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Circular Economy - The Way Forward

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Abstract: ***The circular economy is gaining prominence as a key strategy to help achieve the Paris climate goals. This research paper seeks to compile current knowledge on how the circular economy can contribute to climate change management, with an emphasis on both mitigation and adaptation. By reviewing leading literature and engaging with experts, the paper identifies points of consensus, ongoing debates, and critical knowledge gaps. Additionally, it includes a case study on the textile circular economy, aiming to inspire actions and accelerate circular economy initiatives that most effectively advance climate objectives and foster sustainable growth. The main objectives of the research study are: 1) Understanding the concept of circular economy 2) Highlighting the impact of circular economy on climate 3) To understand how circular economy model works in the textile industry***

Keywords: Circular economy, Paris Climate Goals, Sustainable growth

1. Research Methodology

The study is empirical in nature which includes both primary and secondary data with a qualitative approach. The secondary research was conducted by reviewing journals, research papers, newspapers articles and related books. The primary data was collected through on - site visit in Milan. Through an in - depth structured interview, the researcher had a clear picture of the operational aspects of second - hand clothing market and the various processes involved in bringing a discarded piece of clothing, footwear, shoes back to the market for re - selling and re - use while minimizing the carbon foot print.

2. Introduction

The 2015 Paris Agreement established a goal to limit global warming to "well below" 2˚C, and to pursue efforts to limit it to 1.5˚C. To stay below the 1.5˚C limit, global net greenhouse gas emissions must be cut in half from 2010 levels by 2030, and reach net zero by the early 2050s. This will require far - reaching system changes at an unprecedented scale. As of 2021, it is estimated that even if all existing pledges and targets in the latest NDC submissions are fully achieved, in 2030 there will still be a substantial gap of 25 Gt CO_2 e between actual emissions and those required to meet the 1.5˚C goal (UNEP 2021).

The circular economy is gaining popularity to help meet the Paris climate goal. In the latest Assessment Report by the Intergovernmental Panel on Climate Change (IPCC 2022), the circular economy was mentioned for the first time as a solution for climate change mitigation.

This paper summarizes current knowledge on the role of circular economy strategies in climate change management, focusing on both mitigation and adaptation. Drawing from key literature and expert consultations, it does not aim to be an exhaustive academic review but instead emphasizes several highly influential reports widely referenced by practitioners. Additionally, it includes insights from an on - site visit to a textile circular model in Milan, Italy. The paper explores three mechanisms through which the circular economy can contribute to climate change management. It then provides recommendations on how to translate the current knowledge landscape into actionable strategies, enabling practitioners to adopt and accelerate circular economy initiatives where they can most effectively support climate goals.

The current economic system is primarily a "linear economy", built on a model of extracting raw materials and converting them into products, and then discarding them as waste products. Currently, only 7.2 percent of used materials are re - cycled back into our economy after use. This has a significant burden on the environment and contributes to the climate crisis. Circular economy aims to minimize waste and promotes sustainable use of natural resources. Companies face increasing commodity prices, price volatility and climate change risks. All of these highlight the risks associated with the linear economy.

The Ellen MacArthur Foundation's "2012 Towards the Circular Economy", marked a turning - point - introducing the concept of circular economy, showing its potential benefits for businesses and presenting early successes. The report defines the concept of circular economy as follows:

"A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end - of - life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models." *Ellen MacArthur Foundation, 2012. Towards the circular economy – Economic and business rationale for an accelerated transition*

