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THEMATIC INSIGHT

Circular Economy

Transforming the global economy in the face of finite resources

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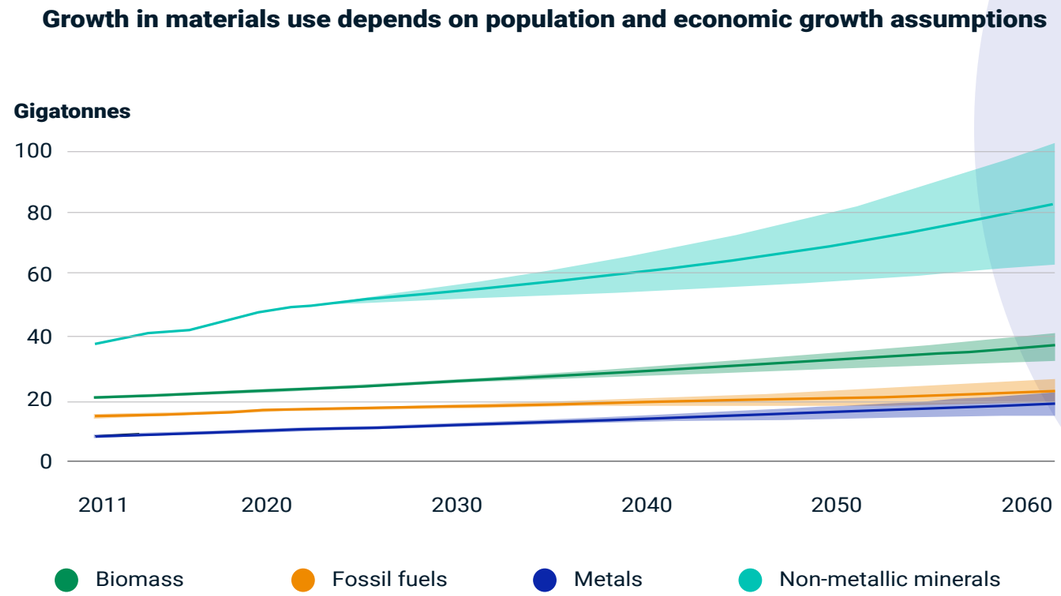
Contents

A World Reshaped by Circularity

As the global population rises to a likely 10 billion people by 2030 and 11 billion by 2050, the demand for energy, materials and minerals has been projected to follow a similar trajectory.[1] Growing populations with higher incomes worldwide have been associated with a strong increase in demand for goods and services, many of whose production and consumption have shifted to emerging and developing economies that, on average, have higher materials intensity.[2] Urbanization and a rising middle class have led to the expansion of megacities, defined as having a population of more than 10 million inhabitants. The number of these population centers has steadily increased, from 10 megacities worldwide in 1990 to 28 in 2014, and they are estimated to expand to 43 by 2030.[3] This trend is likely to stimulate technological advancements in robotics, artificial intelligence, nanotechnology, future mobility, biotechnology and food production,[4] but it also places further pressure on land use, materials and resources needed for new homes and infrastructure, including water and sewage pipelines, railways, roads, energy and other services. Further, in the transition to a low-carbon future, the production of minerals, such as graphite, lithium and cobalt, has been forecast as needing to increase by nearly 500% by 2050 to meet the growing demand for electronics and clean energy technologies such as wind turbines, solar panels, electric vehicles and battery storage.[5]

Exhibit 1:
Global Materials Use to 2060

Source: OECD



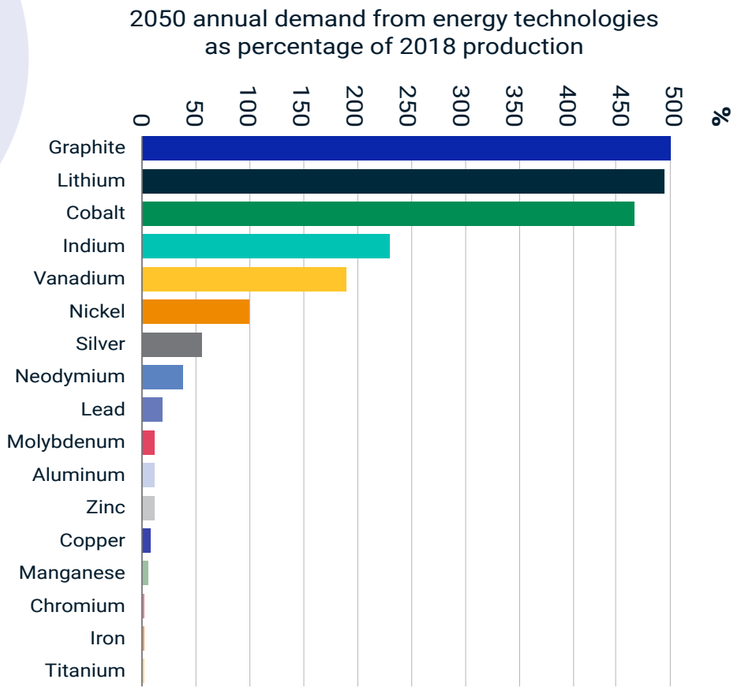
1 "World Population Prospects 2019: Highlights." United Nations Department of Economic and Social Affairs, 2019.

