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Navigating the Environmental Footprint: Pathways to a Circular Economy

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ABSTRACT

In the face of escalating environmental concerns, understanding and mitigating the environmental footprint of human activities has emerged as a global imperative. This paper explores the concept of the environmental footprint, which encapsulates the cumulative effects of human actions on natural resources, waste generation, and emissions, highlighting the urgent need for a strategic shift towards sustainability. With the planet facing unprecedented pressures from overconsumption, pollution, and the relentless exploitation of resources, transitioning to a circular economy presents a viable pathway to address these challenges. The circular economy framework, characterized by the principles of reducing waste, reusing resources, and recycling materials, offers a comprehensive strategy to decouple economic growth from environmental degradation. Through a multidisciplinary approach that integrates insights from architecture, mechanical engineering, and power system design, this paper delineates pathways to design and operate data centers that not only meet the demands of the digital age but also align with the objectives of environmental sustainability. By advocating for a circular economy model, the paper underscores the potential for significant reductions in the environmental footprint, fostering a future where economic development and ecological stewardship coexist harmoniously.

Keywords: Circular Economy, Environmental Footprint, Sustainability, Resource Efficiency, Waste Reduction, Regenerative Design, Sustainable Consumption, Carbon Footprint, Material Footprint, Eco-design, Renewable Energy, Closed-loop Systems, Green Technologies, Resource Conservation, Lifecycle Assessment.

"Each new generation is reared by its predecessor; the latter must therefore improve in order to improve its successor. The movement is circular." - Emile Durkheim, sociologist

INTRODUCTION

In the contemporary global landscape, the environmental footprint left by human activities poses one of the most formidable challenges to the sustainability of our planet. This footprint, a comprehensive measure of the impact human actions have on the Earth's ecosystems, encompasses a wide array of dimensions including carbon emissions, material consumption, water use, and land alteration. The accelerating pace of environmental degradation, driven by rapid industrialization, urbanization, and an ever-growing global population, has led to an urgent call for a paradigm shift towards sustainable practices. The critical need to address this pressing issue has catalyzed the exploration of innovative solutions aimed at mitigating the detrimental impacts of human civilization on the natural world.

Enter the concept of the circular economy, a transformative approach that stands in stark contrast to the traditional linear economic model of "take, make, dispose." The circular economy offers a promising pathway towards sustainability, emphasizing the importance of keeping resources in use for as long as possible, extracting the maximum value from them while in use, and recovering and regenerating products and materials at the end of their life cycle. This model seeks not only to minimize waste but also to create a system that is restorative and regenerative by design. By redefining growth to focus on positive society-wide benefits, the circular economy aims to decouple economic activity from the consumption of finite resources, thus addressing the root causes of environmental degradation.

The transition to a circular economy requires a holistic reimagining of processes across industries, from product design and manufacturing to consumption patterns and waste management. It calls for a collaborative effort among policymakers, businesses, and consumers to foster a culture of sustainability that permeates every facet of society. This paper delves into the intricacies of navigating the environmental footprint through the lens of the circular economy, exploring the multifaceted strategies and innovations that can propel us towards a more sustainable future. Through a detailed examination of the circular economy's principles, practices, and potential, this research underscores the critical importance

of this model as a solution to the environmental challenges we face, paving the way for a future where economic prosperity and environmental stewardship go hand in hand.

UNDERSTANDING THE ENVIRONMENTAL FOOTPRINT

Conceptual Overview

The environmental footprint serves as a comprehensive indicator of the impact human activities have on the Earth, offering a quantifiable measure that encompasses the depletion of natural resources and the generation of waste and emissions. It is a multidimensional concept that reflects the extent to which humanity overshoots the carrying capacity of the planet, emphasizing the urgency for sustainable living practices. This measure not only sheds light on the current state of environmental health but also forecasts the long-term viability of ecosystems worldwide, making it an essential tool for policymakers, businesses, and individuals striving towards sustainability.