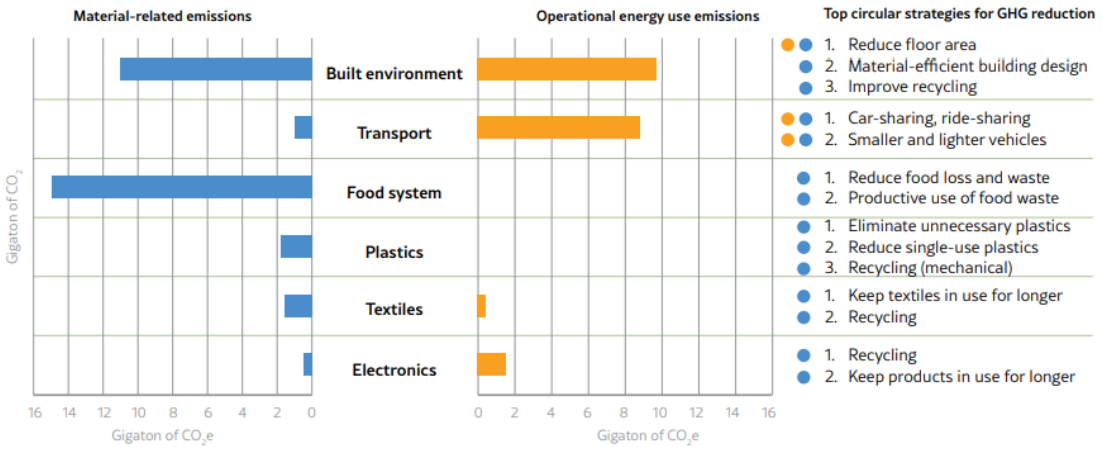
Most circular economy strategies can be clustered into the following four categories:

1) Reduce material inputs, which can be achieved through e. g., material - efficient product design, manufacturing, and substitution
2) Keep products and components in longer use, which can be achieved through e. g., increased durable, upgrade, share, reuse, repair, resale, refurbish, remanufacture, etc.
3) Cycles back materials into the economy through recycling
4) Regenerate natural systems, which is particularly relevant for biomass materials

Projected reduction potential through circular economy strategies

There is broad agreement that by lowering demand for (virgin) raw materials and new products, circular economy strategies can lead to reduced emissions from industrial processes by avoiding production of emissions in the first place. For example, materials - efficient product design can lower demand for industrial material inputs; keeping products in use can reduce demand for new products; and recycling can decrease demand for virgin materials that are often more carbon - intensive to produce compared to recycled materials.

Figure 3 | **Materials-related and operational energy use emissions by sector, alongside the circular economy strategies with highest projected greenhouse gas reduction potential**



Note: Blue dots indicate that a strategy decreases materials-related emissions. Orange dots indicate that a strategy decreases operational energy use emissions.

Sources: Built environment: Global Alliance for Buildings and Construction et al. 2019. Transport: IPCC 2022; Hertwich et al. 2019, with extrapolation by authors. Food system: IPCC 2019. Plastics: OECD 2022. Textiles: McKinsey and Global Fashion Agenda 2020. Electronics: Belkhir and Elmeligi 2018, with extrapolation by authors.

Figure 3 summarises the materials - related emissions, operational energy use emissions from each sector, and top circular economy strategies that have substantial greenhouse gas emission reduction potential. The circular economy has the potential to reduce greenhouse gas emissions across six key sectors: the built environment, transport, food systems, plastics, textiles, and electronics. These sectors align with the primary product value chains identified by the European Commission for the circular economy (European Commission, 2020).

2.2.1 Built environment - Buildings currently account for about 30–40% of global greenhouse gas emissions—including nearly 10 Gt CO_2 energy - related emissions, primarily from energy used for heating, cooling, lighting etc.; and 11 Gt CO_2 e embodied carbon in construction materials (Global Alliance for Buildings and Construction et al.2019). The International Resource Panel (IRP) estimates that material efficiency strategies could reduce greenhouse gas emissions in the material cycle of residential buildings by 80–100% in G7 countries and China, and 50–70% in India by 2050 (IRP 2020).

