, http://www.fao.org/3/a-br095e.pdf (accessed 10 Apr. 2019).
[162] Louedec, J. (2017), 'Indoor Farming In Vietnam: From Shipping Container to Consumer', *Vietcetera*, 21 November 2017, http://vietcetera.com/indoor-farming-in-vietnam-from-shipping-container-to-consumer/ (accessed 10 Apr. 2019).

Priority sectors	Pathways through which the CE may contribute to climate resilience and/or adaptation	Examples from developing countries	Potential trade-offs for consideration by policymakers
Water security	More efficient water use, closed-loop systems for agricultural wastewater recycling, desalination of salt water and reuse of wastewater from other sectors could increase the availability of clean water.	In South Africa, water recycling methods and desalination processes were employed to ensure a continued supply of water in Cape Town during the city's third year of drought.[163] In India, a number of desalination plants have been established in states suffering from water shortages to generate usable water.[164]	Desalination can be extremely energy-intensive, creating a highly concentrated brine waste product which is often discharged back into the oceans.
Energy security	More efficient energy use and waste heat recovery can lower demand for energy inputs. Local waste-to-energy networks can reduce dependence on external markets for energy inputs. Closed-loop mini-grids can improve local electrification and reduce dependence on larger grids that may be exposed to climate impacts elsewhere.	A community near Nairobi, Kenya, has added a waste heat recovery system to its solid-waste incinerator to create a supplementary source of low-cost energy.[165] PV minigrids have been used in a number of Pacific Island states to deliver clean, reliable and self-sufficient energy to remote communities.[166]	An emphasis on resource efficiency in the energy system may lead to reduced redundancy, a core principle of energy-system resilience. There is a risk that lower costs of energy inputs may lead to a 'rebound effect' whereby increased energy efficiency is offset by increased energy consumption.
Income security	CE practices tend to allow for more local opportunities for value creation and employment, thus reducing exposure to resource supply shocks and other shocks. Agro-ecology and eco-efficient agriculture tend to be more labour-intensive than industrialized agriculture, thus preserving jobs in a sector which still provides the bulk of employment in developing countries. Diversifying agricultural production is one way to build resilient livelihoods in this sector over the longer term.	In Nicaragua, a smallholder coffee-growing community diversified its farming practices. It allowed its plantations to be reforested with fruit, wood and fuel trees, and adopted composting to improve organic soil fertility. This allowed the community to withstand a two-year drought.[167]	Widespread adoption of CE practices could mean less income security in resource-intensive sectors, and could displace employment in waste management in the informal sector.

[163] Mulligan, G. (2018), 'Will Cape Town be the first city to run out of water?', BBC News, 12 January 2018, https://www.bbc.co.uk/news/business-42626790 (accessed 10 Apr. 2019).
[164] Lahiry, S. (2017), 'Desalinating seawater can ensure water security', Down To Earth, 30 January 2017, https://www.downtoearth.org.in/blog/water/desalinating-seawater-can-ensure-water-security-56908 (accessed 10 Apr. 2019).
[165] Mwangi Mucugia, M. (2019), 'Impact of Pollution Control on Blue Economy', *Kenya Engineer*, 19 February 2019, https://www.kenyaengineer.co.ke/impact-of-pollution-control-on-blue-economy/ (accessed 10 Apr. 2019).
[166] Raturi, A., Prasad, R. D., Singh, A. (2016), 'Grid-connected PV systems in the Pacific Island Countries', *Renewable and Sustainable Energy Reviews*, 58: pp. 419–28, doi: 10.1016/j.rser.2015.12.141 (accessed 10 Apr. 2019).
[167] Gliessman, S. (2018), *Breaking Away from Industrial Food and Farming Systems: Seven case studies of agroecological transition*, International Panel of Experts on Sustainable Food Systems, http://www.ipes-food.org/_img/upload/files/CS2_web.pdf (accessed 10 Apr. 2019).

Priority sectors	Pathways through which the CE may contribute to climate resilience and/or adaptation	Examples from developing countries	Potential trade-offs for consideration by policymakers
Human settlements	Modular homes built from more durable materials can support disaster preparedness in areas likely to be affected by floods and other extreme weather events. Improved waste management can mitigate the risk of rivers overflowing and flooding surrounding communities.	Companies are building prefabricated, modular and hurricane-resistant houses in the Caribbean. The houses can be erected on stilts, moved to new areas and disassembled. The aim is to increase durability, flexibility and convenience, and reduce construction waste.[168]	Modular and more flexible design sometimes relies on the use of less resilient materials, for example lightweight hybrid materials rather than high-thermal-mass concrete, which could decrease the overall resilience of these homes to climate impacts.
Infrastructure	Debris collected in the wake of disaster-related damage to buildings and infrastructure can be reused in post-disaster recovery to build defensive infrastructure, such as sea walls, to reclaim land from the sea, and to improve the quality of essential infrastructure such as roads. Waste plastic can be used as a construction material to support more robust infrastructure such as roads.	In China, construction and demolition waste is used for land reclamation and defences,[169] while in Haiti, debris from natural disasters has been converted into concrete building blocks.[170] In India, trials are under way to evaluate the potential to bury shredded plastic waste in roads, both reducing amounts of waste sent to landfills and increasing the durability of roads.[171]	The use of waste as a filler material in land reclamation can lead to contamination of soil and the destruction of marine ecosystems. Dumping waste into land reclamation sites may release toxic materials into soil and local waters if poorly managed.
Ecosystem health	Vertical farming and closed-loop food production systems can reduce the pressure of agriculture on land and water resources, while the use of organic waste as fertilizer can limit the leaching of nutrients into soils. Better waste management practices can mitigate the risk of toxic materials and chemicals entering water systems.	A rural community cooperative founded by a local teacher in Shanxi, China, developed a training programme for local farmers to improve synthetic fertilizer use and promote closed-loop farming practices, including the use of fermentation beds for local livestock to reuse animal waste as a natural compost to improve soils.[172]	Negative impacts on biodiversity are potentially associated with the reuse and remanufacturing of waste products. Reintroducing waste products into production and use cycles can lead to contamination of air, soil and water if poorly managed.

[168] Nguyen, C. (2016), 'These modular hurricane-proof homes cost less than $200,000 to build', *Business Insider*, 2 November 2016, https://www.businessinsider.com/cubicco-hurricane-proof-homes-florida-caribbean-2016-10?r=US&IR=T (accessed 10 Apr. 2019).
[169] He, H. (2019), 'Hong Kong, Shenzhen multibillion-dollar land reclamation plans may be on collision course', *South China Morning Post*, 2 January 2019, https://www.scmp.com/economy/china-economy/article/2180273/hong-kong-shenzhen-multibillion-dollar-land-reclamation-plans (accessed 10 Apr. 2019).
[170] Dawson (2015), 'Disaster debris can become building blocks for a new life'.
[171] Subramanian (2016), 'Plastic roads: India's radical plan to bury its garbage beneath the streets'.
[172] Gliessman (2018), *Breaking Away from Industrial Food and Farming Systems*.

3.4 Summary

- If the CE is to gain political traction in developing countries, its advocates will need to demonstrate how circular approaches align with and support existing domestic industrial and social development strategies.
- The CE can support job creation. It can provide opportunities for resource-intensive economies to diversify from primary resource extraction towards higher-value remanufacturing and reprocessing. 'Circular' interventions along the food chain – from agricultural production to processing to food retail and distribution – can contribute to improving the availability and affordability of food, while generating value-adding activities for millions of people employed in the agriculture sector.
- The CE can be an important strategy in building climate resilience and supporting climate adaptation – not only through more efficient and sustainable use of critical resources (including land, water and energy) but also through the prioritization of disaster-ready and sustainable infrastructure.

4. Investing in the Fundamentals

With the policy, business and development communities becoming increasingly enthusiastic about the CE, and with the risks of poorly coordinated domestic CE strategies highlighted by recent developments in the global used-plastics trade, there is an urgent need to consider the conditions under which the CE can flourish while delivering on existing international commitments to sustainable development and climate mitigation.

> Policymakers will need to consider how best to capture and preserve existing CE expertise and innovation in the informal sector.

Robust regulation will be needed both to create the right incentive structures for a transition to the CE and to ensure that businesses are held to the highest labour, health and environmental standards when rolling out CE practices. Policymakers will need to consider how best to capture and preserve existing CE expertise and innovation in the informal sector. They will have to consider how to mitigate the risk of large-scale displacement of informal workers, and put in place the right policy structures to support domestic CE practitioners and innovators while attracting foreign investment and trade. Inequities in access to finance and variations in consumption patterns will need to be addressed to ensure that CE strategies align with the principles of inclusive and sustainable growth.

4.1 Putting in place the policy architecture

4.1.1 Regulation

Experience in developed countries suggests that the range of potential policies for implementing the CE is broad (see Table 4), with a variety of interventions required to facilitate the transition. In developed countries, interventions have included financial incentives such as reduced VAT on repaired products, as well as policies such as labelling schemes to help consumers choose more 'circular' products. While the bulk of policy activity in this area has been in developed countries, some of these interventions are already in use in developing countries: extended producer responsibility (EPR) policies, for example, have been widely adopted in emerging and developing countries, including China, Colombia, India, Nigeria and Thailand, and the governments of Indonesia and the Philippines are considering adopting EPR schemes for the management of plastic waste.[173] Other measures will be less applicable to developing countries. Differentiated and preferable VAT rates for repair services and sales of second-hand goods may, in principle, act as an incentive for CE activities, but in practice are likely to be difficult to administer where institutional capacity is low.

[173] Federigan, L. O. (2018), 'An extended producer responsibility policy for PH', *Manila Times*, 19 July 2018, https://www.manilatimes.net/an-extended-producer-responsibility-policy-for-ph/420998/ (accessed 12 Apr. 2019); and Gokkon, B. (2018), 'Indonesia leans on businesses to do more about plastic waste', *Mongabay*, 12 November 2018, https://news.mongabay.com/2018/11/indonesia-leans-on-businesses-to-do-more-about-plastic-waste/ (accessed 12 Apr. 2019).

Table 4: Selected elements of a circular economy policy toolkit for developed countries

Type	Policy	Example
Economic instruments	Landfill taxation	Landfill tax in Denmark, the Netherlands and the UK
	Carbon tax	Carbon tax in the Netherlands, Norway and Sweden
	Container deposit legislation	AB Svenska Returpak in Sweden
	Infrastructure investment	UK Recycling and Waste LP fund for smaller-scale recycling and waste infrastructure
	Differentiated VAT rate	Reduced VAT rates in China for secondary raw materials
Information-based	Labelling	EU Ecolabel; Der Grüne Punkt in Germany
	Public education programmes	EU public information campaign on environmental damage caused by plastic waste
	Skills and training	Scotland Skills Investment Plan
Ecodesign	Extended producer responsibility (EPR)	India 2016 E-Waste Management Rules; Canada-wide Action Plan for Extended Producer Responsibility
	Ecodesign requirements: durability, repairability, recyclability	EU's Eco-Design Directive
Other regulations	Waste prevention standard	BS 8001: 2017 – a framework standard for implementing the CE in organizations
	Voluntary agreements	European PVC industry voluntary agreement; WRAP's Courtauld Commitment to reducing private-sector food waste
	Waste shipments: proper enforcement	UK Transfrontier Shipment of Waste Regulations
Public procurement and innovation	Green public procurement	Dutch government's Green Deal
	Targeted public R&D	EU Circular Economy Finance Support Platform; EU InnovFin, backed by Horizon 2020; Innovate UK
	Pilot zones	CE industrial parks in China; eco-industrial parks in Scandinavia

Sources: Authors' analysis, building on table in McCarthy, A., Dellink, R. and Bibas, R. (2018), *The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches*, OECD Environment Working Papers, No. 130, doi:10.1787/af983f9a-en, Paris: OECD Publishing.

Accounting for local infrastructure and institutional capacity in the design of CE policies and regulations will be key if policymakers are to avoid pushback from industry. In India, the e-waste EPR system, introduced in 2011, has seen more than 700 electronics producers apply for authorization but has also met with wide resistance. Producers argue that the EPR targets – to collect and recycle at least 30 per cent of products within two years of implementation and 70 per cent within seven years – are too ambitious.[174] Poor at-source segregation of waste, the lack of formalized reverse logistics infrastructure and the continued role of informal workers in collecting around 80 per cent of waste have all posed major challenges for companies trying to trace their products – whether to buy them back, move them around the country or assign them to authorized recyclers.[175] In Nigeria, the government has encountered challenges in implementing its EPR scheme for e-waste.[176] The policy was introduced in 2016, but a lack of capacity has hampered roll-out of the framework across the country. The regulatory enforcement

[174] Central Pollution Control Board Ministry of Environment, Forest and Climate Change Government of India (2018), EPR Authorization Status, 8 October 2018, http://cpcb.nic.in/epr-authorization-status/ (accessed 9 May 2019).
[175] GIZ (2010), *The Waste Experts: Enabling Conditions for Informal Sector Integration in Solid Waste Management: Lessons learned from Brazil, Egypt and India*, https://www.giz.de/en/downloads/gtz2010-waste-experts-conditions-is-integration.pdf (accessed 1 Nov. 2017).
[176] Iwenwanne, V. (2019), 'Nigeria's E-waste Mountain', *Resource*, 3 January 2019, https://resource.co/article/nigerias-e-waste-mountain-13017 (accessed 12 Apr. 2019).

agency, for example, has no official presence in 10 out of 36 states.[177] As in India, the large size of the informal recycling sector presents challenges: Nigerian consumers are used to being paid for their waste by informal workers, and unwilling to hand over end-of-life products without compensation.

In addition to incentives to encourage CE activity, robust regulations will be needed in developing countries both to mitigate the risks of negative environmental and health externalities and to reduce the likelihood of 'regulatory flight' (whereby foreign companies take advantage of a lax regulatory environment in one country to implement practices that would not be permitted in other jurisdictions, as discussed in Section 2.1.1). Standards on durability, reusability and recyclability are particularly important in the construction sector, where developing countries have a window of opportunity to embed CE design principles in new buildings and infrastructure. With appropriate building standards, developing-country governments and urban planners can incentivize the building of structures that are long-lasting, easily maintained and refurbished, and readily repaired in the event of climate-related damage. Similarly, regulating the design and construction of new infrastructure in such a way as to maximize connectivity can encourage more efficient use of primary resources. As part of the Smart Cities Mission in India, more than 100 cities are implementing initiatives to develop urban areas that provide decent quality of life to citizens via the application of 'smart' solutions including integrated multimodal transport and enhanced digital connectivity.[178]

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Commitments under the UN Framework Convention on Climate Change (UNFCCC), notably via countries' Nationally Determined Contributions (NDCs), will be a key vehicle through which to shape climate-friendly and climate-resilient building design. In its updated NDC, in December 2017, Lesotho committed to the decarbonization of its building sector and outlined plans to implement climate-related building codes and standards, launch energy-efficiency programmes and develop national standards for alternative building materials and technologies.[179] Lesotho is in a minority: of the 193 countries that have submitted NDCs, only 40 have committed to creating building energy codes.[180] Nonetheless, the design and implementation of well-developed and robustly enforced building energy codes in other developing countries can mitigate the risk of locking in high energy consumption over the lifetime of the building stock, and reduce the consequent likely need for expensive retrofits as and when future regulations are introduced and implemented.

[177] Ibid.
[178] Government of India (2019), 'Smart Cities Mission', https://smartnet.niua.org/smart-cities-network (accessed 20 Mar. 2019); and Seetharaman, G. (2018), 'Smart Cities Mission is still very much a work in progress post three years of its launch', *Economic Times,* 9 July 2018, https://economictimes.indiatimes.com/news/economy/infrastructure/smart-cities-mission-is-still-very-much-a-work-in-progress-post-three-years-of-its-launch/articleshow/64523035.cms (accessed 20 Mar. 2019).
[179] Lesotho Meteorological Services (2017), *Lesotho's Nationally Determined Contribution under the UNFCCC*, https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Lesotho%20First/Lesotho%20First%20NDC.pdf (accessed 20 Mar. 2019).
[180] UNEP (2017), *Towards a zero-emission, efficient, and resilient buildings and construction sector*.

