Reduce, Reuse, Reshape

Evaluating EU Policies on plastic for sustainable transition of plastic packaging system to align with the 3Rs

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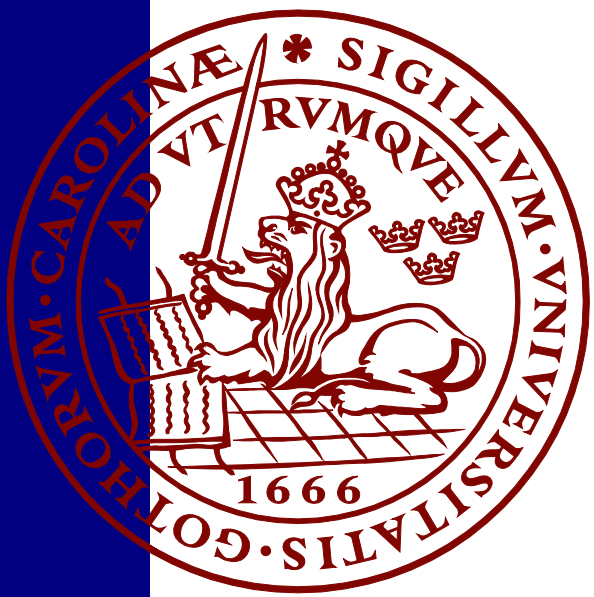

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Abstract:

The global surge in plastic production, particularly single-use packaging, has triggered pressing environmental and health concerns. Addressing this crisis necessitates transformative shifts within the plastic packaging system, prioritizing the reduction, reuse, and recycling of plastic packaging. The European Union (EU) has initiated a Plastic Strategy to combat the plastic issue. This study evaluates whether these policies promote the 3Rs and instigate transformative changes in the plastic packaging sector.

The result reveals that current policies predominantly emphasize recycling, sidelining reduction and reuse strategies. Policy measures primarily encourage incremental innovations, rather than initiating comprehensive systemic changes. Transformation-inducing policies like taxation and regulatory bans receive less attention, requiring further research to gauge their potential impact. The study recommends four areas for enhancement for policy: prioritizing consumption reduction, developing robust reuse programs, diversifying policy instruments, and introducing more disruptive policy measures.

Keywords: Circular Economy, recycling, Creative destruction, regime destabilization, plastic pollution, reuse
Word count: 11457

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Abbreviations

CE	Circular Economy
EPR	Extended Producer Responsibility
EU	European Union
PPWD	Packaging and Packaging Waste Directive
PPWR	Packaging and Packaging Waste Regulation
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
TA	Thematic Analysis
UNEP	The United Nations Environment Programme

1. Introduction

1.1. Proliferation of plastic packaging

The widespread use of plastic has been critical in social development since its invention in the 1950s (Worm et al., 2017). World plastic production is continuously increasing; it has experienced exponential growth from 1.7 million metric tons (Mt) produced in 1950 (Ellen Macarthur Foundation, 2016) to 390 Mt in 2021 (Plastics Europe, 2022). The European Union (EU) holds the position of the fourth-largest global plastic producer, with a production of 50 million tons of plastic resins in 2021, marking an increase of 4.5 million tons compared to the previous year's production (Plastics Europe, 2022, Figure 1). In the same year, 87.6% of the plastic was fossil-based (Plastics Europe, 2022). Much of plastic is used for short-term disposable applications such as single-use packaging (Hopewell et al., 2009). Packaging is the largest application of plastics and the largest end-use market in the EU (Ellen Macarthur Foundation, 2016; Plastics Europe, 2022; Worm et al., 2017).

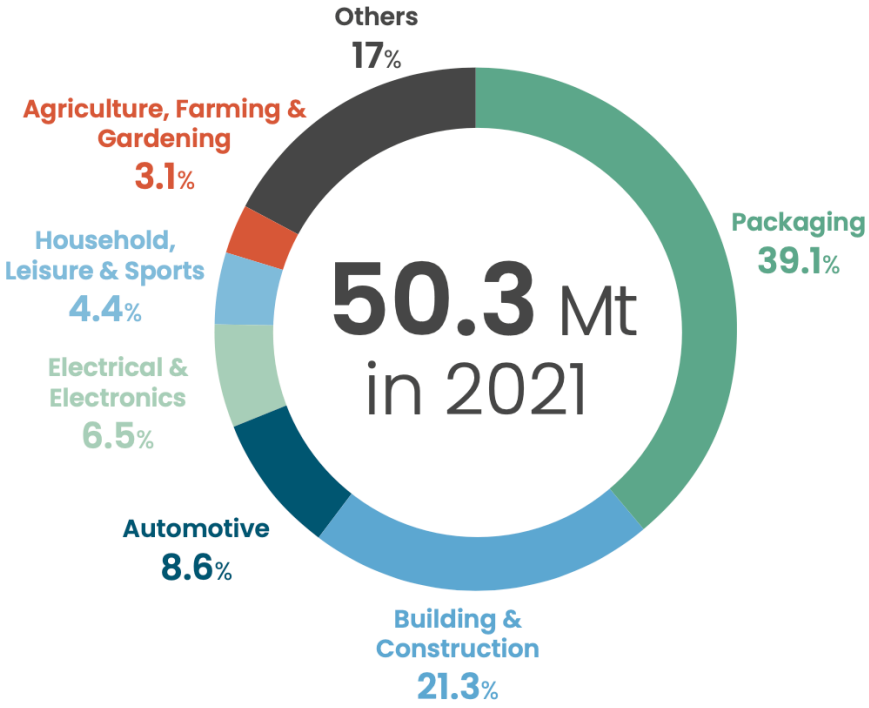


Figure 1. Share of plastic used for packaging compared to all applications of plastic in EU (from Plastic Europe, 2022)

Packaging offers advantages such as durability, cost-effectiveness, communicating product properties, and versatility in preserving and protecting products (Verghese et al., 2015). Plastic packaging has become fundamental to the functioning of modern supermarkets, acting as "the skin of commerce" as Hawkins (2018) puts it. Assuming the current trend of increasing plastic usage persists,

by 2050, the plastics industry is projected to consume 20% of the world's oil supply, equivalent to 15% of the annual global carbon budget (Ellen Macarthur Foundation, 2016). The global carbon budget refers to the amount of carbon dioxide emissions that can be released into the atmosphere to limit global warming to below a 2°C increase by 2050 (Ellen Macarthur Foundation, 2016).

The environmental impact of plastic extends across its entire lifecycle, spanning from the initial stages of feedstock extraction, which is primarily fossil based, to the end-of-life phase. In 2021, global plastic production comprised 90% fossil-based, 8% post-consumer recycled, and 2% bio-based materials (Plastics Europe, 2022). After use, plastic enters the waste stream to be recycled, incinerated, landfilled, or leaked into terrestrial and marine environments (Milios et al., 2018), where it remains for a long time due to its slow degradation process. The ever-growing presence of plastic in the environment has resulted in various environmental and health concerns for ecosystems and humans (Law, 2017; Prata et al., 2020).

The current condition of plastic may be aptly characterized as a state of lock-in (Bauer & Fontenit, 2021). Lock-ins emerge when prevailing societal practices become intricately connected with various other components, including policies, cultural norms, preferences, and infrastructure (Loorbach, 2022). Given that plastic packaging represents the most extensive application of plastics, deeply integrated into daily routines, and characterized by its short-term utility, it becomes an important focus within sustainability research.

1.2. Need for global sustainability transformations

Modern societies have increasingly engaged in disruptive interactions with the biophysical environment, and this characteristic is widely acknowledged as an intrinsic aspect of these societies (Jackson, 2009). Plastic pollution is a part of the broader interconnected global crises of environmental change, which encompass climate change, environmental degradation, and unsustainable development.

There is *very high confidence* that a global temperature increase of 1.5°C above pre-industrial levels by 2040 would lead to heightened climate hazards with inevitable consequences for ecosystems and humanity (IPCC, 2022). Any increments of temperature rise beyond this threshold, even by 0.1°C, would exacerbate environmental impacts, human suffering, and severely limit the ability to adapt and build resilience against the changing climate (IPCC, 2022).

With mounting evidence that the status quo is unsustainable, there is growing scientific consensus that business as usual is no longer viable, and considering the rapid and significant impacts of global environmental change, a fundamental, radical, and potentially swift shift towards reducing carbon emissions is imperative (IPCC, 2022). This rapid structural change has been referred to as 'transition' or 'transformation', signifying profound and long-lasting systemic changes, as opposed to incremental change in socio-technical and socio-economic systems (Feola, 2015). Characteristics that set transformative changes apart from non-transformative ones have been debated (Feola, 2015). However, all transformation concepts refer to complex, dynamic, and multi-level system models and acknowledge that transformative processes involve structural changes, discontinuities, ruptures, or thresholds, and they do not typically unfold smoothly (Feola, 2015). During transformations the established societal equilibrium is challenged and ultimately leads to the formation of a new institutional, technological and cultural equilibrium (Geels, 2002). The plastic sector holds significance in sustainability transformation, as it is responsible for around 8-9% of worldwide oil and gas consumption (split between 3-4% for energy and 4-5% for feedstock) (Nielsen et al., 2020).

1.3. Transnational and EU agreements on plastics

Aligning and integrating international environmental agreements is crucial for achieving far-reaching international development, climate mitigation, and adaptation goals (IPCC, 2022). The spectrum of policy responses to the impacts of plastic ranges from the Sustainable Development Goals (SDGs) to EU-wide policies, and global treaties. Out of the 17 SDGs, one indicator directly relates to plastic under Goal 14: Life below Water, and 12 goals are indirectly impacted by plastic (Walker, 2021). Moreover, the soon-to-be released plastics treaty by UNEP in 2024 marks a pivotal step (UNEP, n.d.). As a binding legal document, its ambitious mission is to combat plastic pollution on a global scale (UNEP, n.d.). Stemming from an agreement reached in Uruguay in 2022, this treaty is touted as the "most important global environmental agreement since the Paris climate accord," signifying a new era of international environmental collaboration (UNEP, 2022).

The European Union (EU) has previously taken steps to address the issue of plastic packaging through the implementation of the Packaging and Packaging Waste Directive (PPWD) since 1994 (Directive 94/62/EC). More recently, the EU introduced a comprehensive strategy for plastics integrated into the EU's Circular Economy Action Plan. The EU's Circular Economy Action Plan is one of the main building blocks of the European Green Deal, Europe's new agenda for sustainable growth (European Commission, n.d.-a). It is a policy initiative to achieve sustainability targets through circularity. A key element of this action plan is the EU Plastic Strategy, a plastics-focused work plan in the Closing the

Loop Action Plan for the Circular Economy (European Commission, 2015). This strategy is the overarching policy on plastic for Europe's transition towards a carbon-neutral and circular economy, aligned with the 2030 Sustainable Development Goals, the objectives of the Paris Climate Agreement, and the industrial policy objectives of the EU. The Directive on reducing the impacts of single-use plastic on the environment (Directive 2019/904) was adopted as an outcome of the EU Plastic Strategy. These measures have three key objectives: first, to cut down on plastic waste; second, to encourage the adoption of sustainable alternatives; and third, to shift toward a more circular economy. This transition aligns with the 3R principles: Reduce, Reuse, and Recycle, which is a guiding framework for sustainable waste management prioritizing reducing waste as the primary strategy, followed by reusing, and finally recycling as a last resort.