2.2.2 Transport - Operational energy use in transport amounted to 15% of global greenhouse gas emissions, or 8.8 Gt CO2 e, in 2019 (IPCC 2022). The embodied emissions in materials used to make vehicles are about an order of magnitude lower compared to the operational energy use emissions (based on data from Hertwich et al.2019), therefore estimated to be about 1 Gt CO2 e in 2019. Circular economy literature on transport focuses so far largely on passenger cars. IRP found that material efficiency strategies could reduce materials - related emissions of passenger cars in 2050 by 57%–70% in G7 countries, and by 40–60% in China and India (IRP 2020). In transport sector, the most significant action for reducing emissions can come from less fuel use vehicles enabled by e. g. lighter/smaller sized vehicles or shifts in usage pattern

2.2.3 Food system - The World Resources Institute estimates that slowing and shifting growth in food demand, including more sustainable diets and reduced food loss and waste, could reduce emissions from agriculture by 5 Gt CO2 e/year globally by 2050 (Searchinger et al.2019). Ellen MacArthur Foundation expects that a circular food system—characterised by regenerative agriculture, food loss and waste reduction, and composting—could reduce annual greenhouse gas emissions from the global food system by 49% in 2050 (Ellen MacArthur Foundation 2019a). The World Bank estimates that a reduction in food loss and waste by 50% at all stages of the supply chain would reduce global greenhouse gas emissions by 3%, with most of the decline associated with reduced output in the farming and transport sectors (World Bank 2020).

2.2.4 Plastics - Plastics generated 1.8 Gt CO2 e of greenhouse gas emissions in 2019 (about 3% of global emissions) —90% of these emissions come from the production phase (OECD 2018). An integrated circular system change in plastics is projected to result in 25% lower plastic - related greenhouse gas emissions in 2040 (The Pew Charitable Trusts and Systemiq 2020). Circular economy strategies that eliminate unnecessary plastics and increase plastics reuse can reduce emissions related to plastics production and disposal. The greenhouse gas reduction potential of plastics recycling strongly depends on the technology.

2.2.5 Textiles - The global apparel industry currently emits between 1.0 and 3.3 Gt CO2 e per year across its value chain (Ellen MacArthur Foundation 2017; Quantis 2018; McKinsey and Global Fashion Agenda 2020; World Resources Institute and Apparel Impact Institute 2021). The large estimate variation originates from the scope, assumptions and methodology of each study and the specific cases used to calculate emissions for each material. It is estimated that 75% of these emissions are from the production stages: from fibre to yarn to fabric and to garment (UNEP 2020).

2.2.6 Electronics - Although electronics are not yet considered a predominant contributor to global greenhouse gas emissions, the sector's carbon footprint is increasing rapidly. It is estimated that ICT alone already accounted for 3–3.6% of global emissions in 2020 (Belkhir and Elmeligi 2018). The breakdown between materials related emissions and operational energy use emissions strongly depends on the product category Substituting virgin materials with recycled materials will reduce greenhouse gas emissions from electronics, as the production of recycled materials is on average much less carbon intensive (OECD 2018).

How Does a Circular Economy Support the Transition to Clean Energy?

Circular economy strategies can support a more sustainable scaling of the clean energy transition by relieving material supply pressure, increasing supply chain resilience, preventing new waste challenges, accelerating the adoption of clean energy technologies, all while maximizing climate benefits, through: material - efficient product design and manufacturing, extending product life. and increasing recycling.

What are the challenges in transitioning to a circular economy? Why aren't we there yet?

A more circular world is possible, but the transition isn't a simple one. There are many challenges:

1) **Limited knowledge:** A better research - based understanding of the benefits and impacts of circular economy measures, particularly for climate and biodiversity, is needed. Knowledge sharing and collaborations are essential as all the countries are not aware about the potential of circular economy.
2) **Finance**: Businesses, particularly small and medium - sized enterprises (SMEs), as well as other organizations, often struggle to access adequate finance to transition from linear to circular business models. For example, it is estimated that it takes approximately three years for a smallholder farmer to shift from conventional cotton production to organic cotton production, and shifting to circular practices can take equally long, if not longer. This transition, therefore, requires not only adequate knowledge transfer and planning but also investment and finance.
3) **Assessing the Impact**: Even if implementing or mainstreaming circular economy practices were easier, assessing their impact may prove to be a challenge. Hence, tracking and reporting progress can often be complex. For example, tracking reductions in "scope 3" emissions (the indirect emissions that an organization or company is responsible for up and down its value chain) presents challenges due to issues such as lack of transparency of supply chains, lack of direct connections with different tiers of suppliers, and complex accounting, among others.