2 "Global Material Resources Outlook to 2060 Economic drivers and environmental consequences: Highlights." OECD, 2018.

3 "2018 Revision of World Urbanization Prospects." United Nations Department of Economic and Social Affairs, 2018.

4 Lacy, P., Long, J., & Spindler, W. (2020). The circular economy handbook. Palgrave Macmillan UK.

5 Hund, Kiersten, La Porta, Daniele, Fabregas, Thao P., Laing, Tim, and Drexhage, John. "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition." The World Bank, 2020.



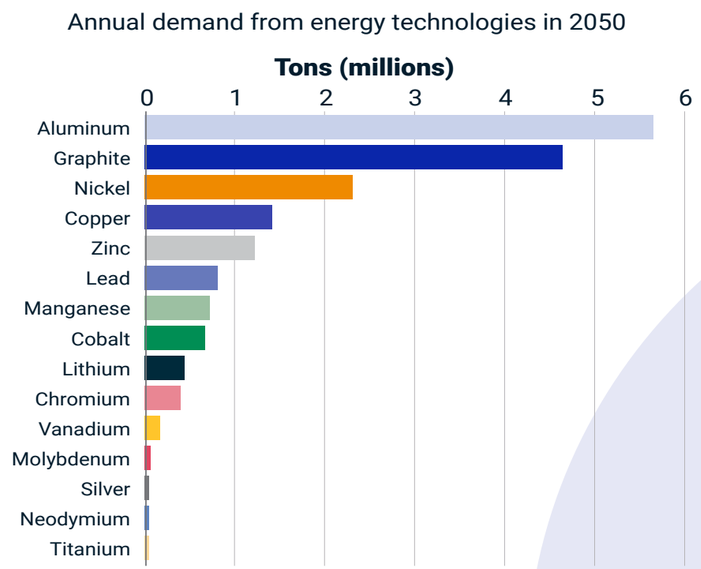


Exhibit 2: Projected Annual Mineral Demand from Energy Technologies in 2050, compared to 2018 Production Levels

Source: The World Bank, 2020

It stands to reason that the global economy is underpinned by natural resources. Everything we use is either grown or mined and ultimately can be traced back to the physical sources of raw materials — food, timber, fibers, metals, minerals or fossil resources that provide fuel, plastics and chemicals. Naturally and eventually, all things will reach an end-of-life stage and have to be disposed. By 2050, worldwide municipal solid waste generation is projected to increase by roughly 70% to 3.4 billion metric tons.[6] Absent a shift in policies and consumer behavior, global material use could rise from 89 billion metric tons in 2017 to 167 billion metric tons in 2060, according to the OECD.[7]

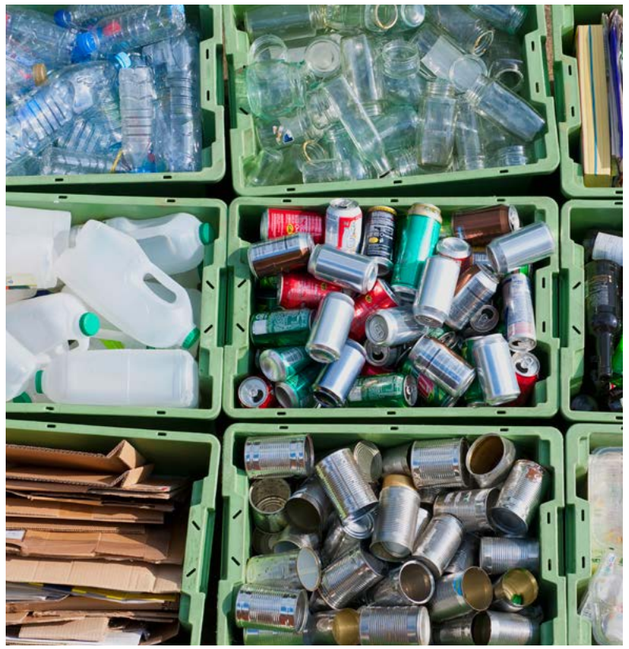
The linear "take, make, use, dispose" economic model of value creation for production and consumption, in which raw materials are extracted and manufactured into goods and then used and discarded as waste, has been the foundation of industrial development over the last 200 years. Amid mounting global concerns about the impact of human economic activity on such factors as resource-price volatility, geopolitics, supply-chain risks, natural systems degradation and systems sustainability, the concept of a circular economy has emerged as an alternative production and consumption model.

6 Kaza, Silpa, Yao, Lisa, Bhada-Tata, Perinaz, and Van Woerden, Frank. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. Washington, DC: World Bank Publications, 2018.