Labour standards are another important yet little discussed area. Protecting labour rights and promoting safe and secure working conditions are particularly important in the waste management sector, where the handling of materials including e-waste potentially poses environmental and human health risks.[181] Hybrid approaches to integrating the informal sector into managed supply chains are one means of promoting basic principles of good practice in workplace safety, but robust labour standards and the promotion of decent work principles will be needed to enshrine appropriate monitoring and accountability frameworks in developing countries.

4.1.2 Integration of informal workers

Informal-sector employment in waste management presents both opportunities and challenges for lower- and middle-income countries seeking to shift towards a CE. Informal waste-pickers contribute significantly to the 'circularity' of developing economies. In India, roughly 80 per cent of waste is collected and processed by informal workers.[182] They collect, sort, trade and often process, recycle and repair secondary products and materials.[183] As a result, few things left on the street are not retrieved for further use. Compared to industrialized waste management processes, these activities are often cheaper and less technology- and energy-intensive. Some studies also suggest that waste-pickers are more effective at collecting waste on a household level than more formalized processes are.[184] Finally, the existence of a strong skills base in separation, repairs and recycling can be an advantage.[185]

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Careful approaches are needed to avoid rapidly displacing employment in the informal sector and losing the skills base and resource efficiency associated with that employment. The most exciting opportunities for harnessing the skills of informal workers without rapidly displacing employment seem to lie in hybrid approaches that provide access to finance for the informal sector (see Box 6) and the adoption of taxation and fiscal structures that tax resources rather than people, thereby lowering the costs of hiring and increasing the costs associated with primary resource extraction and waste generation.[186]

[181] World Economic Forum (2019), *A New Circular Vision for Electronics: Time for a Global Reboot*, January 2019, http://www3.weforum.org/docs/WEF_A_New_Circular_Vision_for_Electronics.pdf (accessed 12 Apr. 2019).
[182] GIZ (2010), *The Waste Experts*.
[183] Wilson, D., Velis, C. and Cheeseman, C. (2006), 'Role of informal sector recycling in waste management in developing countries', *Habitat International*, 30: pp. 797–808, doi: 10.1016/j.habitatint.2005.09.005 (accessed 16 Jul. 2018).
[184] Gupta, S. (2010), *Integrating the informal sector for improved waste management*, Proparco.fr, https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W2/Integrating_informal_sector_improved_waste_management.pdf (accessed 15 Nov. 2018).
[185] Navarrete-Hernandez and Navarrete-Hernandez (2017), 'Unleashing Waste-Pickers' Potential: Supporting Recycling Cooperatives in Santiago de Chile'.
[186] Schroeder, P., Anantharaman, M., Anggraeni, K. and Foxon, T. J. (eds) (2019), *The Circular Economy and the Global South: Sustainable Lifestyles and Green Industrial Development*, Abingdon: Routledge.

Box 6: Informal-sector hybrid model in Brazil

In 2010, following a 20-year deliberation period, Brazil adopted its National Solid Waste Policy, designed to respond to the critical challenges presented by the 67 million tonnes of solid waste the country produces each year.[187] The policy was ambitious, mandating that solid-waste plans be prepared by every municipality by 2012, that all dumpsites be closed by 2013, and that recycling be increased from 1 per cent of solid waste to 45 per cent by 2031, among other directives.[188] The plan also called for the social inclusion of 75 per cent of the estimated 200,000–800,000 waste-pickers, or *catadores*, by 2031.[189] Traditionally independent and working as part of the informal economy, *catadores* separate and gather recyclables to sell.

The National Association of Collectors of Recyclable Waste (Movimento Nacional dos Catadores de Materiais Recicláveis), established in 2001, sought formal recognition of the profession – a goal that was achieved in 2002 – to secure remuneration for the environmental management aspect of informal waste-picking, beyond just the sale of the raw materials. In 2013, the non-profit BVRio Institute signed an agreement with the National Association of Collectors to develop a system to support the remuneration of *catadores* for reverse logistics services.

A pilot project was established. Running from April 2014 to March 2015, it included more than 1,000 *catadores* from 30 cooperatives, as well as the consumer goods companies O Boticario and Biscoitos Piraquê. The cooperatives issued and sold 'reverse logistics credits', certificates which confirmed that reverse logistics services had been provided for the responsible disposal of waste. The credits were applied to more than 1,600 tonnes of solid waste, generating over $100,000 in revenue for the cooperatives, and making it worthwhile for the *catadores* to collect waste materials with a lower raw-material value than aluminium. The cost to the companies ranged from $0.00013 to $0.011 per unit of packaging, so the credits also offered an economically viable way of complying with their obligations under the National Solid Waste Policy.[190]

Digital technology companies have also begun to enter the space, with apps such as Cataki launching an Uber-style service to link householders wanting to dispose of recyclables with *catadores*, although as of 2017 the app had limited penetration.

Brazil has yet to meet the targets outlined in the National Solid Waste Policy. As of 2015, only 40 per cent of municipalities had submitted solid-waste management plans, and around 3,000 dumps remained open.[191] Ultimately, for the policy to be a success, the law must be enforced and innovation must continue to create solutions that respond to both the environmental and economic pressures for the stakeholders involved.

4.1.3 Trade policy

Domestic trade policies potentially provide an important means through which national governments can encourage and incentivize a transition to more circular approaches among domestic actors while creating an attractive investment environment for foreign financiers. Energy-efficiency requirements for imported second-hand vehicles; minimum percentage requirements for recyclable content in plastic waste; health and safety standards for recycled or recyclable products and materials; and quality, health and safety standards for remanufactured products[192] – all could, depending on how they are designed, either expand or restrict international trade in various categories of desirable and undesirable secondary materials. India has banned the import of refurbished Apple iPhones in order

[187] BVRio (2017), 'The Observatory of the National Solid Waste Policy celebrates 3 years of existence', 22 September 2017, https://observatoriopnrs.org/ (accessed 20 Mar. 2019).
[188] World Bank Group (2018), *Municipal Solid Waste Management: A Roadmap for Reform for Policy Makers*, Washington, DC: World Bank.
[189] Global Alliance of Waste Pickers (2019), 'Law Report: Brazil', http://globalrec.org/law-report/brazil/ (accessed 20 Mar. 2019).
[190] BVRio (2017), 'The Observatory of the National Solid Waste Policy celebrates 3 years of existence'.
[191] World Bank Group (2018), *Municipal Solid Waste Management: A Roadmap for Reform for Policy Makers*.
[192] OECD (2018), *International Trade and the Transition Towards a Circular Economy*, Paris: OECD, http://www.oecd.org/environment/waste/policy-highlights-international-trade-and-the-transition-to-a-circular-economy.pdf.

to prevent the dumping of e-waste, and Pakistan is considering banning all second-hand mobile phones.[193] A number of countries have also imposed stricter controls and import restrictions on old and inefficient second-hand vehicles as a means of meeting their NDCs under the Paris Agreement.[194]

Import duties can have a substantial impact on access to affordable inputs for CE activities in developing countries. The reduction or removal of import duties on primary goods used for pollution management and resource management – such as equipment used in recycling plants – or on secondary raw materials can lower the capital costs of CE infrastructure and feedstock in import-dependent countries and boost the competitiveness of downstream CE activities. India, despite boasting limited supplies of domestic scrap steel, has taken a 13 per cent share of global secondary steel production through importing waste and scrap for material recovery;[195] were scrap metal imports available at a lower cost, other countries might be in a position to do the same.

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For developing countries, the removal of restrictions on trade in services relevant to the CE across various modes of delivery (such as measures that restrict domestic businesses' access to operating licences overseas, or to foreign services in IT and communications) will be critical to promoting a more inclusive approach to the CE. Developed countries could benefit from repair services, for appliances and other goods, based in developing countries. Developing countries could benefit from the expertise of specialized companies in the sorting and processing of e-waste.

Box 7: Domestic trade policy and WTO rules

The non-discrimination principle enshrined in the World Trade Organization (WTO) agreements, centred around the General Agreement on Tariffs and Trade (GATT), prohibits the use of protectionist trade measures by member countries. Regulations or taxes must not discriminate between imported and domestically produced 'like products', or between imports from different WTO members. But certain exceptions to these rules permit governments to impose unilateral trade restrictions in specified circumstances, for example when 'necessary to protect human, animal or plant life or health' (GATT Article XX(b)); or 'relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption' (GATT Article XX(g)). A series of dispute cases have helped to clarify the meaning of 'likeness', and the following factors may be taken into account: (1) the properties, nature and quality of the products; (2) the end-uses of the products; (3) consumers' taste and habits in respect of the products; and (4) the tariff classification of the products. It may

[193] Mankotia, A. S. and Aulakh, G. (2016), 'It's official, Apple can't import or sell second-hand phones', GadgetsNow, 4 May 2016, https://www.gadgetsnow.com/articleshow/52103196.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst (accessed 20 Mar. 2019); and Mirza, H. N. (2018), 'Pakistan set to ban import of used mobile phones', *Daily Pakistan*, 23 November 2018, https://en.dailypakistan.com.pk/pakistan/pakistan-to-ban-import-of-used-mobile-phones/ (accessed 20 Mar. 2019).
[194] Brandi, C. (2017), *Trade Elements in Countries' Climate Contributions under the Paris Agreement*, Geneva: International Centre for Trade and Sustainable Development (ICTSD), https://www.ictsd.org/sites/default/files/research/trade_elements_in_countries_climate_contributions.pdf (accessed 20 Mar. 2019).
[195] OECD (2017), *Mapping support for primary and secondary metal production*, 9 November 2017, ENV/EPOC/WPRPW(2016)2/FINAL, Paris: OECD.

therefore be permissible for products which are *like* in terms of physical characteristics and end-uses but which have very different environmental impacts at the point of production (e.g. aluminium cans made of recycled scrap versus those made of new aluminium ore) to be subject to differentiated treatment.[196]

Such treatment could, in theory, include differential tariffs (import and export duties) based on non-product criteria such as a manufacturing process.[197] But this is rare. In practice, trade measures based on non-product criteria have been more common in respect of product standards, labels and accreditation procedures. These factors offer a further basis for encouraging trade in CE products, above all those that are difficult to distinguish from non-CE products at the point of import, such as e-waste and functional used electrical and electronic equipment.

The WTO's Agreement on Technical Barriers to Trade (TBT Agreement) lays down disciplines regulating the use of standards in international trade. It employs the same concept of 'likeness' to ensure that domestically produced goods are not treated more favourably than their imported equivalents. Under the TBT Agreement, technical regulations must not be 'prepared, adopted or applied with a view to, or with the effect of, creating unnecessary obstacles to international trade' and 'shall not be more trade-restrictive than necessary to fulfil a legitimate objective, taking account of the risks non-fulfilment would create'.[198] In this context, the protection of human health or safety and/or the health of animals, plants and the environment is considered a 'legitimate objective'. Products manufactured using CE practices could therefore, in theory, be afforded preferential treatment if their positive environmental impact is easily demonstrable, and if the trade measures in question are clearly not protectionist in effect.

4.2 Fostering innovation and investment

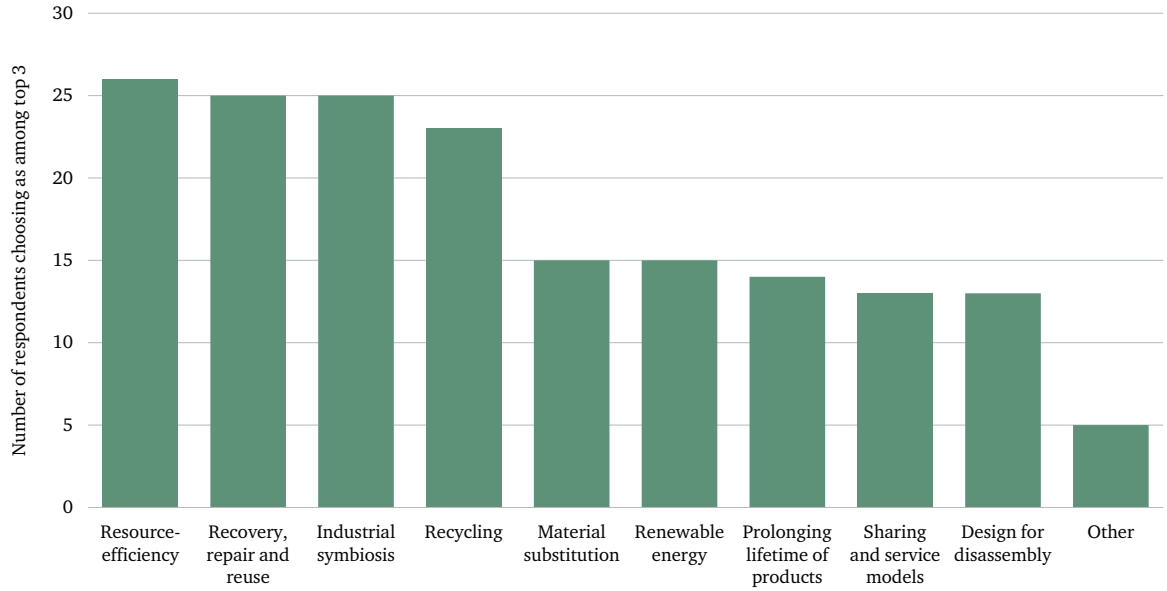
4.2.1 Support for research and innovation

For many companies operating in the developing world, above all in resource-intensive economies, the CE may not initially be seen as an attractive business proposition or fertile space for investment in novel solutions. If governments are to encourage the private-sector innovation needed to support the transition to a CE, they will need to identify early opportunities that harness the competitive advantage of incumbent industries and that demonstrate the potential for the CE to enhance market opportunities.

Fostering innovation will also depend on heightening awareness of the breadth of solutions and practices that contribute to the CE. In developing countries, where urbanization and industrial development are expected to continue apace, manufacturers, investors and policymakers have a window of opportunity to embed CE principles early in those processes. As such, they also have an opportunity to provide consumers with products and business models designed for 'second life' applications, easy repair or asset sharing. Yet responses to the Chatham House–UNIDO survey indicate that improved waste management is seen as the greatest opportunity presented by the CE (see Figures 5 and 6), and that circular approaches are most commonly understood as those designed to deliver greater resource efficiency and recovery and to promote 'repair and reuse' models (see Figure 7). Less well appreciated is the potential for CE practices to contribute to more sustainable and lucrative approaches to construction, electronics production or textiles production, for example, through materials substitution, design for disassembly or longer product lifespans.

[196] Christian, G. E. (2017), 'Trade Measures for Regulating Transboundary Movement of Electronic Waste', *Utrecht Journal of International and European Law*, 33(85), pp.103–27, doi: http://doi.org/10.5334/ujiel.435.
[197] Conrad, C. R. (2011), *Process and Production Methods (PPMs) in WTO Law*, Cambridge University Press.
[198] World Trade Organization (undated), 'Article 2: Preparation, Adoption and Application of Technical Regulations by Central Government Bodies', 'Agreement on Technical Barriers to Trade', https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm (accessed 26 Apr. 2019).

Figure 7: Which activities or practices do you most associate with the circular economy?