Components of the Environmental Footprint

The environmental footprint is composed of several key components, each highlighting a specific area of human impact on the planet:

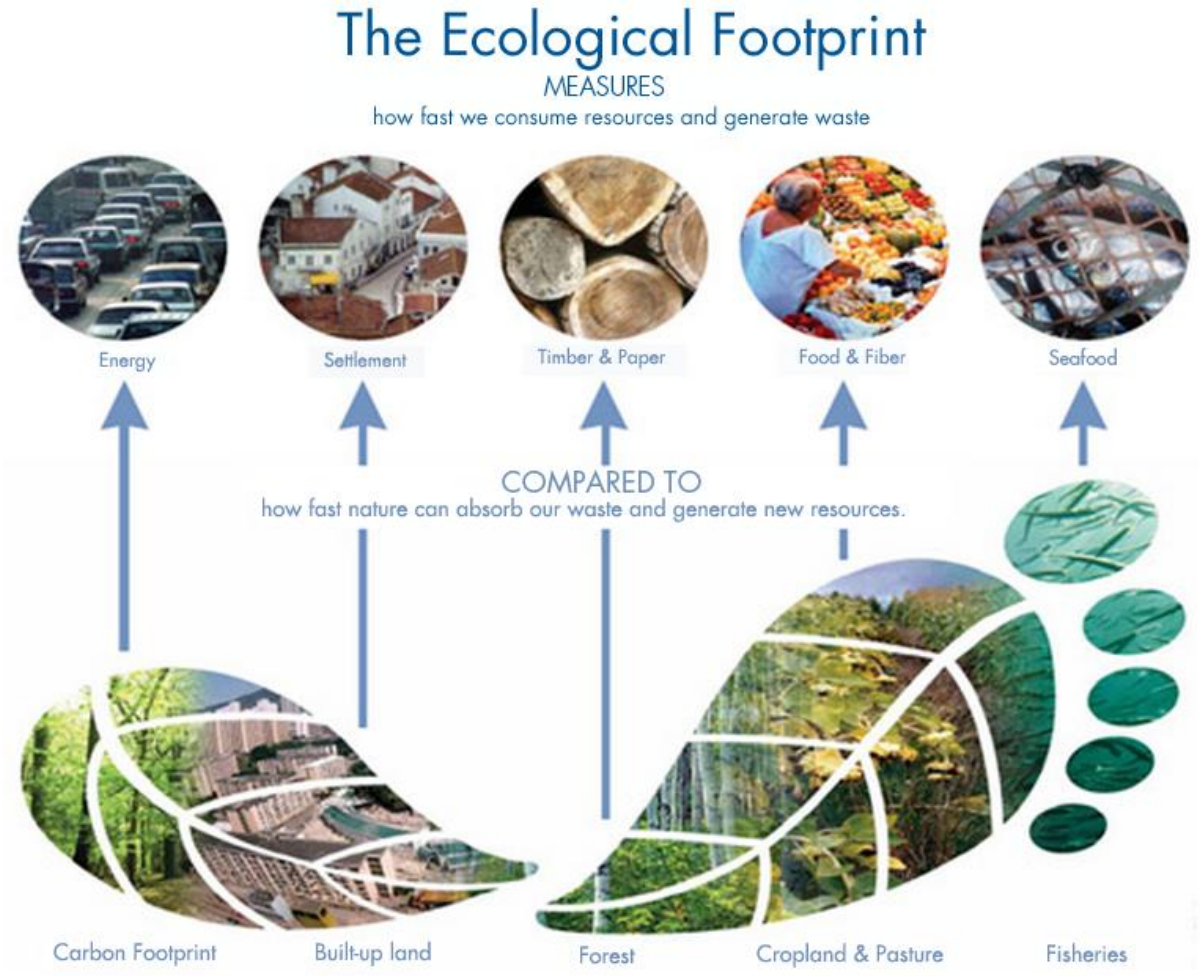

Figure 1. Global Footprint Network is the Ecological Footprint, a comprehensive sustainability metric. It was created by Mathis Wackernagel and William Rees in the early 1990s as part of Wackernagel's PhD research at the University of British Columbia.https://www.footprintnetwork.org/

Carbon Footprint

The carbon footprint, perhaps the most widely recognized component, quantifies the total greenhouse gas emissions attributed to individuals, organizations, or activities, measured in units of carbon dioxide equivalents (CO2e). These emissions, stemming from fossil fuel combustion in transportation, energy production, industrial processes, and

deforestation, significantly contribute to global warming and climate change. Mitigating the carbon footprint is critical for stabilizing global temperatures and preventing the severe ecological and socioeconomic consequences of climate change.

Material Footprint
The material footprint measures the amount of raw materials extracted and consumed by human activities. It encompasses both renewable (such as timber and biomass) and non-renewable resources (including minerals, metals, and fossil fuels). The relentless demand for these materials not only strains finite resources but also leads to environmental degradation and biodiversity loss. Sustainable material management and the shift towards a circular economy are imperative to reduce the material footprint.