7 OECD. Global Material Resources Outlook to 2060: Economic Drivers and Environmental Consequences. Paris: OECD Publishing, 2019.

What is a **Circular Economy?**

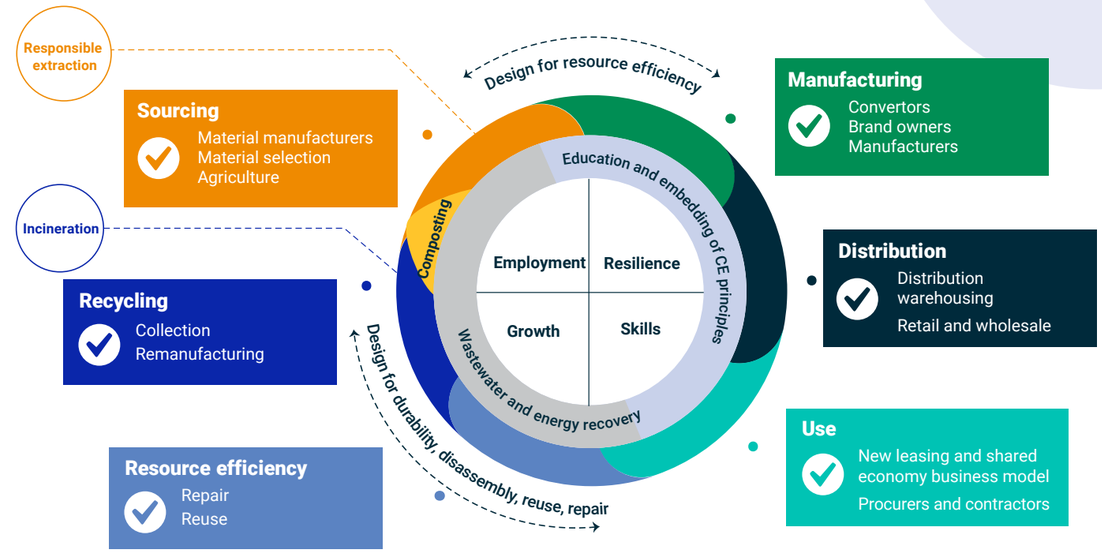
A circular economy is defined as a system that is restorative and regenerative by design, one that builds economic, natural and social capital with the goal of decoupling global economic development from finite resource production through technical and biological cycles.[8] It aims to keep products, components and materials at their highest utility and value throughout their life cycles by closing or decelerating material loops in several ways. This is achieved through repair, reuse, refurbishment and remanufacturing of end-of-life products; the recycling of post-consumer material and waste into secondary raw materials; the extension of material loops through eco-design; and the narrowing of these loops through resource efficiency initiatives.[9] Furthermore, a transformation toward a circular economy potentially presents an opportunity to reimagine ways to reduce material and resource usage by rethinking traditional business models and processes, reevaluating product design



and restructuring the supply chain. For instance, digitalization is a driving force behind a number of new industries; and a transition to a circular future through resource optimization can be enabled, supported, and accelerated through a digital economy.[10]

Exhibit 3:
Circular Economy

Source: Rachel Meidl



A report published during the 2018 World Annual Forum in Davos found that the world economy is only 9.1% circular, and this is trending downward annually, with the current global circularity gap at 8.6%.[11] Adapting to a circular economy is a gradual process, and requires the recalibration and alignment of products, processes and business models within the economic system, including energy production, resource utilization, manufacturing and production, sales, collection, reuse, repair, sharing platforms and environmental regeneration. For a circular economy to gain traction and have lasting impact, it implicitly needs informed companies and consumers, technological innovations, supportive legislation and backing from public authorities.

The overall system's health and balance in a circular economy involves an efficient and effective economy at all scales — for businesses, organizations, governments and individuals, globally and locally. Transitioning to a framework of circularity represents a systemic shift that builds long-term resilience, generates business and economic opportunities while boosting competitiveness, and provides environmental and societal benefits.

8 "Towards the Circular Economy: Economic and business rationale for an accelerated transition." Ellen MacArthur Foundation, 2015.

9 "International Trade and the Transition to a Circular Economy." OECD, 2018.

10 "Circular goes digital." Deloitte.

11 "The Circularity Gap Report 2021." Circle Economy, 2021.

Why the **Current Shift** Toward a Circular Economy?

Although the concept of circularity and the cascading of material and energy flows has been maturing for well over half a century, it recently has become more prevalent in the corporate world and in global political frameworks.[12,13] This is due in part to emerging circular models such as home- and car-sharing services and deposit-refund programs for products, as well as "zero waste" and decarbonization goals. Industries and governments are encountering progressively more complex external elements that affect business success, supply-chain resilience, consumer behavior and economic or political conditions.[14] Influences such as continuing population growth, rapid waste generation and disposal, global power shifts to emerging markets, supply and demand imbalances and changes in consumer preferences toward individualized goods and services continue to challenge the existing linear model and is motivating society to advance to a more circular economy.

