

Circular economy, motivations for its adoption, and the main challenges in its implementation "A presentation of the German experience (2017-2020)"

الاقتصاد الدائري، دوافع التوجه نحوه وأهم تحديات تطبيقه - عرض للتجربة الألمانية-

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Abstract:

This study aims to delve into understanding the nature of the circular economy, and its underlying principles, explore the motivations for transitioning towards it, and highlight the advantages and challenges hindering the shift. Additionally, this is done through using the descriptive approach and a case study method.

The study concludes that the circular economy represents an alternative economic model to the linear economy, aiming to progress toward sustainability by maximizing product value, extending their lifespan, reducing waste and emissions, preserving the environment, and enhancing the efficiency of natural resource utilization.

Furthermore, the study emphasizes that the German experience stands out as a leading example in the field of the circular economy, having embraced it since 1996 through the introduction of laws on the circular economy, waste management, and various legal frameworks enacted until 2019. Among its notable waste management strategies is the implementation of the waste hierarchy principle, aiming to separate economic growth from resource use.

Key words: Circular economy, products, resources, waste, German experience.

ملخص:

تهدف هذه الدراسة إلى الاطلاع والتعمق في معرفة ماهية الاقتصاد الدائري والمبادئ التي يقوم عليها وما هي دوافع السير نحو الاقتصاد الدائري، وما هي المزايا والتحديات التي تعيق للانتقال إليه، وهذا من خلال استخدام المنهج الوصفي وأسلوب دراسة حالة. وتوصلت الدراسة إلى أن الاقتصاد الدائري يُعد نموذجاً اقتصادياً بديلاً عن الاقتصاد الخطي، يهدف إلى التقدم نحو الاستدامة من خلال تعظيم قيمة المنتجات وإطالة عمرها الافتراضي وتقليل النفايات والانبعاثات والمحافظة على البيئة وتحسين كفاءة استخدام الموارد الطبيعية.

كما خلصت الدراسة إلى أن التجربة الألمانية تعد واحدة من التجارب الرائدة في مجال الاقتصاد الدائري، تبنته منذ 1996 من خلال طرحها قانون الاقتصاد الدائري وإدارة النفايات والعديد من الأطر القانونية التي تم سنّها إلى غاية 2019، ومن أبرز استراتيجياتها في إدارة النفايات هو العمل بمبدأ التسلسل الهرمي للنفايات، بهدف فصل النمو الاقتصادي عن استخدام الموارد.

الكلمات المفتاحية: الاقتصاد الدائري، المنتجات، الموارد، النفايات، التجربة الألمانية.

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1. INTRODUCTION

The debate and discussion have intensified recently about the economy, development, and their relationship with the environment. The economic, social, and environmental problems that occurred and are ongoing, including the financial crises of 2008 and 2014, fluctuations in energy resource prices, climate change, pollution, the extinction of many animals, unemployment, poverty, famines, and diseases in various regions of the world, cannot be separated. All these issues and more are explained by the existence of a problematic relationship between the prevailing economic systems in major advanced economies and the environment and its resources.

No one denies the presence of rational parties calling for the necessity of abandoning the linear economy and adopting an economy with less resource consumption and pollution. Various ideas and initiatives have been proposed in this regard, including "environmental economics," some referring to it as "green economy," others introducing the concept of "sustainable development," and there are those who put forward the idea of the "blue economy," ultimately leading to the concept of the "circular economy." While all these initiatives have similarities in many aspects and may differ in some, this study focuses on the circular economy, which is the subject of ongoing discussion in the completion of this collective book.

Study Problem: Adopting and implementing any new scientific or economic approach requires studying and researching its theories, principles, and goals, as well as the benefits it achieves. Therefore, does the circular economy constitute an alternative or complementary model to the linear economy? How successful is the German experience in its application, and what are the challenges and barriers preventing its effective implementation?

Sub-questions: Derived from the main question and to simplify it, the following sub-questions are posed:

1. What is meant by the circular economy, and what are its principles?
2. What are the goals of the circular economy, and what challenges hinder its implementation?
3. What are the motives and reasons for transitioning to the circular economy?
4. What are the legal, regulatory, principles, and achievements that the German experience aspires to through adopting the rules and methods of the circular economy for waste and resource management?