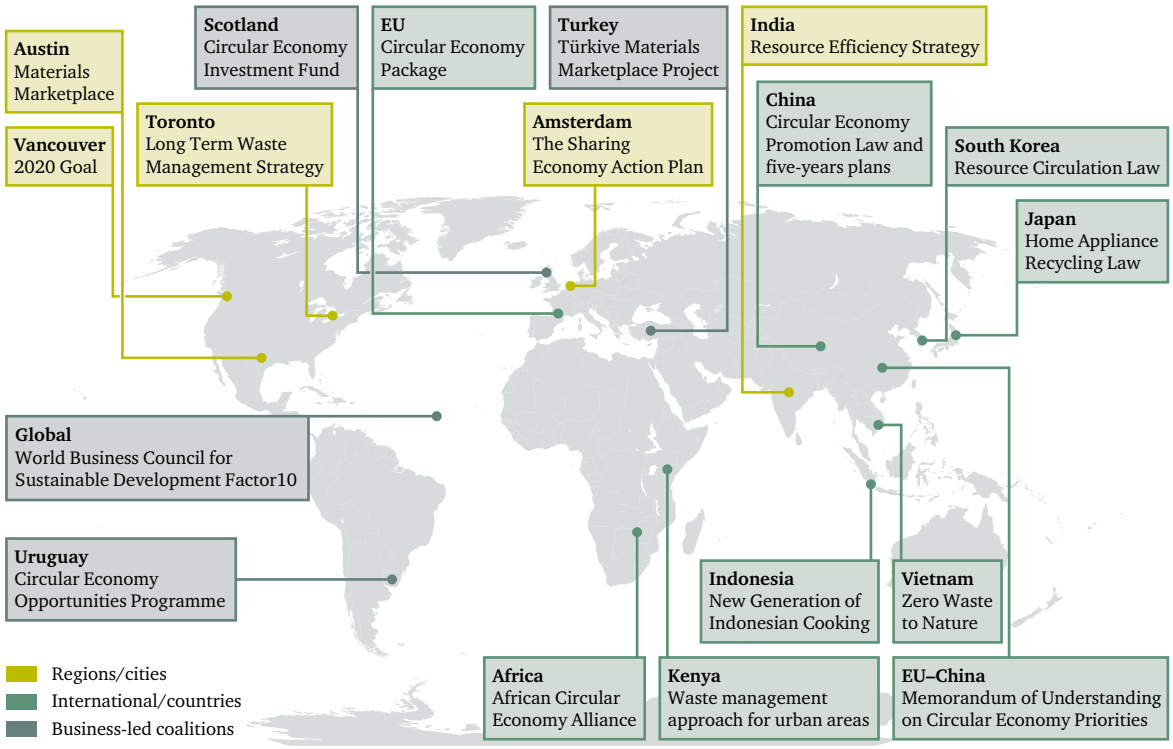
Source: Authors' analysis of Chatham House–UNIDO survey responses.

The curating of knowledge-sharing networks can play an important role in encouraging the early research and experimentation required to establish first principles and lower the barriers to entry for businesses and innovators. Examples of CE solutions and initiatives abound across both developed and developing countries (see Figure 8), but small businesses and CE researchers based in universities may have no easy way of tapping into the lessons learned from existing projects. Virtual networks, supported through government-to-government partnerships, donor projects or civil society initiatives, can link innovators around the world, enabling the exchange of ideas and approaches. Such knowledge-sharing can help to demonstrate the multitude of ways in which CE solutions may be applied to support different actors.

One example is 3D printing. With relatively low-cost 3D printers and easy-to-use software increasingly available,[199] many actors in developing countries are taking up 3D printing technology. Its applications in the CE context vary. The Ethical Filament Foundation has worked with local waste-pickers, industry and entrepreneurs in India, Kenya and Tanzania to produce valuable 3D printer filament out of recycled waste that is then sold to local businesses.[200] New Story, a US-based non-profit organization, has used 3D printing technology to build affordable, customizable and sustainable homes in Bolivia, El Salvador and Haiti, thus reducing demand for materials and providing for greater recyclability.[201] The Victoria Hand Project is using 3D printing to provide prosthetic limbs to amputees in Nepal and Cambodia, in an initiative that has increased quality of life for hundreds of citizens.[202] Knowledge-sharing networks that showcase these projects while connecting suppliers of 3D hardware and software with potential customers could enable wider uptake of the technology.

[199] Woodson, T., Alacantara, J. T. and do Nascimento, M. S. (2019), 'Is 3D printing an inclusive innovation?: An examination of 3D printing in Brazil', *Technovation*, 80–81: pp. 54–62, doi: 10.1016/j.technovation.2018.12.001 (accessed 20 Mar. 2019).
[200] Ethical Filament (2019), 'Introduction', http://ef.techfortrade.org/ (accessed 20 Mar. 2019).
[201] Warren, T. (2018), 'This cheap 3D-printed home is a start for the 1 billion who lack shelter', *The Verge,* 12 March 2018, https://web.archive.org/web/20181016053917/https://www.theverge.com/2018/3/12/17101856/3d-printed-housing-icon-shelter-housing-crisis (accessed 20 Mar. 2019).
[202] Hunter, J. (2017), 'Forging prosthetics from plastic for a pittance', *Globe and Mail*, 12 November 2017, https://www.theglobeandmail.com/news/british-columbia/victoria-hand-project-is-forging-prosthetics-from-plastic-for-a-pittance/article33444630/ (accessed 20 Mar. 2019).

Figure 8: Circular economy activity around the world



Source: Authors' own analysis, multiple sources.

Investment in digital accessibility and digital literacy will be another critical component for government strategies aimed at encouraging innovation in the CE. Digital technologies are likely to play a critical role in accelerating the uptake of circular activities, not least because the barrier to entry is relatively low.[203] There are many possible applications of data in CE approaches: firms are using active location sensors and radio frequency identification (RFID) to track and check the condition of products, which in turn allows the timing of repairs to be optimized and facilitates the sharing of assets between consumers; optical scanners are helping to identify materials in waste streams for more accurate separation into different categories;[204] and online platforms can match available secondary materials and products with potential customers.[205] Equitable access to these technologies, and to the employment opportunities and resource efficiency gains they can deliver, will depend on ensuring that workers – especially in rural and disadvantaged locations – can acquire the necessary training.[206]

Developing novel alternatives to materials used by low-income households and rural communities will be as important as innovation in high-tech solutions. Plastic bottles, sachets and containers, for example, are invaluable for keeping liquids, food and household items safe from contamination and

[203] Lacey, P. (2018), 'Using Digital Tech to Spin the Circular Economy', Accenture, https://www.accenture.com/gb-en/insight-outlook-using-digital-tech-spin (accessed 13 Jul. 2018); Pagoropoulos, A., Pigosso, D. and McAloone, T. (2017), 'The emergent role of digital technologies in the Circular Economy: A review', *The 9th CIRP IPSS Conference: Circular Perspectives on Product/Service-Systems*, 64(2017): 19–24, doi: 10.1016/j.procir.2017.02.047 (accessed 13 Jul. 2018); and Ellen MacArthur Foundation (2016), *Intelligent Assets: Unlocking the Circular Economy Potential*, https://www.ellenmacarthurfoundation.org/publications/intelligent-assets (accessed 1 Nov. 2017).
[204] Wheatley, M. (2018), 'Real-time tracking: Is it Here yet?', *Automotive Logistics*, 10 May 2018, https://automotivelogistics.media/intelligence/real-time-tracking-yet (accessed 13 Jul. 2018).
[205] The Materials Marketplace (2019), 'Join the Circular Economy', https://go.materialsmarketplace.org/ (accessed 20 May 2019).
[206] Chetty, K., Qigui, L., Gcora, N., Josie, J., Wenwei, L. and Fang, C. (2018), 'Bridging the digital divide: Measuring digital literacy', *Economics: The Open-Access, Open-Assessment E-Journal,* 12(2018–23): pp. 1–2, doi: 10.5018/economics-ejournal.ja.2018-23 (accessed 5 Apr. 2019).

allowing them to be sold in amounts that are affordable for the average consumer in lower-income countries.[207] Finding and funding novel alternatives will be critical to ensuring that the removal or substitution of existing packaging and containers does not curtail product access.

4.2.2 Novel finance mechanisms

Whether technology-intensive or not, CE innovations will need to be accompanied by innovative forms of financing if they are to be adopted.[208] Many efforts to establish large-scale financing facilities for the CE in developing countries have yet to be operationalized, given the absence of a strong pipeline of suitable projects. Circular investments are often seen as high-risk, owing to their novelty and to uncertainties around the valuation and insurance of repaired products. Constraining factors also include long asset lifetimes, difficulties around ownership models for products flagged for reuse and remanufacture, and the cross-industry nature of CE models.[209] Product-as-a-service models, for example, require new forms of leasing and insurance contracts and typically require longer-term financing. Similarly, circular business models typically rely on cooperation across a network of suppliers; banks may thus seek assurance that no single point of dependence in a given network poses a threat to the other participants. Innovative financing will also be needed to ensure that local entrepreneurs and small and medium-sized enterprises (SMEs) are supported in the transition to a CE.

> A range of financing organizations will likely need to be involved, providing not only blended finance but guidance on how to structure and operationalize circular value networks. Collaborative approaches to financing guidelines could accelerate the creation of a lower-risk investment environment for private-sector financiers.

Financial instruments with novel risk-sharing mechanisms could help to enhance collaboration along the value chain.[210] Such mechanisms could support the sharing of supply chain risk information, or underpin revenue-sharing and buy-back arrangements to mitigate losses to any one actor in the event of a disruption to supply or demand.[211] A range of financing organizations will likely need to be involved, providing not only blended finance but guidance on how to structure and operationalize circular value networks. Collaborative approaches to financing guidelines, as seen in the CE finance guidelines launched by ABN AMRO, ING and Rabobank in 2018,[212] could accelerate the creation of a lower-risk investment environment for private-sector financiers. Governments can also help to incentivize novel projects via public procurement rules and fiscal policy, potentially building on lessons from renewable energy markets. In the electricity sector, a combination of price guarantee policies – such as feed-in tariffs – and innovative public financing models encouraged the flow of private investment into

[207] Workshop participant.
[208] ING Economics Department (2016), *Rethinking finance in a circular economy*, https://www.ing.nl/media/ING_EZB_Financing-the-Circular-Economy_tcm162-84762.pdf (accessed 17 Aug. 2018); Ellen MacArthur Foundation (2016), *Money makes the world go round: and will it help to make the economy circular as well?*, https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/FinanCE.pdf (accessed 17 Aug. 2018); and Accenture (2014), *Circular Advantage – Innovative Business Models and Technologies to create value in a world without limits to growth*, https://www.accenture.com/t20150523T053139__w__/us-en/_acnmedia/Accenture/Conversion-Assets/DotCom/Documents/Global/PDF/Strategy_6/Accenture-Circular-Advantage-Innovative-Business-Models-Technologies-Value-Growth.pdf (accessed 17 Aug. 2018).
[209] Rizos, V., Behrens, A., Rinaldi, D. and Drabik, E. (2018), 'The contribution G20 governments can make to support the circular economy', *Reverse Logistics Magazine*, 12(1): pp. 34–42, http://rlmagazine.com/RLMagazine_Edition_88.pdf (accessed 27 Jul. 2018).
[210] Ibid.
[211] Li, G., Fan, H., Lee, P. K. C. and Cheng, T. C. E. (2015), 'Joint supply chain risk management: An agency and collaboration perspective', *International Journal of Production Economics*, 164: pp. 83–94, doi: 10.1016/j.ijpe.2015.02.021 (accessed 1 Apr. 2019).
[212] ABN AMRO, ING and Rabobank (2018), *Circular Economy Finance Guidelines*, https://www.ing.com/web/file?uuid=bb60f278-9508-440f-b5f5-f4568f50a789&owner=b03bc017-e0db-4b5d-abbf-003b12934429&contentid=43933 (accessed 27 Jul. 2018).

renewable energy sources. This stimulated technological development in renewable energy. It enabled economies of scale to emerge so that, today, solar PV installations and wind power are competitive with conventional energy sources. In 2016, 90 per cent of renewable energy investment came from private sources.[213]

At the level of individual strategies or products, initiatives to strengthen financial access will be key to enabling small businesses and low-income consumers to participate in circular value chains. Low-cost models for asset sharing, product-as-service models or subscriptions to software can enable lower-income customers to adopt CE products and services.

4.3 Addressing the social dimensions of the CE

In the past, the CE agenda has been criticized for being too focused on technical and engineering aspects, to the detriment of understanding the role of people's desires and aspirations.[214] Discussions of resource management have not always considered the social dimensions of resource access and resource use, or the shifts in attitudes and behaviour implied by a transition away from linear consumption patterns towards the circular and sharing economy.

Social norms and consumer behaviour are key to the success of the CE, and developing countries are in many ways ahead of developed countries when it comes to consumer attitudes towards goods and services. The new consumer classes in developing countries are not perfectly replicating the consumption patterns of developed economies. Affluent Chinese, Indian and Indonesian consumers tend to be younger and more internet-savvy than their counterparts in European and North American markets,[215] shopping online more and spending less on durable goods and more on lifestyle experiences such as travel. On average, people living in lower-income economies tend to display more 'circular' behaviour than those living in higher-income countries. Moreover, despite considerable variation, per capita resource consumption is generally lower in developing countries than in developed ones.[216] In India, for example, 60 per cent of discarded plastics are recycled, compared to just 6 per cent in the US.[217] Similarly, the Marshall Islands recycles 31 per cent of municipal solid waste, whereas New Zealand recycles only 15 per cent.[218] In fact, the Marshall Islands forms part of a group of Pacific islands (including 14 countries and eight territories across Melanesia, Micronesia and Polynesia) that collectively recycle at least 47 per cent of waste; they aim to increase this share to 70 per cent by 2025.[219]

Where current and anticipated trends in consumer behaviour are towards 'throw-away' models of resource use, nudge tactics and awareness campaigns can encourage perceptions of product reuse, recycling and asset sharing as mainstream and appealing. Experience of policy design around

[213] International Renewable Energy Agency (IRENA) and Climate Policy Initiative (2018), *Global Landscape of Renewable Energy Finance, 2018*, Abu Dhabi: IRENA, https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Jan/IRENA_Global_landscape_RE_finance_2018.pdf (accessed 7 Apr. 2019).
[214] Pomponi, F. and Moncaster, A. (2017), 'Circular economy for the built environment: A research framework', *Journal of Cleaner Production*, 143: pp. 710–18, doi: 10.1016/j.jclepro.2016.12.055 (accessed 16 Jul. 2018).
[215] Schultz, D. E. and Jain, V. (2013), 'The young and the upwardly mobile', *Marketing News*, 47 (11): pp. 26–27, https://www.academia.edu/35972276/Luxury_Not_for_Consumption_but_Developing_Extended_Digital_Self (accessed 20 May 2019).
[216] Sustainable Europe Research Institute (SERI), Global 2000 and Friends of the Earth Europe (2009), *Overconsumption: Our use of the world's natural resources*, https://cdn.friendsoftheearth.uk/sites/default/files/downloads/overconsumption.pdf (accessed 16 Aug 2018).
[217] Ellen MacArthur Foundation (2016), *Circular Economy in India: Rethinking Growth for Long-Term Prosperity.*
[218] Hoornweg, D. and Bhada-Tata, P. (2012), *What a Waste: A Global Review of Solid Waste Management*, Washington, DC: World Bank, http://documents.worldbank.org/curated/en/302341468126264791/pdf/68135-REVISED-What-a-Waste-2012-Final-updated.pdf (accessed 15 Nov. 2018).
[219] Secretariat of the Pacific Regional Environment Programme (2016), *Cleaner Pacific 2025; Pacific Regional Waste and Pollution Management Strategy*, https://sustainabledevelopment.un.org/content/documents/commitments/1326_7636_commitment_cleaner-pacific-strategy-2025.pdf (accessed 15 Nov. 2018).

the world in support of sustainable consumption indicates the importance of environmental cues and targeted information in disrupting habits, particularly when the impacts of individual changes may be hard to see.[220] A campaign to encourage more responsible water use in Brazil, for example, included a calculation of the volume of water wasted over an individual's lifetime through leaving the tap running while teeth-brushing; in São Paulo, the campaign contributed to a reduction in water consumption of more than 30 per cent.[221] In the case of 'switch' changes – involving switching from an unsustainable behaviour to a more sustainable one – schemes that automatically make the sustainable option the default have been shown to be successful.[222] So, too, have information campaigns that alert individuals to changes made by their peers: one frequently cited study demonstrates that hotel guests are more likely to reuse their towels when told that most guests at the hotel had done so.[223]

Encouraging positive consumer attitudes will be particularly important to the scaling up of value-added surplus products (VASPs) in the food system.[224] Certain approaches will require a degree of public education to demonstrate their safety and to socialize their use. For example, sludge recycling – the collection, treatment and use of human sewage – offers opportunities for the manufacturing of fertilizer, fuel, building materials (bricks and cement), animal feed and bioplastics,[225] but there has been substantial consumer resistance to expansion of the associated supply chains in many countries. Moreover, considerable effort will need to go into influencing consumer mindsets to avoid the 'rebound effect' whereby price reductions for a commodity that occur as circular practices take hold either increase consumption of that commodity or result in higher spending elsewhere in the economy.