Case study of a Textile Circular Model

"With our size comes responsibility. The way fashion is consumed and produced today is not sustainable. We have to transform the industry we are in. Our ambition is to transform from a linear model to become circular. " - Pascal Brun, Head of Sustainability at H&M

The second - hand clothes sector fills an important role in the globalised textile value chain and the global circular economy. For more than forty years, Humana People to People network has collected, sorted and sold secondhand clothes. Operated by not - for - profit organisations or by commercial businesses with charitable ends, a number of highly professional enterprises have been developed to meet the market demands, both in terms of operation and products.

By collecting, sorting and selling used clothes, first for reuse directly with the next person and then for recycling into other products, the sector saves the planet from millions of tonnes of CO_2 emissions, fresh - water use, chemicals, and all the other polluting elements of textile and garment production. It also saves the planet from millions of tonnes of textiles and clothes being disposed of in landfills or left for incineration. The sector does so through businesses operating in a competitive market, be it as collectors, sorting centres and shops in the Global North, or in sorting centres, wholesale outlets or retail shops in the Global South.

By giving garments a longer lifespan through reuse, the sale of clothes for reuse responds to a demand for clothing which alternatively would either not be covered at all, or covered by imports of cheap, new clothes, mainly made from oil - based fabrics. This type of production increases the negative environmental impact.

Founded in 1998, Humana People to People Italia is an independent and secular international cooperation humanitarian organization, founded on the concepts of solidarity and sustainability.

For twenty - five years, Humana has been implementing medium - long term programs around the world to enable people in communities to build a better future for themselves, through training and the acquisition of new skills. Humana is also involved in social and awareness - raising actions in Italy.

Humana Italia recovers clothes that are no longer worn, giving them a second life through reuse and recycling and generating environmental and social benefits. We are present with approximately 5, 000 containers in 1, 200 Italian municipalities. To give value to the donations made by citizens, after being carefully selected, unique and in excellent condition clothes are sold at affordable prices in our Humana Vintage and Humana People stores in Milan, Rome, Turin, Verona, Florence, Genoa and Bologna and online at www.humanavintage. it . The profits from the sales support our international cooperation projects.

Humana Italia, already active in eight regions of Italy with over 5, 000 containers, follows all phases of the supply chain, from collection to distribution and this allows for the creation of a truly integrated and accountable system. This structure allows the organization to support municipalities and multi - service companies at a national level in an innovative and efficient way in the management of the collection and recovery service of used clothing, mandatory from January 1, 2022. By giving a new life to used clothes we protect the environment: we avoid their disposal and reduce polluting emissions, also guaranteeing economic savings to local authorities. At the same time, with their value we finance social projects. With over 5, 000 roadside containers, storage facilities, 1 semi - automatic sorting facility, 15 stores and numerous partnerships with clothing companies, HPP Italia collect approximately 21 million kilos of clothing per year**.** In order to achieve this goal, the selection process is fundamental and on this front Humana Italia takes a further step forward, inaugurating the new semi - automatic selection plant, the largest in Northern Italy. Thanks to a team of 40 people, the plant has a treatment capacity of up to 12, 000 tons per year and allows all incoming materials to be traced.

Visit to Humana People to People Italia in Milan.

I have been associated with Humana People to People India, since 2020. I organised collection drives for second hand clothes in the community and distributed it among the needy people through Humana People to People India. I have been acknowledged for my efforts by Humana People to People India and Pramerica. In the summer of 2024, I got the opportunity to visit HPP Italia.

In June, 2024, I had the opportunity to visit Humana People to People Italia in Milan.