Study Methodology: To answer the main question and sub-questions, a descriptive methodology using a case study approach is employed. This involves grounding the concept of the circular economy scientifically and presenting the experience of Germany. Information, data, and scientific materials were gathered from various sources, including books, journals, previous studies, and online research on the topic of the circular economy.

Study Importance: The importance of the study lies in:

- Show the importance of adopting the circular economy as a model that works to preserve

natural and environmental resources, human health, and society by reducing waste and pollutant emissions.

- Contributing significantly to improving ecological efficiency and reducing the negative effects of production processes in institutions.

- Offering a solution to the problem of waste and the issue of burning or burying it.

- Providing a solution to the resource problem through reuse, remanufacturing, renewal, and recycling.

Origin Study Objectives: Through this study, we aim to achieve the following objectives:

- Understanding the concept and origin of the circular economy.

- Exploring the goals and principles of the circular economy.

- Understanding the motives for adopting the circular economy and the main challenges and barriers hindering its application.

- Shedding light on the German experience and its adoption of the circular economy, along with how it manages waste.

2. General Introduction to the Circular Economy

2.1 of the Circular Economy

The concept of the circular economy doesn't have a single origin; it has been discussed by numerous researchers and experts. Contributors include Andersen (2007), Su and others (Su et al., 2013), Swiss architect and economist Walter R. Stahel (2015), Winans Kendall & Deng (2017), and environmental economist Herman Daly. Barbara Ward and Kenneth Boulding in 1969 proposed the idea of the circular economy as a closed system without material exchange with the external environment (Manniche, 2017, p. 15). Boulding, influenced by space exploration, saw Earth's sustainability as dependent on a closed and circular system achieved through resource recycling and waste reduction (Geissdoerfer, Savaget, M.P. Bocken, & Jan Hultink, 2017, p. 761).

Stahel and Reday (1976) introduced specific characteristics of the circular economy, focusing on industrial strategies to prevent waste, create regional job opportunities, resource efficiency, and eliminate the materialistic nature of industrial economies. Stahel (1982) emphasized the performance economy, where services are sold instead of owning goods, creating sustainable and cost-effective models for industries.

The concept of the circular economy evolved after the 1972 Club of Rome report on "The Limits to Growth" and the subsequent "Meadows Report," addressing the issue of excessive resource consumption. Reports from the European Commission in 1976 and the sustainable development report by Brundtland in 1987 further contributed. The Cradle-to-Cradle concept emerged in the late 1980s by Germans Michael Braungart and William McDonough, influencing the

circular economy's development (GELDRON, 2014, p. 2).

The term "circular economy" first appeared in 1990 in the book "Natural Resources and Environmental Economics" by English economists David W. Pearce and R. Kerry Turner. The idea gained momentum with the concept of "zero waste" in 1989. In 2000, Japan enacted the Basic Law for Establishing a Recycling-Based Society, leading to the international initiative known as the 3R Initiative (reduce, reuse, recycle). In 2008, China issued the Circular Economy Promotion Law (GELDRON, 2014, p. 3).

The circular economy's evolution is attributed to the integration of various features, contributions, and concepts related to closed-loop systems, including Cradle to Cradle, innovative design, industrial ecology, environmental laws, green economy, and blue economy...

2.2 Circular Economy Definition:

The concept of the circular economy encompasses various perspectives, lacking a universally agreed-upon definition among experts, researchers, and academics. Several definitions highlight different aspects of this modern term. Here are some diverse definitions:

The circular economy is defined as a "vibrant economy aiming to change our way of living through reliance on development and innovation in industry and consumption. It provides opportunities for sustainability and long-term growth by reducing waste, decreasing heavy reliance on raw material imports, enhancing resource productivity, creating a more competitive economy, ensuring sustainable resource use, generating more job opportunities, and minimizing environmental impacts" (الجزار، 2018، صفحة 12).

According to the Ellen MacArthur Foundation, the circular economy is "a regenerative economy that aims to preserve the utility of products, components, materials, and retain their value" (Europe, 2018, p. 4). The European Union Commission, in its transition plan to the circular economy, describes it as "maintaining the value of products and materials for the longest possible period, reducing waste generation, and keeping resources within the economy when a product reaches its end of life, for repeated use and creating additional value" (Houston, 2020, p. 9). This involves guiding and reducing waste, reusing it in industry, ultimately reducing the use of new resources and materials, and repeating the process of employing those raw materials.