> Policies will likely be needed to promote equitable access to the CE-associated benefits – including increased access to cheaper transport and living spaces – that are enjoyed predominantly by the wealthier segments of developing-country populations.

As the middle classes expand, governments in developing countries will need to manage a growing divergence between the consumption and wastefulness of a fast-growing elite and the consumer habits of an increasingly 'left behind' group of poorer and more vulnerable people. Policies will likely be needed to promote equitable access to the CE-associated benefits – including increased access to cheaper transport and living spaces – that are enjoyed predominantly by the wealthier segments of developing-country populations.[226] It will also be important for policymakers to manage gender inequities. As women tend to have poorer access to digital technologies – in Africa, only 12 per cent use or own digital technologies, versus 18 per cent of men[227] – there is a risk that the roll-out of the CE will further exacerbate inequities in women's access to goods, services and employment.

[220] UNEP (2017), *Consuming Differently, Consuming Sustainably: Behavioural Insights for Policymaking*, http://www.ideas42.org/wp-content/uploads/2017/11/UNEP_consuming_sustainably_Behavioral_Insights.pdf (accessed 11 Apr. 2019).
[221] Ibid.
[222] Ibid.
[223] Clayton, S. (2015), 'Psychology's Role In Addressing Environmental Problems', *Behavioural Scientist*, 12 November 2015, https://behavioralscientist.org/psychologys-role-in-addressing-environmental-problems/ (accessed 11 Apr. 2016).
[224] Bhatt, S., Lee, J., Deutsch, J., Ayaz, H., Fulton, B. and Suri, R. (2017), 'From food waste to value-added surplus products (VASP): Consumer acceptance of a novel food product category', *Journal of Consumer Behaviour*, 17: pp. 57–63, doi: 10.1002/cb.1689 (accessed 23 May 2018).
[225] Wald, C. (2017), 'Economy in the Toilet', *Nature*, 549: pp. 146–48 (accessed 8 May 2018).
[226] Colby, C. and Bell, K. (2016), 'The On-Demand Economy Is Growing, and Not Just for the Young and Wealthy', *Harvard Business Review*, 14 April 2016, https://hbr.org/2016/04/the-on-demand-economy-is-growing-and-not-just-for-the-young-and-wealthy (accessed 30 Jan. 2017).
[227] Ibid.

4.4 Summary

- Developing-country governments will need to provide an enabling environment for private-sector innovation and change in public behaviour if the CE is to take hold at scale. Fundamental to such an environment will be a robust policy architecture that creates the right incentives and punitive measures to guide industry action, that integrates the large and vibrant informal sector, and that encourages foreign investment in domestic industries engaged in circular activities.
- Innovation strategies will be required to encourage R&D in CE solutions beyond recycling and waste management. Where CE approaches are untested or involve coordination across multiple actors in a supply chain, novel financing mechanisms are likely to be needed to lower the investment risk.
- Development of a comprehensive CE will also depend on public uptake of circular behaviours, including consumption of used or refurbished goods and participation in asset-sharing models. Equally as important will be policy measures to tackle inequities in resource access and use, both between low- and high-income groups and between genders, to ensure that the benefits of the CE are reaped widely and fairly.

5. Supporting an Inclusive Global Agenda

National strategies to support the transition to a CE have the potential to deliver industrial growth that mitigates negative environmental externalities. But without parallel investment in regional and global circular value chains, and in the sharing of knowledge and innovation, it is unlikely that the CE will reach meaningful scale. A transformation is needed not only at the level of domestic industry but across international resource and material supply chains; for this, collaboration will be key. Optimizing the impact of CE investments will depend on ensuring that activities are aligned with existing sustainable development programmes and investments, and that the potential trade-offs associated with CE approaches (for example, reconciling environmental sustainability and inclusive growth) are carefully managed. Here, government-to-government collaboration will play a critical role, through bilateral investments, cross-border partnerships to encourage the emergence of regional and international circular value chains, and cooperation in agreeing common terms for the global trade in secondary materials and CE-related services.

5.1 Mainstreaming the CE in the global sustainability agenda

The Paris Agreement and adoption of the SDGs in 2015 set in motion global efforts to promote sustainable and resilient growth that tackles poverty and inequities while safeguarding finite natural resources and biodiversity. Central to both agendas is the tenet of sustainable resource production and consumption. Goal 12 of the 17 SDGs consists of ensuring responsible production and consumption patterns. Ongoing dialogues at the G7 and G20 have acknowledged that, with roughly 70 per cent of global resource extraction ultimately ending up in the atmosphere as greenhouse gas emissions,[228] the transformative changes envisaged by the Paris Agreement can only be achieved alongside a decoupling of economic growth from natural resource use and environmental degradation.[229]

Various studies have identified linkages through which the CE can support delivery on the SDGs, and vice versa.[230] According to the International Resource Panel (IRP), 12 of the 17 SDGs rely directly on society-wide changes in the management of resources;[231] another analysis identified 10 SDGs that depend on the CE.[232] One detailed analysis[233] identifies particularly close links between CE practices and the following SDGs:

- **SDG 6 – clean water and sanitation.** More effective use of water should reduce overall consumption and wastage. The safe and effective recycling and reuse of wastewater can further reduce wastage while providing greater access to water for circular manufacturing processes. CE practices can contribute to more sustainable sanitation, e.g. through composting toilets.

[228] Scherer, L., Behrens, P., de Koning, A., Heijungs, R., Sprecher, B. and Tukker, A. (2018), 'Trade-offs between social and environmental Sustainable Development Goals', *Environmental Science and Policy*, 90: pp. 85–62, doi: 10.1016/j.envsci.2018.10.002 (accessed 20 Mar. 2019).
[229] Rizos et al. (2018), 'The contribution G20 governments can make to support the circular economy'.
[230] Preston and Lehne (2017), A *Wider Circle? The Circular Economy in Developing Countries*; and Schroeder, Anggraeni and Weber (2018), 'The Relevance of Circular Economy Practices to the Sustainable Development Goals'.
[231] Ekins and Hughes (2017), *Resource Efficiency: Potential and Economic Implications*.
[232] United Nations Industrial Development Organization (2018), 'Circular economy creates global environmental benefits', DevelopmentAid, 26 June 2018, https://www.developmentaid.org/#!/news-stream/post/25286/circular-economy-creates-global-environmental-benefits (accessed 26 Jul. 2018).
[233] Schroeder, Anggraeni and Weber (2018), 'The Relevance of Circular Economy Practices to the Sustainable Development Goals'.

CE initiatives can also reduce the release of hazardous waste into water sources, reducing the risks of harm to people and to marine and fluvial ecosystems.

- **SDG 7 – affordable and clean energy.** CE approaches have the potential to limit energy use in the extraction of raw materials and manufacturing of primary products. Renewable energy initiatives, including small-scale waste-to-energy technologies, can improve access to clean energy, particularly in rural areas. Waste heat recovery initiatives can contribute to greater energy efficiency. End-of-life battery recovery and reuse can lower the costs of stabilizing mini-grids, thereby supporting rural electrification.
- **SDG 8 – decent work and economic growth.** The CE will bring new employment opportunities and greater market access for workers in a range of industries, including waste management, textiles, remanufacturing and CE services. At the same time, CE technologies will allow for a greater geographical distribution of employment opportunities. Regional and circular value chains should enable developing countries to position themselves as key players in the trade of high-value circular goods.
- **SDG 12 – responsible consumption and production.** CE practices and innovations will be critical to achieving more sustainable use of resources, including water and energy. Small-scale waste-to-energy practices can reduce food waste. Sustainable procurement guidelines can incentivize CE business models. Greater valorization of waste products and secondary materials, together with promotion of the sharing economy, will be central to reducing waste generation.
- **SDG 15 – life on land.** Regenerative and organic agriculture can dramatically reduce fertilizer and land use, while contributing to improved soil health and ecosystem conservation. Circular water management can support the restoration of ecosystems in arid and climate-affected regions. Circular means of food production can limit demand for land-use change.

In many cases, success in delivering on the SDGs will facilitate the transition to a CE. Targets under SDG 9 – industry, innovation and infrastructure – to increase access to financial services and value-chain integration (target 9.3) among SMEs should also, for example, support their participation in innovative practice and value chains, while investment in domestic technology development, research and innovation in developing countries (target. 9.B) can drive the emergence of digital platforms for CE practices such as asset sharing.

Several analyses have highlighted the CE as a framework for identifying additional mitigation opportunities not currently included in NDCs.[234] A report by Material Economics suggests that a more circular economy can cut emissions from heavy industry in the EU by 56 per cent by 2050.[235] The European Commission, in developing its strategic long-term vision for 2050, considered the role of a highly circular economy in generating consumer demand for less carbon-intensive goods, as well as in maximizing opportunities to sequester carbon in the land and reduce the need for negative emissions technologies in meeting commitments under the Paris Agreement.[236]

[234] Hoogzaad and Bardout (2018), *Looking Beyond Borders: The Circular Economy Pathway for Pursuing 1.5 °C*; Material Economics (2018), *The Circular Economy – a Powerful Force for Climate Mitigation,* http://materialeconomics.com/publications/publication/the-circular-economy-a-powerful-force-for-climate-mitigation (accessed 3 Jul. 2018); and Circle Economy and Ecofys (2016), *Implementing Circular Economy Globally Makes Paris Targets Achievable*, https://www.ecofys.com/files/files/circle-economy-ecofys-2016-circular-economy-white-paper.pdf (accessed 26 Jul. 2018).
[235] Material Economics (2018), *The Circular Economy – a Powerful Force For Climate Mitigation*.
[236] European Commission (2018), 'Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank', https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_en.pdf (accessed 20 Mar. 2019).

To advance understanding of the synergies between the CE and the SDGs, CE strategies could be incorporated into existing multi-stakeholder discussions on pathways to sustainable consumption and production (SCP), such as those instigated in early 2019 in the Republic of the Maldives by the country's Ministry of Environment and supported by the EU SWITCH-Asia Sustainable Consumption and Production Facility. Bringing together policymakers, civil society organizations and practitioners to explore challenges to the implementation of SCP and set national priorities, such dialogues provide a means to gather a range of perspectives on the opportunities and risks associated with the transition to a CE.

Further opportunities for mainstreaming the CE into the global sustainable development agenda will come in 2019 and 2020, with a number of key moments set to occur in global climate and biodiversity negotiations: at the UNFCCC's 25th Conference of the Parties (COP 25) in November 2019, countries will be expected to demonstrate a ratcheting up of ambition in their NDCs; while at the Convention on Biodiversity, also in November 2019, a post-2020 global biodiversity framework is expected to be agreed. In 2020, a number of CE-relevant SDG targets are also expected to be met. These include target 11.b – to 'substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters';[237] and target 12.4 – to 'achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment'.[238]

The next two years therefore offer a moment of opportunity for development actors to align efforts on the Paris Agreement, the SDGs and global biodiversity targets with those of the CE, and to galvanize political and financial support for ambitious policies that deliver on multiple global commitments at once.

5.2 Focusing multilateral and bilateral cooperation

5.2.1 Multilateral investments

For international financial institutions seeking to support the implementation of the SDGs and the Paris Agreement, investments in CE innovations or value chains could be used to reinforce and accelerate existing programmes of sustainable development. Many multilateral development banks (MDBs) are scaling up their activities in the CE space through activities that build on existing funds targeted in these areas, and are also setting aside specific funding pots for CE approaches. Some examples of MDB activity include the following:

- **European Investment Bank (EIB):** Between the start of 2013 and the end of 2017, the EIB provided €2.1 billion of co-financing for CE projects.[239] While most of this funding is directed at European projects, a growing number are in developing countries. In 2015, for example, the EIB signed a €8 million loan to finance a carbon burn-out facility in Mauritius[240] which converts coal fly ash – a waste product from coal combustion – into an additive for local cement producers.

[237] UN (2018), 'Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development', https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%20refinement_Eng.pdf (accessed 26 Apr. 19).
[238] Ibid.
[239] European Investment Bank (2018), *The EIB in the circular economy*, https://www.eib.org/attachments/thematic/circular_economy_en.pdf (accessed 20 Mar. 2019).
[240] Ibid.

- **European Bank for Reconstruction and Development (EBRD):** The EBRD funds CE activities through its Green Economy Transition approach, agreed in 2015 as a means of mainstreaming environmental criteria in investment decisions. One example of the EBRD's investments that align with the CE is a €30 million loan to the Şişecam Group, which hopes to increase glass recycling rates to over 50 per cent in cities across Turkey.[241]
- **World Bank:** The bank's technical assistance programme 'China: Promoting a Circular Economy' supported the development of national legislation on the CE in China in 2009. The bank has continued to work on CE activities in China, supporting solid-waste minimization and recycling schemes.[242] It also works with other countries to develop green growth strategies expanding integrated waste management.
- **African Development Bank (AfDB):** The AfDB is examining how the CE can support the industrial development pillar of its strategy[243] and has financed the implementation of plastic waste collection and recycling infrastructure in a number of African countries. In 2018, the AfDB signed a cooperation agreement with UNIDO to develop joint activities of shared interest, including in the CE.[244]

Given the challenges for multilateral donors in investing in CE solutions outlined in Section 2.1, increasing the flow of investment from MDBs into the CE may depend on a collaborative approach that unifies CE-related strategies across the banks. Cooperative financing arrangements in which multiple MDBs or donor agencies pool their resources to support CE investments would create a lower-risk environment in which to expand engagement in the CE.[245] An equally important approach might be to reorient investment strategies and revise eligibility criteria to allow CE projects to benefit from existing schemes,[246] such as the Global Environment Facility (GEF). The GEF's seventh framework programme has the CE as one of its Impact Programmes. The facility has helped to foster collaborations involving the AfDB, the World Economic Forum, and the World Bank in Rwanda and Nigeria;[247] in January 2019, the Nigerian government announced a $2 million (£1.53 million) initiative, supported by the GEF and UN Environment, to kickstart the recycling of waste electric and electronic equipment.[248]

5.2.2 Bilateral cooperation

For many developed countries, the more labour-intensive components of the CE, including reverse logistics, are unlikely to be economically viable in domestic contexts until such time as they become automated. The development of resilient international circular value chains will be an important enabler for the scaling up of domestic remanufacturing and recycling commitments, while at the

[241] European Bank for Reconstruction and Development (2016), *Green Economy Transition*, http://ec.europa.eu/environment/archives/greenweek2016/uploads/additional-assets/green-economy-transition-brochure.pdf (accessed 20 Nov. 2018).
[242] World Bank (2015), 'Remarks by Elisabetta Capannelli at the Circular Economy Conference', 1 September 2015, http://www.worldbank.org/en/news/speech/2015/09/01/remarks-by-elisabetta-capannelli-world-bank-country-manager-romania-at-circular-economy-conference (accessed 27 Jul. 2018).
[243] African Development Bank Group (2013), *At the Center of Africa's Transformation: Strategy for 2013–2022*, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Policy-Documents/AfDB_Strategy_for_2013%E2%80%932022_-_At_the_Center_of_Africa%E2%80%99s_Transformation.pdf (accessed 23 Oct. 2017).
[244] African Development Bank (2018), 'African Development Bank and UNIDO join forces to accelerate Africa's industrialization', 21 May 2018, https://www.unido.org/news/african-development-bank-and-unido-join-forces-accelerate-africas-industrialization (accessed 27 Jul. 2018).
[245] Rizos et al. (2018), 'The contribution G20 governments can make to support the circular economy'.
[246] Ibid.
[247] Global Environment Facility (2017), 'GEF-7 Programming Directions and Policy Agenda', First Meeting for the Seventh Replenishment of the GEF Trust Fund, 28–30 March 2017, Paris.
[248] Dickinson, K. (2019), 'Nigeria invests in WEEE recycling as UN highlights value in discarded electronics', *Resource*, 1 February 2019, https://resource.co/article/nigeria-invests-weee-recycling-un-highlights-value-discarded-electronics-13073 (accessed 26 Apr. 2019).

same time supporting delivery on commitments to global sustainable development frameworks. The CE may offer opportunities for bilateral investments and partnerships which simultaneously contribute to the CE at home and overseas.