In today's resource-constrained world, with rapid population growth, shifting demographics, urbanization, digitization and electrification (all magnified by heightened concerns about environmental, social and economic degradation), policymakers, businesses and societies have aligned strategies around two landmark pillars of ambitious international collaboration. These are the United Nations Sustainable Development Goals and the global climate targets of the Paris Agreement. Also, recent events such as China's National Sword Policy,[15] which imposed unprecedented import restrictions on plastic wastes and recyclables, extreme weather events disrupting production of critical goods and manufacturing feedstocks and the COVID-19 pandemic all have exposed systemic vulnerabilities in linear business models and tested the resilience and adaptability of global supply chains.[16, 17, 18, 19] These incidents have pushed circularity to the forefront of business and government agendas by illustrating the practical appeal of circular economy principles. While these events have catalyzed governments, brands and industries to restructure and transform strategies, they also have created opportunities for readjusting long-term planning and investments in innovative and disruptive ways, approaches that are more transparent, adaptable and socially and environmentally aware.

12 Arruda, Erick H., Melatto, Rosângela A.P.B., Levy, Wilson, and de Melo Conti, Diego. 2021. "Circular Economy: A Brief Literature Review (2015-2020)." Sustainable Operations and Computers 2: 79-86.

13 Murray, Alan, Skene, Keith, and Haynes, Katherine. 2017. "The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context." Journal of Business Ethics 140: 369–380.

14 Weetman, Catherine. A Circular Economy Handbook. How to Build a More Resilient, Competitive and Sustainable Business. London/New York: Kogen Page Limited, 2020.

15 For over two decades, China imported the vast majority of recyclables and waste from North America, Europe and other developed nations. Due to concerns of environmental degradation, the Chinese Ministry of Ecology and Environment enacted the "National Sword" policy that went into force in January 2018. The policy placed restrictions on the import of most plastics, wastes, and other materials. A total ban on imported waste went into effect January 1, 2021.

16 "China Notification." World Trade Organization Committee on Technical Barriers to Trade, 2017. Wong, Steve. 2017. "New World Order." Recycling Today.

17 Ghadge, Abhijeet, Wurtmann, Hendrik, and Seuring, Stefan. 2020. "Managing Climate Change Risks in Global Supply Chains: A Review and Research Agenda." International Journal of Production Research 58: 44-64.

18 Ebad Sichani, Majid, Anarde, Katherine A., Capshaw, Kendall M., Padgett, Jamie E., Meidl, Rachel A., Hassanzadeh, Pedram, Loch-Temzelides, Ted P., and Bedient, Philip B. 2020. "Hurricane Risk Assessment of Petroleum Infrastructure in a Changing Climate." Frontiers in Built Environment 6: 104.

19 Sodhi, Manmohan S., and Tang, Christopher S. 2021. "Supply Chain Management for Extreme Conditions: Research Opportunities." Journal of Supply Chain Management 57: 7-16.

Circular Economy: **The Importance of Scope and Framing**

As research and interest in a circular economy gather pace and the notion of circularity becomes integrated in national agendas, varying interpretations across organizations and sectors have added complexity to the development of distinct and consistent guidelines. Despite growing interest, introducing the circular economy into policymaking and governance has been limited so far, and circular strategies likely need to be better defined, understood and measured to translate them into concrete policy goals.[20] The circular economy directives and policies of the European Union (EU) exemplify the multiple interpretations that have been adopted into a variety of national laws by its member states. The framework for a circular economy needs to be applicable from local to global levels, within both public and private sectors.

The scope of circular economy strategies comprises circularity at the process or product level (including different stages of the life cycle, but ideally systemwide), service-oriented arrangements (sharing platforms such as home- and car-sharing services among other models)[21] or operational or institutional practices and policies. Circularity may convey benefits such as: reduced extraction of virgin natural resources; resource security and regeneration; resilience; adaptation to innovation; avoided risk (either price, geopolitical or reputational); improved relationships with consumers, suppliers, employees and local communities; and can be a natural progression of an ESG agenda. However, the way industries, organizations and governments define and apply the concept of a circular economy varies greatly.

Early circular economy strategies were designed primarily around waste management, waste-to-energy, waste diversion and recycling programs.[22] Driven by concerns about waste facilities nearing capacity, Germany was the first European country to systematically confront issues with solid waste, using circular economy principles through manufacture liability laws that shift responsibility to producers, meaning their products have to be designed to minimize waste, ensure waste recovery and reuse in both production and use.[23] This served as a model for European environmental legislation.[24] Although early circular economy strategies to solving waste issues are achieved through landfilling, incineration and export arrangements, there is now a growing awareness worldwide of the validity of such activities as a part of a circular agenda.

