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Article

Circular Regulations (CR) for Bioeconomy Development

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ABSTRACT

The term Circular Regulations (CR) is introduced to describe a broad regulatory framework, designed with a circular understanding of the economy. Central in this discussion is the transition towards bioeconomy, a term that is not always used consistently, and sometimes treated in the same way as circular economy (CE), although these terms are not necessarily equivalent. In this article we endorse a systemic interpretation of CE, where a continuum of approaches, extending from reusing/recycling/upcycling to refuse/rethink/reduce, gradually replace existing linear "end-of-life" concepts. CE is a key prerequisite for the bioeconomy shift, a transition that further builds on CE, where circular design and processes are further augmented with increased resource utilization and intensive applications of innovative science and technology. The prevailing regulatory arrangements in CE, however, remain either fragmented or largely based on pre-existing policies, drafted to address issues of the linear economy, thus presenting several limitations when dealing with the underlying paradigm shift: complex market relationships that go beyond the standard neoclassical model. CR adopts an encompassing approach to regulatory design; it is not meant to be a rigid set of rules, but rather a regulatory framework where institutions, market rules, and business practice explicitly account for environmental and socially responsible activities, while securing an enabling environment for innovation. CR directly reflects on CE, where bioeconomy growth is informed by science, enabled by technology, driven by business, and supported by relevant policies and institutional frameworks. The article presents a conceptual setting towards CR and a practical example for its development.

KEYWORDS: circular regulations; circular economy; bioeconomy; governance; government interventions

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INTRODUCTION

The emerging bioeconomy is not only an expression of new technologies and processes, but a fundamental change in our socio-economic system; a central element is the increased utilization of biological resources and the overall redesign of economic activities so that

we transition towards a state where our production processes *use things* rather than *use them up*—the former being a reflection of our natural systems. Bioeconomy therefore brings a *paradigm shift*, not only in terms of production and consumption, but also in our understanding of economic activity (Pyka, 2017) [1].

Although bioeconomy has gained increasing popularity, there is still confusion and inconsistencies among researchers and practitioners. Terms that relate to the bioeconomy, such as sustainable development, circular economy (CE), bio-based economy, and others, are sometimes treated interchangeably, although they may not necessarily reflect to the same concept. The systematic classification and nomenclature of these terms lies beyond the scope of our discussion and has already been addressed in the literature (Kirchherr et al., 2017; McCormick and Kautto, 2013; Brunori, 2013) [2–4]. For the purpose of this paper we rely on the CE definition by Kirchherr et al. (2017) [2], where a CE continuum, extending from reusing/recycling/upcycling processes to refuse/rethink/reduce, gradually replaces the linear "end-of-life" concepts of the linear economy. Bioeconomy then builds on the circular end of this CE continuum, to expand the utilization of biological material and processes with the help of innovative science and technology. CE is therefore the foundation for bioeconomy growth.

The transition to bioeconomy, sometimes also called the "green shift", has not yet fully manifested in contemporary research, since the latter mostly relies on tools and concepts from the previous linear paradigm - especially in terms of defining and measuring. In some ways it is the same discussion of producing more, increasing (production) efficiency, enhancing profitability, and so on. Similarly, regulatory developments and our understanding of regulations and institutions remain largely out of pace with bioeconomy developments and needs. The transition to the bioeconomy raises the need for a new approach in our understanding and measuring of the bioeconomy, moreover on ensuring enabling environments around these new concepts. The purpose of this paper is to highlight the need for such new approaches, especially with respect to regulations, and suggest some modest proposals towards regulatory innovations that we call Circular Regulations (CR).

The rest of the paper is structured as follows. The next section frames bioeconomy and its relation to CE, while emphasizing the paradigm shift that raises the need for CR. Next, an abridged description of some key national bioeconomy strategies is presented; regulations that are, to a large extent, based on pre-existing policies drafted with a linear approach in mind and present significant shortcomings in addressing modern bioeconomy needs. The introduction to the concept of CR follows, along with a practical example on how CR can be further developed. The article ends with a short summary.