The EU, China and Japan have been proactive in seeking out cross-border opportunities for partnership on the CE. The EU has dispatched CE missions to Chile, China, India and South Africa.[249] The focus of these missions is to communicate the opportunities from transitioning to a CE, as well as to support European businesses in expanding their activities in these countries. In June 2018, the EU and India signed a joint declaration of intent to foster resource-efficient practices in India and support recommendations made in the Strategy on Resource Efficiency.[250] A number of joint initiatives will be undertaken, including support for an eco-labelling scheme for secondary products; assistance in developing recycling standards for e-waste, plastics, and construction and demolition waste; promotion of R&D in resource efficiency; and development of a 'Waste Exchange Platform', a marketplace for by-products and industrial waste.

> President Xi Jinping has stipulated that the Belt and Road Initiative should promote a 'green, low-carbon, circular and sustainable' form of development.

In China, President Xi Jinping has stipulated that the Belt and Road Initiative (BRI) – an ambitious set of foreign and economic policies centred on infrastructure building to connect China's less developed border regions with Southeast Asia, Central Asia and Europe[251] – should promote a 'green, low-carbon, circular and sustainable' form of development.[252] While the specific activities remain to be determined, China's recycling industry is preparing to expand its activities abroad.[253] Many of China's partner or prospective partner countries for BRI projects are still in the early stages of developing modern recycling and waste management, and some of the infrastructure investment planned under the BRI is focused on that sector.[254] At the same time, China is seeking to capitalize on its experience in industrial symbiosis and the use of eco-industrial parks to pilot new business models and activities. One example is the planned construction of a China-African Circular Economy Industrial Park in South Africa, led by GEM Co. Ltd, a Shenzhen-based company specializing in resource recycling.[255]

Japan, meanwhile, has demonstrated regional leadership in the CE through its inauguration of the Regional 3R Forum in Asia and the Pacific. This cooperative platform enables governments from 39 countries in the region[256] to promote policy coordination; network building; research cooperation; the piloting of CE projects; and knowledge-sharing with international organizations, the private sector

[249] European Commission (2017), 'Circular Economy Missions to Third Countries', http://ec.europa.eu/environment/international_issues/missions_en.htm (accessed 12 Sep. 2017).
[250] Delegation of the European Union to India and Bhutan (2018), 'The European Union and India sign a Joint Declaration on Resource Efficiency', 5 June 2018, https://eeas.europa.eu/delegations/india/45883/european-union-and-india-sign-joint-declaration-resource-efficiency_en (accessed 29 Jul. 2018).
[251] Cai, P. (2017), *Understanding China's Belt and Road Initiative*, Sydney: Lowy Institute, March 2017, https://think-asia.org/bitstream/handle/11540/6810/Understanding_Chinas_Belt_and_Road_Initiative_WEB_1.pdf?sequence=1.
[252] Ortolani, G. (2018), 'China's Belt and Road poised to transform the Earth, but at what cost to the environment?', Eco-Business, 25 April 2018, http://www.eco-business.com/news/chinas-belt-and-road-poised-to-transform-the-earth-but-at-what-cost-to-the-environment/ (accessed 29 Jul. 2018).
[253] Xinhua (2018), 'Chinese recycling company sees opportunities in circular economy', 23 January 2018, http://www.xinhuanet.com/english/2018-01/23/c_136918116.htm (accessed 29 Jul. 2018).
[254] Huang, J., Zhao, R., Huang, T., Wang, X. and Tseng, M., (2018), 'Sustainable Municipal Solid Waste Disposal in the Belt and Road Initiative: A Preliminary Proposal for Chengdu City', *Sustainability,* 10(4): p. 1147, doi: 10.3390/su10041147 (accessed 14 Aug 2018); and Lehne, J. (2017), 'Opinion: China will be key to creating a global circular economy', China Dialogue, 15 December 2017, https://www.chinadialogue.net/article/show/single/en/10298-Opinion-China-will-be-key-to-creating-a-global-circular-economy (accessed 16 Aug 2018).
[255] Xinhua (2018), 'Chinese recycling company sees opportunities in circular economy'.
[256] Afghanistan, Australia, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, the Cook Islands, Fiji, India, Indonesia, Japan, Kiribati, the Republic of Korea, Lao PDR, Malaysia, the Maldives, the Marshall Islands, the Federated States of Micronesia, Mongolia, Myanmar, Nauru, Nepal, New Zealand, Niue, Pakistan, Palau, Papua New Guinea, the Philippines, Samoa, Singapore, the Solomon Islands, Sri Lanka, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu and Vietnam.

and civil society stakeholders.[257] As G20 chair in 2019, Japan has an opportunity to take its domestic and regional experience on to the international stage, building on the work started by Germany two years ago, and to promote policy alignment and knowledge exchange on resource efficiency and the CE among G20 countries and developing-country partners.[258]

Several other donors are discussing the CE as a potential new focus area for development assistance. Few detailed strategies have yet emerged, but early examples include Denmark's DKK 900,000 ($136,000) strategic sector cooperation agreement with Indonesia on 'circular economy and waste management'; a similar agreement with Kenya on 'circular economy, cleaner manufacturing, regulation and enforcement';[259] and the Norwegian international development minister's highlighting in April 2018 of the CE as a priority in Norway's international development policy, with a focus on cooperation with developing countries to establish profitable value chains for waste.[260] Commitments to supporting CE initiatives in the developing world have also emerged in other countries, in response to a surge in public awareness of the global waste challenge (see Box 8).

The Memorandum of Understanding on Circular Economy Cooperation between the EU and China, signed in July 2018, could provide a vehicle through which to broaden CE cooperation and leadership. Under the MoU, the EU and China agree to cooperate on 'dialogue on the design, planning and implementation of strategies, legislation, policies, and research', 'strategic exchanges on management systems and policy tools such as eco-design, eco-labelling, extended producer responsibility and green supply chains', 'strategic exchanges on best practices of circular economy', and 'exchanges on investments in and financing of circular economy'.[261] Such modes of cooperation could, in theory, be extended to third countries, including in sub-Saharan Africa where both the EU and China have significant investment interests and existing donor programmes.

> Initiatives that marry donor funds with multilateral expertise may be used to encourage donor or private investments in novel areas of research and innovation, mitigating the risk of the unknown by capitalizing on sectoral expertise and existing knowledge-sharing networks.

Cooperation between donors and multilateral agencies can provide a further avenue through which to advance CE activities and strategies. The UK's Department for International Development (DFID), for example, has partnered with the UN Conference on Trade and Development (UNCTAD) to develop the Sustainable Manufacturing and Environmental Pollution (SMEP) programme.[262] SMEP will fund research and technical solutions that focus on mitigating the environmental pollution and degradation associated with certain industrial and manufacturing processes in sub-Saharan Africa

[257] Japanese Ministry of the Environment (undated), 'Regional 3R Forum in Asia and the Pacific', http://www.env.go.jp/recycle/3r/en/index.html (accessed 5 Apr. 2019).
[258] Preston and Lehne (2017), *A Wider Circle? The Circular Economy in Developing Countries*.
[259] Ministry of Foreign Affairs of Denmark (2018), 'Strategic Sector Cooperation projects', http://um.dk/en/danida-en/sustainable%20growth/strategic-sector-cooperation-new/list-of-strategic-sector-cooperation-projects/ (accessed 27 Jul. 2018).
[260] Government of Norway (2018), 'Address on Norway's international development policy 26 April', 26 April 2018, https://www.regjeringen.no/en/aktuelt/address_policy/id2599458/ (accessed 27 Jul. 2018).
[261] European Commission (2018), 'Memorandum of Understanding on Circular Economy Between the European Commission and the National Development and Reform Commission of the People's Republic of China', 16 July 2018, http://ec.europa.eu/environment/circular-economy/pdf/circular_economy_MoU_EN.pdf (accessed 5 Apr. 2019).
[262] UNCTAD (undated), 'Sustainable Manufacturing and Environmental Pollution (SMEP)', https://unctad.org/en/Pages/DITC/Trade-and-Environment/Sustainable-Manufacturing-Environmental-Pollution.aspx (accessed 5 Apr. 2019).

and South Asia. Similar initiatives that marry donor funds with multilateral expertise may be used to encourage donor or private investments in novel areas of research and innovation, mitigating the risk of the unknown by capitalizing on sectoral expertise and existing knowledge-sharing networks.

Box 8: Plastic pollution and public interest

In late 2017 and early 2018, plastic pollution in oceans rocketed to the top of political and media agendas in countries around the world. Partly spurred by media attention around the BBC's *Blue Planet II* television series in the UK and by China's ban on 24 types of solid waste, a plethora of commitments by multinational organizations, governments and companies have emerged. The EU committed to making all plastic packaging on the European market recyclable by 2030, the UK committed to eliminating all avoidable plastic waste by 2042, and 193 countries passed the United Nations Clean Seas agreement at the UN Environment Assembly in December 2018. Many of these commitments have made a specific link to the CE as a fundamental way to tackle marine plastic pollution, recognizing that one of the best ways to do so is to prevent plastic waste from entering the ocean in the first place.[263] The European Commission's plastics-management strategy is titled 'A European Strategy for Plastics in A Circular Economy. The New Plastics Economy Global Commitment'. Signed by over 250 businesses, governments and other organizations, it commits signatories to eliminate unnecessary plastic items; innovate to ensure plastics can be composted, recycled or reused; and circulate plastic items to prevent their damaging the environment.[264]

A number of governments have paired domestic commitments with development finance to tackle the issue in developing countries. The UK has directed roughly £8 million in aid to help developing nations reduce plastic waste.[265] The German Ministry for Economic Cooperation and Development (BMZ) has expanded its cooperation with partner countries on integrated waste management as part of its marine litter action plan.[266]

5.2.3 Corporate action

While consumers can lobby for change and governments are able to mandate compliance, it is evident that major corporations possess the financial, technical and logistical resources that can speed up the transition to a global CE.[267] The incentives for doing so include business growth, competitive advantage, reduced energy consumption and increased supply chain security (see Table 5).[268] Numerous companies, the most notable being member firms of the CE100 grouping, have committed to implementing CE practices.[269] That said, with some companies it is often difficult to distinguish sustainability rhetoric from genuine CE implementation.[270]

[263] Schroeder, P. (2018), 'How can development cooperation address ocean plastic pollution?', Institute of Development Studies, 23 January 2018, https://www.ids.ac.uk/opinion/how-can-development-cooperation-address-ocean-plastic-pollution (accessed 26 Jul. 2018).
[264] New Plastics Economy (2018), 'A line in the sand: Global Commitment to eliminate plastic pollution at its source', https://newplasticseconomy.org/projects/global-commitment (accessed 20 Mar. 2019).
[265] Green, J. (2018), 'Reasons to be hopeful about new funding to tackle plastic waste in developing countries', Insidetrack blog, 16 May 2018, https://greenallianceblog.org.uk/2018/05/16/reasons-to-be-hopeful-about-new-funding-to-tackle-plastic-waste-in-developing-countries/ (accessed 27 Jul. 2018).
[266] German Federal Ministry for Economic Cooperation and Development (2018), 'Marine litter – a danger to humans and animals', https://www.bmz.de/en/issues/abfall/meeresmuell/index.html (accessed 27 Jul. 2018).
[267] Cord, D., J. (2017), 'Large companies can lead the transition to a circular economy', Sitra, 5 June 2017, https://www.sitra.fi/en/articles/large-companies-can-lead-transition-circular-economy/ (accessed 20 Mar. 2019).
[268] World Business Council for Sustainable Development (WBCSD) (2018), *CEO Guide to the Circular Economy*, Geneva: WBCSD, https://docs.wbcsd.org/2017/06/CEO_Guide_to_CE.pdf (accessed 20 Mar. 2019).
[269] Ellen MacArthur Foundation (2019), 'Members', https://www.ellenmacarthurfoundation.org/our-work/activities/ce100/members (accessed 20 Mar. 2019).
[270] Vonk, L. (2018), 'Paying attention to waste: Apple's circular economy', *Journal of media and cultural studies,* 32: pp. 745–57 (accessed 20 Mar. 2019).

Companies that have adopted more circular business models and practices have recorded significant reductions in waste and emissions. For example, at end-2017, the US retailer Walmart had diverted to recycling or reuse 81 per cent of its packaging, waste materials and unsold products that would otherwise have been destined for landfill in the US.[271] In 2015, Samsung Electronics recycled 79,950 tons of products and 7,040 tons of packaging in South Korea alone.[272]

Table 5: Opportunities and challenges associated with the circular economy in developing countries for multinational corporations (MNCs)

Potential benefits for MNCs from implementing and supporting CE activities in developing countries	Challenges for MNCs in implementing and supporting CE activities in developing countries	Possible MNC actions to implement and support CE activities in developing countries
• Increased supply chain security and transparency. Ability to better ensure sustainable sourcing and improve supply chain relationships • Significant reductions in waste and emissions from in-country operations • New value generation opportunities, e.g. creating value from waste • Tapping into increasingly sustainability-conscious consumer and investor base • Creating positive sustainability impacts for local population • Readiness for future legislation	• Limited existing transport, waste management and reverse logistics infrastructure • Lack of awareness among suppliers and consumers • Complexity and time required to establish collaborative supply chains • Lack of data on SMEs/local producers and suppliers • Lack of political support, low levels of regulation, weak enforcement of regulation and lack of transparency in enforcement	• Investment in CE-related infrastructure • Tackling waste in production, processing and logistics in-country • Tackling post-consumer waste in-country • Public awareness campaigns • Adopting CE standards in procurement practices • Sharing compliance costs and building the capacity of local suppliers to meet CE standards • Setting CE targets for in-country supply chains • Research collaborations and pilot schemes • Developing training plans and tools to disseminate best-practice CE approaches

These companies nevertheless remain, for the moment, in a minority. A 2016 survey of 1,700 respondents from global corporates found that fewer than 20 per cent of those companies were actively identifying sustainability challenges along their global supply chains.[273] In a report based on interviews with 14 global companies in 2017, low commodity prices were noted as a factor in there being minimal impetus to replace raw materials with recycled materials.[274] There is also concern that, among other CE issues, the secondary market for plastics is underdeveloped.[275]

The obstacles to corporate action on CE can be even more pronounced in developing countries (see Table 5). Companies may face more limited infrastructure, less awareness of the CE among suppliers and consumers, and, depending on the country, potentially much less political support in the form of regulations, policies and price incentives. The processes for collecting and analysing much-needed data on SMEs and local suppliers, to identify potential partners in CE activities, may be absent.

[271] Walmart (2018), *2018 Global Responsibility Report*, https://corporate.walmart.com/2018grr/reducing-waste (accessed 20 Mar. 2019).
[272] Samsung (2016), 'The Circular Economy Today and Tomorrow', Samsung Newsroom, 2 December 2016, https://news.samsung.com/global/the-circular-economy-today-and-tomorrow (accessed 20 Mar. 2019).
[273] The Sustainability Consortium (2017), *Greening Global Supply Chains: From Blind Spots To Hostspots To Action*, https://www.sustainabilityconsortium.org/wp-content/themes/enfold-child/assets/pdf/2016-impact-report.pdf (accessed 20 Mar. 2019).
[274] The Prince of Wales Corporate Leaders Group (2017), *European industry in the 21st century: New models for resource productivity*, https://www.corporateleadersgroup.com/reports-evidence-and-insights/publications/publications-pdfs/european-industry.pdf (accessed 20 Mar. 2019).
[275] Ibid.

Nonetheless, companies in a number of different sectors are committing to ambitious CE targets and taking actions to enable CE practices along their supply chains, including in developing countries (see Table 6). Clothing retailer H&M, for example, is aiming to use 100 per cent recycled or other sustainability sourced materials by 2030.[276] With manufacturing and processing plants in Bangladesh, Cambodia, Ethiopia, India, Indonesia, Kenya, Myanmar, Pakistan, Rwanda, Sri Lanka and Vietnam, among other countries,[277] achieving this goal requires new processes and training in lowering the environmental and resource impacts of production across these settings. Similarly, Renault's action plan on the CE[278] has seen the French carmaker introduce a range of CE practices – from reuse and recycling to industrial symbiosis – across a number of plants in different countries.