Preston (2012) defines the circular economy as an "approach that changes the role of resources in the economy, turning waste into inputs for factories and valuable resources for other production processes. Products can be repaired, reused, or upgraded instead of being discarded" (Rizos, Katja, & Arno, 2017, p. 4).

In summary, the circular economy is a new system or model replacing the linear economy. It revolves around ideas and principles focusing on preserving the value and utility of products for as long as possible, reusing them multiple times, and recycling waste to serve as inputs for production processes. The concept spans from product design to the end of its life, ensuring safe and environmentally friendly disposal.

2.3 Circular Economy Objectives:

The circular economy aims to achieve several goals, including (الرميدي، 2018، الصفحات 351- (352:

- Enhancing environmental efficiency.
- Reducing waste volume, air and water emissions, and soil pollution.
- Reusing resources in production multiple times.
- Decreasing the use of non-renewable energy sources.
- Reducing raw material and energy use costs.
- Lowering environmental maintenance costs.
- Increasing environmental and social responsibility awareness.
- Creating new job opportunities.
- Promoting collaboration and participation across economic sectors.
- Minimizing losses and maximizing value (maximizing product value by extending its lifespan).
- Reducing waste management costs.
- Lowering costs of controlling harmful emissions.
- Creating new markets and industries.
- Adopting environmentally friendly production systems.

In addition to these goals and advantages, embracing the circular economy can confer competitive benefits, improve environmental quality, enhance an organization's image in society, and prevent legal action, fines, and environmental fees.

2.4 Motivations Towards Adopting the Circular Economy:

Rémy Le Moigne and the Ellen MacArthur Foundation have identified a series of constraints inherent in practicing the linear economy. These constraints represent its weaknesses and the reasons and motivations for abandoning it in favor of transitioning to and adopting the circular economy.

Summarized as follows (قطوش و بورغدة، جوان 2020، الصفحات 97-98):

- Environmental Degradation and Resource Scarcity: Increased waste production and resource and energy consumption have adverse effects on the environment, disrupting its balance. Heavy reliance on petroleum as a primary material in industry forecasts it will become scarce in the future.
- Fluctuations in Raw Material Prices: Although products theoretically adhere to supply and

demand laws, control over certain resources, such as petroleum, can lead to fluctuations in products relying on it as a raw material.

- Risks of Raw Material Supply Disruption: Unequal distribution of natural resources globally makes supply and sourcing a sensitive issue in export-import operations, especially for petroleum and gas.

- Rising Stringent Regulatory Trends: Since 1992, there has been an increase in climate-related legislation in Europe. About 20 countries impose taxes on landfills, generating tax revenues of 2.1 billion euros in 2009/2010. These restrictions underscore authorities' desire to shift towards a new model.

- Technological Advancements and New Opportunities: The circular economy is increasingly dominating various fields, with new communication technologies enabling the development of business models based on circular economy principles.

- Emergence of Alternative Models: Gradually, new technologies are changing transaction patterns for goods and services. Circular economy models transform customer relations toward products, emphasizing participation, leasing, and performance. New technologies act as a driving force for circular economy expansion.

- Population Explosion and Urbanization: Population and demographic explosions result in significant population increases, coupled with rapid growth in living standards and purchasing power. This intensifies pressure on natural resources, food supply, and urbanization due to rural-to-urban migration.

2.5 Principles of the Circular Economy:

The circular economy is an alternative to the linear economy that is based on the depletion of resources, production and consumption, and more waste and pollutants it works under the principle of "cradle to grave", it is the opposite of the circular economy based on the principle of "cradle to cradle", that is, from the idea of design to reuse and recycling several times with zero waste and pollutants, and therefore the analysis of, SB Insight's. The principles of circular economy are as stated by the Ellen MacArthur Foundation in its report, the Ellen Mac Arthur Foundation. Towards a circular economy, a rapid and efficient transition is based on three principles: (Erik, Maria, & SOFIA, 2019, pp. 7-8):

- Enhancing Resource Yields in the Circular Economy: Biological and technical cycles manage stocks of limited and renewable materials. Maximizing resource yields involves the effective trading of products and materials in these cycles. In the circular economy, materials flow as many times as possible within tightly closed loops before entering external cycles, considering reuse as more valuable than recycling in technical cycles.

- Improving System Efficiency by Identifying Negative External Factors: This stage involves minimizing damages to existing systems and monitoring and managing negative external factors, such as air pollution, which is challenging to attribute to a specific party known as market failure.