The EU's strong stance and initiatives on plastic-related policies have positioned it as a leader in setting the standards and guidelines for managing plastics on a global scale (Nielsen et al., 2020). Thus, it has the potential to effectively shape a significant aspect of worldwide plastics governance (Palm et al., 2022). Examining Europe's policies and practices may give insights into how they can be used to address global issues such as plastic packaging. Given this context, my upcoming research will closely examine the EU Strategy for Plastics in a Circular Economy. I will particularly explore whether these policies can create transformative change within the context of the plastic packaging system.

1.4. The research aims and questions

This study seeks to offer insights into the potential of EU policies to drive the transformation within the plastic packaging system in the EU, emphasizing the promotion of the 3Rs principles (Reduce, Reuse, and Recycle). The goal is realized through a comprehensive analysis of the EU Plastic Strategy, assessing its capacity to facilitate the adoption of 3R principles and identifying areas for improvement. This will be accomplished by addressing the following research question:

RQ: How can the EU Plastic Strategy transform the plastic packaging system to promote 3Rs?

Sub question 1: to what extent do the EU plastic policies align with the 3R hierarchy?

Sub question 2: to what extent do the EU plastic policies promote transformative change?

1.5. Outline of thesis

To illustrate how transitions can be achieved, I use the multi-level perspective (MLP) on socio-technical transitions as a heuristic to think about the potential of policy instruments to contribute to wider transition processes. Following an introduction to the life cycle of plastic packaging system in the EU and the legislative hierarchy in in section 2, I will analyze the EU Strategy for Plastics in a Circular

Economy to identify how they contribute to the functions of creative destruction and how they relate to the principles of reduce, reuse, recycle. Results of this analysis is presented in section 5. In section 6 I answer my main research question by putting the results in the context of plastic packaging, discuss the gaps and shortfalls and provide practical points of improvement.

2. Background

2.1. Plastic packaging life cycle

The complete lifecycle of packaging can be broken down into five distinct stages: the preproduction stage (comprising material selection, design, and refinement processes), the production stage, the distribution stage (encompassing transportation, storage, and product packaging), the product usage stage, and the disposal stage (Vezzoli, 2014). The disposal stage offers various scenarios, including reuse, remanufacture, mechanical and biological recycling, as well as incineration or landfilling.

The material extraction stage is the main contributor to the overall packaging lifecycle effects. In the lifecycle of plastics, 61% of Green House Gas (GHG) emissions are produced in the first stage; resin production followed by conversion (30%) and end-of-life management (9%) (Zheng & Suh, 2019). The adverse impacts of plastic have triggered the development of biodegradable plastics and plant-based plastics which reduce the reliance on fossil-based feedstock (Hottle et al., 2013; Mendes & Pedersen, 2021).

The recovery processes for plastic waste encompass mechanical and chemical recycling, as well as energy recovery from incineration. Mechanical recycling involves a sequence of steps, including collection, sorting, cleansing, grinding, compounding, and pelletization, ultimately yielding secondary materials for various other products (Ragaert et al., 2017). Packaging design has a significant impact on mechanical recyclability (Ragaert et al., 2017). Mechanical recycling, encompassing both downcycling and upcycling endeavors, results in the creation of fresh products from the recycled material. Nonetheless, there exists a finite number of times it can undergo such transformations, eventually culminating in disposal through landfills, incineration, or co-processing (Meys et al., 2020). Only a mere 5% of the material value of all plastic packaging is reclaimed after a single-use cycle (Ellen Macarthur Foundation, 2016). Chemical recycling is a process that breaks down plastic waste into its chemical building blocks or monomers, which can then be used to produce new plastics or other valuable products (Meys et al., 2020). Unlike mechanical recycling, which involves melting and reprocessing plastics, chemical recycling uses various chemical processes such as depolymerization, pyrolysis, and gasification to break down the complex polymer chains of plastics into their original monomeric form (Meys et al., 2020).

Although certain rigid and flexible plastics applications are recyclable, the preferred end-of-life option for conventional plastic (plastic or bioplastic material) remains unclear from a life cycle analysis perspective (Albrecht et al., 2013). Multilayer materials commonly used in today's packaging pose

significant challenges for mechanical recycling and are not yet cost-effective to recycle (Matthews et al., 2021). Chemical recycling processes may be more suitable for packaging, but the lower cost of virgin materials creates disincentives for adopting chemical recycling (Matthews et al., 2021).

Another end-of-life management option is incineration for energy recovery, which is the dominant source of GHG emissions among end-of-life processes (Zheng & Suh, 2019). In 2021, 35% was collected to go into recycling, recovery and landfilling (Plastics Europe, 2022), channeling the other 75% into incineration or export to non-EU countries where waste could potentially end up entering the environment (Ritchie, 2022). Plastic leakage into the environment has a great negative impact. It is estimated that approximately 8 million metric tons of plastic end up in the ocean every year (Ellen Macarthur Foundation, 2016). Marine species mistake plastic for food and ingest it, causing them to suffer from various health issues or even death (Law, 2017). Plastic can entangle and suffocate animals (Duncan et al., 2017), or affect their development, reproduction, and behavior (Worm et al., 2017). Microplastics have also been found in different human body tissues such as lungs, livers, spleen, kidneys, placenta, and breast milk (Ragusa et al., 2022). They can travel to distant tissues, impede metabolisms, and interfere with the immune system (Prata et al., 2020).

2.2. The roles of policy, Directives, and regulations in the EU

In the EU, policy, Directives, and regulations are key components of the legislative framework that governs the member states. EU policy represents the overarching goals and objectives set by the EU institutions, which guide decision-making in various areas, from environmental sustainability to economic development (European Commission, n.d.-b). Regulations are EU laws that are directly applicable in all member states without the need for national legislation (European Commission, n.d.-c). They create uniform rules and standards across the EU and are binding on member states from the moment they come into force.

Directives, on the other hand, are specific instructions issued by the EU to its member states, outlining the outcomes that need to be achieved within a certain timeframe (EUR-Lex, n.d.). Unlike regulations, which become directly applicable in Member States upon entry into force, Directives are not directly applicable and must be transposed into national law within a specific time period before they can be enforced in each Member State (EUR-Lex, n.d.). Member states are given flexibility in how they implement Directives into their national laws, as long as the desired outcomes are met. Directives are binding with respect to the intended outcomes to be accomplished (EUR-Lex, n.d.). Together, EU

policy, Directives, and regulations form a comprehensive framework for harmonizing laws and policies among member states to promote unity, cooperation, and common standards within the EU.

3. Concepts and frameworks

3.1. Circular Economy and the 3R system

In a conceptual sense, Circular Economy (CE) has generated more than 100 distinct definitions, reflecting its interdisciplinary nature and impact on research (Kirchherr et al., 2023). For this study I take one of the most used definitions by Ellen Macarthur Foundation (2016): the Circular Economy is a regenerative and revitalizing system that breaks away from the notion of products reaching their end-of-life. It enables the preservation of raw material value, reduces waste and emissions, and enhances efficiency through practices like recycling, reusing, and remanufacturing. In a circular economy, resources are managed in a way that aims to minimize waste, maximize the lifespan of products, and regenerate natural systems (Ellen Macarthur Foundation, 2016). This approach contrasts with the traditional linear economy, which follows a "take-make-dispose" pattern, where resources are extracted, turned into products, and ultimately discarded as waste.

Circular economy is realized through three main actions, the so called 3R's principles of Reduction, Reuse and Recycle (Ghisellini et al., 2016). In the EU waste legislation, the similar concept exists under the term “waste hierarchy” (Figure 2), prioritizing strategies for plastic management as follows: (a) Prevention, (b) Preparing for reuse, (c) Recycling, (d) Other recovery (such as energy recovery), (e) Disposal (Directive 2008/98/EC).

Reduce involves the minimization of waste generation at its source, achieved by reducing both production and consumption. This approach diminishes the overall demand for resources and energy, effectively lowering environmental impacts. Emphasizing the reduction of plastic product consumption should be a priority, as recovery processes are complex and energy-intensive (Jones, 2021). Source reduction, reducing the generation of waste materials at the point of origin or source, is the most sustainable approach to managing end-of-life packaging, as it effectively addresses climate change concerns, yields low-material footprint, and minimizes natural resource depletion (Asadollahi et al., 2022).

Reusing items or components instead of discarding them helps extend their lifespan and reduces the need for new products (Ellen Macarthur Foundation, 2016). Reuse can involve repairing, refurbishing, or repurposing items to give them a second life (Ellen Macarthur Foundation, 2016). "Preparing for re-use" involves the examination, cleansing, or repair of discarded products or their components, enabling them to be reused without the need for additional pre-processing or treatments in recovery operations (Directive 2008/98/EC).

Recycling entails collecting and processing materials to create new products, preventing valuable resources from ending up in landfills and reduces the need for virgin raw (Ellen Macarthur Foundation, 2016). Recycling usually incurs significant costs (Asadollahi et al., 2022).

Landfilling and incineration are examples of disposal that remove the material from the circular system. These are less preferred options since they have highly negative impacts (Asadollahi et al., 2022).

Figure 2. The waste hierarchy

Note. From the European Commission website

3.2. Transformation Theories

In recent years, the study of structural solutions for environmental problems has extended beyond the traditional focus on firms and sectors in science, technology, and innovation studies (Kern, 2012). There has been a shift towards analyzing socio-technical systems as a primary unit of investigation to recognize that both firms and technologies are deeply interconnected within broader social and economic contexts (Geels, 2002).

At the heart of a socio-technical system lies its ability to serve a societal function, such as transportation, housing, heat provision, and food provision. Socio-technical systems can be defined as interconnected elements that work together to fulfill these societal functions (Geels, 2002). In

essence, socio-technical systems are conceptualized as clusters of aligned components, including technical artifacts, knowledge, markets, regulations, cultural meanings, rules, infrastructure, and more (Geels, 2002). The interconnectedness of these diverse elements often leads to strong economic, social, and psychological stability that favor incremental efficiency improvements within established equilibrium of socio-technical systems rather than embracing more radical systemic change (European Environment Agency, 2018). The plastic packaging system can be conceptualized as a socio-technical system consisting of multiple elements including infrastructure, user practices, policies, value chains and markets (Geels, 2012). The plastic packaging market in the EU is well-established (Beltran et al., 2021). The spread in using plastic packaging sits at the intersection of various industries, business activities, and practices such as production, transportation, marketing, consumption pattern and retail (Hawkins, 2018), due to its superiority in terms of costs, processability, and functional properties (Leal Filho et al., 2019).