Corporate action on the agenda in developing countries is likely to grow. The opportunities for CE activities cover a wide range of sectors, from food and consumer goods to ICT and consumer electronics, and there are signs of increasing action and commitment to ambitious CE targets, which would have implications for supply chains in developing countries. Fast-food retailer McDonald's has announced that 100 per cent of its packaging will come from renewable, recycled or certified sustainable sources by 2025.[279] Adidas is planning to use only recycled polyester in all its shoes and clothing by 2024 to help increase the sustainability of its supply chain.[280] Another clothing retailer, Levi Strauss and Co., is targeting a 40 per cent reduction in greenhouse gas emissions in its supply chain by 2025.[281] A growing number of companies based in China and India are also starting to adopt the language of the CE and put its principles into practice. Alibaba, for example, currently generates a huge amount of packaging waste, but the Chinese e-commerce firm is partnering with carton manufacturers to recycle packaging in several key cities throughout the country.[282] In India, Tata Motors has been running a resale, refurbishment and reuse service for its cars since 2009.[283]

[276] H&M (2017), *The H&M Group Sustainability Report 2016*, https://sustainability.hm.com/content/dam/hm/about/documents/en/CSR/Report%202016/HM_group_SustainabilityReport_2016_CircularAndRenewable_en.pdf (accessed 20 Mar. 2019).
[277] H&M (undated), 'Our supplier factory list', https://sustainability.hm.com/en/sustainability/downloads-resources/resources/supplier-list.html (accessed 12 Apr. 2019).
[278] Groupe Renault (undated), 'Circular Economy', https://group.renault.com/en/our-commitments/respect-for-the-environment/circular-economy/ (accessed 11 Apr. 2019).
[279] Climate Action (2018), 'All McDonald's packaging will be sustainable by 2025', 17 January 2018, http://www.climateaction.org/news/all-mcdonalds-packaging-will-be-sustainable-by-2025 (accessed 20 Mar. 2019).
[280] Storbeck, O. (2018), 'Adidas vows to use only recycled plastics by 2024', *Financial Times*, 15 July 2018, https://www.ft.com/content/73ca70d8-84e1-11e8-96dd-fa565ec55929 (accessed 20 Mar. 2019).
[281] Levi Strauss & Co. (2018), 'Levi Strauss & Co. Ramps up Climate Commitments', 31 July 2018, https://www.levistrauss.com/unzipped-blog/2018/07/31/levi-strauss-co-ramps-climate-commitments/ (accessed 20 Mar. 2019).
[282] Business Sweden (2017), *Circular Economy in China: opportunities for companies*, https://www.business-sweden.se/contentassets/c5d6f8e5acc041aca5f7187920559930/circular-economy-in-china.-report-v.1.0_final.pdf (accessed 23 Jul. 2018).
[283] Trichilo, G. (2016), 'TATA Motors and Mahindra & Mahindra: Showing the way to India's sustainable development', MC Media Change, 25 November 2016, http://www.mediachange.info/Circular_Economy/TATA_Motors_and_Mahindra_Mahindra_Showing_the_way_to_Indias_sustainable_development (accessed 23 Jul. 2018).

Table 6: Sector-specific opportunities and challenges for MNCs in developing countries

Sector	Actions MNCs can take in developing countries	Specific challenges for sector in developing countries	Example of MNC activity
Food manufacturing and consumer goods	Tackling packaging waste, e.g. innovative packaging, public awareness campaigns, investment in waste management infrastructure, providing incentives for recovery and recycling. Tackling food waste, e.g. investment in cold-chain infrastructure, public awareness campaigns, food-sharing networks. Adopting CE standards in procurement from local food suppliers, e.g. emphasis on organic fertilizer, reuse of farm by-products. Helping to promote local CE value chains, e.g. through facilitating trade among local suppliers across multiple sectors in by-products and agricultural waste to be turned into energy and fertilizer.	Moving away from plastic in food and drink packaging can be more challenging in developing countries where water and food safety is not always assured. Moving away from sachets in food, drink and consumer goods packaging can make these goods too expensive for poorer communities. Demand for recycled plastics may be limited owing to low commodity prices. When oil prices are low, virgin plastic may be cheaper than recycled plastic.	Unilever is a member of Project MainStream, a multi-industry, CEO-led global initiative to accelerate business-driven innovation and help scale the CE,[284] and has formed a Global Partnership with EMF.[285] The company has set out its waste strategy commitments in its Sustainable Living Plan.[286] Unilever initiatives in developing countries include the Community Waste Bank Programme in Indonesia[287] and a project to establish a pilot plant in the Philippines to recycle plastic sachets.[288]
Textiles and garment manufacturing	Lowering impacts in production, e.g. procurement and specification of lower-impact fibres from local suppliers, adopting CE principles on dyeing, working with supply chain partners to increase resource efficiency. Extending the life cycle of clothes, e.g. designing clothes to prolong their useful life, providing consumer information on use, reuse and recycling. Encouraging the recycling of clothes, e.g. establishment of take-back schemes for textiles and garments.	Textile and garment supply chains generally face higher risks in terms of labour rights violations in developing countries. Any changes to supply chain management to promote CE practices must take into account impacts on workers' health, safety and income.	H&M is an EMF Global Partner[289] and a signatory of the New Plastics Economy Global Commitment.[290] The company has made a commitment to be 100 per cent circular and renewable by 2030.[291] H&M initiatives in developing countries include a hazardous-substances training pilot scheme for supply chain partners in Bangladesh, China, India, Indonesia and Turkey.[292] H&M has also developed a tool to assess performance in chemical usage by suppliers, which it has subsequently tested in Bangladesh, China, India, Indonesia, Pakistan and Turkey.[293] The firm has partnered with the food company Danone and an Indonesian textile supplier to recycle plastic bottles into clothes.[294]

[284] Ellen MacArthur Foundation (2014), 'Project MainStream', 24 January 2014, https://www.ellenmacarthurfoundation.org/news/project-mainstream (accessed 11 Apr. 2019).
[285] Ellen MacArthur Foundation (2017), 'Unilever', https://www.ellenmacarthurfoundation.org/our-story/partners/global/unilever (accessed 11 Apr. 2019).
[286] Unilever (undated), 'The Unilever Sustainable Living Plan', https://www.unilever.co.uk/sustainable-living/the-unilever-sustainable-living-plan/ (accessed 11 Apr. 2019).
[287] Unilever (undated), 'Rethinking plastic packaging – towards a circular economy', https://www.unilever.com/sustainable-living/reducing-environmental-impact/waste-and-packaging/rethinking-plastic-packaging/ (accessed 23 Jul. 2018).
[288] Cahiles-Magkilat, B. (2018), 'Unilever PH pushes plastic sachet recycling project', *Manila Bulletin*, 11 January 2018, https://business.mb.com.ph/2018/01/09/unilever-ph-pushes-plastic-sachet-recycling-project/ (accessed 11 Apr. 2019).
[289] Ellen MacArthur Foundation (2017), 'H&M', https://www.ellenmacarthurfoundation.org/our-story/partners/global/h-m (accessed 11 Apr. 2019).
[290] H&M (2019), 'H&M Group Signatory of the New Plastics Economy', 14 March 2019, https://about.hm.com/en/media/news/general-news-2019/hm-group-signatory-new-plastics-economy-commitment.html (accessed 11 Apr. 2019).
[291] H&M (2017), *The H&M Group Sustainability Report 2016*, https://sustainability.hm.com/content/dam/hm/about/documents/en/CSR/Report%202016/HM_group_SustainabilityReport_2016_CircularAndRenewable_en.pdf (accessed 20 Mar. 2019).
[292] Ibid.
[293] Ibid.
[294] Russell, M. (2017), 'H&M Indonesia turning plastic waste into clothes', just-style, 7 September 2017, https://www.just-style.com/news/hm-indonesia-turning-plastic-waste-into-clothes_id131601.aspx (accessed 11 Apr. 2019).

Sector	Actions MNCs can take in developing countries	Specific challenges for sector in developing countries	Example of MNC activity
Building construction and design	Adopting CE principles in sourcing raw materials, e.g. emphasizing reuse of construction and design waste where possible, incorporating waste sources from other sectors where possible. Facilitating the repurposing of waste materials, e.g. investing in delivery-and-return logistics to recover construction and design waste and materials. Building local CE capacity, e.g. training local construction workers and providing them with tools to improve resource efficiency on site, establishing and promoting best practice for minimizing wastage, training local construction workers and teams in deconstruction and disassembly methods to preserve materials for reuse. Encouraging more durable construction and design, e.g. working with local architects and engineers to mainstream concepts such as designing for durability, modularity, deconstruction and disassembly.	Developing countries will tend to have lower in-use building stocks, meaning that MNCs may have limited access to building components for reuse. Weak enforcement of standards for buildings and materials could raise safety concerns in reusing and recycling older materials.	Royal BAM Group – a Netherlands-based construction company – is a member of EMF's CE100, a network of companies engaged in the CE agenda. BAM has hosted workshops in collaboration with the Supply Chain Sustainability School to mainstream CE thinking in the built-environment sector.[295] BAM initiatives in developing countries include the introduction of waste management targets at an Indonesian hotel construction site to sort, reuse and recycle waste dug up during excavation works.[296]
Automotive	Reducing primary resource use, e.g. working with suppliers to integrate CE principles into procurement of raw material inputs into vehicle manufacturing. Facilitating regional CE value chains, e.g. establishing remanufacturing hubs for vehicles and engine parts, training supply chain partners, assemblers and first-tier suppliers to disassemble, sort and use second-hand parts. Encouraging second-life use, e.g. establishing take-back and return schemes for electric batteries from vehicles, trading with other sectors for reuse, establishing a platform for trading and sourcing end-of-life vehicles. Increasing recycling of raw materials in production, with the goal of keeping as much material as possible in the local industry. Piloting vehicle-as-a-service schemes.	An automotive remanufacturing skills base is lacking in many countries. The complexity of remanufacturing processes and logistics may prove challenging, especially for SMEs in developing countries. Supply chains for recycled materials are poorly developed, and the lack of a reliable and secure stream of secondary materials may create difficulties in planning manufacturing operations.	Renault is an EMF Global Partner. It has an action plan on the CE and has signed the French government's Roadmap for the Circular Economy, which has set the goal of moving towards a 100 per cent plastic recycling rate in France by 2025.[297] Renault initiatives in developing countries include a collaboration in Colombia with a local manufacturer and supply chain partner, Sofasa, to recycle paint solvents at a vehicle manufacturing plant.[298] Renault also collects, sorts and reuses packaging at one plant in Brazil.[299] At another, in Morocco, it collects and recycles ashes from biomass heating systems for use as biofertilizers in organic farming.[300]

[295] Messenger, J. (2017), 'Thinking circular: engaging with our supply chain', BAM, 27 March 2017, https://sustainability.bam.co.uk/insights/2017-03-27-thinking-circular-engaging-with-our-supply-chain (accessed 11 Apr. 2019).
[296] BAM (2013), 'Construction team attaching waste in Indonesia', *View*, 4(1), https://www.baminternational.com/sites/default/files/domain-616/documents/client_magazine_view_bam_international_007-616-1475152665889933982.pdf (accessed 11 Apr. 2019).
[297] Groupe Renault (undated), 'Circular Economy'.
[298] Ibid.
[299] Ibid.
[300] Ibid.

Sector	Actions MNCs can take in developing countries	Specific challenges for sector in developing countries	Example of MNC activity
ICT and consumer electronics	Facilitating reuse and recycling among consumers, e.g. developing a global take-back programme and providing consumers with information regarding repair and recycling options. Encouraging remanufacturing and reuse hubs for consumer electronics, e.g. designing products so that they can be easily disassembled and repaired, and tapping into repair and refurbishment skills bases in developing countries. Establishing a digital materials and parts marketplace to help local suppliers sources the parts and materials they need.	It may be difficult to protect data and intellectual property for consumer electronics if disassembly and repair are conducted by third parties. Sourcing enough secondary material feedstock and goods may be a challenge if informal secondary markets for these products are already in place.	Computer retailer Dell is a member of the CE100 and received the inaugural Accenture Award for CE pioneers in 2015.[301] Dell initiatives in developing countries include a global take-back programme for monitors, desktop computers and notebook computers, which spans 78 countries including India, Malaysia and Vietnam.[302]

5.3 Harnessing regional and international trade

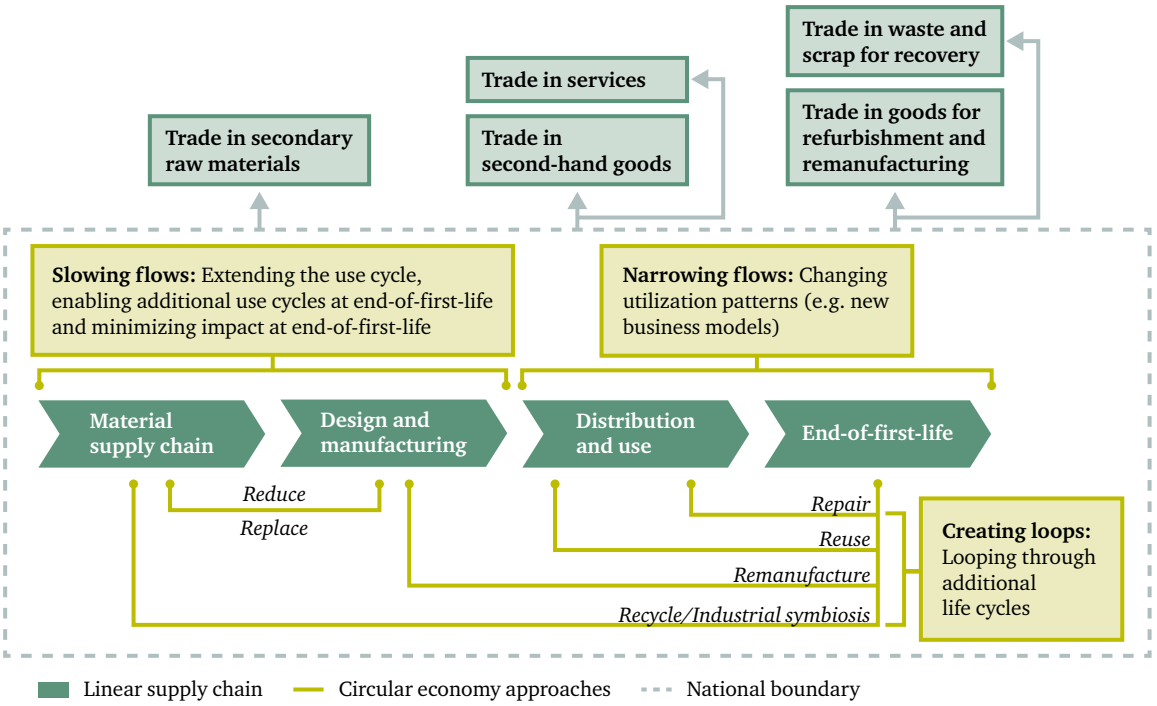
Trade will be a powerful tool for fostering engagement from both the public and private sectors in regional and global circular value chains. Trade-focused CE discussions have the potential to open up new perspectives on opportunities for mutual gain, and to shape a global and inclusive vision that goes beyond the zero-sum world implied by some CE strategies today. While the CE may offer some protection in a turbulent world in which tensions over trade are rising, it will only reach meaningful scale through international coordination and alignment. At the global level, this will be critical to expanding the markets for circular goods and services, pooling innovation knowledge bases, optimizing circular value chains, attracting cross-border investment and providing entrepreneurs with access to data while delivering an inclusive approach.

5.3.1 Trade in CE services and goods

Increased demand for services related to the sharing economy and provided by so-called 'collaborative sectors' could bring new opportunities for trade in services.[303] Countries with a large, young and digitally literate workforce may look to export software services, for example, while countries with abundant manual labour may see new market opportunities in providing remanufacturing services for imported used goods. By the same token, architects overseeing the construction of new building stock in developing countries may, for example, elect to employ lighting services from overseas lighting companies rather than take ownership of the lighting equipment itself and assume responsibility for its maintenance and refurbishment.[304] Trade opportunities and new trade flows could also emerge in various environmental services related to recycling, waste management and waste-to-energy generation.