This company plays a key role in the management of used clothing and giving it a second life through recycling or reuse, and offering it for sale in its stores and giving it a second life through recycling or reuse, and offering it for sale in its stores. Thanks to a visit to the factory, I had the chance to understand how the second - hand cloth economy proceeds:

- Used Clothing Collection: Humana is present with around 5, 000 containers in 1, 200 Italian towns, where people can drop off clothes that they no longer need.
- Sorting and selection: Once collected, the clothes are sorted by hand. This sorting separates the items according to category, condition and potential for reuse or recycling.
- Pricing: Clothes in good condition are then analysed by the pricing teams, who indicate the price by hand on the tags, based on a pre - established grid.
- Resale: Clothes are sold in Humana second - hand stores. These stores offer items at affordable prices, helping both to extend the life of the clothes and to support more sustainable consumption.
- Recycling: Clothing that cannot be resold is recycled. Recovered materials can be used to make new textile products, reducing the need for new raw materials.

First of all, we wore the visitor jackets and safety shoes. We started our tour after registering ourselves as visitors. The Humana officials gave us the tour explaining the step - by - step process.

1) Collection of old clothes

The first step is the collection of old clothes. The containers are placed in the city after an agreement with the municipality of the town. The citizens can locate the position of the containers through the Junker App. The containers, which already stand out in the streets of many towns, report important information on the correct use of the service and highlight the environmental and social purpose of the collection, elements that distinguish the work of the organization.

2) Transportation

Transportation of the containers to the Humana People to People Italia. The company has a fleet of trucks and drivers who transport the containers from various parts of the city to the industrial unit. The trucks are weighed at entry and exit level to determine the exact weight of the clothes received at the recycling unit. The trolleys are rolled on to the floor.

3) Unloading and transfer to assembly line

The automated hydraulic system lifts the trolleys and drops the collection of clothes on to the pulley chain where they are sanitised and then dropped onto the working stations where they are sorted into various categories i. e. garments, linen, purses, shoes, etc. the four main categories are summer, winter, recycle and reuse which is further sorted into 70 categories.25% of the denim is recycled. Humana collaborates with Stella Mccartney and Gucci for recycling and reuse of denim products. This process is done manually at the work stations. The products are also sorted for their condition, whether they can be can be reused or recycled.




4) Pricing - The clothes and items which can be re - used are evaluated and a price tag is put on the clothes. Price is determined by market value and demand.

5) Packing - The automated compressing machines are used to pack the clothes and the packages are labelled by weight.



6) Ready to be shipped- The clothes are then packed ready to be shipped.


- After the visit to the unit, we had a presentation by the HPP Italia team on how the industry works and its implications for the climate change and the economy at large.
- Next day, a visit was planned to the Humana people to People second hand stores and Vintage stores in Milan. The shops are not only a platform for selling of clothes but are also a platform for raising awareness to address sustainability and social issues. Awareness campaigns are

also organised in the schools and summer school visits are organised for the college students.

Collection and Sales of clothes and Shoes

For more than forty years we've collected, sorted and sold second - hand clothes. This gives good clothes a longer lifespan and the sales proceeds support development projects across Africa, Asia and Central and South America.

Second - hand clothes collection contributes to reduction of waste, saves precious resources through reuse, provides affordable clothing to people in both hemispheres - and it ultimately enables us to undertake invaluable development work. Goal is to ensure that all clothing and footwear is used in the best possible way for the benefit of people and environment. Second - hand clothes system is a people - to - people system. There is close contact between the sorting centres in Europe and the clothes sales projects in Africa.

All over the world, as awareness of the negative environmental impact of the fashion and textile industry grows, people are turning to second - hand clothes as a better way forward, reusing clothes rather than buying them new.