From a sustainability standpoint, the slow progress of incremental changes in regime poses a significant challenge, as addressing persistent environmental issues requires urgent and comprehensive systemic transformations across societal systems. Nevertheless, research on socio-technical systems provides some cause for optimism. Historical case studies reveal that change within these systems tends to follow a pattern known as 'punctuated equilibrium,' characterized by prolonged periods of stability and gradual changes interrupted by relatively short but impactful periods of disruption and 'waves of creative destruction,' often referred to as transitions (European Environment Agency, 2018). Such insights indicate that significant and rapid systemic reconfigurations are indeed possible.

For the analysis of sustainability transitions, the key challenge lies in understanding how societies can initiate and guide these processes of systemic reconfiguration towards achieving long-term environmental and socio-economic objectives. It necessitates identifying the drivers, policies, and interventions that can effectively steer these transitions towards sustainability goals.

3.2.1. Theoretical framework: The multi-level perspective

One prominent conceptualization of how and why transformations occur is the multi-level perspective (MLP) (Geels, 2002). The core concept of the MLP is that transitions occur as the result of interactions across three analytical levels: the niche level, the regime level, and the landscape level (Geels, 2002). Each level represents different scales of socio-technical systems and actors, and their interactions shape the dynamics of sustainability transitions (Geels, 2002).

The *niche* level is the level of innovation and experimentation, where new and radical ideas, technologies, or practices emerge (Geels, 2002).. Niches represent the experimental space for novel sustainable solutions. These innovations often start at the margins of the existing regime and are driven by niche actors, such as researchers, start-ups, and grassroots initiatives (Geels, 2002).

The *regime* level represents the dominant socio-technical system that currently governs a specific sector or domain (Geels, 2002).. It comprises the established rules, norms, regulations, and dominant technologies that shape the status quo (Geels, 2002). The regime level is typically resistant to change because it is supported by powerful vested interests and established infrastructures (Geels, 2002). The existing regime often acts as a barrier to the diffusion of niche innovations (Geels, 2002).

The *landscape* level encompasses broader societal, economic, political, and cultural factors that influence sustainability transitions (Geels, 2002). It includes factors like government policies, public opinion, economic conditions, and global trends. Changes at the landscape level, such as crises, geopolitical shifts, or changes in societal values, can create windows of opportunity or external pressures for transitions to occur (Geels, 2002).

The confluence of top-down landscape pressures and bottom-up developments of emerging niches can result in the destabilization of incumbent regimes (Geels, 2002; Kivimaa & Kern, 2016). This creates opportunities for niches to build momentum, break through the barriers posed by the incumbents, and ultimately lead to the overthrow of the existing regime. However, empirical evidence indicates that incumbents can prevent the destruction of existing industries by creatively accumulating and integrating new technologies into their current capabilities (Bergek et al., 2013).

Here, my focus lies on analyzing the regime level, as it is where policies have the potential to disrupt the existing plastic packaging socio-technical system at a large scale and pave the way for the adoption of emerging alternatives.

3.2.2. Analytical framework: Creative destruction

Sustainability transitions are being partly enabled by the destabilization of established socio-technical regimes. Built on the MLP, Technological Innovation Systems (TIS) function as a foundation, and some adjustments based on the Social Network Model (SNM) literature, Kimivaa & Kern (2016) developed an analytical framework that focuses on policy instruments and measures targeting two crucial

processes for sustainability transitions: the creation of niche innovations and the destruction of incumbent regimes.

Creative destruction is a process in which innovative entrepreneurs challenge existing firms and technologies, rendering them obsolete and forcing them out of the market (Soete & Weel, 1999). This involves 'disruptive innovation' that changes processes or products in a way that existing resources and knowledge cannot adequately fulfill (Bergek et al., 2013). Empirical evidence indicates that incumbent firms can counter the destruction of existing industries resulting from abrupt technological changes by absorbing and incorporating new technologies into their current capabilities, effectively preventing their own obsolescence (Bergek et al., 2013).

The concept of 'disruptive innovation' is adopted by Kivimaa & Kern (2016) under the name of 'creative destruction' and applied to policy-making, proposing that policies could bring disruption within institutions, shaking up the existing regime by devaluing current practices and technologies (Kivimaa & Kern, 2016). Disruptions could destabilize incumbent regimes, drive transitions, and potentially encourage established players to actively participate in the transformative process (Kivimaa & Kern, 2016). The conflict between emergence and growth of niches, and the dominant design of the regimes upheld by gradual innovation often happens across various dimensions, including markets, regulations, infrastructure, and associated political dynamics (Geels, 2010).

Although the foundations and policy tools for nurturing creations of niche innovations are widely recognized, the same cannot be asserted for policies related to the destabilization aspect, which remains both under-explored and less favored, often due to political challenges (Kivimaa & Kern, 2016). Addressing niches support and destabilizing regimes need equal attention in interventions to increase the chance of transformation (Kivimaa & Kern, 2016). Focusing on the aspect of destruction becomes notably pertinent when alternative innovations have gained momentum rather than being in their initial stages (Kivimaa & Kern, 2016), as it is in the plastic packaging system where alternative materials and practices have developed (Accorsi et al., 2020; Fuentes et al., 2019; Hafsa et al., 2022; Mendes & Pedersen, 2021).

On the 'creative' side there is a list of seven innovation inducing processes that policies and measures at the regime level could potentially address to support niches (Table 1).

Knowledge creation, development, and diffusion (C1)

These policies involve policies aiming to increase knowledge creation and diffusion through networks such as subsidies for demonstrations, educational policies, training schemes, coordination of intellectual property rights, R&D funding schemes, innovation platforms and guidelines for best available technology (Kivimaa & Kern, 2016).

Establishing market niches/market formation (C2)

Policy mechanisms such as regulation, tax exemptions, and market-based policy instruments like certificate trading, feed-in tariffs, public procurement, deployment subsidies, and labeling play a crucial role in creating new market demand or bridging niche and mass markets (Kivimaa & Kern, 2016).

Price-performance improvements (C3)

Sustainable innovations are initially less competitive within typical selection environments due to weaker performance compared to incumbent technologies (Kivimaa & Kern, 2016). Policy interventions can facilitate and accelerate their uptake through price-performance improvements (Kivimaa & Kern, 2016). Cost reduction can happen through deployment and demonstration subsidies (Kivimaa & Kern, 2016).

Entrepreneurial experimentation (C4)

This function aims to reduce the uncertainties of testing new technologies through policies that promote entrepreneurship encompass diversifying existing firms, offering guidance systems for small and medium-sized enterprises (SMEs), establishing incubators, providing low-interest company loans, offering venture capital support, and implementing more relaxed regulatory conditions to encourage experimentation (Kivimaa & Kern, 2016).

Resource mobilization (C5)

This function is addressed through policies that mobilize human and financial capital and is fulfilled by securing resources for research and development (R&D) funding, providing deployment subsidies to facilitate the adoption of new technologies, offering low-interest loans to support innovation, and making venture capital accessible for entrepreneurial initiatives (Kivimaa & Kern, 2016). In terms of human capital, policies involves implementing educational policies to cultivate a skilled workforce, enacting labor-market policies that encourage innovation and entrepreneurship, and facilitating the exchange of expertise through secondment programs (Kivimaa & Kern, 2016).

Support from powerful groups/legitimation (C6)

Legitimacy, which involves gaining social acceptance and complying with relevant rules and norms, is essential for various functions to operate effectively (Kivimaa & Kern, 2016). This includes securing resources, establishing markets, and empowering participants in the system (Kivimaa & Kern, 2016). Furthermore, legitimacy significantly influences the expectations of decision-makers and, in turn, impacts the function of guiding the direction of search (C7) (Kivimaa & Kern, 2016). Policies such as innovation platforms, forward-looking exercises, procurement, and labeling efforts are employed to build and sustain legitimacy for new technologies, practices, and visionary ideas (Kivimaa & Kern, 2016).

Influence on the direction of search (C7)

This function is supported by measures that incentives or pressures organizations to venture into the technological sector that is shaped by policies (Kivimaa & Kern, 2016). The articulation of expectations and visions in the context of is integral to this dynamic (Kivimaa & Kern, 2016). This can include the formulation of goals, the framing of strategies, targeted funding schemes for research and development, regulatory measures, tax incentives, foresight exercises, and voluntary agreements (Kivimaa & Kern, 2016).

The 'destruction' processes are developed from the concepts of regime and destabilization in the MLP and consist of four processes (Geels, 2010; Kivimaa & Kern, 2016, Table 1).

Control policies (D1)

Control policies are necessary to put pressure on the existing regime by internalizing the environmental costs (Kivimaa & Kern, 2016). Without such policies the innovation inducing measure might not lead to transition (Kivimaa & Kern, 2016). These policies include taxes, import restrictions, regulations and bans on certain technologies (Kivimaa & Kern, 2016).

Significant changes in regime rules (D2)

One aspect of destabilization may involve restructuring the institutional rules that currently support the status quo or the path-dependent evolution of the regime (Kivimaa & Kern, 2016). Policies supporting this destabilization constitute structural reforms in legislation or significant new overarching laws in a way that destabilizes the regime (Kivimaa & Kern, 2016).

Reduced support for dominant regime technologies (D3)

Support for established technologies can become deeply ingrained within the existing regulatory and institutional frameworks, making it challenging for innovative solutions to gain momentum. A prime illustration of this phenomenon is the substantial subsidization of fossil fuel technologies, and any efforts to withdraw this support are seen as a potential destabilizing factor (Turnheim & Geels, 2012). Historical cases highlight the serious repercussions that can result from the discontinuation of support for specific technologies such as the case of British deep coal mining (Turnheim & Geels, 2012). Furthermore, achieving radical technological innovation typically involves shifting the balance between a new process or product and the utilization of existing resources (Abernathy and Clark, 1985). This shift may entail actions like reducing research and development (R&D) funding, eliminating subsidies for fossil fuel production, or revoking tax deductions for private motor transport (Kivimaa & Kern, 2016).

Changes in social networks, replacement of key actors (D4)

Close government relationships with key regime actors are often cited as a significant factor in causing lock-ins (Walker, 2000). Strategies like replacing existing actor knowledge and skills with new ones by deliberately disrupting established actor-network structures or creating alternative advisory forums contribute to this function (Kivimaa & Kern, 2016).

Table 1. The analytical framework (Kivimaa & Kern, 2016)

	Potential innovation/system influence of policy instrument
Niche support	Knowledge creation, development, and diffusion (C1)
	Establishing market niches/market formation (C2)
	Price-performance improvements (C3)
	Entrepreneurial experimentation (C4)
	Resource mobilization (C5)
	Support from powerful groups/legitimation (C6)
	Influence on the direction of search (C7)

Regime destabilization	Control policies (D1)
	Significant changes in regime rules (D2)
	Reduced support for dominant regime technologies (D3)
	Changes in social networks, replacement of key actors (D4)

4. Methodology

To answer the research questions, EU Plastic Strategy was analyzed as presented in Table 2.