[301] Ellen MacArthur Foundation (2015), 'Dell Becomes Member of Circular Economy 100 Programme', 1 October 2015, https://www.ellenmacarthurfoundation.org/news/dell-becomes-member-of-circular-economy-100-programme (accessed 11 Apr. 2019).
[302] Shumon, R. and Ahmed, S. (2013), 'Sustainable WEE management in Malaysia: present scenarios and future perspectives', *IOP Conference Series Material Science Engineer*, https://iopscience.iop.org/article/10.1088/1757-899X/50/1/012066/pdf (accessed 11 Apr. 2019).
[303] UNCTAD (2018), *Circular Economy: The New Normal?*, Policy Brief No. 61, May 2018, Geneva: UNCTAD, https://unctad.org/en/PublicationsLibrary/presspb2017d10_en.pdf (accessed 1 Apr. 2019).
[304] Yamaguchi, S. (2018), *International Trade and the Transition to a More Resource Efficient and Circular Economy–Concept Paper*, Paris: OECD, http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/ENV/JWPTE(2017)3/FINAL&docLanguage=En (accessed 20 Mar. 2019); and McCarthy, Dellink and Bibas (2018), *The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches*.

Figure 9: Opportunities for trade in waste and secondary materials



Source: Authors' own analysis adapted from a diagram by InnovateUK and a diagram in Yamaguchi, S. (2018), *International Trade and the Transition to a More Resource Efficient and Circular Economy: A Concept Paper*, Trade and Environment Working Papers – 2018/03, Paris: OECD Publishing, http://www.oecd.org/environment/waste/policy-highlights-international-trade-and-the-transition-to-a-circular-economy.pdf.

The adoption of CE policies and measures will also likely encourage trade in secondary goods, including materials and waste for recycling and energy recovery, secondary raw materials, second-hand goods, and goods for refurbishment and remanufacturing (see Figure 9).[305] Products that reach the end of their operational life can be exported to other countries as secondary goods for further consumption, as secondary materials for production feedstock, or as materials and waste for further processing. For example, $37 billion worth of iron and steel scrap was traded globally in 2017, accounting for 7 per cent of all global iron and steel trade in that year.[306]

5.3.2 Global governance and trade rules

There remains much uncertainty regarding how the rules and frameworks that govern international trade will be applied in practice to goods and services in the CE.[307] The application of trade measures based on processes and production methods rather than on product criteria is a controversial and contested topic. Developing countries in particular often see such measures as a potential form of protectionism, through which developed countries impose their environmental standards (which are assumed to be higher and costlier) on poorer countries' exports. More broadly, the definition of 'like products' in the context of CE policies, and the WTO treatment of trade measures based on them, is a largely untested topic. The extent to which countries may seek to use trade policies in their pursuit

[305] OECD (2018), *International Trade and the Transition Towards a Circular Economy*.
[306] Chatham House (2019), resourcetrade.earth database, https://resourcetrade.earth/ (accessed 20 Mar. 2019).
[307] Sell, M. and Pajunen, N. (2018), 'The circular economy – What's Trade Got to Do with it?', ICTSD Opinion, 14 September 2018, https://www.ictsd.org/opinion/the-circular-economy-.

of the CE – for example, to restrict all imports of new cars or virgin plastic packaging and allow the import only of remanufactured cars and recycled plastic, with similar conditions imposed on domestic manufacturers – is itself unclear. The WTO treatment of trade measures such as these is similarly ambiguous; there may be no clear answer until a trade dispute actually happens.

> The application of trade measures based on processes and production methods rather than on product criteria is a controversial and contested topic.

A degree of regulatory alignment and, at a minimum, greater as well as better coordination and cooperation among countries will be required to manage the risk of market disruptions resulting from protectionist or distortive trade measures (see Box 9). To ensure that any trade policies or agreements intended to support the CE are in line with international trade rules, it will be important that countries can agree on the terms and standards for trade; in general, the WTO dispute system favours attempts to reach multilateral solutions rather than the imposition of unilateral measures. Digital and blockchain technologies may enable better traceability of materials (including information on the type of embedded materials and manufacturing processes), and aid identification and classification. Until then, standards and related labelling measures to identify and distinguish many types of secondary materials based on quality, performance, safety, health or environmental impacts will be necessary.

Box 9: Managing the risk of protectionist trade measures

Characterized by a complex web of value chains with products and services crossing borders multiple times, the international trade system is susceptible to interruption when one or several countries imposes restrictive trade measures. Products sold in the developed world often rely on raw materials, components and final products imported from developing countries, with a reverse flow of waste streams occurring as materials are subsequently sent back to those countries (in particular China) for reprocessing. Following China's de facto ban on imports of solid waste, countries in Southeast Asia to which waste intended for Chinese facilities has been diverted have been overwhelmed and are considering imposing their own bans: in October 2018, Malaysia issued a permanent ban on plastics imports. China's import ban has served as a wake-up call, underlining the need to rethink policies and significantly reconfigure value chains to ensure that international trade truly supports the shift towards a CE.

Domestic trade policies, if improperly designed or enforced, can have unintended and negative consequences. A notable example is the decision by the Rwandan government to raise import duties on used clothing as a means of safeguarding the domestic textile industry. The move has been criticized for having adverse impacts on Rwandans working in the used-clothing sector, who have been unable to access an affordable supply to match demand.[308] Moreover, given limited domestic production capacity, the rise in duties has simply prompted growth in imports of new but cheaper Chinese clothing.[309]

Subsidies are another important policy tool used by governments worldwide to develop specific sectors, regions and industries. As CE policies become mainstream, it is not difficult to envisage that many countries, including developing countries, might wish to develop CE-based industries such as product refurbishment and remanufacturing centres. However, the provision of subsidies conditional on exports or the use of domestic goods (i.e. via 'local content' requirements) is automatically prohibited under the WTO's Agreement on Subsidies and Countervailing Measures (SCM Agreement). Such measures are actionable under WTO law if proven to cause 'adverse trade impacts' and injury to trading partners.

[308] Calabrese, L. (2018), 'Rwanda's used-clothes sellers are struggling', *Financial Times*, 26 June 2018, https://www.ft.com/content/545aa80a-763e-11e8-b326-75a27d27ea5f.
[309] AFP (2018), 'Locals lose out in Rwanda's second-hand clothes war', news24, 1 July 2018, https://www.news24.com/Africa/News/locals-lose-out-in-rwandas-second-hand-clothes-war-20180701.

5.3.3 Global standards for CE product classification

A globally accepted approach to identifying and classifying CE-related activity will be critical for enabling the gathering of precise data on important variables such as the proportion of trade flows affected by the CE and the contribution of CE-related sectors to GDP, imports, exports, wages and jobs. This will require adopting harmonized approaches to data gathering at the national level, as well as international efforts through the World Customs Organization (WCO) to agree on Harmonized System (HS) customs codes classifications[310] that more accurately capture secondary goods (such as recycled material) and identify waste types.

Currently, the definition and classification of waste, scrap and secondary materials differ from country to country; the distinction between end-of-life products, non-hazardous waste and secondary raw materials is often not the same across different jurisdictions.[311] HS product descriptions are to a large extent based on physical product attributes that are easily verifiable by customs officials, while environmental regulatory frameworks and environmental inspectors focus on the 'intention to discard' in order to identify waste.[312] This makes it difficult to distinguish primary products from secondary products, to assign separate HS codes on the basis of *how* products have been manufactured (e.g. using recycled aluminium), or to determine that certain products are remanufactured. Amendments proposed by the Basel Convention Secretariat to the WCO also raise a number of issues, such as the difficulties in distinguishing and separating hazardous waste from non-hazardous waste, or waste from second-hand goods.[313]

Restrictions on the export of hazardous waste are provided for under the Basel Convention, a multilateral environmental agreement adopted in 1989. But in the absence of any measure for differentiating between e-waste and functional used electrical and electronics equipment (UEEE) under the Basel framework,[314] there are limits to implementing genuine CE-related trade for waste recovery and recycling while ensuring that adequate standards, regulations, technology and management practices are met.

Box 10: Classifying CE products in line with trade rules

Agreed standards for product classification will be central to facilitating trade in secondary materials, but the standards will need to be carefully designed and implemented to avoid infringing trade rules. The WTO's Agreement on Technical Barriers to Trade (TBT Agreement) requires that any technical regulations must use, as their basis, relevant international standards where they exist. While there is scope within the TBT Agreement to clarify the treatment of 'private standards' and standardization activity by local governments and non-governmental bodies, the reference to 'international standards if they exist' is significant. From a CE perspective, it may constrain governments from applying mandatory CE-related standards that are higher than internationally agreed standards (such as those mandated by international standard-setting bodies such as the International Standards Organization or the International Electro-technical Commission).

[310] The Harmonized Commodity Description and Coding System is an internationally standardized system of codes and product descriptions used to classify traded products.
[311] OECD (2018), *International Trade and the Transition Towards a Circular Economy*.
[312] Secretariat of the Basel Convention (2013), *Amendment proposals from the Secretariat of the Basel Convention to the Harmonized System Committee, World Customs Organization*, Discussion Note, www.basel.int/Portals/4/download.aspx?d=UNEP-CHW-WASTELST-CON-HarmonizedSystem CommitteeAmendment-20130402.English.pdf.
[313] Ibid.
[314] Christian (2017), 'Trade Measures for Regulating Transboundary Movement of Electronic Waste'.

5.3.4 Integrating the CE into plurilateral trade agreements

With negotiations on multilateral liberalization agreements on trade in environmental goods and services having stalled, interest in regional trade initiatives has been growing. A number of agreements have been successfully completed. Countries may wish to build upon or replicate these agreements and include CE-based elements in order to address barriers not only to trade in primary environmental goods and services, but also to trade in secondary materials.

A plurilateral agreement similar to the WTO's information technology agreement, whereby like-minded countries could agree to reduce or remove all duties on specific types of secondary materials on a most-favoured-nation (MFN) basis,[315] could offer a promising avenue for collaboration. Alternatively, governments could negotiate bilateral or regional trade agreements through which concessions are made available only to participants in the agreement (a permitted exception to WTO non-discrimination rules). In either case, countries could be given the option to select the particular secondary material category (e.g. specific types of plastic waste or remanufactured goods) for which they would be ready to lower import duties.

Such an agreement could establish minimum thresholds for health, safety and environmental standards. Alternatively, governments could be given flexibility to specify their own minimum domestic standards if no international standards are set. Any such plurilateral agreement could borrow from CE-relevant provisions in existing trade agreements as well. An instructive model is the EU–Vietnam free-trade agreement, signed in 2015 but not yet ratified, which stipulates that remanufactured goods shall receive the same treatment as provided to new like products and which also allows specific labelling. Until now, the Vietnamese authorities have considered these remanufactured goods be 'used' goods, the import of which into Vietnam is prohibited.[316]

Mutual recognition agreements (MRAs) on CE-related standards and conformity assessment offer another form of possible coordination at bilateral or regional level. Such MRAs could build on existing regional trade agreements. They could include 'WTO plus' provisions on mutual recognition, and conformity assessment agreements on standards and certification procedures related to the CE, as well as technical and financial assistance packages. The reduction or elimination of tariffs and non-tariff measures on environmental goods and services and secondary materials relevant to the CE – such as equipment to sort and process e-waste, recycling equipment, and equipment for extracting secondary raw materials from products in a safe manner – could significantly boost access to CE activities.

CE-specific technical and financial assistance packages may also be negotiated as an integral part of future trade agreements. They could include provisions for assistance in creating special CE zones (on the model of low-carbon zones proposed by experts[317]) in developing countries, for example. Such zones could serve as 'laboratories': showcasing best practices in CE standards, technology and management, and focusing on CE-relevant exports (for example, via repair or remanufacturing centres) that could generate export revenue as well as jobs.

[315] Meaning that the lower duties are available to all WTO members, whether or not they are signatories to the agreement.
[316] Delegation of the European Union to Vietnam (2016), *Guide to the EU-Vietnam Free Trade Agreement*, http://trade.ec.europa.eu/doclib/docs/2016/june/tradoc_154622.pdf.
[317] Lee, B. and Mabey, N. (2008), 'From export processing zones to low carbon development dones', International Centre for Trade and Sustainable Development, 1 May 2008, https://www.ictsd.org/bridges-news/biores/news/from-export-processing-zones-to-low-carbon-development-zones (accessed 20 Mar. 2019).

5.4 Summary

- Many potential synergies exist between CE activities and ongoing efforts in support of climate mitigation and sustainable development, in line with the SDGs. A coordinated approach that mainstreams the CE within existing sustainability initiatives offers an opportunity to harness and amplify the communities of practice, resources and expertise already devoted to the UN's 2030 Agenda for Sustainable Development.
- Key to unlocking the requisite political and financial investment in the CE will be partnership and coordination at bilateral and plurilateral level, both between governments and between public- and private-sector stakeholders. Pooled financing arrangements, high-level cooperation agreements and CE-focused or -aligned donor investment programmes all offer means through which to accelerate the piloting and financing of nascent circular value chains.
- Trade at regional and international level will be an important enabler in scaling up domestic circular activities and industries, both in developing and developed countries. Efforts to clarify global trade rules for secondary materials and circular services will be critical to overcoming existing barriers to the cross-border exchange of inputs and ideas in the CE.

6. Conclusion and Recommendations

The CE concept is fast becoming a new model for resilient growth in both developed and developing economies. In particular, it offers a viable alternative strategy for industrial development and job creation compared with the traditional manufacturing-led growth pathway for developing countries. Political and economic conditions in developing countries will necessitate different pathways to the CE from those employed to date in developed countries, but the CE opens up many new economic opportunities which developing countries are well positioned to harness.

The next two years offer a critical window of opportunity in which to set in motion an inclusive, global vision for the CE which is aligned with existing policy commitments at both domestic and international level. As countries around the world ratchet up their climate policy ambitions in 2020 under the Paris Agreement and take stock of progress against the 2030 Agenda for Sustainable Development, the CE offers a useful pathway through which to embed sustainable resource use at the heart of industrial growth.

The next two years offer a critical window of opportunity in which to set in motion an inclusive, global vision for the CE which is aligned with existing policy commitments at both domestic and international level.

Investment now in the fundamentals of a CE – in robust governance frameworks, in inclusive policies that harness existing circular activities in the informal sector in developing countries, and in partnerships at national, regional and international level to support cross-border trade and knowledge exchange – can provide the impetus required to deliver on circular practices at scale.

Below we outline a series of priority steps through which national policymakers, international policy and financial institutions, and the ecosystem of stakeholders supporting the UN's 2030 Agenda can support the deployment and scaling up of the CE in developing countries.

6.1 Aligning the CE with existing policy priorities

- **National governments should identify synergies between the CE and existing national plans and priorities.** Rather than developing a separate 'circular economy' strategy to sit alongside existing industrial development, 'green growth' and climate strategies, for instance, governments should identify specific interventions and policies that can accelerate the delivery of existing national development goals as well as the objectives of industrial strategies. A cross-ministerial working group should be established on the CE to support the mainstreaming of CE approaches across sectoral strategy and policy development. Given the important role that the CE can and should play in mitigating emissions from sectors including agriculture, heavy industry and waste, national governments should prioritize the identification of avenues through which mitigation and adaptation can be strengthened by more circular approaches as they ratchet up the ambition of their NDCs by 2020.

- **National finance ministries should undertake an assessment of the scale of opportunity associated with transitioning to a CE across key sectors of the economy.** Demonstrations of the scale of opportunity in developed countries have been central to socializing acceptance of the CE and encouraging early investment and innovation; key to generating investment and buy-in for CE initiatives in developing countries will be a strong evidence base that illustrates the financial gains to be achieved and the economic and structural conditions associated with them. Finance ministries should work in partnership with national or international research institutes, universities and civil society organizations that are already exploring the potential for the CE in developing countries.
- **Donor governments should support the CE as an industrial development strategy.** Donors can mobilize the funds needed to support governments and business in developing countries in pioneering and scaling up CE initiatives. To do so, it will be critical that donors position the CE not simply as a waste management, environmental protection or resource efficiency exercise, but as an industrial development strategy with opportunities for value-adding activities across the economy. This can also ensure that the CE will be approached in a manner that enhances cross-sectoral cooperation and systems-level planning. To kick-start investment in developing-country CE value chains, donors should commit to ringfencing a share of overseas development aid for spending on projects and initiatives that include a CE element.