BIOECONOMY AND VALUE WEBS

Bioeconomy is associated with an ongoing paradigm shift, the "green shift", and has received several definitions. According to the OECD (2009) [5], bioeconomy is "…transforming life science knowledge into new, sustainable, eco-efficient and competitive products", while according to the first Global Bioeconomy Summit (GBS) bioeconomy is the "…knowledge-based production and utilization of biological resources, biological processes and principles to sustainably provide goods and services across all economic sectors" (Global Bioeconomy Summit, 2015) [6]. Several other definitions of the bioeconomy can also be found, illustrating the confusion and complexity of the term that sometimes is treated in the same way as the terms CE or bio-based economy, although these terms are not necessarily equivalent (D'Amato et al., 2017; Kirchherr et al., 2017) [2,7]. In our discussion for bioeconomy we use CE as the starting point, where we adopt the approach from Kirchherr et al. (2017) [2] that define CE as "…an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. It operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations. It is enabled by novel business models and responsible consumers." Bioeconomy builds on CE developments and further expands resource utilization (biological materials and processes) with the intensive application of innovative science and technology. In this article we therefore consider CE as key prerequisite for bioeconomy development. The rest of the section highlights some of the complex market dynamics that characterize bioeconomy development, a paradigm shift that sets the demand for regulatory innovation.

Zilberman et al. (2013) [8] argue that the transition towards bioeconomy "…is a continuing evolutionary process of transition from systems of mining non-renewable resources to farming renewable ones". Bioeconomy is primarily based on biogenic instead of fossil resources, and inherently incorporates circular value chains (e.g., recycling, upcycling, reusing, etc.). In that respect, bioeconomy stands on two legs: one is the extensive usage (and extraction) of bio-resources, and the other is the efficient and sustainable (economically, environmentally, and socially) utilization of such resources. The new extraction methods are supported by (economically and environmentally) efficient utilization technologies, as well as by enabling markets and institutional arrangements.

Modern bioeconomy emerged largely due to technological advances and the intersection of various technologies and principles (genetics, chemical technologies, construction, new materials, etc.) across different industries and sectors. However, *biotechnology advancements are*

necessary but not sufficient for bioeconomy development—what remains central is establishing profitable and efficient value chains, or better stated: *value webs*; the term value webs better reflects the necessary interconnected and flexible value chains (Block et al., 2008) [9]. To properly set up supporting value webs one first must have a good understanding on the foundations upon which they are established and the market need(s) for such products and services. The need(s) for bioeconomy-related products and services, (i.e., the demand side) still comes mostly from traditional flows, even though the modern bioeconomy created a significant disturbance on the supply side. More importantly, the emerging bioeconomy gives rise to new value webs that extend beyond our traditional understanding of supply chains and markets. In that way, the bioeconomy is not a new industrial sector *per se*, but rather a cluster of intersecting value webs.

The traditional linear models of economic activity are characterized by value chains that are extractive in nature—i.e., their aim is typically towards efficiently extracting as much value possible from a certain product or service. What happens after the extraction (i.e., when the linear value chain is considered to be complete) is an externality. Sometimes such an externality may be partially captured with complex contracts and the strategic behavior of various actors, other times with complicated juristic arrangements from different parts of the industry. This kind of linearity is still reflected in the existing regulatory environments and the ways they address business behavior (e.g., in terms of taxation, competition regulations, business formations and relationships, etc.).

Against this backdrop, a new concept emerges, the concept of circular economy (CE). CE was popularized by the Ellen MacArthur Foundation, where on its 2015 report describes it as "…restorative and regenerative by design, and aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles" (Ellen MacArthur Foundation, 2015) [10]. A central element in CE is that the value chains are not extractive but rather adopt a systemic circular approach to value creation that extends across market segments and industries (Kirchherr et al., 2017) [2]. Although promising, there are still several challenges in the proper implementation of CE, with several restrictions extending to technology, business practice, and of course regulations. Technology restrictions involve new technologies as well as the utilization and scaling-up of existing technologies and prototypes. Business restrictions can be internal or/and external to the firm environment. The former covers issues such as capacity, competence, etc. while the latter has to do with the strategic relationships of the firm. The regulatory restrictions relate to the Law and regulatory traditions; they can be particularly critical since regulations are essential for providing the enabling environment for the paradigm shift—moving towards bioeconomy.