Table 2. Research design

Research question	Data	Method
RQ1. To what extent do EU plastic policies align with the principles of 3R?	EU Strategy for Plastics in a Circular Economy	Thematic analysis
RQ2. To what extent do the EU plastic policies promote transformative change?	EU Strategy for Plastics in a Circular Economy	Thematic analysis
Main RQ. How can the EU Plastic Strategy transform the plastic packaging system to promote 3Rs?	Results from RQ1 and RQ2	Critical Discussion

4.1. Thematic analysis

Thematic analysis (TA) is a widely used method in qualitative research for identifying, analyzing, and reporting patterns or themes within data (Braun & Clarke, 2006). It is a flexible, iterative process that can be applied to a variety of research questions and data types, including but not limited to regulations, interview transcripts, focus group discussions, and survey responses (Braun & Clarke, 2006).

TA assumes that knowledge is socially constructed and that meanings are created through interactions between individuals and their environment. Meaning is situated within a particular context, and the context plays an important role in shaping the meaning. It can be identified through patterns and themes that emerge from the data (Braun & Clarke, 2006). This involves identifying patterns of meaning that are salient, meaningful, and significant to the research question (Braun & Clarke, 2006). Deductive thematic analysis is an approach to TA that is guided by a pre-existing theoretical framework or research question (Elo & Kyngäs, 2008). In this approach, the researcher develops a set of codes or themes based on existing theory, prior research, or a specific research question (Elo & Kyngäs, 2008). The codes are then used to analyze the data and identify patterns or themes that are relevant to the research question (Elo & Kyngäs, 2008). This research uses deductive thematic analysis guided by the creative destruction framework, and the 3R principles of CE.

4.1.1. Steps for thematic analysis

Initially, to familiarize myself with the dataset I read the strategy document, took notes, and highlighted the parts that evoked my curiosity. I then re-read the documents, actively engaging in finding potential meanings and patterns. In the second step, I generated codes that were derived from theory and from reading the document (Table 3). Codes are succinct labels assigned to relevant segments of data that capture the important features of data related to the research question (Braun & Clarke, 2006). Coding was carried out using Nvivo 12, and judgment on assigning codes was made by me based on the analytical framework and related to transformation and the waste hierarchy. I coded the document iteratively, meaning that I read the strategy once for each code. The number of policies attributed to each code were put into a graph to provide an overall sense of the distribution between the 3Rs and the functions of creative destruction.

Codes were then reviewed to start developing broader patterns of meaning in the data and generate initial themes. The candidate themes were then reviewed against the coded data and the entire dataset to verify that they present a coherent and credible account of the data, while also addressing the research question. Then, I developed a detailed analysis of each theme, working out the scope and focus of each theme, determining the the description that explains and provide context for the theme. It also involves deciding on an informative name for each theme which are presented in the results. Lastly, I started to weave together the analytic narrative and data extracts and contextualizing the analysis in relation to existing literature on plastic packaging.

Table 3. Summary of codes and definitions for Thematic Analysis.

Note. Description of creative destruction codes from Kivimaa & Kern, 2016)

	Codes	**Description**
3R system	Reduce	Measures resulting in reduction of virgin plastic use or waste
	Reuse	Measures that promote reuse
	Recycle	Measures that relate to or promote recycling
Niche innovations	Knowledge creation, development, and diffusion (C1)	R&D funding schemes, innovation platforms and other policies aiming to increase knowledge creation and diffusion through networks; subsidies for demonstrations; educational policies, training schemes, coordination of intellectual property rights, reference guidelines for best available technology.

	Establishing market niches/market formation (C2)	Regulation, tax exemptions, market-based policy instruments such as certificate trading, feed-in tariffs, public procurement, deployment subsidies, labeling.
	Price-performance improvements (C3)	Deployment and demonstration subsidies enabling learning-by-doing; R&D support (cost reductions through learning).
	Entrepreneurial experimentation (C4)	Policies stimulating entrepreneurship and diversification of existing firms, advice systems for SMEs, incubators, low-interest company loans, venture capital; relaxed regulatory conditions for experimenting.
	Resource mobilization (C5)	Financial: R&D funding, deployment subsidies, low-interest loans, venture capital. Human: educational policies, labor-market policies, secondment of expertise.
	Support from powerful groups/legitimation (C6)	Innovation platforms, foresight exercises, public procurement and labeling to create legitimacy for new technologies, practices, and visions.
	Influence on the direction of search (C7)	Goals set and framing in strategies, targeted R&D funding schemes, regulations, tax incentives, foresight exercises, voluntary agreements.
Regime destabilization	Control policies (D1)	Policies, such as taxes, import restrictions, and regulations. Control policies, for example, may include using carbon trading, pollution taxes or road pricing to put economic pressure on current regimes. Banning certain technologies is the strongest form of regulatory pressure (e.g., phase out of fluorescent light bulbs).
	Significant changes in regime rules (D2)	Policies constituting, for example, structural reforms in legislation or significant new overarching laws. Historic examples of major rule changes include the privatization and liberalization of electricity markets in the 1990s which completely changed the selection environment within which utilities were operating.
	Reduced support for dominant regime technologies (D3)	Withdrawing support for selected technologies (e.g., cutting R&D funding, removing subsidies for fossil fuel production, or removing tax deductions for private motor transport).
	Changes in social networks, replacement of key actors (D4)	Balancing involvement of incumbents for example in policy advisory councils with niche actors (as attempted in the Dutch energy transition programme through the transition platforms); formation of new organizations or networks to take on tasks linked to system change.

5. Results

5.1. EU policies and the 3R system: recycling in the spotlight

Overall, the analysis shows all the 3Rs are addressed in the policy, however, in terms of the content and number of policies, priority is given to improving recycling through research, legislation and market instruments (Figure 3). Reduction is the second priority and is addressed indirectly through revisions of packaging legislations and research (Figure 3). Reduction strategies primarily emphasize minimizing environmental waste leakage, mitigating plastic's environmental footprint, and curbing overall waste generation, with little attention to reducing consumption. There are limited strategies such as the revision of legislations and research programs that could potentially promote reuse, however, at the policy level it is not clear if reuse will be a priority in these strategies (Figure 3). Policies that directly related to plastic packaging are mainly the revision of PPWD and the implementation of the Directive on single-use plastics. General research policies can also have an indirect impact the plastic packaging system.

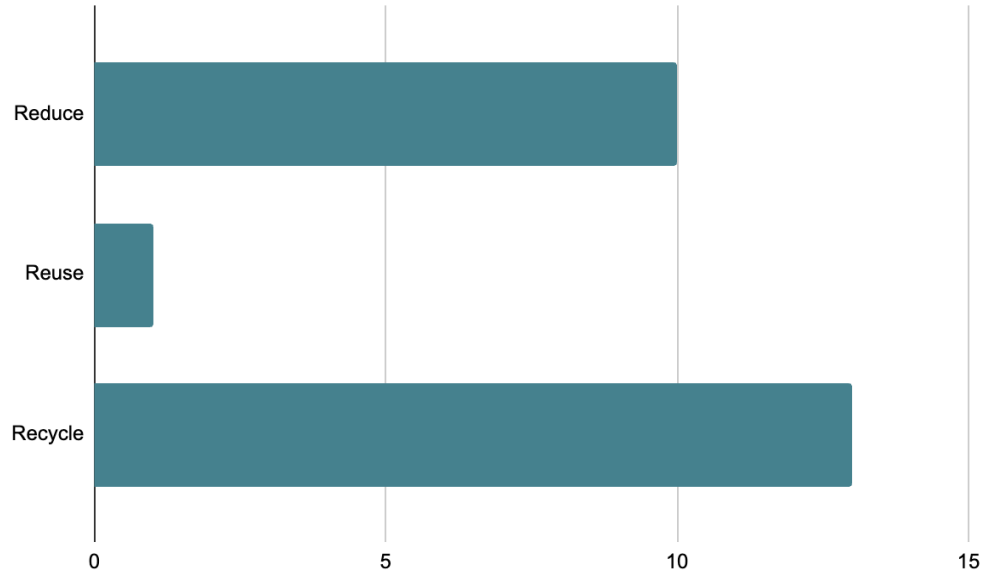


Figure 3. *Number of policy instruments promoting the 3Rs*

5.1.1. Reduce

Two policies impact plastic packaging system more directly. One is the revision of the PPWD which requires the Commission to initiate preparatory work to develop new rules to ensure that by 2030, all plastics packaging introduced into the EU market can be effectively reused or recycled, thus potentially contributing to the reduction of plastic waste. The revised version of the PPWD promotes reduce by encouraging Member States to take measures to prevent the formation of packaging waste.

These measures may include national reduction targets, economic instruments, projects to introduce Extended Producer Responsibility (EPR) and marketing restrictions (Directive 2018/852). However, no limitations are set on the amount of packaging waste generated (Appendix 1). Another proposal is drafted for a Packaging and Packaging Waste Regulation (PPWR) which contains targets for reduction of packaging (European Commission, 2022a). Initially, by 2030, a 5% reduction in waste compared to 2018 levels is targeted, resulting in an approximate 19% overall absolute reduction across the Union compared to the 2030 baseline (European Commission, 2022a). Additionally, Member States are mandated to reduce packaging waste generation by 10% by 2035 compared to 2018 levels, expected to lead to a 29% reduction in packaging waste compared to the 2030 baseline (European Commission, 2022a). To ensure sustained efforts beyond 2030, a 10% reduction target from 2018 levels (equivalent to a 29% reduction compared to the baseline) is set for 2035. Finally, in 2040, a 15% reduction target from 2018 levels (equivalent to a 37% reduction compared to the baseline) is proposed (European Commission, 2022a).

Another policy measure is analytical work, including the launch of public consultations, to determine the scope of legislative initiatives concerning single-use plastics (European Commission, 2018). This policy measure has led to the adoption of a new Directive on single-use plastics. The Directive encourages the setting up of national targets to reduce the consumption of single-use plastic products, banning plastic items that have eco-friendly alternatives, implementing measures to reduce the use of single-use plastics by 2026, restricting the use of expanded polystyrene containers, and striving for ambitious and continuous reductions in single-use plastics while maintaining safety and hygiene standards (Directive 2019/904).

Furthermore, the EU is taking steps to restrict the use of oxo-plastics and the intentional addition of microplastics to products via the REACH regulation (European Commission, 2018). REACH is a regulatory framework that aims to enhance the protection of human health and the environment and affects packaging by regulating the substances used in packaging materials. Moreover, the EU is exploring the feasibility of a private-led investment fund to finance innovative solutions and new technologies for reducing the environmental impacts of primary plastic production (European Commission, 2018). This approach encourages sustainable practices and the adoption of eco-friendly technologies in the packaging industry.

Policies that could impact plastic packaging indirectly include the development of measures to reduce plastic pellet spillage, such as the establishment of a certification scheme along the plastic supply

chain, is also underway (European Commission, 2018). This initiative seeks to prevent the unintentional release of plastic pellets into the environment. Efforts are also focused on improving the monitoring and mapping of marine litter, including microplastics, using harmonized methods (European Commission, 2018). Internationally, the EU policy promotes engaging in projects to reduce plastic waste and marine litter in regions like East and South-East Asia (European Commission, 2018). These projects aim to support sustainable consumption and production and promote the waste hierarchy, thus reducing the global impact of plastic pollution (European Commission, 2018). The EU is also examining options for specific actions to combat plastic pollution aligning with the goals of the Barcelona Convention, which seeks to protect the marine environment in the Mediterranean region (European Commission, 2018).