6.2 Investing in the fundamentals

- **National governments should identify priority reforms to domestic policy in support of CE activities.** Governments, in collaboration with businesses and other relevant stakeholders, should undertake a landscape mapping of existing fiscal and trade policies, identify where those policies are likely to hinder or discourage domestic innovation and foreign investment, and implement the appropriate reforms to remove the barriers. Governments should also explore and implement incentives and support structures to encourage R&D partnerships to accelerate innovation in relevant CE solutions. The incentives and structures could include network facilitation, tax incentives for SMEs looking to collaborate with universities, public grant provision and investment in national CE innovation hubs and pilot zones.
- **Investors should develop cooperative and blended finance mechanisms to support and de-risk early investment in CE value chains.** Public and philanthropic funds should be packaged to attract greater volumes of private-sector investment in CE activities. In the public sector, cooperative financing arrangements in which multiple MDBs or donor agencies pool resources to support CE investments would create a lower-risk environment in which to expand engagement in the CE.[318] In the private sector, collaborative approaches to financing guidelines such as those launched by ABN AMRO, ING and Rabobank in 2018[319] could accelerate the creation of a lower-risk investment environment for private-sector financiers.
- **Intergovernmental organizations (IGOs) such as the OECD, UNIDO or UNCTAD should launch a global 'circular economy accelerator network'.** This should include the establishment of 10 to 20 pilot zones in a range of countries – encompassing developing, emerging and developed economies – that trial new CE solutions and that provide a hub for learning and technology transfer

[318] Rizos et al. (2018), 'The contribution G20 governments can make to support the circular economy'.
[319] ABN AMRO, ING and Rabobank (2018), *Circular Economy Finance Guidelines*.

to build the capacity both of domestic actors and of regional and global networks. IGOs should work with developing-country governments and multinational companies to create these zones. In doing so, they would support the establishment of institutional and regulatory frameworks while also building the capacity of developing-country suppliers in international supply chains. This would help to demonstrate the viability of whole-supply-chain CE approaches.

6.3 Supporting an inclusive global agenda

- **Developed countries should identify early opportunities for 'triple-win' collaboration with developing countries to deliver on trade, the CE and broader sustainability goals.** OECD countries should pursue trade negotiation opportunities that minimize trade restrictions standing in the way of more circular value chains in developing-country trade partners. Such opportunities could include the reduction or elimination of tariffs and non-tariff measures on environmental goods and services and secondary materials, and/or the removal of existing tariffs on secondary raw materials. The measures implemented could lower the costs of feedstock in import-dependent countries and boost the competitiveness of downstream industry in developing countries.
- **Regional CE forums in developing countries should engage proactively in knowledge- and lesson-sharing at an international level.** The Regional 3R Forum in Asia and the Pacific should explore opportunities to share lessons from its cooperative approach to policy coordination, investment in pilot projects and research – including through political missions and the convening of an international meeting, and building on the success of its own annual conferences. The African Circular Economy Alliance should work with regional and international civil society organizations to facilitate collaboration among cities, universities and start-ups and to explore opportunities for linking strong local networks with internationally focused forums. Multilateral organizations should facilitate this engagement through technical support and, where necessary, financial investments.
- **G20 governments should demonstrate leadership in cooperative action in support of the CE, with Japan spearheading a ramping up of ambition.** G20 leaders, building on the 'resource efficiency dialogue' instigated under the German G20 presidency and supported by Germany and the wider EU, should commit to ambitious action to support international cooperation on the CE, including with a range of developing countries that are not members of the G20. As G20 chair in 2019, the Japanese government, with the support of other G20 leaders, should announce its political support for the above-mentioned 'circular economy accelerator network' of CE pilot sites in developing countries. Such coordinated commitments would signal to the business and investment communities that future CE pathways will depend on international coordination and openness to trade in CE goods and services, and would strengthen the position of international financial institutions seeking to strengthen the synergies in their investments between the CE and wider sustainable development programmes.
- **The EU and China should, under the auspices of their MoU, commit to establishing deeper dialogues with developing countries.** High-level policy dialogues, the exchange of strategic information and policy ideas, and the sharing of best practice should be extended beyond the EU and China to include leading developing-country governments that are pioneering CE strategies. These dialogues should include an exploration of the potential impacts of domestic CE policy in the EU and China on developing countries and a commitment to mitigating any

associated environmental or health risks. Multilateral organizations should facilitate this engagement through technical support and, where necessary, financial investments.

- **MDBs should align investments in climate resilience, biodiversity protection and sustainable development with the CE.** Donors should develop a compelling narrative outlining the ways in which the CE can accelerate delivery on climate mitigation and adaption, biodiversity protection and sustainable development. In support of this, MDBs should look to revise eligibility criteria to include CE projects for those funds that are well aligned with the principles of a CE, including the Global Environment Facility. Successful alignment of the CE with broader investment programmes in these areas should de-risk investments in CE initiatives by demonstrating multiple benefits and returns, and should promote synergistic investment approaches that promote CE innovations focused on climate resilience and biodiversity.
- **Global trade bodies should spearhead the development of common standards for internationally traded waste and secondary materials.** The OECD Council and Basel Convention Secretariat should establish a set of common minimum health, safety and environmental standards for international trade in waste products and secondary materials, to support the lowering of non-tariff barriers on cross-border CE trade. OECD countries with established CE value chains should lead on efforts to formally harmonize, through the WCO, HS classifications for secondary-material streams such as remanufactured goods and end-of-use goods intended for repair, recycling, disposal and/or energy recovery. They should explore the potential for new provisions for electric and e-waste and scrap under the WCO, while also working in a coordinated manner outside the WCO to ensure better consistency of descriptions for secondary-material streams at the national tariff line level. Options for using new digital and blockchain technologies for improved traceability in secondary-material flows should also be explored.

Appendix 1: Methodology for the Chatham House–UNIDO survey

Below is a description of the steps taken for the Chatham House–UNIDO survey, some of the results of which are presented in Figures 4, 5, 6 and 7 in this paper.

The purpose of the Chatham House–UNIDO survey was to gain an insight into how the circular economy (CE) is understood in developing countries and among international development actors. It was conducted in August and September 2018, and facilitated by UNIDO's Global Network for Resource Efficient and Cleaner Production (RECP*net*) Secretariat. RECP*net* aims to facilitate collaboration and North–South/South–North dialogue on resource-efficient production; and to support the development and scale-up of RECP*net* concepts, including the CE, in developing and transition economies. The network's members include cleaner-production centres, sustainable technology hubs, environmental funds and foundations, research institutes and consultancy firms.

Respondents were asked the following questions:

- How familiar are you with the circular economy concept?
- Which of the following do you most associate with the circular economy? (Please tick your top three)
    - Recovery, repair and reuse
    - Recycling
    - Sharing and service models
    - Prolonging lifetime of products
    - Resource efficiency
    - Industrial symbiosis
    - Material substitution
    - Design for disassembly
    - Renewable energy
    - Other
- Is the circular economy a strategic priority for developing countries?
- Which of the following outcomes is the circular economy most likely to help deliver?
    - Better waste management
    - Cleaner air, water and soil
    - More and better jobs
    - Poverty alleviation
    - Reduced risk of resource-related shocks
- What are likely to be the most significant barriers to implementing circular economy approaches in your country? (Choose up to three)
    - Institutional capacity
    - Skills
    - Access to technology
    - Infrastructure
    - Resistance from incumbent industries
    - Access to finance
    - Cooperation between different sectors/actors
    - Other
- In your view, what is the most exciting sector, issue and/or opportunity for the circular economy?
- Are there any risks or problems that decision-makers should take into account?

Thirty-nine individuals from 28 economies responded to the survey:[320]

Emerging and developing economies		Advanced economies
Algeria	Montenegro	Austria
Argentina	Nicaragua	Finland
Bosnia and Herzegovina	North Macedonia	United Kingdom
Cambodia	Palestine	
Colombia	Romania	
Costa Rica	Russia	
El Salvador	Rwanda	
Georgia	Serbia	
Honduras	Tanzania	
Hungary	Uzbekistan	
India	Vietnam	
Jordan	Zimbabwe	
Laos		

Owing to the small sample size, the results of the survey cannot be taken as indicative of broader perceptions. Instead, they offer food for thought for those exploring the implications of a transition to the CE in developing countries and within the broader sustainable development agenda. Further efforts are needed to map real and perceived opportunities for, and barriers to, scaling up CE solutions in developing countries.

[320] Country classifications based on the International Monetary Fund's 2018 World Economic Outlook Database: https://www.imf.org/external/pubs/ft/weo/2018/02/weodata/groups.htm.

Appendix 2: Selected Circular Economy Initiatives Across Time

This table is a more extensive version of Figure 2 in the main body of the paper. These selected initiatives are taken from the authors' analysis and are not intended to represent the full spectrum of CE initiatives across time; instead, this list is intended to illustrate the *increase* in the number of initiatives across time.

Year	Month	Name of initiative	Label in Figure 2	Origin	Level	Type
2000	May	Law for the Promotion of Effective Utilization of Resources	Japan's Law on Resource Efficiency	Japan	National	Law
	June	Basic Act for Establishing a Sound Material-Cycle Society	Japan's Act for a Sound Material-Cycle Society	Japan	National	Law
2002	June	Law of the People's Republic of China on Promotion of Cleaner Production	China's Law on Cleaner Production	China	National	Law
2007	April	Wastes Control Act	South Korea's Wastes Control Act	South Korea	National	Law
2008	March	Recommendation of the Council on Resource Productivity	OECD Recommendation on Resource Productivity	OECD	Multilateral	Policy
		Act on the Promotion of Saving and Recycling of Resources	South Korea's Law on Recycling Resources	South Korea	National	Law
	May	Kobe 3R Action Plan	Kobe 3R Action Plan	G8	Multilateral	Policy
	August	Circular Economy Promotion Law of the People's Republic of China	China's Law on CE Promotion	China	National	Law
2011	July	Greenest City Action Plan	Vancouver's Greenest City Action Plan	Vancouver	City	Policy
	August	Roadmap to a Resource Efficient Europe	EU Roadmap on Resource Efficiency	European Commission	Multilateral	Policy
2012	February	Reorganising the Law on Closed Cycle Management and Waste	Germany's Law on Closed Cycle Management and Waste	Germany	National	Law
	July	Circular Economy Task Force	UK CE Task Force	UK	National	Dialogue
2013	January	Circular Economy Development Strategies and Action Plan	China's CE Development Strategies Plan	China	National	Policy
	March	Ha Noi 3R Declaration	Ha Noi 3R Declaration	Regional 3R Forum in Asia and the Pacific	Multilateral	Policy
	June	10 Year Framework of National Programme on SCP (10Y SCP Indonesia)	10Y SCP Indonesia	Indonesia	National	Policy
2014	December	Commission Regulation (EU) No 1357/2014 replacing Annex III to Directive 2008/98/EC of the European Parliament and of the Council on waste and repealing certain Directives	EU Revised Waste Directive	European Commission	Multilateral	Policy
2015	June	G7 Alliance on Resource Efficiency	G7 Alliance on Resource Efficiency	G7	Multilateral	Policy
	July	The US BCSD Materials Marketplace	US BCSD Materials Marketplace	US	National	Private-sector initiative
	September	2030 Agenda for Sustainable Development	2030 Agenda for SDGs	UN	Multilateral	Policy
	October	U.S. EPA Sustainable Materials Management Program Strategic Plan	US's Sustainable Materials Management Plan	US	National	Policy
	December	Closing the loop – An EU action plan for the Circular Economy	EU Action Plan for CE	European Commission	Multilateral	Policy

Year	Month	Name of initiative	Label in Figure 2	Origin	Level	Type
2016	March	Brussels Regional Program for a Circular Economy 2016–2020 (BRPCE)	Brussels's CE 2016–2020 Plan	Brussels	City	Policy
		Circular Amsterdam: A vision and action agenda for the city and metropolitan area	Amsterdam's CE Agenda	Amsterdam	City	Policy
	April	Circular Economy Mission to Chile	EU CE Mission to Chile	European Commission	Multilateral	Dialogue
	May	Toyama Framework on Material Cycles	Toyama Framework on Material Cycles	G7	Multilateral	Policy
	June	Resource Recovery and Circular Economy Act	Ontario's CE Act	Ontario	City	Law
	July	Long Term Waste Management Strategy	Toronto's Waste Management Strategy	Toronto	City	Policy
	November	Circular Economy Mission to China	EU CE Mission to China	European Commission	Multilateral	Dialogue
		Finnish road map to a circular economy 2016–2025	Finland's Roadmap for CE	Finland	National	Policy
		Turkey Materials Marketplace	Turkey Materials Marketplace	Turkey	National	Private-sector initiative
2017	March	Circular Economy Capital Investment Fund	Wales's CE Investment Fund	Wales	National	Fund
	May	South Africa – EU Dialogue on the Role of the Circular Economy in Sustainable Transition	South Africa's Dialogue on CE	South Africa	National	Dialogue
	June	London's Circular Economy Route Map	London's Roadmap on CE	London	City	Policy
		Factor10	WBCSD's Factor10	WBCSD	Multilateral	Private-sector initiative
		World Circular Economy Forum 2017	World Circular Economy Forum 2017	Sitra	Multilateral	Dialogue
		Sustainability and Circular Economy Summit	US Circular Economy Summit	US	National	Dialogue
	July	Paris Circular Economy Plan	Paris Circular Economy Plan	Paris	City	Policy
		G20 Resource Efficiency Dialogue	G20 Resource Efficiency Dialogue	G20	Multilateral	Policy
	September	Primer Foro de Economía Circular	Primer Foro de Economía Circular de Latinoamérica	UNIDO and government of Uruguay	Multilateral	Dialogue
		Circular Economy Strategies for Lao PDR	Lao PDR's CE Strategies	Laos	National	Research
	October	Circular Economy Mission to Colombia	EU CE Mission to Colombia	European Commission	Multilateral	Dialogue
		Circular Economy Investment Fund	Scotland's CE Investment Fund	Scotland	National	Fund
	November	African Circular Economy Alliance	African Circular Economy Alliance	Nigeria, Rwanda, South Africa	Multilateral	Dialogue
		The UK's Industrial Strategy	UK's Industrial Strategy	UK	National	Policy

Year	Month	Name of initiative	Label in Figure 2	Origin	Level	Type
2018	January	A European Strategy for Plastics in a Circular Economy	EU Strategy for Plastics in a CE	European Commission	Multilateral	Policy
	March	Public Consultation on the Circular Economy Strategy	Spain's Public Consultation on CE Strategy	Spain	National	Dialogue
	April	Circular Economy Opportunities Programme	UNIDO's CE Opportunities Programme	UNIDO	National	Dialogue
		France's Roadmap for the Circular Economy	France's Roadmap for CE	France	National	Policy
		Roadmap towards the Circular Economy in Slovenia	Slovenia's Roadmap on CE	Slovenia	National	Policy
		UK Plastics Pact	UK Plastics Pact	UK	National	Dialogue
	May	Proposal for a Regulation of the European Parliament and of the Council on Minimum Requirements for Water Reuse	EU Proposal on Water Reuse	European Commission	Multilateral	Policy
		Catalunya Circular	Catalunya Circular	Spain	National	Dialogue
	July	Strategy for the Transition to Circular Economy in the Municipality of Maribor	Maribor's CE Strategy	Maribor	City	Policy
		Memorandum of Understanding on Circular Economy Cooperation	EU's Memorandum on CE Cooperation	European Commission and China	Multilateral	Dialogue
		UKGBC Circular Economy Programme	UKGBC Circular Economy Programme	UK	National	Private-sector initiative
	September	Circular Charlotte: Towards a zero waste and inclusive city	Charlotte's CE Plan	Charlotte	City	Policy
		Circular Economy Mission to India	EU CE Mission to India	European Commission	Multilateral	Dialogue
		Strategy for Circular Economy	Denmark's CE Strategy	Denmark	National	Policy
	October	Circular Economy Mission to Japan and Indonesia	EU CE Mission to Japan and Indonesia	European Commission	Multilateral	Dialogue
		New Plastics Economy Global Commitment	New Plastics Economy Global Commitment	New Plastics Economy	Multilateral	Private-sector initiative

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Cover image: 'In Season' farm uses the hydroponic method to grow vegetables and herbs on the rooftop of a residential building in Johannesburg, South Africa, 5 November 2018.

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