3. Conclusion and Recommendations

A growing number of businesses, governments and civil society organizations are coming together to drive the change through the Platform for Accelerating the Circular Economy (PACE). More than 200 experts from 100 organizations helped develop the Circular Economy Action Agenda, a set of publications that analyse the potential impact and call for action across five key sectors: plastics, textiles, electronics, food and capital equipment (machinery and large tools such as medical scanners, agricultural equipment and manufacturing infrastructure).

The Action Agenda demonstrates five opportunities associated with the shift to a circular economy:

1) **Make better use of finite resources -** The circular economy concept is an effort to make better use of natural resources like forests, soil, water, air, metals and minerals.
2) **Reduce emissions -** Changing consumption patterns is also crucial. Creating a circular economy for food by reducing loss and waste is particularly crucial to lowering emissions.
3) **Protect human health and biodiversity -** Working towards a circular economy helps protect human health and biodiversity in many ways, including by making better use of natural resources (e. g. protecting water and land), and by mitigating the climate crisis. One of the clearest and most direct impacts of the shift to a circular economy will come from how we deal with products at the end of their life.
4) **Boost economies -** Research shows that the circular economy offers a $4.5 trillion economic opportunity (Accenture, 2015) by reducing waste, stimulating innovation and creating employment. New business models focused on reuse, repair, remanufacturing and sharing models offer significant innovation opportunities. Many of these economic benefits and opportunities are long - term, indirect and require significant investment; a long - term view is key, as are short - term incentives to drive the change. This can include policies that create more immediate financial incentives for businesses to develop innovative new business models and enable the efficient flow of reused and recycled materials across global value chains.
5) **Create more and better jobs -** Transitioning to a circular economy could create a net increase of 6 million jobs by 2030. (ILO, 2018) Making the most of this opportunity will require a clear focus on social and environmental justice. Jobs may be lost in more linear businesses; however new jobs will be created in fields such as recycling, services like repair and rental, or in new enterprises that spring up to make innovative use of secondary materials. These new jobs cannot be considered direct replacements, as they may be in different locations and require different skills. For instance, we must consider the millions of garment workers — mostly women — whose employment depends on the continuation of the fast fashion industry. Investing in a just transition via social dialogue, social protection and reskilling programs is key. While a net increase in jobs is important, another value - add of circularity is the opportunity to provide formal work and improved working conditions for informal labourers.

Maximising the Impact of the Circular Economy

Working towards large - scale, systemic change requires the co - operation and collaboration of the various stakeholders. The governments have to take the lead in framing the policies, supporting the lead players and recognising them as the change makers. The shift from the linear economy to circular economy is not a linear path. Shifting to natural materials is a crucial part of the solution, but only if those materials are

produced in a sustainable way — and it is equally pertinent to change consumption habits. It is important to recognize the interconnected and interdependent nature of the global economy. Multiple industries must shift to create systemic change. Last but not the least, it is crucial to keep social well - being and equity top - of - mind. For example, moving to a circular economy can shift investment and employment away from production and manufacturing (which tends to happen in lower - income countries) and towards later stages of the value chain, such as repair, resale, sorting and recycling (which are often concentrated in wealthier countries). It needs to be ensured that the economic benefits are equitably distributed to maximise the opportunity of a circular economy.

A Role for Everyone

The above five impact areas exhibit some of the social, environmental, and economic benefits of a circular economy, but realising these benefits will require commitment, research, planning and action. Governments, businesses, civil society, finance institutions, research organisations—everyone has a role to play. The new Circular Economy Action Agenda can act as a guiding light for the much - needed transition to a circular economy.

Actions Needed for a Circular Economy to Aid in Climate Action

1) Shift consumption patterns.
2) Stimulate product circularity starting from the design phase.
3) Incorporate circular practices across the clean energy value chains.
4) Integrate circular economy strategies into climate policies and plans of the nations.
5) Incentivize cross - border greenhouse gas emission reductions
6) Connect circular economy statistics with climate change impacts.
7) Increase transparency and accountability in modelling methodologies.
8) Apply systemic impact assessment to inform weighted decision - making.
9) Investigate the role of the circular economy in climate change adaptation.

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