Even today, circular economy activity remains mostly associated with waste management, due to growing end-of-life considerations. However, that viewpoint is gradually beginning to shift, with countries interpreting and adopting other elements of the circular framework. Germany, as a heavy-industrial economy, has focused on a raw materials strategy, integrating circularity through a top-down emphasis on resource efficiency.[25] Initially concentrating on recycling and incineration, Japan is assessing material flows of resources, looking at productivity and footprint, to determine how to refine existing processes to improve remanufacturing products through recovering, disassembling, repairing and sanitizing components for resale at "new-product" performance, quality and specifications.[26], [27] The Netherlands relies on innovation in materials and business models and uses public procurement requirements for circular products and services.[28] Finland's strategy leverages a bio-economy, using renewable biological resources for the production of food and feed, products and energy. France embraces eco-innovation as a part of its circular economy framework.[29]

China, a pioneer in the circular economy, has been evolving its national policy since the early 2000s, regularly introducing legislation to improve the effectiveness of its outcomes.[30] With an initial emphasis on industrial ecology, China's objective was waste repurposing — using waste and byproducts from one company as a resource for another entity. More recent versions include a strong innovation agenda, eco-design and extended producer responsibility initiatives, where generators are required to ensure products are recycled or recovered. Although the U.S. does not have national circular economy legislation, companies and state and local governments are designing elements of circularity into their business models through recycling targets, deposit-refund systems and other methods.

20 Lacy, Peter, Long, Jessica, and Spindler, Wesley. The Circular Economy Handbook: Realizing the Circular Advantage. London: Palgrave Macmillan, 2020.

21 Han, Junghee, Heshmati, Almas, and Rashidghalam, Masoomeh. 2020. "Circular economy business models with a focus on servitization." Sustainability 12: 8799.

22 Weber, Thomas, and Stuchtey, Martin (Eds.). 2019. "Pathways Towards a German Circular Economy: Lessons from European Strategies Preliminary Study." Acatech-National Academy of Science and Engineering.

23 Ogunmakinde, Olabode E. 2019. "A review of circular economy development models in China, Germany and Japan." Recycling 4: 27.

24 Hiebel, Markus, Bertling, Jürgen, Nühlen, Jochen, Pflaum, Hartmut, Somborn-Schulz, Annette, Franke, Matthias, Reh, Katharina, and Kroop, Stephanie. 2017. Studie zur Circular Economy im Hinblick auf die chemische Industrie (study commissioned by the German chemical industry association (VCI)). Fraunhofer UMSICHT

25 Kazmierczyk, Pawel, Geerken, Theo, Bahn-Walkowiak, Bettina, Vanderreydt, Ive, van Veen, Janneke, Veneziani, Marco, De Schoenmakere, Mieke, and Arnold, Mona. 2016. "More From Less: Material Resource Efficiency in Europe; 2015 Overview of Policies, Instruments and Targets in 32 Countries." European Environment Agency.

26 Bangert, Helene. 2020. "Japan's Circularity: A Panorama of Japanese Policy, Innovation, Technology and Industry Contributions Towards Achieving the Paris Agreement." EU-Japan Centre for Industrial Cooperation.

27 "Circular Economy Vision 2020 Compiled." 2020. Ministry of Ecology, Trade and Industry.

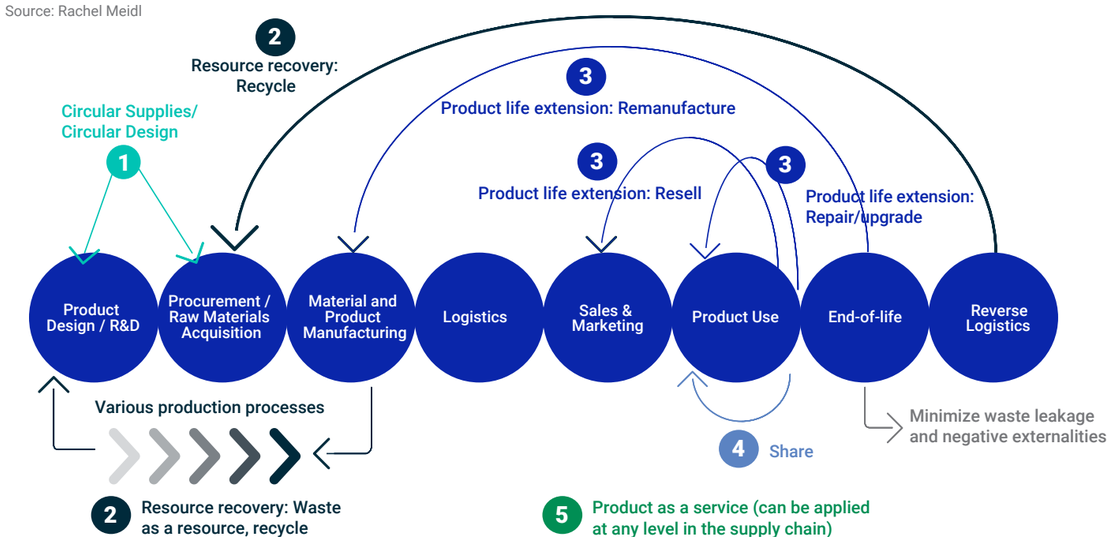
28 "A Circular Economy in the Netherlands by 2050." 2016. The Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs.