Land Footprint
The land footprint reflects the area of biologically productive land and water ecosystems required to support human consumption and waste absorption. It encompasses agricultural lands, forests, urban areas, and infrastructure. Excessive land use for agriculture, urbanization, and infrastructure development results in deforestation, soil erosion, habitat destruction, and loss of biodiversity, underscoring the need for sustainable land-use practices and conservation efforts.

Water Footprint
The water footprint accounts for the total volume of freshwater used, contaminated, or made unavailable through human activities. It highlights critical issues such as water scarcity, pollution, and the competition for water resources among agriculture, industry, and domestic uses. Addressing water footprint challenges necessitates efficient water use, pollution prevention, and the implementation of technologies and practices that support sustainable water management.

CONTRIBUTING FACTORS AND CIRCULAR ECONOMY IMPLICATIONS

Population Growth and Economic Expansion
The exponential growth of the global population, alongside rapid economic expansion, serves as a primary catalyst for increasing environmental pressures. As the world's population continues to rise, so does the demand for food, water, energy, and resources, leading to intensified extraction and exploitation of natural assets. Economic expansion, particularly within emerging markets, further amplifies this demand, driving up consumption levels and, consequently, the environmental footprint associated with manufacturing, transportation, and waste. The interplay between demographic growth and economic activities underscores a critical challenge: how to accommodate the needs and aspirations of a growing global populace while safeguarding the planet's ecological balance.

Consumption Patterns
In affluent societies, consumption patterns significantly contribute to the environmental footprint. The prevalence of high-consumption lifestyles, characterized by frequent purchases, a preference for disposable products, and excessive energy use, magnifies the demand on natural resources and elevates waste generation. Such patterns not only strain limited resources but also result in substantial emissions and pollutants, exacerbating environmental degradation. The disparity in consumption between affluent and less affluent societies highlights the unequal distribution of environmental impacts, calling for a reassessment of consumption norms and values towards more sustainable practices.

The Role of the Circular Economy
In response to these challenges, the circular economy emerges as a transformative framework designed to decouple economic growth from environmental degradation. By redefining progress, the circular economy aims to create economic value and opportunities within a system that regenerates rather than depletes. This approach advocates for keeping products, materials, and resources in use for as long as possible, extracting maximum value during usage, and recovering and regenerating products and materials at the end of their life cycle.

The circular economy presents an alternative to the traditional linear "take-make-dispose" model, emphasizing efficiency, waste reduction, and the innovation of business models that foster access over ownership. Through principles such as design for longevity, repairability, recyclability, and biodegradability, the circular economy seeks to minimize waste, utilize renewable energy sources, and embrace systems thinking in product design and business strategy. This paradigm shift not only addresses the root causes of the environmental footprint but also offers a pathway to sustainable development that aligns economic activities with ecological resilience and social well-being.

By tackling the contributing factors of population growth, economic expansion, and unsustainable consumption patterns, the circular economy framework underscores the potential for systemic change. It presents a cohesive strategy to mitigate

environmental impacts through innovative and sustainable practices, paving the way for a future where prosperity and sustainability are not mutually exclusive but inherently interconnected.