There are increasing signs that biotechnology may flourish in clusters (Philp and Winickoff, 2017) [11], however there is still not definitive answer on how to properly set up value webs that will efficiently take advantage of such synergies to advance the bioeconomy transition. There have been several industrial symbiosis schemes in the Nordics, along with Innovation Platforms (IPs) and quadruple helix templates, however, it remains a key challenge remains in setting up new value webs that will efficiently carry the bioeconomy outputs to their markets, and unless this last crucial step is addressed the whole premise is precarious, no matter how impressive the technological possibilities are or how willing the political environment is. The issue of establishing profitable and efficient value webs becomes particularly challenging since *we don't know, that we don't know*—in other words, the possibilities of the emerging bioeconomy are yet developing and in order to set up value webs one first must have a good understanding on the possibilities, challenges, and (potential) market need(s) for such products and services; the emerging bioeconomy gives rise to whole new value webs that extend beyond our traditional understanding of value chains and markets. As already discussed, the need(s) (i.e., the demand pull) still comes mostly from our traditional understanding of product/service flows, and modern bioeconomy development started with disturbance of the supply side. There is still uncertainty both with respect to (intermediate and "final") markets (demands, side and by-products, potential waste, efficiency%, etc.), as well as the institutional and regulatory framework developments at national and international levels. In fact, the author has experienced the latter to arise as a major hindrance in several bioeconomy related initiatives in the Nordics. Further bioeconomy development will require increasing biomass yields (Lewandowski, 2017, [12]) that can be realized in various ways, including increasing the amount of productive lands, or introducing new and/or improved species that may be based on biotechnology. The latter element is consistent with GMO utilization that despite recent developments, it remains a contested topic in Europe with significant opposition among the public and most of the European-based environmental NGOs.

Bioeconomy development fundamentally relies on extensive energy and material flows that can drastically alter market conduct and our understanding on what the market is. In addition, several bioeconomy initiatives can only be successfully addressed through extensive collaboration among different market players, and only with the proper support from their institutional setting. All these new market dynamics and complex relationships lie at the heart of the paradigm shift that characterizes the bioeconomy transition, raising novel challenges for both businesses and governments, and fueling the need for regulatory innovation that can be addressed by the CR. The proposed CR is a broad regulatory framework that is specifically designed with a circular understanding on the economy and the ongoing paradigm shift, and thus

has the potential to support bioeconomy transition. As we discuss in the next section, existing regulatory approaches are not sufficient and, in some cases, can even inhibit CE development and thus the bioeconomy transition, mostly due to their fragmented and outdated approach that typically originates from a linear understanding of the markets.

It is worth noting that bioeconomy presents new economic opportunities that can be particularly important for rural areas in the European periphery. These areas are naturally situated within rich bioeconomy zones (i.e., they have a natural advantage in terms of bioeconomy resources) and therefore they have the potential to become (with the help of appropriate policies) bioeconomy hubs. A key issue however, lies on the design of value webs in such ways where the additional economic surplus that is being generated will also benefit those communities actively affected (as opposed to linear extractive schemes where surpluses are extracted to large operators in big urban centers or abroad). Properly setting CR may help alleviate such distributional issues and allow for truly embedded bioeconomy hubs.

CURRENT NATIONAL STRATEGIES ON BIOECONOMY AND CIRCULAR ECONOMY

There has been considerable effort over the last years to develop strategies and policies for the bioeconomy and the circular economy. In Europe, the EU published in 2017 the “Review of the 2012 European Bioeconomy Strategy” [13], based on the European Commission (EC) 2012 Bioeconomy Strategy “Innovating for Sustainable Growth: A Bioeconomy for Europe” and its Action Plan—jointly developed by the Commissioners for Research and Innovation, Agriculture and Rural Development, Enterprise & Industry (now renamed as Internal Market, Industry, Entrepreneurship and SMEs), Environment, and Maritime Affairs & Fisheries. More recently, the “European Green Deal” highlights a growth strategy to transform the EU into a resource-efficient and competitive economy by 2050. OECD published in 2009 [5] “The Bioeconomy to 2030: designing a policy agenda” and has started a preliminary consultation process on a new study on bioeconomy and sustainability of the agricultural and food systems.