Additionally, one measure promotes cooperation on plastic waste prevention in major world river basins, emphasizing the importance of addressing plastic pollution at its source, even beyond EU borders (European Commission, 2018).

5.1.2. Reuse

One policy directly mentions reuse, which is the revision of PPWD (European Commission, 2018). The revised version of PPWD promotes reuse by encouraging the adoption of packaging systems that can be reused in an environmentally friendly manner (Directive 2018/852). Member states are required to report to the commission their plans for, and comparison of the costs and benefits of reuse (Directive 2018/852).

The Directive on single-use plastic also promotes reuse by encouraging the use of products suitable for multiple uses and ensuring re-usable alternatives to single-use plastic products are available at the point of sale to the final consumer (Directive 2019/904). These products should not be provided free of charge, and marketing restrictions, such as deposit refund systems, should be enforced to deter them from becoming litter (Directive 2019/904). None of the Directives set any specific goals or measurement standards for reuse (Appendix 1). The PPWR proposal, yet to be adopted by EU, sets more precise targets for reuse and refill systems (European Commission, 2022a).

Reuse is indirectly addressed by generic innovation policies, implementation of the Eco-Design Directive which sets design standards for material efficiency and better recycling, and procurement policies (European Commission, 2018).

5.1.3. Recycle

The EU is actively following up on its circular economy package. This involves efforts to enhance the traceability of chemicals and address the presence of legacy substances in recycled materials (European Commission, 2018). Such measures are crucial for improving the overall sustainability and safety of recycling processes.

The policy includes new eco-design measures that focus on making plastics more recyclable and prioritize plastic packaging as the focus area (European Commission, 2018). In addition, the EU is assessing various regulatory and economic incentives to promote the use of recycled content (European Commission, 2018). To bolster these efforts, the EU is launching an extensive pledging campaign targeting both industry and public authorities (European Commission, 2018). The campaign encourages commitments to sustainability and recycling, aligning with the broader circular economy objectives (European Commission, 2018). The Ecolabel and Green Public Procurement initiatives aim to incentivize the use of recycled plastics by developing effective verification methods and promoting eco-friendly purchasing practices (European Commission, 2018). Specifically, regarding food-contact materials, there is a focus on finalizing authorization procedures for plastics recycling processes (European Commission, 2018). Efforts are also being made to better characterize contaminants and introduce a monitoring system to ensure the safety of recycled materials used in food applications (European Commission, 2018).

Another instrument is the revision of the PPWD. The current PPWD emphasizes the importance of establishing effective collection systems for packaging waste, aiming to ensure its proper management for recycling systems (Appendix 1). Additionally, the utilization of recycled packaging waste materials in the manufacturing of packaging and other products is encouraged, which could be addressed through enhancing market conditions for these materials and reviewing any existing regulations that might impede their adoption (Directive 2018/852). As opposed to reduce and reuse, recycling measures include specific targets and deadline to achieve those targets (Directive 2018/852). A minimum of 50% recycling rate for plastic packaging must be met by the end of 2025 (Directive 2018/852). Furthermore, an information campaign is proposed to educate both the public and economic operators about recycling targets (Directive 2018/852). The new proposal for PPWR promotes recycling more ambitiously by requiring all packaging to be recyclable by 2030 (European Commission, 2022a).

The Directive on single-use plastics sets promotes recycling by encouraging the development of standardized product design requirements, the promotion of recycled material adoption in the market, and the establishment of deposit-refund systems (Directive 2019/904). Notably, there are specific targets for the use of recycled plastic in beverage bottles made from polyethylene terephthalate (PET) by 2025 and 2030 (Directive 2019/904). Additionally, the plan outlines collection goals, aiming to recover 77% of single-use plastic products for recycling by 2025 and raising this target to 90% by 2029 (Directive 2019/904).

Policy includes measures that might impact plastic packaging system indirectly. For example, the EU is collaborating with the European Standardization Committee to develop quality standards for sorted plastics waste and recycled plastics, enhancing consistency and quality in recycled materials (European Commission, 2018).

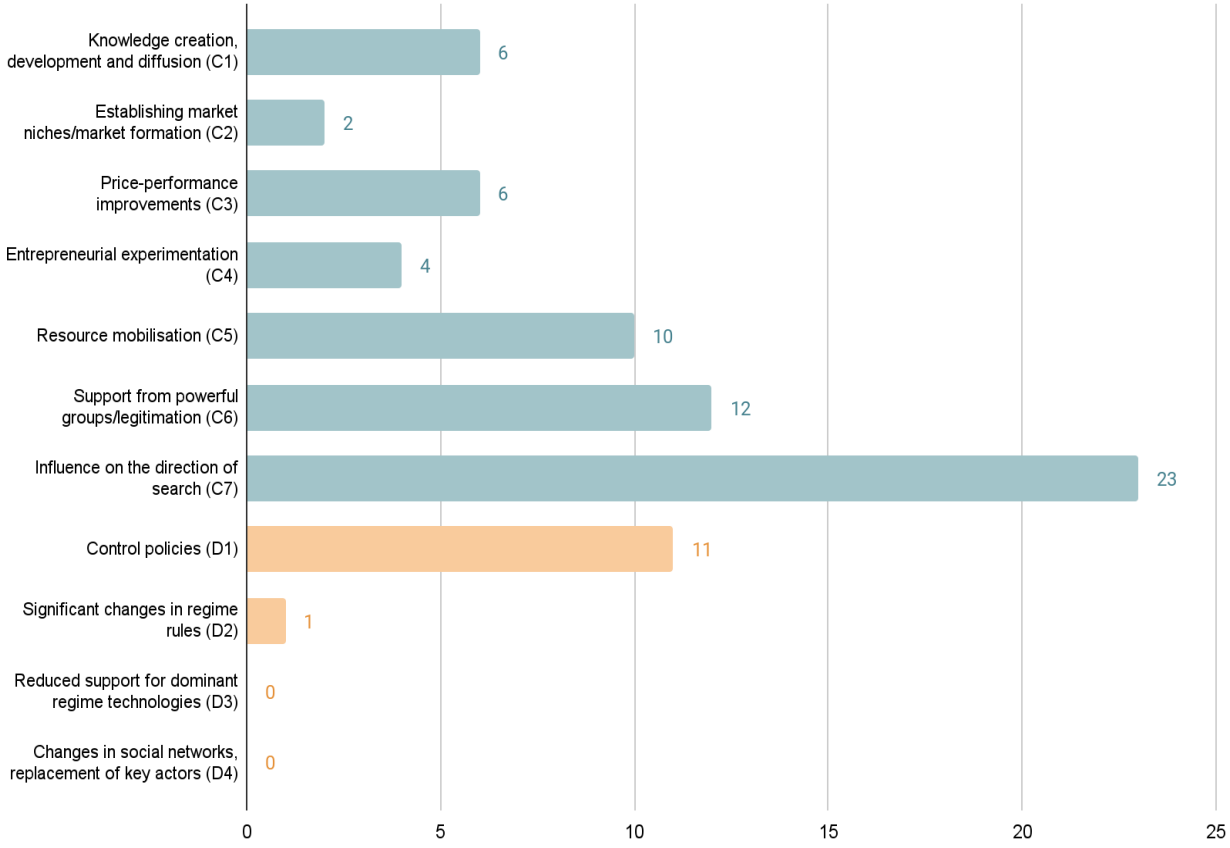
Efforts are underway to issue new guidelines for the separate collection and sorting of waste and improving recycling processes (European Commission, 2018). Additionally, the EU is committed to better implementing existing obligations on separate collection through ongoing reviews of waste legislation (European Commission, 2018). Lastly, the EU is actively supporting the development of international industry standards related to sorted plastic waste and recycled plastics, as well as a certification scheme for recycling plants within the EU and in third countries (European Commission, 2018). These efforts aim to enhance the global sustainability and quality of recycling practices.

5.2. Unleashing innovation: the EU's approach to transformation

The analysis shows measures to implement the EU Plastic Strategy have a stronger focus on promoting niche innovations than regime destabilization (Figure 4). All niche supporting functions are addressed, however, the majority of niche supporting functions comprise of research fundings and agendas mostly influencing the direction of research (C7). A few instruments focus on establishing market niches (C2) and entrepreneurial experimentation (C4). Instruments such as tax exemptions for niches, training schemes, low interest loans, and educational policies are not mentioned in the policy.

On the regime destabilization side, the strategy targets two of the four functions, with a stronger focus on control policies. There are no measures in the EU Plastic Strategy to reduce support for dominant regime technologies (D3) or change social networks (D4).

Figure 4. Number of policy instruments supporting functions of creative destruction



5.2.1. Niche support policies

5.2.1.1. Knowledge creation, development, and diffusion (C1)

Five policies have been identified that support this function. Firstly, the EU provides direct financial support for infrastructure and innovation through initiatives such as the European Fund for Strategic Investment, structural funds, smart specialization strategies, and Horizon 2020 (European Commission, 2018). Nearly half of the Horizon 2020 funding has been directed towards developing alternative feedstock to plastic which can contribute to reducing the impacts of fossil-based plastic packaging (European Commission, 2018).

Secondly, the EU has developed two policies focused on conducting lifecycle assessments (European Commission, 2018). These assessments determine where the use of biodegradable plastics can be beneficial for the packaging industry since biodegradable plastics are mostly used in disposable packaging (D. Moshood et al., 2022). By comprehensively examining the environmental impacts and sustainability aspects of these materials, these policies lay the groundwork for making well-informed decisions regarding their application.

Additionally, the EU is actively exploring the feasibility of a privately led investment funds designed to finance innovative solutions and new technologies aimed at reducing the environmental impacts of primary plastic production (European Commission, 2018). This initiative demonstrates a commitment to involving the private sector in driving sustainability and knowledge creation, which in turn can lead to significant price-performance improvements (C3).

Lastly, the EU developed a Strategic Research Innovation Agenda dedicated to plastics that serves as a strategic roadmap that guides and nurtures innovation in this field (European Commission, 2018). This agenda plays a pivotal role in directing future funding decisions. It includes subprograms dedicated to plastic packaging which aim to harness the environmental concerns of younger and future generations as a driving force for delivering services that minimize or eliminate packaging (European Commission, 2022b).

5.2.1.2. Establishing market niches/market formation (C2)

Two policies were identified that contribute to market formation and new customer demand for recycled plastic that might affect the packaging industry. An EU-wide pledging campaign encouraging industry and public authorities to use more recycled content, ensuring that by 2025 ten million tonnes of recycled plastics find their way into new products on the EU market, and initiatives such as Ecolabel

certification and Green Public Procurement, incentivizing businesses and public entities to adopt recycled materials through verification standards for recycled plastics (European Commission, 2018). The criteria for the Ecolabel and Green Public Procurement promote reusable items and packaging by for example, restricting the use of single-use packaging in catering (European Commission, 2018).