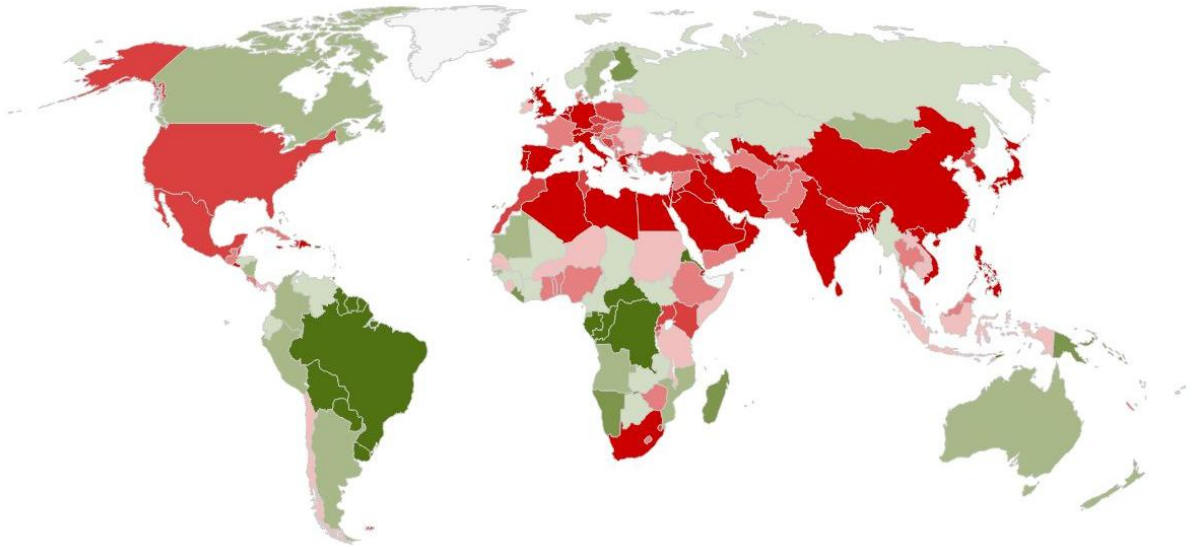

Figure 2. Ecological Deficit/reserve: an ecological deficit occurs when the ecological footprint of a population exceeds the biocapacity of the area available to that population. A national ecological deficit means that the country is net-importing biocapacity through trade, liquidating national ecological assets or emitting more carbon dioxide waste into the atmosphere than its own ecosystems absorb. In contrast, an ecological reserve exists when the biocapacity of a region exceeds its population's ecological footprint.
Https://data.footprintnetwork.org/?_ga=2.132081551.1460273307.1712465903-491451225.1712465903#/

CIRCULAR ECONOMY PRINCIPLES AND PRACTICES

The circular economy represents a systemic approach to economic development designed to benefit businesses, society, and the environment. Central to the circular economy are four key principles and practices that facilitate the transition from a linear to a circular mode of operation:

Decoupling Economic Growth from Resource Use and Waste Generation

The principle of decoupling economic growth from resource use and waste generation underpins the circular economy. It challenges the traditional correlation between economic expansion and environmental degradation, advocating for growth that does not rely on exhaustive resource consumption. Strategies to achieve this include:

- **Innovative Product Design:** Developing products with minimal resource needs and extended durability.
- **Resource Efficiency:** Maximizing the utility of resources throughout their lifecycle to reduce the overall demand.
- **Renewable Energy:** Transitioning energy sources from fossil-based to renewable, thus reducing the carbon footprint associated with economic activities.

Eco-design and Innovation

Eco-design and innovation focus on the entire lifecycle of a product, from conception to disposal, ensuring that every stage minimizes environmental impact and fosters circularity. Key aspects include:

- **Design for Longevity:** Creating products that last longer and are easier to maintain, repair, and upgrade.
- **Design for Disassembly:** Ensuring products can be easily disassembled for component reuse or recycling.
- **Material Innovation:** Developing new materials that are more sustainable, recyclable, or biodegradable to replace those that are resource-intensive or harmful to the environment.

Business Models for Sustainability

The circular economy encourages the development of business models that reduce waste and promote the sustainable use of resources. These models include:

- **Product as a Service (PaaS):** Offering services rather than products to consumers, such as leasing, which encourages manufacturers to create durable and maintainable products.
- **Sharing Economy:** Facilitating shared access to goods and services to reduce the need for individual ownership, which can significantly lower the collective environmental footprint.
- **Take-back Schemes:** Encouraging consumers to return used products for recycling or refurbishment, thereby ensuring materials re-enter the production cycle.

Waste Management Hierarchies
At the heart of the circular economy is an advanced waste management hierarchy that prioritizes waste prevention, followed by reuse, recycling, and recovery of energy, with disposal as the last resort. This hierarchy emphasizes:

- **Waste Minimization:** Implementing measures to reduce the volume and toxicity of waste generated.
- **Reuse and Repurposing:** Encouraging the use of products for new purposes when they are no longer needed for their original function.
- **Recycling and Composting:** Transforming waste materials into new products or organic compost, thus conserving natural resources and reducing pollution.
- **Energy Recovery:** Utilizing waste as a resource to generate energy, in processes such as waste-to-energy incineration, with strict controls to minimize environmental impact.

These principles and practices form the cornerstone of the circular economy, aiming to create a regenerative system that maintains the value of products, materials, and resources within the economy for as long as possible, thereby minimizing the generation of waste and the use of finite resources. Through the adoption and implementation of these strategies, the circular economy offers a coherent framework for achieving sustainable growth, environmental protection, and enhanced societal well-being.

SECTOR-SPECIFIC STRATEGIES AND APPLICATIONS

The circular economy framework, with its emphasis on sustainability and resource efficiency, offers transformative strategies and applications across various sectors. By focusing on the manufacturing and waste management sectors, we can explore how circular economy principles are applied to reduce environmental footprints and promote sustainable practices.