Several European countries have independently produced their own bioeconomy policies—for instance: France with “A Bioeconomy Strategy for France” (2017) that focuses on bioenergy, green chemicals, clusters, circular economy; Norway with the “Norwegian Bioeconomy Strategy” (2016) that offers an integrated approach to climate, the green shift, resource effectivity, low carbon society; Italy with “Bioeconomy in Italy” (2016), based on primary production and selected industrial sectors (chemical, biotechnology, and energy); Spain with “The Spanish Bioeconomy Strategy” (2015) with a focus on agriculture and food, and forestry, as well as industrial bio products and bioenergy from various sources of biomass; Finland with “The Finnish Bioeconomy Strategy”

(2014), focusing on forests, soil, fields, and water; Denmark with "Growth Plan for Water, Bio and Environmental solutions" (2013), and "Growth Plan for Food" (2013), with a focus on energy, agricultural industries, cosmetics, chemicals, and health care; Sweden, with the "Swedish Research and Innovation Strategy for a Bio-based Economy" (2012), and more recently "Från värdekedja till värdecykel—så får Sverige en mer cirkulär ekonomi" (2017), focusing mostly on forestry and bioenergy; Greece with the "National Circular Economy Strategy of the Hellenic Republic" (2019) by the Ministry of Environment and Energy, targeting sustainable resource management, support for circular economy and circular consumption; Germany with "National Research Strategy BioEconomy 2030" (2011), focusing on food security, sustainable agriculture, healthy nutrition, industrial processes, and bioenergy. Similarly, several other countries have developed their own bioeconomy strategies, in many cases with different focus areas and approaches—Dieckhoff, et al. [14,15] offer an extensive overview of various bioeconomy related initiatives around the world, while the Bioeconomy Council also offers an up-to-date online list at http://biooekonomierat.de/en/international0/.

In most cases the existing strategies mostly relate to waste management and remain either fragmented or otherwise limited. These strategies developed from pre-existing national policies, which in turn were drafted to address issues arising from increased pollution and waste, and thus were usually targeting well-defined and specific problems in the value chain. Thus, there is an inherently linear approach that still defines those policies and characterizes their way on addressing bioeconomy and CE issues. The emergence of value webs, complex market dynamics, co-opetition and industrial symbiosis structures, brings news challenges and drastically changes both market conduct and the way we understand the new markets, therefore restricting the effectiveness of such approaches, and in some cases even rendering them obsolete. One characteristic example lies in the food sector, and specifically on the meat industry, where CE developments require extensive collaboration across the value webs and significant material flows among the market players. In many cases, the existing regulations narrowly target specific areas of the old value chain, where different actors are responsible for different segments in the value chain—e.g., meat transportation in Sweden lies in the oversight of different institutions, some on local and some on national level, depending on where the material is physically located; such fragmentation raises several issues that relate to jurisdiction, competence, enforcement, and collaboration, among others.

A MODEST PROPOSAL TOWARDS CIRCULAR REGULATIONS (CR)

Central in the discussion on bioeconomy advancement is the continuous and, in some cases, unprecedented technology convergence. The author believes that bioeconomy initially emerged largely due to