The EU Ecolabel is a voluntary certification scheme that identifies products and services with reduced environmental impacts throughout their lifecycle (European Commission, 2023). It is a recognizable, flower-shaped logo that signifies that a product meets high environmental standards. To earn the EU Ecolabel, a product must adhere to specific criteria established by the European Commission, which take into account aspects such as resource efficiency, energy and water consumption, emissions, waste management options and other environmental considerations (European Commission, 2023). The label helps consumers and public procurement bodies identify products and services that have a reduced environmental footprint (European Commission, 2023).

Green Public Procurement (GPP) is a policy approach where public authorities, when purchasing goods, services, or works, take into account their environmental impact, and opt for products and services that have a lower negative impact on the environment (European Commission, n.d.-d). GPP encourages public procurement processes that consider environmental criteria, such as energy efficiency, recyclability, reduced emissions, and sustainable sourcing (European Commission, n.d.-d). It leverages the purchasing power of public entities to drive demand for eco-friendly products and services, thereby also contributing to the price-performance improvements (C3).

No policies were identified that exempt sustainable innovations from tax.

5.2.1.3. Price-performance improvements (C3)

Aside from the policies mentioned in section 5.2.1.2 and 5.2.1.1, one policy was identified that contribute to price-performance improvement which is the eco-modulation of EPR fees (European Commission, 2018). The concept of eco-modulation in the context of EPR refers to the practice of adjusting fees or financial contributions that producers pay based on certain environmental criteria, such as the eco-design of products, the recyclability of materials, or the environmental impact of their products. Plastic packaging producers will have to pay higher fees if their product design or material have higher environmental impacts.

5.2.1.4. Entrepreneurial experimentation (C4)

The research and funding programs that are already mentioned in sections 5.2.1.1. and 5.2.1.2. can potentially contribute to functions of entrepreneurial experimentation. The revision of the Packaging and Packaging Waste Directive could enhance this function by requiring reuse and recycling schemes (European Commission, 2018). Additionally, in the context of food-contact materials, one policy aims to speed the finalizations of pending authorization procedures for plastics recycling processes, enhance the characterization of contaminants, and establish a monitoring system to ensure safety and quality (European Commission, 2018), which can contribute to more relaxed regulatory conditions for experimenting with recycled material in packaging.

This function can benefit from diversifying firms, low-interest company loans, and guidance systems which are absent in the policy.

5.2.1.5. Resource mobilization (C5)

The policies that promote research development and public procurement mentioned in sections 5.2.1.1. and 5.2.1.2 can contribute to this function. Additionally, five measures are being implemented to harness global action. This includes initiatives in East and South-East Asia target plastic waste reduction, marine litter prevention, and improved fishing gear recovery (European Commission, 2018). Options are being examined to tackle plastic pollution in the Mediterranean within the framework of the Barcelona Convention. Cooperation focuses on preventing plastic waste in major global river basins (European Commission, 2018).

Engagement in international forums and practical tools development enhance efforts against marine litter (European Commission, 2018). Support under the Basel Convention aids environmentally sound waste management (European Commission, 2018). Policy dialogues and economic diplomacy aim to establish circular plastics economies outside the EU. EU funding, including 'Switch to Green' and the External Investment Plan, backs waste management and circular economy efforts (European Commission, 2018). These policies do not have a direct impact on the mobilization in the packaging industry. The policy does not mention subsidies, loans, and educational programs for more sustainable plastic producers.

5.2.1.6. Support from powerful groups/legitimation (C6)

Multiple policies are being pursued to that fulfill this function in the plastic packaging sector including launching an EU-wide pledging campaign, incentivizing the uptake of recycled plastic through Ecolabel

and Green Public Procurement initiatives, developing unified labeling for compostable and biodegradable plastics, promoting innovation by following recommendations from the Circular Economy Finance Support Platform, exploring the feasibility of a private-led investment fund for eco-friendly plastic production, providing direct financial support for innovation and infrastructure through EU funding instruments, promoting circular plastics economies globally through policy dialogues and economic diplomacy, and collaborating on plastic waste prevention in major world river basins. Additionally, all the programs that direct fund to research and innovation mentioned in the previous sections can also contribute to this function (European Commission, 2018).

5.2.1.7. Influence on the direction of search (C7)

The policies in this section can be categorized into three categories: regulatory revisions, research visions, and general policy goals.

Firstly, several policies aim to revise the current legislations on packaging and single-use plastics. The revision of the PPWD ensures all plastic packaging is cost-effectively recyclable or reusable by 2030 (European Commission, 2018). Accelerating authorization procedures for food packaging material as mentioned in section 5.1.1.4. can contribute to this function as well. Policy also requires development of quality standards for sorted plastics waste and recycled plastics in cooperation with the European Standardization Committee (European Commission, 2018). Moreover, issuing new guidelines and improving the implementation of existing obligations on separate waste collection, including through legislative initiatives such as the Directive on single-use plastics (European Commission, 2018) can impact the direction of research.

Secondly, in terms of research visions, various funding mechanisms, including private-led investment funds, direct financial support, and support for international standards and certification schemes exist in policy (European Commission, 2018).

Another measure influencing the direction of research is the overall framing of strategies in policy (Kivimaa & Kern, 2016). The targets and framing in the policy consists of four categories: improving the economy of recycling, curbing plastic waste and littering, driving investment toward innovation and harnessing global action (European Commission, 2018).

5.2.2. Regime destabilization policies

5.2.2.1. Controlling the dominant regime (D1)

Eleven policies were identified that influence this function. Introduction of the Directive on single-use plastic and eco-modulation of EPR fees directly impact plastic packaging producers (European Commission, 2018). Enhancing traceability of chemicals and addressing legacy substances in recycled materials, developing quality standards for sorted plastic waste and recycled plastics in collaboration with the European Standardization Committee, issuing new guidelines on separate waste collection and sorting, and establishing harmonized rules for defining and labeling compostable and biodegradable plastics (European Commission, 2018) also contribute to this function.

Two policy exerts ban on plastic which aim to restrict the addition of microplastics and the use of oxo-plastics through REACH (European Commission, 2018). Policies that might indirectly influence the plastic packaging system encompass promoting international industry standards for sorted plastic waste and recycled plastics, and ensuring proper management of exported plastic waste in accordance with EU Waste Shipment Regulation.

5.2.2.2. Significantly changing the rules of the regime (D2)

Only one policy was identified as a significant change in the rules of the regime which is the revision on the Packaging and Packaging Waste Directive (European Commission, 2018).

5.2.2.3. Reducing the support for the dominant regime (D3)

No policies were identified.

5.2.2.4. Changing social networks and replacing key actors (D4)

No policies were identified.

6. Discussion and policy gaps

6.1. The transformational potential to a 3R compliant system in plastic packaging

The expected global and EU-wide rise in plastic packaging usage necessitates a transformative approach. Recognizing the merits of plastic packaging, it becomes crucial to harmonize plastic usage with the principles of reducing, reusing, and recycling. Effective plastic policies are fundamental prerequisites for driving this transformation toward more sustainable practices.

6.1.1. Limitations in recycling plastic packaging

While the policy addresses all the 3R principles, most of the focus is kept on improving recycling through design, public procurement, and quality standards and better waste sorting. Plastic recycling provides benefits, including reduced reliance on landfills, resource and energy conservation, decreased emissions in comparison to primary production, and the generation of employment (Prata et al., 2020). However, recycling packaging raises certain concerns. Packaging material is complicated and not all recyclables are designed in a way that can go through the recycling system. For example, in the EU 43% of plastic that is used for food packaging comprises plastic films (Ceresana, n.d.) made of multi-layered composite plastic which is non-recyclable, and there are currently no alternatives that provide the same level of food safety (Matthews et al., 2021). In 2021, 10% of production consisted of post-consumer recycled plastic, only 8.5% of which went back into the packaging industry (Plastics Europe, 2022). The diversity of plastic, the heterogeneity material in thin plastic wrappers, and contamination by pigments, additives, glue, labels, food residue or other materials, make it unrecyclable. Policy measures on eco-design and chemical traceability can partially address these issues and improve recycling, however, outcomes depend on successful implementation and the extent to which they can address plastic packaging in particular. Still, even with a highly optimized supply chain that addresses packaging design, collection, sorting, and recycling, it is possible to achieve a maximum net plastic packaging recycling rate of only 72% (Brouwer et al., 2020). The new requirements for eco-design and treatment of plastics seem to boost the recycling system, however, it remains uncertain to what extent they will address the complications of plastic packaging.

Another complication is that market demand for recycled plastics is currently limited due to low material quality of scraps and the possible presence of hazardous compounds (Nicolli et al., 2012), which is why using recycled plastic that comes in contact with food faces strict legislative barriers (Sustainable Plastics, 2017). Recycled plastics are predominantly repurposed into applications of lower value, which typically cannot be recycled again once they are used (Ellen Macarthur Foundation, 2016). This hinders closing the loop for circularity of plastic packaging. The low quality of scraps is

generally attributed to consumers behavior in waste separation and collection systems. This is not due to a lack of awareness since consumers are well-informed of the adverse environmental impacts of plastic packaging (Herrmann et al., 2022; Holmberg & Persson, 2023; Lindh et al., 2016). It is the time and effort required for source separation that create resistance among households (Sahlin et al., 2007). Establishing standards for recycled streams will not be able to address this issue at household level.

6.1.2. Shifting Focus from Recycling to Reduction and Reuse

Within the context of EU policy, it becomes evident that the strategies of reduce and reuse are less developed and existing policies tend to lack sophistication when addressing these two principles, while they exhibit a higher level of intricacy in their approach to recycling.

Recycling policies do play a vital role in reducing the introduction of virgin plastic into packaging production systems and, by extension, support reduction efforts. However, recycling alone cannot fully resolve the plastic pollution crisis, as previously discussed (Van Doorn & Kurz, 2021). Therefore, there is an imperative need for an absolute reduction in plastic use. In the EU policy framework, reduction measures aim to curtail waste leakage and its associated environmental impacts. This is achieved through standardizing waste streams and exploring potential alternatives like biodegradable plastics. Nonetheless, these measures often fail to address the fundamental issue of reducing consumption in cases where plastic packaging is unnecessary, such as in certain food applications (White & Lockyer, 2020). While a more detailed examination of specific programs within the policy may reveal nuanced outcomes, it remains evident that, at the policy level, there is a tendency to underestimate the importance of an absolute reduction in the consumption.

Similarly, although the EU promotes reuse through revision to the PPWD and the Eco-Design Directive, the transition towards greater adoption of reusable packaging faces substantial hurdles within the region's value chains and infrastructure. The Ellen Macarthur Foundation (2019) has outlined four industry-scale reuse models centered on refill and return systems, accompanied by numerous case studies showcasing the untapped business potential of such strategies. However, measures at the policy level tend to place relatively little emphasis on expanding these reuse systems in particular.

To summarize, the policy might not be able to advance the plastic packaging to comply with the 3R system. The policy's preferential focus on recycling suggests that plastic is primarily perceived as a waste management issue. This preference for bolstering the established recycling technological system can form a core alliance geared towards the preservation of the status quo and existing plastic

consumption patterns (Geels, 2014). This overlooks other areas of impact in the plastic lifecycle. Focusing on the last stage of the plastic lifecycle, as in the EU policy, can address at most 9% of the emissions (Zheng & Suh, 2019). Achieving the necessary reduction in plastic emissions by 2030 requires significant efforts as the projected growth in plastic packaging waste generation exceeds the potential of enhancing waste management capabilities alone (Borrelle et al., 2020). The best way to promote responsible production and consumption is through an absolute reduction in plastic use (Plastic Soup Foundation, n.d.).