Manufacturing Sector
In the manufacturing sector, the integration of eco-design and remanufacturing practices stands at the forefront of the transition towards a circular economy.

- **Eco-Design:** This approach involves the intentional design of products with their entire lifecycle in mind. By prioritizing durability, repairability, and recyclability from the outset, manufacturers can significantly reduce the environmental impact of their products. Eco-design also includes the use of sustainable materials and the minimization of energy consumption during production. For instance, modular design allows for easier disassembly and replacement of parts, extending product life and reducing waste.
- **Remanufacturing Practices:** Remanufacturing refers to the process of restoring used products to a 'like-new' condition, offering an alternative to complete product disposal. This practice not only conserves the materials and energy embedded in products but also decreases demand for new raw materials. By implementing remanufacturing practices, the manufacturing sector can achieve substantial reductions in CO_2 emissions and resource use. A successful example of this is the automotive industry, where parts such as engines and transmissions are often remanufactured, resulting in significant environmental and economic benefits.

Waste Management
The waste management sector plays a crucial role in the circular economy by ensuring the effective recovery, recycling, and reuse of materials. Advanced recycling technologies and supportive policies are pivotal to enhancing circular practices within this sector.

- **Advanced Recycling Technologies:** Innovations in recycling technologies have expanded the capacity to process complex waste streams, such as electronic waste and mixed plastics, that were previously considered non-recyclable. These technologies, including chemical recycling and enhanced mechanical processing, facilitate the

breakdown and recovery of high-quality materials for use in new products. The adoption of such technologies enables a shift from downcycling to true recycling, where the value of materials is maintained or even enhanced.

- **Policies Promoting Circular Practices:** Effective policy frameworks are essential to encourage the adoption of circular practices in waste management. Policies such as extended producer responsibility (EPR) require manufacturers to take back products at the end of their life, thus incentivizing the design of products for easy recycling and the development of efficient take-back systems. Other policy measures include landfill bans for recyclable materials, incentives for recycling industries, and standards for recycled content in products. These policies cansignificantly increase recycling rates, reduce waste, and stimulate the market for recycled materials.

By implementing sector-specific strategies and embracing circular economy applications, the manufacturing and waste management sectors can contribute significantly to environmental sustainability. These practices not only mitigate the depletion of finite resources and reduce waste generation but also foster innovation, competitiveness, and economic growth within a more sustainable framework.

CASE STUDIES: IMPLEMENTING CIRCULAR ECONOMY PRINCIPLES

The transition to a circular economy is gaining momentum globally, with various organizations and regions pioneering innovative approaches to sustainability. Here are two compelling case studies that exemplify the successful implementation of circular economy principles to mitigate environmental footprints.

IKEA’s Circular Business Model

IKEA, the world’s largest furniture retailer, has committed to becoming a fully circular business by 2030. The company's circular economy strategy focuses on designing products with reuse, repair, repurposing, and recycling in mind. One notable initiative is the introduction of the "Buy Back & Resell" program, where customers can sell back their used IKEA furniture in exchange for store credit. Returned items are either resold or recycled. Moreover, IKEA has invested in the development of renewable materials, such as the KUNGSBACKA kitchen fronts made from recycled wood and plastic. By integrating these circular principles, IKEA aims to reduce its environmental impact while still offering affordable products, demonstrating that large corporations can lead the way in sustainable business practices.

The City of Amsterdam: A Circular Urban Economy

Amsterdam is at the forefront of adopting circular economy principles at a municipal level. The city's ambitious Circular Strategy 2020-2025 outlines a vision for reducing waste and maximizing the reuse of resources across various sectors. One of the strategy’s focal points is the construction sector, where Amsterdam aims to halve the use of new raw materials by 2030. The city promotes the use of secondary materials in new building projects and the deconstruction of buildings for material recovery. Another innovative project is the Wasted Lab, which encourages residents to separate plastic waste in exchange for tokens redeemable at local businesses. Through these and other initiatives, Amsterdam is not only reducing its environmental footprint but also fostering economic innovation and community engagement in sustainability efforts.

Patagonia's Closed-Loop System

Outdoor clothing manufacturer Patagonia has long been a pioneer in sustainable business practices. The company’s Worn Wear program exemplifies its commitment to a circular economy. Patagonia encourages customers to return their used garments, which are then repaired, resold, or recycled. This initiative extends the life of their products and significantly reduces the demand for new raw materials. Patagonia also invests in the development of recyclable and non-toxic materials, further minimizing its environmental impact. By prioritizing durability and reparability in its product design, Patagonia showcases how businesses can thrive while prioritizing the planet.