technological advances and the intersection of various technologies and principles (e.g., chemical technologies, building and insulation materials, construction, energy production and storage, etc.) across different sectors. More recent developments, as in the case of GRIN (Genetics, Robotics, Information, and Nanotechnology), may further change the field even in ways that are impossible to predict (Poppe et al., 2013) [16]. However, technological breakthrough alone is not enough, and according to OECD (2009) [5] there are two key factors that will define the (economic) benefits from the bioeconomy: economic competitiveness of biotechnology, and the quality of governance. The former relates to the discussion on economic efficiency (as accessed by economists through the lens of competitiveness), while the latter raises the issue of adequate regulations and institutions; governance (deriving from the Greek κυβερνάειν, κυβερνῶ), in particular relates to both formal and informal structures and therefore can be context specific and influenced by local customs and traditions. *Enabling governance* involves various political support measures (e.g., grants, field investments, etc.) and *constraining governance* actively sets the frame for an effective and efficient framework of economic conduct (e.g., state regulation, specifically-targeted incentive schemes, etc.) (Dietz et al., 2018) [17]. For the most part the enabling part of governance seems to be adequately addressed with various schemes—e.g., the program BIONÆR—Bærekraftig verdiskaping i mat-og biobaserte næringer from the Norwegian Research Council (Norges forskningsråd). It is the constraining governance (i.e., the regulatory part), that, as discussed on previous sections, is mostly inadequate. Therefore regulations, although a more narrow concept than general governance, are particularly critical in the transition towards bioeconomy; they are open to public discourse, and can be negotiated and even contested, thus establishing frameworks of power and legitimacy that set the mental frame on market interactions, performance, and expectations from market players and institutions.

In the linear paradigm of the economy, regulatory arrangements have been typically designed to enhance competition, since it served as a path for greater efficiency: competition *is a means to an end*—i.e., ensuring efficiency in the market. Apart from non-market (government) failures (e.g., internalities and private goals, redundant and rising costs, derived externalities from governmental programs, distributional inequity, etc.), the potential market failures (e.g., externalities, monopolies, information, etc.) are dealt with mostly fragmented and complex regulations that are usually assessed through quantitative welfare proxies for specific groups—e.g., taxing negative externalities (e.g., petrol tax), subsidizing positive externalities (e.g., subsidies for public transport), specific legislature (e.g., ban on smoking advertising), etc. The key purpose lies in enhancing competition and through that, achieving higher efficiency in those market segments. Existing environmental regulations, although in many cases extensive and well-designed, face the shortcomings

highlighted on previous sections, namely that extensions of older regulatory frameworks are not sufficient when there is a paradigm change.

The transformation from linear economy to truly CE can be gradual and involve several stages where the economy operates in-between the two extremes (Kirchherr et al., 2017) [2]. CE closes the loop of the traditional linear economy through the maximization of both material and energy efficiency, and increased reusing/recycling/upcycling (through new developments in technologies and industrial symbiosis) as well as refusing/rethinking/reducing (replacing processes and industrial flows). Products may become services (i.e., providing a service that replaces an existing product) and what would be considered waste from one industry transfers as resource to another. Bioeconomy builds further on the CE both in terms of material utilization and innovative science and technology applications; it is typically envisioned in achieving economic, environmental, and social goals, and as such, wider stakeholder groups and civil society become naturally engaged. Industrial inputs are complemented or sometimes substituted by renewable bio-resources in processes that strongly favor inter-sectorial collaborations and innovation.

It is not the purpose of this article to compare and contrast bioeconomy vis-à-vis the traditional linear model, but evidently some of the fundamental concepts are altered: standard competition expands towards non-traditional competition forms and arrangements, as in the case of symbiosis, and welfare measurements now take account of the public interest of larger stakeholder groups, extending to the civil society at large, as well as nature. Symbiosis becomes particularly relevant in the CR discussion since the complex relationships on CE go beyond the standard competition paradigm and may include coopetition, indispensable synergies, and systems thinking (Sterman, 2000) [18]. In a similar vein, welfare implications are wider and extend across multiple economic levels and cohorts. Existing regulations, to a great extent, originate from pre-existing environmental policies that were inherently based on, or directly linked to the linear model of the economy, thus failing to properly reflect the paradigm shift that characterizes CE—for instance, the requirements for extensive value webs may contradict with anticompetitive legislation, while upcycle/reuse can become restricted by patents and other IPR regulations. The same may also hold for grants and other government benefits that largely are defined across specific sectors and come with restrictions on their usage within those sectors. In many cases when dealing with decentralized bioeconomy clusters (e.g., CHP plants on rural northern peripheries in Europe) the resulting situation resembles a localized natural monopoly, therefore opening questions for the role of the State in terms of competition regulation, taxation, etc.