29 Iles, Joe. 2018. "Which country is leading the circular economy shift?" Circulate, An Ellen MacArthur Foundation publication.

30 Fan, Yupeng, and Fang, Chuanglin. 2020. "Circular Economy Development in China — Current Situation, Evaluation and Policy Implications." Environmental Impact Assessment Review 84: 106441.

Exhibit 4:
Five business models to facilitate a circular economy

Source: Rachel Meidl



Business Models and **Thematic Opportunity Areas**

The uptake of various business models of circularity has differed across geographies, industries, governments and products. It is easiest for circular economy business models to gain traction when they can embed into existing supply chains and create obvious value. Examples would include: circular supply chains that use alternative energy, bio-based and recyclable materials; recovery and recycling of primary and secondary goods and raw materials; value-retention processes such as product life cycle extensions; sharing or collaborative consumption platforms; and product-as-a-service solutions. Circular business models open the way to coalesce multiple principles for value creation beyond financial values, ultimately including environmental and social considerations. These models have much potential to generate new business prospects, limit material costs and price volatility, reduce dependency on imports and increase resource security, minimize greenhouse gas emissions and improve social benefits such as enhanced quality of life and new jobs.[31]

There are numerous opportunities in highly promising thematic areas for increased circularity; areas such as mining and metals, food systems, plastics and other packaging materials, the built environment and infrastructure, electronics, transportation, energy and fashion and textiles. Consumer-facing industries such as packaging and fashion and textiles have seen more activity and commitments around circularity.[32], [33] In September 2020, for example, a group of more than 10 of the world's largest food retailers announced that more than 200 of their suppliers, operating in over 80 countries, had joined the commitment to reduce food loss and waste from their supply chains.[34] Circular opportunities can extend beyond industry boundaries, especially when a life cycle perspective requires collaboration to maximize recycling and remanufacturing.

Similarly, deeming waste a valuable resource allows society to extract maximum value. This can be done through electronic waste (e-waste) repair, recycling and recovery, waste-to-compost and soil-enhancing conversion technologies in the food value chain or reuse of materials in secondary markets that purchase refurbished products, components and materials. For example, the EU's Waste Electrical and Electronic Equipment (WEEE) Directive promotes reuse, recycling and other forms of recovery and sets the criteria for the sale, take-back and proper disposal of WEEE.[35] Penalties for non-compliance depend on country-specific regulations and can include fines, distribution bans, personal liability and corporate reputational risk.

Although the inclusion of a waste hierarchy in a circular system is crucial, focus on circularity to date has largely centered on recycling.[36] From a circular hierarchy perspective, the priority should be maximizing the use of resources to extract optimal value — whether by minimizing extraction of virgin raw materials or disrupting traditional business models through innovation. Doing so would allow practitioners to redefine and re-engineer processes, products and services for system-wide innovation while minimizing negative impacts and creating positive outcomes for specific circular scenarios.

31 Velenturf, Anne P., and Purnell, Phil. 2021. "Principles for a Sustainable Circular Economy." Sustainable Production and Consumption 27: 1437-1457.

32 "Are you 'Looped In'? Circular Economy Leaders Share Their Latest Solutions." 2021. Dow sponsored content on Sustainable Brands.

33 "A New Textiles Economy: Redesigning Fashion's Future." 2017. Ellen MacArthur Foundation.
Nicholos, Katie, and Martins, Kaela. 2021. "Packaging Sustainability: Retail State of Play." Retail Industry Leaders Association blog

34 "World's Leading Food Retailers and Providers Engage Nearly 200 Suppliers in Cutting Food Loss and Waste in Half." 2020. Champions 12.3 press release.

35 "Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on Waste Electrical and Electronic Equipment (WEEE)." 2012. Official Journal of the European Union 55: 38.

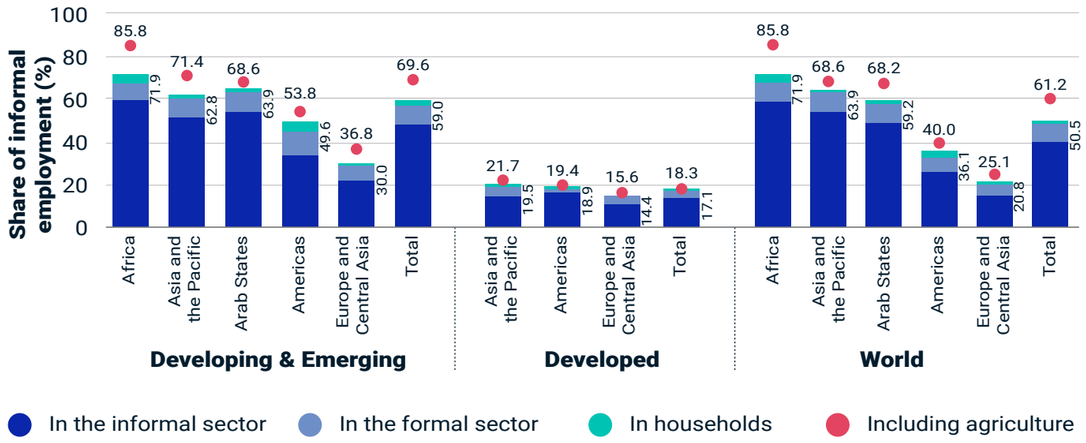
36 https://www.weforum.org/agenda/2019/11/build-circular-economy-stop-recycling/