CHALLENGES AND OPPORTUNITIES

The journey toward embedding circular economy principles into the fabric of global industries presents both significant challenges and vast opportunities. By dissecting these elements, we can better navigate the path to sustainability.

Technological and Financial Hurdles

One of the primary barriers to the widespread adoption of circular economy practices lies in technological and financial constraints. Technologically, the development and integration of systems designed for circularity, such as recycling technologies that can handle complex materials or digital platforms for product lifecycle tracking, demand substantial investment in research and development. Financially, the initial cost of implementing these technologies, alongside the

restructuring of business models to align with circular principles, can be prohibitive, especially for small and medium-sized enterprises (SMEs). Furthermore, the return on investment (ROI) for such endeavors is often long-term, challenging the short-term financial metrics by which many businesses operate.

Regulatory Landscape

The regulatory landscape plays a crucial role in either facilitating or hindering the transition to a circular economy. Inconsistencies in regulations across regions, lack of enforcement, and policies that inadvertently favor linear economy practices can stall progress. However, positive strides are being made in some regions where governments have begun to recognize the value of circular economy frameworks, enacting policies that incentivize sustainable practices, such as extended producer responsibility (EPR) schemes, subsidies for green technologies, and standards for recycled content. Aligning policy frameworks globally remains a challenge but also presents an opportunity for international cooperation on sustainability.

Opportunities for Innovation

Despite these hurdles, the shift towards a circular economy is ripe with opportunities for innovation that can drive future sustainability. Technological advancements, such as artificial intelligence (AI) and the Internet of Things (IoT), offer promising solutions for enhancing efficiency, optimizing resource use, and creating value from waste. For instance, AI can optimize recycling processes through material identification, while IoT devices can enable the tracking of products and materials for effective recovery and reuse. Moreover, the growing consumer demand for sustainable products encourages businesses to innovate and differentiate themselves in the market. This consumer-driven shift is fostering new business models, such as product-as-a-service (PaaS), which aligns profitability with sustainability.

In conclusion, while the path to fully realizing a circular economy is laden with challenges, it is also filled with unparalleled opportunities for innovation and growth. Tackling technological and financial barriers, navigating the regulatory landscape, and seizing opportunities for innovation are crucial steps in harnessing the full potential of circular economy practices. As industries and policymakers work together to overcome these obstacles, the promise of a sustainable future, characterized by reduced environmental footprints and enhanced economic resilience, becomes increasingly attainable.

TOWARDS A SUSTAINABLE FUTURE

As we navigate through the challenges posed by environmental degradation and resource depletion, transitioning towards a sustainable future requires a concerted effort across multiple fronts. Integral to this transition are strategies that encompass renewable energy adoption, resource conservation, and the promotion of sustainable consumption and production patterns. Additionally, the role of clean technologies and collaborative action cannot be overstated in achieving our sustainability goals.

Renewable Energy Transition

The shift from fossil fuels to renewable energy sources is paramount in mitigating climate change and reducing our environmental footprint. Strategies for this transition include incentivizing the development and deployment of solar, wind, hydro, and geothermal energy. Governments and private entities alike can play a crucial role by providing subsidies for renewable energy projects, facilitating research and development, and implementing policies that encourage the adoption of clean energy. Transitioning to renewables not only addresses the carbon footprint but also paves the way for energy independence and security.

Resource Conservation

Conserving natural resources is essential to ensure their availability for future generations. This involves adopting practices that increase efficiency in resource use, such as water-saving technologies in agriculture and industry, sustainable forest management, and the protection of biodiversity-rich areas. Encouraging circular economy principles—such as recycling, reusing, and reducing consumption—can significantly contribute to resource conservation. By minimizing waste and maximizing the utility of resources, societies can lessen their impact on the environment and foster a more sustainable relationship with the natural world.

Sustainable Consumption and Production Patterns

Altering consumption and production patterns to be more sustainable is crucial in reducing the environmental impacts of our lifestyles and economic activities. This entails promoting products that are designed for longevity, repairability, and recyclability, thus reducing waste and the demand for new raw materials. Governments can support sustainable consumption through green public procurement, while businesses can adopt models that offer products as services,

reducing the need to own physical goods. Educating consumers about the environmental impacts of their choices and providing sustainable alternatives can also drive the shift towards greener consumption habits.