Recognizing that bioeconomy applications are diverse and are still evolving, has lead several authors to explore how voluntary industry

standards may augment or in some instances replace regulatory frameworks and government interventions (DeBoer et al., 2020) [19]. The increased heterogeneity that emerges from bioeconomy applications, can become an element of competitive advantage for the private firm, thus the incentive for voluntary self-regulation. However, modern bioeconomy extensively relies on wide networks of interconnected actors that in many cases have to share value webs and, in some cases, can also be co-depended. Moreover, issues of IPR, natural monopolies, and temporal synergies can further complicate market relations, along with more traditional issues of market power and conduct. There can be diverse, complex, and evolving interests among market players, therefore voluntary schemes, although helpful, may be neither sufficient nor efficient (Chapardar, 2019) [20].

The term *circular regulations (CR)* is introduced for regulatory frameworks that are designed with a circular understanding of the economic activity. CR adopt an encompassing approach to regulatory design, covering issues of insurance, taxation, competition rules, contract structure, etc. The primary aim of CR is to internalize what is currently external to the typical for-profit firm—e.g., the efficient recycling and/or upcycling of materials becomes an explicit element for the objective of the firm. Circular Regulations directly reflect on Circular Economy, where *bioeconomy growth is informed by science, enabled by technology, driven by business, and supported by policies and institutional frameworks* (Figure 1). The science and technology push is shaped by technological advancements, some expected but some unpredictable. Businesses can take advantage of the new developments in order to increase efficiency and strengthen their market position, while enhancing their ability to respond to demand. Finally, good (enabling and constraining) governance, provides the necessary enabling environment, in terms of regulations and supportive institutions.

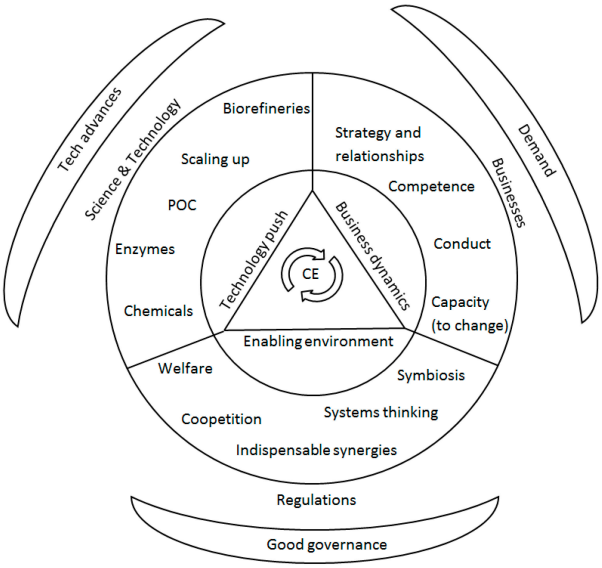

Figure 1. Pillars in CR development.

Ensuring the social perspectives in bioeconomy development will likely require significant public engagement, along with extensive involvement from the civil society and relevant NGOs. Therefore, the role of the State becomes critical at this early stage: from various subsidies, to securing early-stage demand, actively promoting industrial symbiosis and clustering, enabling Innovation Platforms, and IPR transfers. Furthermore, the civil society engagement, along with NGOs and open consultations with stakeholder groups, can help towards the acceptance of bioeconomy products/services—especially when coupled with necessary changes in consumer habits and behaviors (cf. GMO acceptance). The CR framework sets the foundations for an enabling environment, where the State, civil society, NGOs, and private actors can co-develop bioeconomy solutions. In doing so, CR opens for a combined effort from the fundamental (after establishing sovereignty) powers of the State, where regulatory, fiscal, and monetary policies coordinate towards bioeconomy advancement.