Effective system design should prevent environmental and health harm, avoiding environmental charges.

- Preserving and Enhancing Natural Capital in the Circular Economy: Careful resource selection, sourcing from renewable energies, and efficient resource utilization processes in the circular economy increase the value of natural capital. This is achieved by creating conditions for the flow of renewable resources.

2.6 Challenges of Implementing the Circular Economy:

While the circular economy offers numerous benefits to society and the economy as a whole, several barriers and obstacles hinder its smooth transition and effective implementation. The key challenges include (BAHN-WALKOWIAK, 2019, p. 17):

- Insufficient Investment in Recycling, Recovery, and Eco-Innovation Infrastructure: Inadequate investment in the infrastructure for recycling, recovery, and eco-innovation technologies to close the loops in the circular economy.

- Inadequate Expertise, Skills, and Investments in Circular Ecological Product Design and Production: Lack of expertise, skills, and investments in circular ecological product design and production that facilitates reuse, remanufacturing, repair, and recycling.

- Current Low Raw Material Prices Sending Economic Signals: Low current levels of raw material prices create economic signals that do not encourage the efficient use of resources, pollution reduction, innovation, and creativity in technologies and product development to extend their lifespan.

- Limited Information and Knowledge, and Economic Incentives for Key Supply Chain Elements: Limited information and knowledge, along with economic incentives, for key elements in the supply chain and maintenance. For example, regarding the chemical composition of certain products like materials found in electronic devices.

- Inefficient Waste Separation at the Source: Inefficient waste separation at the source, such as food waste and packaging.

- Lack of Incentives Due to Insufficient External Factor Integration Through Policies or Other Measures: Absence of incentives due to insufficient integration of external factors through policies or other measures.

- Absence of Incentives Supporting Green (Sustainable) Product Purchases: Lack of incentives supporting the purchase of green (sustainable) products.

- Challenges in Obtaining Sufficient Financing for Environmental Investments: Challenges in obtaining sufficient funding for environmental investments.

- Lack or Absence of Environmental Awareness Among Consumers: Lack or absence of environmental awareness among consumers.

In addition to these barriers, other significant challenges include the high costs associated with transitioning to the circular economy, organizational culture, lack of commitment, reluctance to take risks, absence of clear legal and regulatory frameworks, and the lack of specific standards for implementation. Addressing all stakeholders, including interests, communities, governments, companies, and non-profit organizations, is crucial to encourage the adoption of the circular economy.

3. The German Experience in the Circular Economy:

Germany stands as the first European country to move towards transitioning to the circular economy, driven by environmental protection concerns. Faced with waste disposal and overflowing landfills, Germany embarked on waste management, implementing various measures, legislation, and laws regulating waste processes. This journey evolved into the concept of a closed loop for resources and products, aiming to extend their lifespan. Here's an overview of this pioneering experience:

3.1 Legal Framework for Transitioning to the Circular Economy:

Germany faced oil crises and economic recession from 1974 to 1978, leading to economic diversification policies. However, this resulted in additional environmental issues. In response, the government developed a comprehensive environmental plan in 1971, culminating in the first waste disposal law in 1972. Sensitivity towards effective waste management grew through the late '70s and '80s. Transitioning to the circular economy became imperative, aligning with sustainable development integrated into the German constitution in 1994. This commitment included preserving natural resources, environmental protection, reducing soil pollution, conserving biodiversity, and promoting sustainable resource use (Olabode, 2019, p. 6).

The general framework for sustainable development encompassed laws related to nature conservation, renewable energy, energy efficiency, and environmental information. Ground was paved for the circular transition, leading to the German Parliament approving the Circular Economy Law in 1996. This law aimed to reduce land allocated for waste disposal, focusing on hierarchical waste disposal sequencing and closed-loop recycling. Moreover, it shifted product responsibility to producers, mandating designs that minimize waste and recycling.

Germany implemented various laws and policies for material circularity. For instance, a collection mandate for old electrical and electronic devices was introduced in March 2006. Producers were obligated to accept them for free. In 2005, the government imposed a waste landfill ban to encourage the complete phase-out of landfills by 2020. Resultantly, recycling rates reached around 50% by recycling about half of the waste, with municipal waste not sent to landfills since 2009. These legislative measures underscore Germany's commitment to achieving environmental protection, energy efficiency, and responsible resource usage.