Investing in Clean Technologies

The development and widespread adoption of clean technologies are essential for a sustainable future. Investment in research and development of technologies that reduce emissions, enhance energy and resource efficiency, and minimize pollution is necessary. Such technologies not only contribute to environmental sustainability but also offer economic opportunities, creating jobs and opening new markets. Public and private sector investments, along with supportive policies and innovation ecosystems, are crucial for accelerating the development and adoption of clean technologies.

Collaborative Action

Achieving sustainability goals requires collaborative action among governments, businesses, communities, and individuals. Multilateral agreements and partnerships can facilitate the sharing of knowledge, resources, and best practices across borders. Collaborative initiatives that involve various stakeholders can address complex environmental issues more effectively than isolated efforts. By working together, societies can forge a sustainable path forward, one that harmonizes economic development with environmental stewardship and social well-being.

CONCLUSION

As we stand at the crossroads of environmental sustainability and economic development, the imperative to transition to a circular economy has never been more critical. This journey, explored throughout this paper, underscores the circular economy not merely as an alternative but as a necessary pathway to mitigate the ever-expanding environmental footprint of human activities. By redefining how we view and utilize resources—from extraction to consumption and ultimately, waste—we unlock the potential for a sustainable future that harmonizes with the natural world.

The circular economy, with its principles of reducing waste, extending the lifecycle of resources, and regenerating natural systems, offers a blueprint for sustainable development. It challenges the traditional linear model of "take, make, dispose" and proposes a system where economic growth does not come at the expense of the planet's health. This transition is not solely the responsibility of policymakers or businesses; it requires a concerted effort from stakeholders at all levels. Governments must create enabling environments through supportive policies and regulations, businesses must innovate and adopt sustainable practices, and consumers must advocate for and embrace these changes.

As this paper has articulated, the implications of continuing on our current path are too significant to ignore. The degradation of natural ecosystems, the depletion of finite resources, and the exacerbation of climate change are but a few of the consequences. However, within these challenges lie opportunities for innovation, economic growth, and the reparation of our relationship with the environment. The adoption of circular economy principles presents an opportunity to redefine success in terms of not only economic gains but also environmental preservation and social well-being.

Thus, this paper serves as a call to action for stakeholders across all levels to promote and adopt sustainable practices. It is a call for a collective shift in mindset, from short-term gains to long-term sustainability, from individualism to collaboration, and from exploitation to stewardship. By embracing the circular economy, we pave the way for a healthier planet, resilient communities, and a sustainable legacy for future generations.

In conclusion, navigating the environmental footprint through the pathways outlined by the circular economy is more than a strategy; it is a moral imperative. As we move forward, let us commit to this transition, fostering a world where sustainability is not just an aspiration but a reality. The time to act is now, for the sake of our planet and all who inhabit it.