OECD vs. Non-OECD Perspectives of a Circular Economy

The progression toward a circular future has specific implications for developing economies. Their consumer preferences and consumption cycles may be misaligned with the priorities of high-income societies. The notion of circularity can be perceived as "OECD-centric" and potentially opposed to the economic growth priorities of developing nations, which may not yet be receptive to theories about reduction, prevention and elimination of waste. Basic needs such as access to safe and secure food and water may take precedence over ideas about circularity, even if it promises more sustainable long-term solutions. With over a billion emerging-market consumers, many of whom are experiencing a rise into the middle class, residents in developing economies may naturally seek an opportunity to consume and improve their standard of living.

Exhibit 5:
Panel C. Components of informal employment as a percentage of total employment: the informal sector, formal sector and household sector (percentages, 2016)

Source: International Labour Office



Additionally, failure to account for the informal sector[39] in non-OECD countries could widen the gap between socioeconomic classes and affect the economies. The informal sector's almost two billion global workers from small-scale and large enterprises form a significant portion of the world's economy and are at the front lines of enabling a circular economy.[41] In 2016 alone, the informal waste sector collected 27 million metric tons of polyethylene terephthalate (PET) plastic waste and kept it from ending up in landfills or migrating to oceans. This means more than half (about 59%) of all the plastic material collected for recycling globally is carried out by the informal waste sector.[42] Protecting the right to economic prosperity of those in the informal sector must be considered so they can generate social and economic benefits for their local communities. Recognizing and incorporating informal workers into circular economic models is important to enable the required systemic shifts that can build long-term resilience, generate business and economic opportunities and provide environmental and societal benefits.

The shipment of waste across jurisdictional boundaries for treatment, recycling, recovery or disposal, is prevalent throughout developed economies and raises issues of environmental and social justice. When waste management in OECD economies relies on export, the system primarily benefits the higher-income countries, as it fails to incorporate true costs such as environmental and social impacts in the receiving countries, along with emissions of transboundary movement and actual end-of-life management of wastes.[43] Decades of consistently low recycling rates for certain materials, the consequences of China's National Sword Policy, and an overreliance on waste exports to offshore markets is expanding the idea of the circular economy to a broader perspective. A systems-level approach quantifies and understands the risks, trade-offs and unintended consequences, from a life cycle perspective, across the entire value chain. This is what leads to long-term system balance and global sustainability.

39 The informal sector is broadly characterized as individuals engaged in the production of goods or services with the primary objective of generating employment and incomes to the persons concerned. The informal sector is a part of a country's economy that is not taxed or monitored by any form of government.