The following table summarizes the most important laws and regulations from 1992 to 2019, showcasing Germany's legislative efforts towards its environmental goals.

Table 1. German laws and policies towards a circular economy

Laws, Policies, and Procedures	Years
Waste Disposal Law	1972
Federal Emissions Control Act	1974
Law Defining Producer's Liability for Packaging Waste	1991
Law on circular economy and waste management, issuance of waste disposal verification regulation, and decree for waste disposal companies and monitoring organizations.	1996
Battery Law	1997
Biowaste Law	1998
Packaging Law	1998
Federal Soil Protection and Contaminated Sites Act	1999
Renewable Energy Law (<i>Erneuerbare – Energien – Gesetz EEG</i>)	2000
Law on the Environmentally Compatible Storage of Waste from Human Settlements	2002
Expired Vehicles Law	2002
Wood Waste Management Law	2002
Landfill (Landfill) Law	2002
Law on the Management of Municipal Waste of Commercial Origin and Construction and Demolition Waste	2002
Waste Storage Law	2005
Animal Waste Disposal Act, Waste Shipping Fines Ordinance	2006
Electrical and Electronic Equipment Law	2006
Waste Shipping Law	2007
Circular Economy Law, Fertilizer Law, and Resource Efficiency Program	2012
Waste Prevention Program: Decree on notification and licensing procedures for waste collectors and transporters, traders, and intermediaries.	2013
Amended Renewable Energy Law	2017
Packaging Law - Amended	2019

Source: Olabode Emmanuel Ogunmakinde, A Review of Circular Economy Development Models in China, Germany and Japan, v 4, N 27, 3 July 2019, Australia, www.mdpi.com/journal/recycling, 5/11/2020, p 6.

Since the early 1970s, Germany has dedicated significant efforts to create an integrated waste management system. Regarded as a fundamental cornerstone in building a circular economy, this system progressed through stages starting with safe waste disposal. In 2013, the German government and federal states initiated a waste prevention program to reduce waste. Subsequently, a mandatory waste recycling law was enacted, leading to the Circular Economy and Waste Management Law in 1996. This law shifted waste management responsibility to product producers, integrating them into the circular economy through a five-level waste hierarchy, alongside fundamental waste management principles.

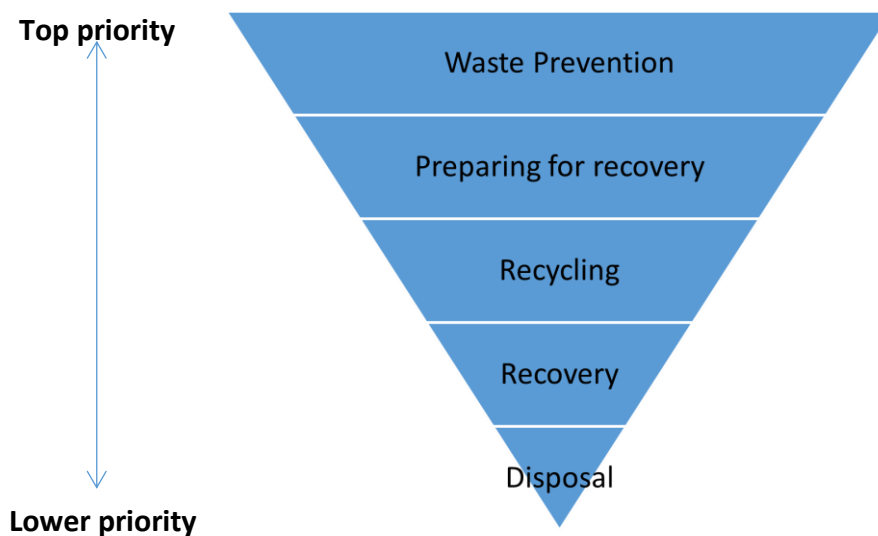
3.2 Fundamental Principles and Strategic Objectives of Waste Management:

3.2.1 Sustainable Basic Principles of Waste Management: The core principles of waste management encompass the following (Laura & Kim, 2019, p. 9):

- Waste Hierarchy Principle: Preventing waste, reuse, recycling, recovery, and disposal.
- Polluter Pays Principle: The producer or waste owner bears responsibility and pays for the waste they generate, creating incentives for environmentally friendly behavior and necessary investments (green investments).
- Precautionary Principle: The state must intervene to prevent any harm resulting from improper waste disposal, utilizing alternative financing systems or waste management structures to achieve advanced waste management goals.
- Proximity Principle: Disposal should occur near the point of generation to avoid unnecessary transport and related environmental impacts and risks. However, if environmentally friendly facilities are distant, transportation may be justified, possibly involving cross-border transport.
- Subsidiarity Principle: Tasks should be carried out at the most appropriate level, be it public or private sector, local or national, considering costs, benefits, and efficiency in proximity to waste generation and treatment.