6.1.3. Transformation through niche support

There is a noticeable imbalance between niche supporting policies and regime destabilization policies. On the niche support side, the majority of policy instruments are focused on directing funds towards research and supporting circular innovations. However, it is not certain where funds are directed to in policy as funds are generally supporting research in circular innovations and do not target specific areas. Considering the complications of recycling mentioned in the previous section on circularity of plastic packaging material, I conclude that transforming the plastic packaging industry requires more pointed research agenda.

Additionally, innovations alone do not necessarily lead to transformation (Kivimaa & Kern, 2016). Although over 300 circular innovations have been identified to reduce the impacts of plastic, the adoption of circular innovations is low in practice (Hafsa et al., 2022). For example, Accorsi et al. (2020) Accorsi et al. (2020) designed and implemented a closed-loop network design model for reusing plastic for transportation in the food industry that allows infinite reuse of transportation plastic packaging. Another example is the Foschi & Bonoli (2019) presented the case of a packaging company that has adopted a successful circular system to decouple value creation and economic growth. However, there is not enough pressure on the regime for investing in such establishments resulting in limited adoption of more sustainable practices (Hafsa et al., 2022). Sustainability objectives are not priorities in packaging companies in comparison to other company goals, and legislation is not incentivizing the industry enough to adopt more sustainable processes on a large scale (Pålsson & Sandberg, 2022). This is in line with previous research showing that EU policies might encourage incremental enhancements to the present plastic packaging system for a circular economy, but they might not support a significant transformation of the prevailing socio-technical plastic packaging system (Beltran et al., 2021).

6.1.4. Destabilization through implementing new legislations and standards

Most of the destabilization measures contribute to the function of controlling the dominant regime (C1). The policy aims to revise several legislations to better regulate packaging waste, packaging design and chemical composition, and single-use plastic. Legislations bring life into policy interventions by facilitating their implementation and effectiveness and increase their chance of success (United Nations Environment Programme, 2023). Currently two legislations are specifically related to plastic and packaging: the PPWD (Directive 2018/852), and the Directive on single-use plastic (Directive 2019/904). They create pressure on the packaging producers by internalizing the environmental costs of carbon emissions (Kivimaa & Kern, 2016) through the EPR schemes. These schemes are referred to as a major outcome of these EU Directives (Milios et al., 2018) that hold the producer of packaging responsible for taking care of its waste in terms of cost and treatment (Directive 2018/852). However, the implementation and effectiveness of EPR schemes vary among the member states (Lorang et al., 2022). Reports indicate that out of the 27 member states, a mere eight have taken steps to transpose the Directive on single-use plastics into their national legal frameworks, and these countries have not achieved full compliance (Balkan Green Energy News, 2021). Additionally, while some scholars recognize it as a key instrument in promoting the circular economy of plastics (Leal Filho et al., 2019) and adhering to the waste hierarchy (Milios et al., 2018), others argue that EPR requires excessive effort and can only produce outcomes in the long term (Trubetskaya et al., 2022), and are currently proven to be ineffective in reducing packaging waste (Van Sluisveld & Worrell, 2013) or in motivating producers to engage in eco-innovations (Røine & Lee, 2006). While EPR has led to increased collection and recycling rates in EU member states that have implemented them, a major barrier to achieving the 50% recycling target is the inadequate recycling infrastructure, as the EU's recycling capacity is currently only 23% (Lorang et al., 2022). The eco-modulation of EPR schemes in the EU, and the proposed PPWR Directive which is set to change the nature of the legislation from a Directive to a Regulation show an improvement and may enhance the disparities among member states. Its effectiveness hinges on successful implementation.

While regulations can put pressure on the incumbents, several other instrument that contribute to regime destabilization are absent from the policy. Destabilization typically requires weakening the flow of resources into reproduction of the regime (Turnheim & Geels, 2012) by for example removing subsidies from fossil-based plastic feedstock for packaging. Dismantling established actor-networks is another destabilization strategy that diminishes the legitimacy of the old regime (Kivimaa & Kern, 2016) which is not employed in the policy. The absence of these instruments suggests that the policy might not be able to transform the plastic packaging system to promote the 3Rs.

6.2. Policy recommendations

Four areas of improvement for policy are identified based on the gaps discussed: prioritizing reduction of consumption; elaborating on reuse schemes; diversifying policy instruments; and introducing more destabilizing policies. The specific interventions in this section serve as examples and are partially based on the suggestions UNEP zero draft on plastic pollution which showed to have transformational potential through an analysis by the creative destruction framework (Appendix 2).

Firstly, considering the current limitations of recycling for packaging material, policies that aim to prevent the occurrence of plastic waste in the first place, or to substitute plastic material with environmentally friendly alternative materials, should be considered in these broader plastic policies. This can be achieved through, for example, an incremental rising tax/fee on the purchase of virgin plastic feedstock by manufacturers of plastic packaging, prohibition of problematic or unnecessary plastic packaging, and obligation to replace plastics if safe and more sustainable alternatives exist (Appendix 2).

Secondly, considering the benefits of plastic packaging and the business potential of introducing reusable packaging, mandating reuse schemes, and supporting the development of necessary infrastructure, fiscal incentives for companies that implement reuse schemes can address both waste issues and the reliance on virgin plastic material.

Thirdly, the policy could use a wider range of instruments to address the plastic packaging issue besides research and control policies. More diverse instruments such as tax incentives, tax exemptions, diversifying firms, low-interest company loans, and guidance systems can be employed to catalyze transformation.

Lastly, there is a significant lack of policies that remove the support for the plastic packaging industry. This function could be better addressed through for example, removing fossil fuel-based feedstock subsidies (Kivimaa & Kern, 2016) that make virgin plastic so inexpensive. Additionally, policies that aim to balance the involvement of incumbents with the niche actors, or aid the formation of new organizations or networks to take on tasks linked to system change can be impactful in regime destabilization (Kivimaa & Kern, 2016).

7. Limitations

Regarding the MLP and creative destruction framework, an admitted limitation of this analysis is that although various instruments targeting plastic packaging are identified, their actual effectiveness remains uncertain (Kivimaa & Kern, 2016; Whitmarsh, 2012). Another limitation arises from the broader context of transformation studies. Here, the absence of a comprehensive understanding and a well-established theory of transformation, compounded by conceptual diversity and a lack of consensus within the field, may pose challenges to the practical applicability of research outcomes in driving effective actions (Feola, 2015). These limitations should be considered when interpreting the implications and generalizability of the study's findings.

Regarding the method, the practice of TA is naturally subjective, emphasizing the importance of researchers reflecting on their own perspectives and biases. Furthermore, these approaches reject the notion that coding can be completely accurate, as it is an inherently interpretive process, and the meaning within data is not fixed (Braun & Clarke, 2023). Deductive approaches can be more structured and efficient but may result in a narrower analysis that is less sensitive to unexpected or divergent findings (Braun & Clarke, 2006). I tried to decrease the impact of this inherent subjectivity by several rounds of coding at different stages to remove possible biases.

Regarding the data used, a limitation of this study is that certain policies that are absent in the EU Plastic Strategy could potentially be tackled by other EU policies that are not specifically linked to plastics. These could involve actions like prohibiting the trading of waste or setting up fiscal policies. Due to time limitations, these particular policies were not included in the analysis.

8. Conclusion

The primary objective of this study was to scrutinize the capacity of European Union (EU) policies to transform the plastic packaging system to promote the principles of Reduce, Reuse, and Recycle (3Rs). This was accomplished through an in-depth analysis of the EU Strategy for Plastics in a Circular Economy, evaluating its alignment with the 3Rs, and with the creative destruction framework.

The study's findings underscore that existing policies predominantly frame plastic packaging as a waste issue and emphasize recycling as the primary remedy. While mentions of reduction and reuse are present, they lack politically actionable measures in comparison to recycling initiatives. Moreover, these policies fail to demonstrate a comprehensive grasp of the intricate challenges posed by recycling plastic packaging.

It is evident that the current policies do not exert sufficient pressure on the plastic packaging regime to induce transformation process. The majority of measures are geared towards fostering niche innovations via research funding and innovation programs. Addressing regime destabilization functions is only partially achieved through regulatory revisions. Policy measures such as taxation, fiscal policies, and regulatory bans, which undermine the legitimacy of regime and could significantly impact the transition, are noticeably absent from the policy landscape.

In light of these findings, the study identifies four areas for enhancement that could potentially catalyze the transformation of the plastic packaging system: prioritizing reduction of consumption, elaborating on reuse schemes; diversifying policy instruments; and introducing more destabilizing policies.

It is crucial to acknowledge that the plastic issue is multifaceted. There is no single plastic problem, but many plastic problems, as it is possible to have a variety of interpretations of the challenges, ranging from mismanagement of waste to health concerns and shift to a circular economy (Nielsen et al., 2020). Waste management processes on their own may not be able to keep up with the pace of plastic production (Ellen Macarthur Foundation, 2016). Achieving transformation in the plastic packaging system necessitates policies that disrupt the existing regime. Although regime destabilization poses political challenges, it has significant potential for effectively achieving sustainability objectives (Callorda Fossati & Fransolet, 2021).

An important area for investigation involves examining the effectiveness of the specific measures in the policy, such as the PPWR, and how the system would react and adapt in the face of radical policy changes. **Future research could focus on** understanding the potential responses and consequences from the industry and consumers for better assessment of the overall impact of such changes. Insights could be gathered through interviews with actors from the target groups to discern how they interpret the signals emanating from different regulatory instruments and how this interpretation shapes their approaches (Kivimaa & Kern, 2016). Furthermore, research could delve into the requisites for the successful enforcement of radical regulatory measures. Identifying the necessary conditions and strategies to ensure compliance and meaningful implementation would contribute to the feasibility and sustainability of transformative policies.