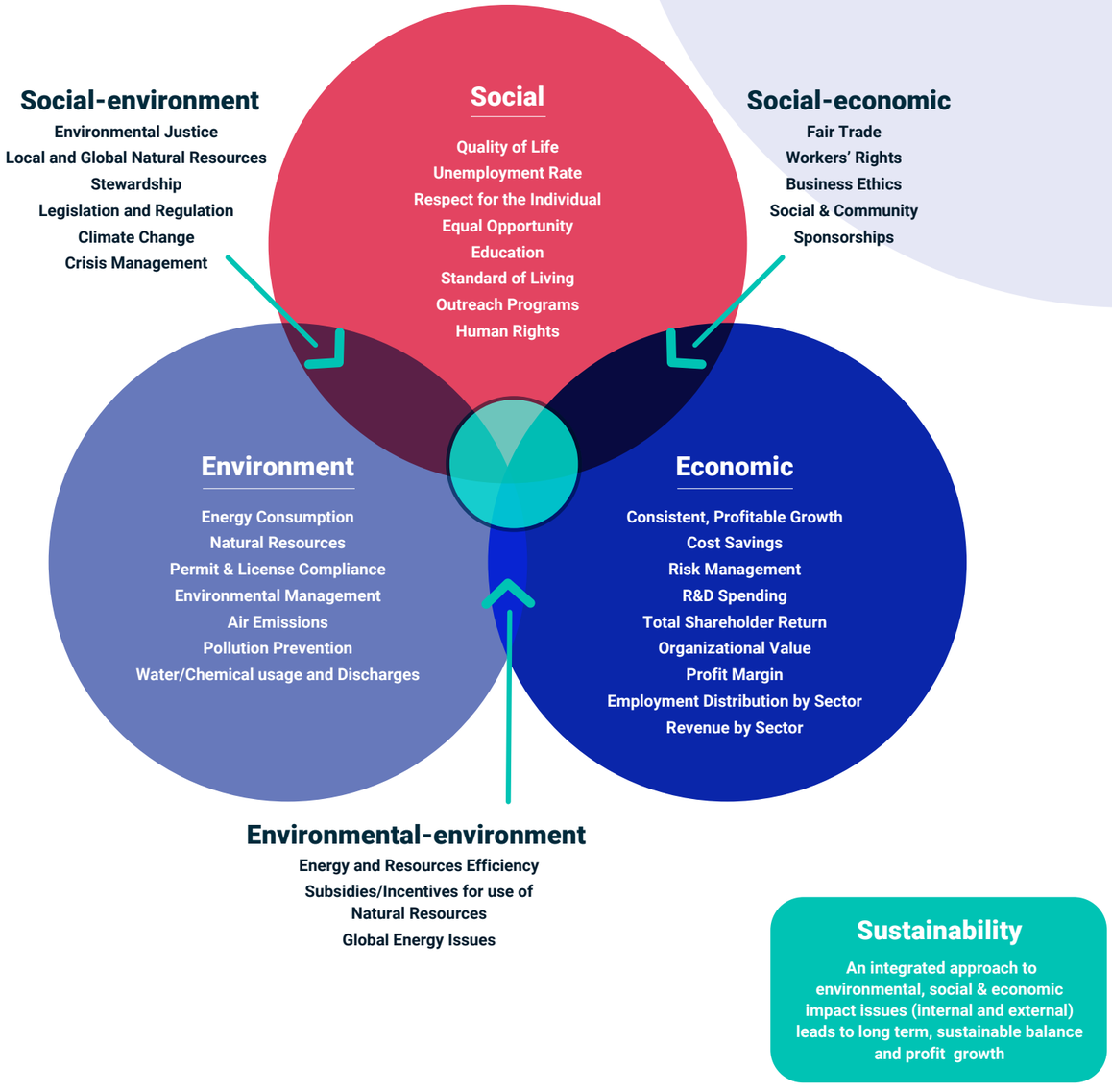
41 "Women and men in the informal economy: A statistical picture." 2018. International Labour Office, Geneva.

42 "Breaking the Plastic Wave Thought Partners: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution." 2020. The Pew Charitable Trusts and SYSTEMIQ.

43 World Bank. World Development Report 2020: Trading for Development in the Age of Global Value Chains. Washington, DC: World Bank, 2020.

Exhibit 6:
Sustainability: A systems-level approach

Source: Rachel Meidl



The Relationship of Sustainability to a Circular Economy

In recent years, the term sustainability has been frequently associated with a circular economy. Sustainability is an integrated, systems-level approach that factors in environmental, social and economic aspects of a product, material, process or technology and assesses how they interact. Sustainability should be an underlying principle of a circular economy, and circularity can be a means to achieve sustainability, but not all systems that include circular flows are intrinsically more sustainable.[44] Circularity in and of itself does not necessarily create a sustainable outcome, nor is it a panacea for resource efficiency or economic prosperity. Recycling, although a key category of circularity, can be a costly, energy- and resource-intensive process that imposes higher overall life cycle impacts than alternative methods. Similarly, not all sustainability pathways contribute to circularity. In regions of the world that lack recycling infrastructure, modernized technologies or financial resources, the lowest-carbon option, and perhaps the most economical choice, may be to manage waste in secure landfills where methane gas can be converted to power, heat or fuel or waste-to-energy plants that use existing co-processing infrastructure. Sustainability is far more complex than a singular focus on environmental preservation, opting for presumed circular and eco-friendly options or switching to alternative energies.

44 Charter, Martin. (Ed.). Designing for the Circular Economy. London: Routledge, 2018.

The potential conflicts between sustainability and a circular economy can be addressed through a more holistic approach. This approach can form the basis for assessing the range of impacts of a product, material, service, process or technology. Systems-level thinking and properly scoped life-cycle-based assessments are a key tool for measuring the sustainability of circular solutions. They can help identify risks, add understanding of trade-offs, avoid unintended externalities that are currently not priced and ascertain a range of opportunities.

Circularity: **An Engine for Creating Opportunity**

The transition to a circular economy, by definition, brings disruption and change to all aspects of society and the global economy. However, as we have shown, it is also a potential engine for creating opportunity across industries and governments. Balanced policies, systems-level thinking, innovative models and enabling new technologies all can help society operate in a more sustainable, robust and resilient way.

MSCI would like to thank Rachel A. Meidl, fellow in energy and the environment at Rice University's Baker Institute for Public Policy, for useful discussions and insightful analysis of this megatrend. Her insights greatly facilitated the preparation of this docume*nt*.

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