The CR are envisioned as offering a framework that initially works on two central levels: (i) framing bioeconomy-related concepts and processes, and (ii) minimizing the uncertainty from existing regulatory frameworks (Figure 2). Framing will both standardize and consolidate the various concepts (e.g., CE, bio-based economy, green economy, etc.) that are used interchangeably, although they can also mean different things to different people (Kirchherr et al., 2017) [2]. Uncertainty on regulatory developments is an issue that has been repeatedly identified as one of the major hinders for bioeconomy development. An efficient CR framework will take into consideration the necessary environmental constraints along with possible externalities and other social costs, without hindering any socially desirable innovations. The latter is particularly important for innovation-driven developments as in the case of bioeconomy, since regulatory frameworks can strongly affect such processes—e.g., GMOs (Just et al., 2006; Graff et al., 2009) [21,22], Golden Rice (Potrykus, 2010) [23]. Therefore, to properly design and implement CR one needs to distinguish between technology-related questions and welfare-related questions, and central to those questions are the underlying environmental and societal aspects. When something is evaluated as being environmentally friendly, it essentially leads to a technology question: maybe with today's technology it is a toxic waste, but in tomorrow's technology it becomes another input. On the other hand, when something is evaluated as being societal friendly (e.g., in terms of fairness and equality), it becomes dependent to business and regulatory restrictions: for instance, being compatible with the UN Sustainable Development Goals (SDGs) (Sachs, 2012) [24], it is therefore a question on conduct, market structure, etc. Issues on climate change and sustainability can also be seen as technology-related issues, giving rise to external arguments (e.g., the argument that climate is changing, and we cannot affect it easily)

or internal arguments (e.g., the argument that technology can potentially be developed to address changes in the environment).

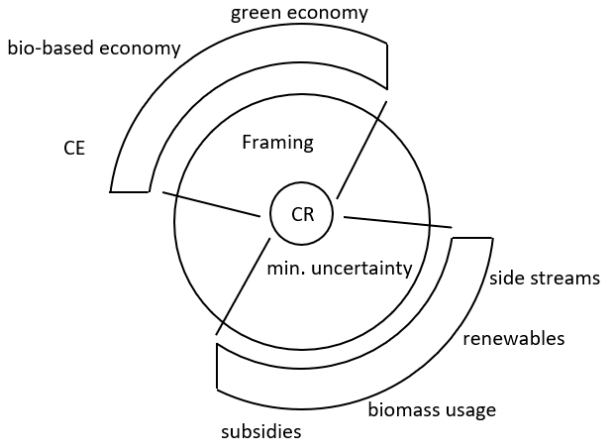

Figure 2. CR proposed framework: first levels.

In a broader sense, CR attempts to re-establish the balance between the ongoing changes in the market side and traditional regulatory elements. The former is characterized by new market dynamics, such as value webs, that create the demand for regulatory innovation; this demand is not met with existing frameworks, mostly due to their linear (or semi-linear) approach. The continued reliance on existing regulatory frameworks while facing a paradigm shift is an oxymoron that the CR addresses.

A practical way to implement CR development is by engaging Innovation Platforms (IP), thus bringing together researchers, actors in the value chains, civil society, and relevant authorities—especially on local levels (Elzen et al., 2012; Schut et al., 2015) [25,26]. The IP structure has the capacity to facilitate regulatory innovation, especially when facing a paradigm shift that requires significant restructuring of various market and institutional elements—e.g., production systems, institutions, value chains/webs, monitoring and accreditation issues, etc. (Roep et al., 2003; van Mierlo and Totin, 2014) [27,28]. A central component in IP is the ongoing dialogue among the participants, and through this iterative feedback process loop the re-evaluation of CR development and proper adjustments. The latter can be particularly important in the case of bioeconomy, since it is still developing and there is a continuous need for reassessment and adaptation. IPs can further help reveal barriers and contradictions that hinder bioeconomy growth, and their synthesizing capacity can help to set the frame towards encompassing CR development.

SHORT SUMMARY

The transition to the modern bioeconomy is fueled by new knowledge and developments in technology, that give rise to new products/services that are renewable and have the capacity to become economically relevant. CR suggests a broad meta-level regulatory framework that

attempts to bridge the gap between existing linear (or semi-linear) regulatory structures and the ongoing paradigm shift in the markets. At a first level, CR can help frame the relevant concepts and minimize regulatory uncertainty, while ensuring the social perspectives in bioeconomy development. A practical way towards CR development is through IPs; they can provide the necessary tools for an encompassing CR design that can facilitate the bioeconomy transition, where technological innovation and business dynamics are supported by enabling environments.

CONFLICTS OF INTEREST

The author declares that there is no conflict of interest.

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