The primary challenge lies in improving resource efficiency and productivity, enabling high material use efficiency throughout the supply chain's lifecycle stages. This requires waste management policies aligned with the waste hierarchy, classifying waste management and material options from most to least preferred, as illustrated in Figure 01.

Fig.1. Waste hierarchy



Source: Laura Schroeder, Kim Jeong Hyun, GERMANY'S WASTE MANAGEMENT POLICY DEVELOPMENT- A Focus on Municipal Solid Waste, Published by: Deutsche Gesellschaft für International Zusammenarbeit (GIZ) GmbH, China, 2019, <https://www.iwm-nama.org/topic/germanys-waste-management>, 06/11/2020, p 10.

Within the extreme options, waste prevention requires reducing waste generation and avoiding hazardous components in products. The second priority, preparation for recovery, involves reusing and recycling discarded products. The third priority, recycling, processes waste to use as secondary raw materials or new products. The penultimate option, recovery, involves using waste as energy fuel or producing new items. The lowest priority, disposal, includes landfilling or incinerating waste without energy recovery.

In the context of waste prevention (highest priority), the German Ministry for Environment emphasizes (Environment, 2018, p. 10):

- Raising awareness about consuming durable and repairable products, avoiding unnecessary and short-lived products, and preferring services over ownership.

- Promoting conscious waste behavior, highlighted during the European Week for Waste Reduction.

- Despite Germans using fewer plastic bags than the European average, voluntary efforts by retailers reduced plastic bag usage to around 38 bags annually per person.

Regarding waste disposal (lowest priority) in the German strategy, waste that can't be recovered is safely disposed of without harming the environment (Environment, 2018, pp. 12-13). Organic waste undergoes mechanical, biological, or thermal treatment to make it inert, reducing leachate and gas leakage. Landfilling untreated organic waste has been prohibited since mid-2005.

3.2.2 The German circular economy strategy aims to (Jaron, 2022, p. 8):

- Decouple economic growth from resource use and environmental impacts.

- Alleviate environmental burdens, enhancing German economic sustainability and competitiveness.

- Promote stable employment and social cohesion.

- Make resource extraction and use more sustainable, minimizing associated environmental pollution.

- Analyze potential future measures along the entire value chain.

- Explore additional indicators and objectives.

3.3 German circular economy statistics:

highlight the country's economic strength. The Gross Domestic Product (GDP) in 2019 was approximately \$3.846 trillion, compared to \$2.496 trillion in 2003. Per capita income increased from \$26,070 in 2003 to \$48,520 in 2019, with the population exceeding 83 million. Carbon dioxide emissions per capita decreased from 9.972 metric tons in 2003 to 8.84 metric tons in 2016. Imports of raw materials skyrocketed from €50 billion in 2002 to €162 billion in 2017, reflecting the German economy's resource consumption and final consumption. The following table illustrates the

evolution of various waste types produced by household, production, construction, and demolition waste.

Table 2. Evolution of waste volumes (million tons)

Source: ALBA Group, *Facts and figures on circular economy in Germany*,

Years	Municipal waste	Waste extraction and treatment of mineral resources	Other waste: Production waste and trade	Construction and demolition waste and road construction waste	Waste from waste treatment plants	Total
2000	50.1	48.2	47.7	260.7	—	406.7
2003	49.6	46.7	46.7	223.4	—	366.4
2004	48.4	50.5	53.0	187.5	—	339.4
2005	46.6	52.3	48.1	184.9	—	331.9
2006	46.4	42.0	54.8	197.7	32.0	372.9
2007	47.9	42.9	58.5	201.8	35.8	386.9
2008	48.4	39.3	56.4	200.5	38.2	382.8
2009	48.5	27.5	51.3	195.0	37.1	359.4
2010	49.2	36.9	53.3	193.3	40.3	373.0
2011	50.2	34.7	58.4	199.5	43.9	386.7
2012	49.8	30.3	54.2	199.3	47.0	380.6
2013	49.6	29.3	57.1	202.7	47.1	385.7
2014	51.1	30.2	59.5	209.5	50.6	401.0
2015	51.6	31.4	59.2	209.0	51.0	402.2
2016	52.1	28.1	55.9	222.8	52.6	411.5
2017	51.9	31.0	55.8	220.3	53.4	412.2

<https://www.alba.info/en/newsroom/service-for-journalists/press-kits/detail/facts-and-figures-on-circular-economy-in-germany-1/>, 07/11/2020.