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REFERENCES

[1]. Ellen MacArthur Foundation. (2020). The circular economy: A transformative Covid-19 recovery strategy. https://www.ellenmacarthurfoundation.org/publications/the-circular-economy-a-transformative-covid-19-recovery-strategy
[2]. Geissdoerfer, M., Savaget, P., Bocken, N. M. P., &Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production, 143, 757-768. https://doi.org/10.1016/j.jclepro.2016.12.048
[3]. IKEA Group. (2021). Sustainability report 2021. https://www.ikea.com/sustainability-report-2021
[4]. Patagonia, Inc. (2019). Environmental + social initiatives 2019. https://www.patagonia.com/environmental-social-initiatives-2019/
[5]. Stahel, W. R. (2016). The circular economy. Nature, 531(7595), 435-438. https://doi.org/10.1038/531435a
[6]. World Economic Forum. (2019). Building blocks for a circular economy: Economic opportunities for the transition. http://www3.weforum.org/docs/WEF_Building_blocks_for_a_circular_economy_report_2019.pdf
[7]. Amsterdam Municipality. (2020). Amsterdam Circular Strategy 2020-2025. https://www.amsterdam.nl/en/policy/sustainability/circular-strategy/
[8]. McDonough, W., &Braungart, M. (2002). Cradle to cradle: Remaking the way we make things. North Point Press.
[9]. Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308-320. https://doi.org/10.1080/21681015.2016.1172124
[10]. Ghisellini, P., Cialani, C., &Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production, 114, 11-32. https://doi.org/10.1016/j.jclepro.2015.09.007
[11]. Korhonen, J., Honkasalo, A., &Seppälä, J. (2018). Circular economy: The concept and its limitations. Ecological Economics, 143, 37-46. https://doi.org/10.1016/j.ecolecon.2017.06.041
[12]. Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., & Evans, S. (2018). Business models and supply chains for the circular economy. Journal of Cleaner Production, 190, 712-721. https://doi.org/10.1016/j.jclepro.2018.04.159
[13]. Stahel, W. R. (2019). The circular economy: A user's guide. Routledge.
[14]. Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: An interdisciplinary exploration of the concept and application in a global context. Journal of Business Ethics, 140(3), 369-380. https://doi.org/10.1007/s10551-015-2693-2
[15]. Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in context of manufacturing industry. Journal of Cleaner Production, 115, 36-51. https://doi.org/10.1016/j.jclepro.2015.12.042
[16]. Pearce, D. W., & Turner, R. K. (1990). Economics of natural resources and the environment. Harvester Wheatsheaf.
[17]. Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environmental Development, 17, 48-56. https://doi.org/10.1016/j.envdev.2015.09.002
[18]. Blomsma, F., & Brennan, G. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. Journal of Industrial Ecology, 21(3), 603-614. https://doi.org/10.1111/jiec.12603
[19]. Gregson, N., Crang, M., Fuller, S., & Holmes, H. (2015). Interrogating the circular economy: The moral economy of resource recovery in the EU. Economy and Society, 44(2), 218-243. https://doi.org/10.1080/03085147.2015.1013353
[20]. Kirchherr, J., Reike, D., &Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221-232. https://doi.org/10.1016/j.resconrec.2017.09.005
[21]. Merli, R., Preziosi, M., &Acampora, A. (2018). How do scholars approach the circular economy? A systematic literature review. Journal of Cleaner Production, 178, 703-722. https://doi.org/10.1016/j.jclepro.2017.12.112
[22]. Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: An interdisciplinary exploration of the concept and application in a global context. Journal of Business Ethics, 140(3), 369-380. https://doi.org/10.1007/s10551-015-2693-2
[23]. Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environmental Development, 17, 48-56. https://doi.org/10.1016/j.envdev.2015.09.002
[24]. Webster, K. (2017). The circular economy: A wealth of flows. Ellen MacArthur Foundation Publishing.
[25]. Geng, Y., &Doberstein, B. (2008). Developing the circular economy in China: Challenges and opportunities for achieving 'leapfrog development'. International Journal of Sustainable Development & World Ecology, 15(3), 231-239. https://doi.org/10.3843/SusDev.15.3:6

[26]. Ritzén, S., &Sandström, G. Ö. (2017). Barriers to the circular economy – integration of perspectives and domains. Procedia CIRP, 64, 7-12. https://doi.org/10.1016/j.procir.2017.03.005
[27]. Haas, W., Krausmann, F., Wiedenhofer, D., & Heinz, M. (2015). How circular is the global economy?: An assessment of material flows, waste production, and recycling in the European Union and the world in 2005. Journal of Industrial Ecology, 19(5), 765-777. https://doi.org/10.1111/jiec.12244
[28]. UNEP International Resource Panel, 2016, Global Material Flows and Resource Productivity
[29]. Accenture Strategy, 2015, Waste to Wealth
[30]. Circle Economy, 2018, The Circularity Gap Report, An assessment of the circular state of the global economy
[31]. World Economic Forum, Ellen MacArthur Foundation, 2016, The New Plastic Economy: Rethinking the value of Plastics
[32]. The Lancet, 2017, The Lancet Commission on pollution and health,
[33]. Accenture Strategy, 2015, Waste to Wealth
[34]. FAO, 2017, SAVE FOOD: Global Initiative on Food Loss and Waste Reduction
[35]. ING, 2017, Less is more: Circular Economy solutions to water shortages
[36]. Ellen MacArthur Foundation, 2016, Circular Economy in India: Rethinking Growth for Long-Term Prosperity
[37]. United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), 2017, Global E-waste Monitor
[38]. World Economic Forum, Tsinghua University, 2018, Recovery of Key Metals in the Electronics Industry in the People's Republic of China: An Opportunity in Circularity(draft white paper)
[39]. World Economic Forum, Ellen MacArthur Foundation, 2016, The New Plastic Economy: Rethinking the Value of Plastics
[40]. Ocean Conservancy, 2015, Stemming the Tide: Land-based strategies for a plastic free ocean
[41]. UN Environment, 2018, Building Circularity into Economies through Sustainable Procurement (draft white paper)
[42]. Ellen MacArthur Foundation, 2016, Growth Within: A Circular Economy Vision for A Competitive Europe