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10. Appendices

10.1. Appendix 1: Analysis of EU Directives with the 3R system

10.1.1. An overview of the targets and objectives of the PPWD by the 3R system.

	Objectives	**Targets**
Reduce	• Implement waste prevention measures, such as national programs • Encourage public information and awareness campaigns concerning the adverse environmental impact of the excessive consumption of lightweight plastic carrier bags.	• No targets
Reuse	• Encourage reuse systems of packaging, which can be reused in an environmentally sound manner	• No targets
Recycle	• Ensure systems for collection of packaging waste • Promote the use of recycled packaging waste materials in the production of packaging and other goods by enhancing market conditions for these materials and reassessing any existing regulations that hinder their utilization • Information campaign for the general public and economic operators on recycling and recovery targets	• Minimum of 50% recycling rate for plastic packaging by the end of 2025
Generic	• Encourage studies and pilot projects concerning prevention measures, development of packaging indicator for simpler waste management, knowledge on reuse and recycling benefits and costs, and financial aspects of producer responsibility • Achieve maximum targets higher than the targets set in the Directive on the condition that it does not disrupt internal market • Decide on a marking and identification system that signifies the material content of packaging to facilitates collection, reuse, recovery and recycling	

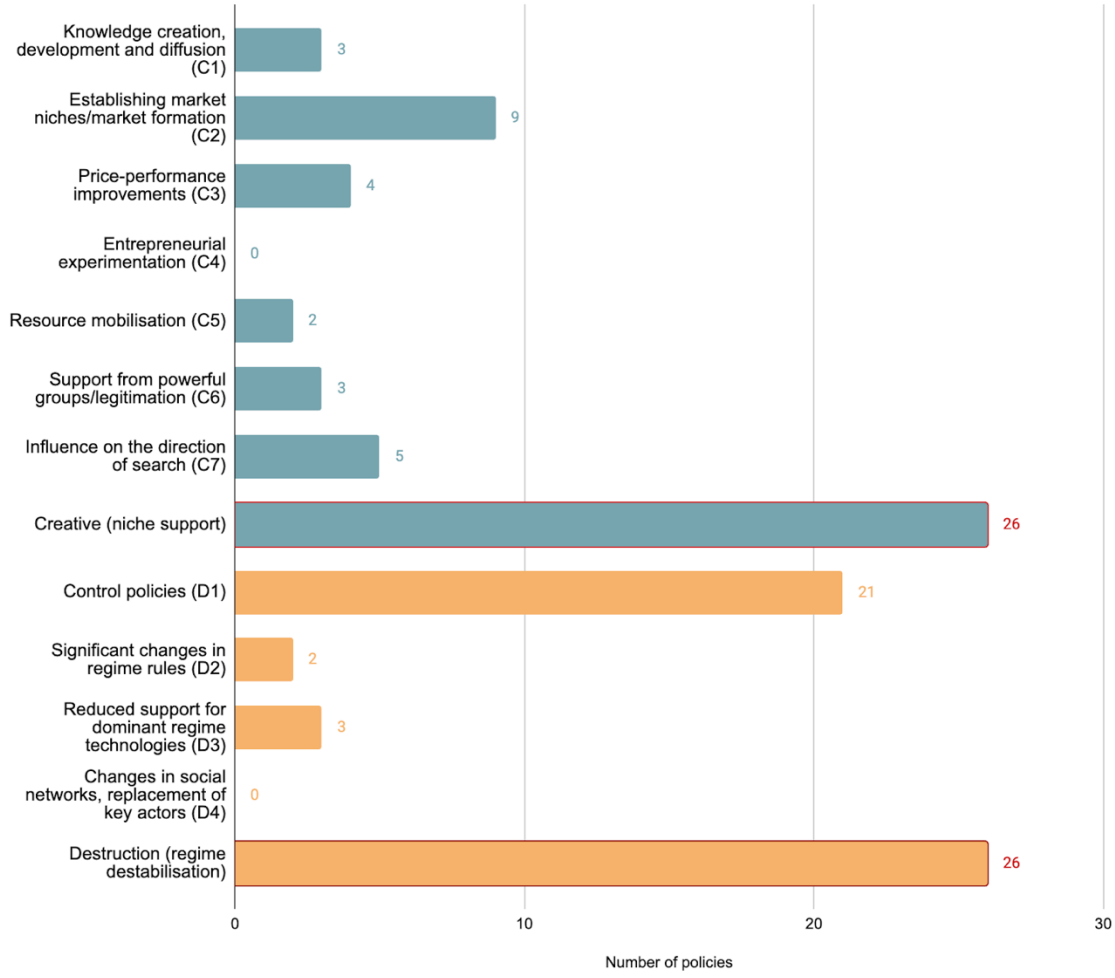
10.1.2. An overview of the targets and objectives of the Single-use Plastic Directive by the 3R system

	Objective	**Target**
Reduce	• National consumption reduction goals for certain single-use PET products • Prohibit the placing on the market of plastic products that have readily available and sustainable alternatives • Take measures to reduce consumption of single-use plastic products and achieve a measurable reduction in consumption by 2026 compared to 2022 • Encourage all producers to strictly limit microplastics in their formulations. • Restrict single-use food and beverage containers and cups for beverages made of expanded polystyrene • Take the necessary measures, for example, by setting national consumption reduction targets, to achieve an ambitious and sustained reduction in the consumption	• Prohibit the placing on the market of oxo-degradable single-use plastic products

	of single-use plastics, without compromising food safety, good hygiene practices, good manufacturing practices, consumer information, or traceability requirements	
Reuse	• Encourage the use of products suitable for multiple uses and those that can be prepared for re-use and recycling after becoming waste • Ensure re-usable alternatives to single-use plastic products are available at the point of sale to the final consumer, ensure that those products are not provided free of charge, and impose marketing restrictions to prevent them from becoming litter, such as deposit refund systems	• No targets
Recycle	• Develop harmonized standards to ensure conformity with product design requirements, • Promote the market uptake of recycled materials • Establish deposit-refund schemes	• Beverage bottles made from polyethylene terephthalate (PET), must contain a minimum of 25% recycled plastic by 2025 and 30% by 2030 • Distinct collection of recyclable waste as follows: By 2025, 77% of single-use plastic products placed on the market must be collected for recycling, and by 2029, this target increases to 90%
Generic	• Create unified standards for beverage container closures • Ensure that single-use plastic products carry a noticeable, easily readable, and permanent label on their packaging or the product itself, informing consumers about a) The suitable methods for managing the product's waste or the waste disposal methods that should be avoided, aligned with the waste hierarchy, and b) inclusion of plastics in the product and the adverse environmental consequences of littering or improper waste disposal of the product. • Take actions aimed at educating consumers and encouraging responsible consumer behavior to decrease litter caused by single-use plastics, availability of alternatives that can be reused, various reuse systems, and waste management options, The negative consequences of littering and improper waste disposal of these single-use plastic products. • Each year, report to the Commission the following: (a) data on the placement of single-use plastic products on their market, demonstrating consumption reduction; (b) details of measures taken for reducing plastic consumption; (c) data on separate collection of single-use plastic products to show achievement targets; (d) information on recycled content in beverage bottles to demonstrate compliance with targets; and (e) data on post-consumption waste of single-use plastic products	• Caps and lids remain attached to containers during the product's intended use stage to reduce littering. • All plastic packaging placed on the market has to be re-usable or easily recyclable by 2030

	• Implement Extended producer responsibility • Integrate the plan into national legislation by July 2021	

10.2. Appendix 2: Analysis of UNEP treaty



10.2.1. Overview of number of plastic policies by UNEP contributing to functions of creative destruction

10.2.2. Regulatory interventions suggested by UNEP treaty and associated gaps in the EU Directives by potential area of impact in the 3R system (data from Directive 2019/904, n.d.; UNEP, 2023)

Potential area of impact in the 3R system	**Regulatory interventions suggested by UNEP**	**Packaging and packaging waste Directive**	**Single use plastic Directive**	**Gaps in the EU regulations and implementation**
Reduce	• An incremental rising tax/fee on the purchase of virgin plastic feedstock by manufacturers of plastic packaging • Prohibition of products containing problematic or unnecessary plastic • Obligation to replace plastics if safe and more sustainable alternatives exist • A prohibition of all intentionally added microplastics	• Implementation of national programs to prevent packaging waste • Ensuring a limit to consumptions of lightweight plastic bags	• Encouraging producers to strictly limit microplastics in their formulations • Taking measures to reduce national plastic consumption such as reduction targets • Replacement of plastics if safe and more sustainable alternatives exist • Prohibition of oxo-degradable plastics	• No fiscal policies or tax on virgin plastics • Not specific on reduction targets • No mandates on microplastics or unnecessary plastics except for oxo-degradable plastic
Reuse	• Mandate establishing large scale packaging reuse schemes in the fast moving consumer goods sector • Incorporation of reuse in public procurement • Fiscal policy incentives for companies that implement reuse models	• Encourage reuse systems of packaging	• Encourage the use of products that are suitable for multiple use and that are, after having become waste, suitable for preparing for re-use and recycling	• No mandates on reuse systems • No governmental support for reuse schemes • No fiscal policy supporting reuse

Recycle	• Mandate the implementation of Extended Producer Responsibility schemes • A legal requirement for plastic products to contain increasing minimum recycled content for plastics • Incorporation of recycled content criteria in public procurement • Increase mechanical recycling capacity through financial and fiscal policy incentives • Increase chemical conversion capacity through financial incentives for plastic materials that cannot be recycled mechanically • Mandate to strengthen the alignment between the informal and formal plastics waste sector • Establish ambitious recycling targets per material / application	• Mandate the implementation of Extended Producer Responsibility schemes • Minimum of 22.5% recycling rate for plastic packaging by the end of 2008 • Improve market conditions for uptake of recycled packaging • Establish systems for packaging waste collection and recovery, including recycling	• Ensure that extended producer responsibility schemes are established for all single-use plastic products • Inclusion of minimum 25% recycled content in PET bottles by 2025, 30% by 2030 • Establish separate collection rate for bottles • Establish deposit refund schemes	• No target for inclusion of recycled plastic in materials other than PET • Not specific on the recycling targets of different materials • Not specific on the target for different recycling processes • No fiscal support for recycling schemes • Modest recycling targets • EPRs not implemente d in all member states • Deposit refund schemes not implemente d on all member states
Generic/M ultiple areas of impact	• Control measures on chemicals of concern • Fiscal policy incentives for companies shifting their operations to circular plastics • Mandate the implementation of Extended Producer	• Limit the sum of concentration levels of lead, cadmium, mercury and hexavalent chromium present in packaging	• Ensure caps and lids remain attached to the containers during the products' intended use stage	• No tax/fiscal incentives for shifting to more circular actions • Design standards limited to caps on

	Responsibility schemes • Binding common design standards for reuse and recycling • A single, standardized, global plastics labeling scheme • Trade mechanisms to reduce trade of problematic plastics • International standard and definitions for compostable and biodegradable materials. If standards and definitions are not in place, then the terms should be banned. • Establish deposit return schemes for all suitable products • Public investment in plastic waste collection • Adopting effective social and behavior change communication strategies to end plastic pollution • Global standards for landfill, incineration and waste-to-energy facilities • Taxes to disincentivize plastic disposal in landfills and incinerators • Standards for downcycled plastic products to avoid shedding of microplastics	• Encourage energy recovery where material recycling is not cost-beneficial • Development of a packaging environment indicator to render packaging waste prevention simpler and more effective	• Member States shall take measures to inform consumers and to incentivise responsible consumer behavior • Member states shall implement Extended Producer Responsibility • Establish deposit-refund schemes* • Ensure packaging labels include information on plastic type, appropriate disposal means and negative impacts of littering • Ensure by 2025 and 2029 the separate collection of single use plastics for recycling equals 77%, and 90% by weight, respectively.	bottles and labels on the packaging • No standards on biodegradable/compostable plastics • No standards on plastic waste trading • No standards or tax on incineration and landfilling of plastic • No standards for downgraded recycled plastics

	• No plastic waste exported to nations with insufficient waste management capacity • Global standard and verification system for plastic credits			