Through the above table, we observe the evolution of waste volumes. Municipal waste production remains stable at around 50 million tons annually. In contrast, waste from mineral resource extraction and processing decreases significantly from 50 million to 30 million tons annually. Waste related to production and trade operations ranges around 56 million tons annually. Construction and demolition waste, along with road construction waste, constitute the largest portion, approximately 200 million tons annually.

It's noteworthy that around 2.5 billion tons of waste are generated annually by European Union residents. Only 38% of this waste is recycled, with the remainder going to landfills or incineration.

The table illustrates the significant impact of human waste on society, economy, and trade. Circular economy initiatives, with their programs and policies, positively influence waste management by absorbing secondary resources for reuse in the same economic activities or other sectors.

Achievements in Germany's progress toward a circular economy include (Environment F. M.,

2016, p. 10):

- The percentage of recyclable materials from household waste increased significantly over the years (13%, 58%, 61%, and 59% for 1990, 2004, 2008, and 2017, respectively) after implementing circular economy measures.

- In 2019, approximately 74% of paper, 90% of glass, and 45% of steel were recovered from recyclable materials.

- Construction and demolition waste had the highest recycling rate in 2017 (88%), followed by municipal waste (67%) and hazardous waste (55%).

- Germany's closed-loop recycling market share for lead in 2016 was around 18% of the total recycled, establishing Germany as a leader in this field.

- Reused plastic materials in 2017 were directed primarily to the construction sector (42.9%), followed by packaging (22.6%), agriculture (11.2%), vehicles (4.4%), electronics (1.6%), household goods and furniture (1.7%), with the remaining 15.6% distributed across various other sectors.

- Plastic packaging consumption and recycling showed significant developments. In 1991, around 11.6% of 1656 kilotons were recycled. By 2016, consumption rose to 3098 kilotons, with approximately 50% recycled.

- In 1990, industrial activities emitted around 38 million tons of greenhouse gases, decreasing to 9.6 million tons by 2016, reflecting a 74% reduction.

Waste management in Germany has evolved into a robust economic sector, with over 270,000 people working in approximately 11,000 companies generating around €70 billion annually. Germany's high recycling rates, such as 67% for household waste and nearly 70% for production and commercial waste, contribute significantly to the global waste management technology market, where Germany holds a 25% share.

3.4 Challenges Facing Germany and the European Union in the Context of the Circular Economy:

The challenges hindering the smooth implementation of various circular economy measures and policies are significant barriers. Some of these challenges include (Laura & Kim, 2019, pp. 36-37):

- Increase in Waste Quantities: Particularly packaging waste due to rising purchase activities and accompanying consumption increases. Waste prevention remains an economic challenge, as well as in terms of goal setting, monitoring, and tracking. Addressing this situation requires collaboration across value chains to enhance the design of environmentally friendly products and cleaner production technologies. Dealing with the challenge of increasing waste quantities goes beyond efficient waste management and recycling alone. It necessitates analyzing and treating waste as an integral part of material flows in a specific context (community, city, region, state, etc.).

- Ineffective Plastic Recycling and China's Waste Import Ban: In July, China notified the World Trade Organization of its intention to ban the import of 24 types of waste, including plastic and paper, starting from January 2018. By 2020, China aimed to eliminate waste imports. This ban posed a challenge to the global waste supply chain, prompting advanced countries to adjust waste management practices. The European Union, accustomed to exporting 3 million tons of plastic annually to China, faced the need to redirect these exports to other countries like Malaysia, Vietnam, and the Philippines. In March 2019, mixed plastic scrap was added to the Basel Convention, effective in 2020, preventing the future export of mixed plastic between convention parties or outside it.

- Increasing Plastic Pollution in Organic Waste and Fertilizers: Plastic pollution in organic waste poses a significant challenge for European countries. Recognized by the German Conference on Biowaste in 2018, analyses revealed high plastic levels in organic fertilizers. It is crucial to limit the disposal of non-compostable plastic in organic waste before reaching digestion and anaerobic digestion facilities.

- Diverse Waste Management Systems in the European Union: Waste management practices vary within the European Union, especially concerning definitions (lacking a common definition for waste treatment) and methodologies for quantitatively measuring waste and emissions (no single method for measuring recycling rates, for instance). Therefore, the Circular Economy Action Package aims to increase coordination between systems, including addressing the underlying calculations for recycling rates.

- Uncertainty about the Impact of Microplastics: Once released into our surrounding areas, microplastics can accumulate in living organisms, including fish and shellfish, posing a risk to human health. The potential effects of microplastics on human health along the food chain remain unknown, but the issue is gaining increased attention due to the growing presence of microplastic particles in the environment.

4. CONCLUSION

The concept of the circular economy has grown in prominence globally over the past few decades, aiming to address environmental, climate, and scarcity-related challenges. Rooted in ecological, environmental economics, and industrial ecology, the circular economy presents itself as an alternative model to classical economics by acknowledging and emphasizing the vital role of the environment and improving the remaining stocks of resources. However, its full and widespread application is still distant in most world economies. Estimates indicate that globally, 20% of extracted materials end up as waste, and according to the 2019 Circular Gap Report released at the World Economic Forum in Davos, only 9% of the global economy was circular in 2018. This slow progress suggests that linear practices dominate world economies more than circular ones.

4.1 Study Results:

- The circular economy can be considered a means of progressing towards sustainable development. Research and development in the circular economy are still in the consolidation stage regarding definition, boundaries, principles, and associated practices.

- Key objectives of the circular economy include maximizing product value, extending product lifetimes, reducing waste, emissions, and waste management costs, in addition to preserving the environment, and its resources, and creating new jobs and markets.

- Circular economy principles focus on improving resource yields, enhancing external emission monitoring system efficiency, and conserving natural capital.

- The circular economy faces several barriers to effective implementation, including significant investments in infrastructure, research, development, and machinery replacement. Additionally, there's a lack of awareness, expertise, sufficient skills, and incentives.

- Germany has made significant progress in implementing the circular economy through various legislations since the early 1970s, aiming to reduce waste, maximize resource value, and reduce greenhouse gas emissions. In 2018, the waste recovery and recycling rates reached 81% and 69%, respectively.

- The German waste management strategy is based on principles such as the hierarchy sequence, the polluter-pays principle, the preventive principle, proximity, and the subsidiarity principle.

- The German waste management strategy relies on the hierarchical sequence of five waste levels, prioritized based on the highest priorities within closed loops.

- German statistics highlight outstanding progress in circular economy aspects such as recycling, recovery, providing secondary materials for certain industries, and a decrease in greenhouse gas emissions.

- Despite implementing a waste prevention program in 2013, imposing fees on waste collection, transport, trade, and brokers, Germany continues to produce waste, especially household waste. Efforts are needed to raise consumer awareness and waste prevention.

- The waste management sector contributes to sustainable production with high rates of recycling and recovery, aiding in conserving raw materials and primary energy.

- One of the significant hindrances to circular progress is the volume of waste production, especially in construction and demolition waste and household waste linked to increased individual consumption. Additionally, the Basel Convention restricts waste exports.

4.2 Study Recommendations:

1. Review and reconsider taxes imposed on products produced within a linear economy, with a need to increase them. Conversely, products produced within a circular economy, which should be supported, ought to have various taxes affecting operations reduced.

2. The transition to a circular economy requires sufficient information, legal and regulatory frameworks, lifting service restrictions, and facilitating international trade.

3. Transitioning to a circular economy requires substantial funding for investment in green projects, encouraging research and innovations in this field, along with providing incentives toward circular practices.

4. There is a need to work on spreading awareness regarding recycling, remanufacturing, robust design, and using materials that are more easily recyclable, aiming to reduce waste for

institutions.

5. Work towards raising awareness among consumers to choose environmentally friendly products, avoid wastefulness, and maximize the value of products by using them for as many cycles as possible.

4.3 Study Perspectives:

Given some points related to the topic's aspects that have a connection but were not addressed, we suggest them as topics for future research and studies:

- Study on Algerian consumer behavior toward eco-friendly products.
- Methods of financing projects and their relationship to green investments.
- Mechanisms for implementing the circular economy in Algeria.

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