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A Just Transition to Circular Economy

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A Just Transition to Circular Economy

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A Just Transition to Circular Economy

PROJECT No. 101003491

Just2ce will assess the current state of transition towards the circular economy in relevant economic sectors and analyse possible transition scenarios, as well as their outcomes and impacts. It will identify the key factors that can stimulate or hinder this transition. Natural resources are extracted and transformed into products, which are eventually discarded. As many natural resources are finite, it is important to keep materials in circulation for as long as possible. This makes the transition to a circular economy more vital than ever but is a responsible, inclusive, and socially just transition to a circular economy possible or even desirable? What technical, political, and social factors can enable or hamper such transformation? The EU-funded JUST2CE project will answer these questions. It will explore the economic, societal, gender and policy implications of the circular economy paradigm. The project's findings will shed light on how to ensure democratic and participatory mechanisms when designing and managing such technology.

History Chart

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V1.0	31.10.2022	Dilay Celebi, Ben Purvis, Mario Pansera, Tess Doezema, Vassiliki Miladi

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JUST2CE
A Just Transition to Circular Economy

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List of abbreviations

AIRR	*Anticipation, Inclusion, Reflection, Responsiveness*
CE	*Circular Economy*
CSR	*Corporate Social Responsibility*
CTA	*Constructive Technology Assessment*
DSS	*Decision Support System*
EC	*European Commission*
ERA	*European Research Area*
eTA	*Ethical technology assessment*
RRI	*Responsible Research & Innovation*
R&I	*Research & Innovation*
SDGs	*Sustainable Development Goals*
S-LCA	*Social Life-cycle Assessment*
SME	*Small-Medium Enterprise*

Executive summary

This deliverable reports the findings of Task 3.2: Development of a conceptual RRI framework for Circular Economy (CE). The aim of the task is to develop a framework for designing CE practices that include the principles of RRI. It presents an array of techniques and methods to integrate the RRI keys and the AIRR dimensions into the design of CE initiatives, particularly offering:

- Public engagement and co-production techniques to support the involvement of the public and a wider array of stakeholders in CE projects. This includes focus groups, deliberative mapping, science shops, consensus conferences among others.
- Anticipation tools such as horizon scanning and foresight techniques, vision assessments and technology assessment tools.
- Reflexivity exercises such as codes of conduct, moratoriums, ethical technology assessment, embedding social scientists and ethicists in CE projects.
- A set of RRI indicators from MoRRI and SuperMoRRI to assess and monitor CE projects.
- The AIRR framework and grounding of its dimensions within the wider CE literature.

It presents a critical assessment of the CE paradigm alongside each of the AIRR dimensions in turn, considering how they can engender a just and responsible approach to the CE transition. Finally, it brings together these critical assessments to present a tentative framework for embedding RRI practices into the development of CE initiatives.

The framework is designed to create new tools and methods oriented to industry, Small-Medium Enterprises (SMEs), cooperatives and community-based initiatives to consider social, environmental and economic aspects, and particularly to include gendered innovation and global environmental justice among criteria for the design of circular business models. The framework also supports creating incentives and developing strategic governance mechanisms that enable the transition to a CE and contribute to the effective implementation of the Sustainable Development Goals (SDGs) in Europe. The outcome of this deliverable directly feeds the development of a Decision Support System (DSS) (WP4).

1. Introduction

In the last decade, the Circular Economy (CE) has gained increasing attention within business, policy, and academic spheres as an umbrella term for a range of approaches which seek to reduce dependence on 'linear' models of societal production and consumption (Korhonen et al., 2018; Homrich et al., 2018). Necessarily, various critical strands have arisen in the academic literature which question the frameworks of value which underpin narratives of circularity (Lowe & Genovese 2022, Pansera & Genovese, 2021), and crucially question the desirability of a 'circular' future which doesn't centre on principles of environmental and social justice (Harris et al. 2021; Lonca et al. 2021).

The transition to a CE must therefore be a *just* transition (Velicu & Barca, 2020), looking beyond recycling, waste management and technological 'fixes' to consider social transformation. To better answer who *should* benefit from the transition to a CE, we draw on the concept of Responsible Research & Innovation (RRI) as a process which emphasises the centrality of social actors and local communities as active participants in the development of new practices. By embedding a critical consideration of CE within the 'anticipation, inclusion, reflection, and responsiveness' (AIRR) dimensions of RRI (Owen et al., 2013), we suggest a framework to support the design of responsible CE practices.

Inigo and Blok (2019) successfully set the ground for a more-strongly socio-ethically grounded CE by integrating RRI as an innovation governance framework. In this work, we extend their approach over discussions on how each of the AIRR dimensions can support better addressing social challenges raised by CE and enhance our understanding of how the major problems, possibilities, and constraints of the CE concept can be tackled in the implementation of the CE, beyond recycling and technological research. To that end, the suggested framework attempts to sketch a conceptual approach for a just transition to CE, with the goal of presenting the major interventions that could strengthen the CE transition process across environmental, social, ethical, and fairness values. The framework also offers a systematic approach to fostering thoroughness and reliability in the understanding of socio-technical issues fundamental to decision-making processes for the CE transition. Our intention is not to present a comprehensive recipe or solution to socio-technical issues raised by the CE transition, but rather to provide a starting point for future refinement and enrichment of the decision context faced by relevant groups.

2. A review and discussion of "tools" of intervention proposed by existing RRI literature

2.1 Overview of RRI concepts and dimensions

RRI is a multi-faceted concept that may be described in a variety of ways. The European Commission (EC) describes RRI as "an approach that anticipates and assesses potential implications and societal expectations concerning research and innovation, with the aim to foster the design of inclusive and sustainable research and innovation.[1]" Under this definition of RRI, the concept is also defined by five so-called RRI keys; Ethics; Gender; Open Access; Science Education; and Societal/ Public Engagement (Roger et al, 2015). Meanwhile, the concept has attracted significant scholarly interest (Schomberg and Hankins, 2019) and alternative definitions of RRI have grown in popularity, most notably the AIRR dimensions (anticipation, inclusion, reflection, and responsiveness), which are also known as RRI process dimensions (Owen et al., 2013). According to Von Schomberg (2013), RRI should be recognized as an approach for stakeholders to become collectively responsive to each other and anticipate research & innovation (R&I) consequences underlying the challenges of our time for which they bear responsibility. This strategy necessitates wider foresight and impact assessments for technological advances further than their projected market benefits and risks.

RRI reflects a variety of goals, including avoiding unintended effects, bringing innovation into line with society's expectations, and democratising research by exposing it to a larger range of viewpoints, especially when research goes against fundamental values (Ribeiro et al. 2017).

2.2 The RRI Keys

2.2.1 Ethics

Research ethics, scientific integrity, and critical reasoning on social implications of science and technology are all key terms used in the RRI framework to describe ethics (Grinbaum and Groves 2013). This viewpoint has been developed and is particularly reinforced by other RRI-related EU projects.

[1] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsibleresearch-innovation

While it is common to encounter ethics in reference to monitoring instances of scientific misconduct and upholding ethical standards in research, in the context of RRI, the term has a deeper meaning. An ethical perspective on RRI also takes into account the transformational, innovative, and creative capacities of science and technology. This critical reflection discusses issues like the potential societal effects of science and technology, the moral acceptability of scientific and technological advancements, the relationship between science and technology and societal values and norms, and the requirement to include the latter in research programs. From a sociological perspective, this highlights the need to facilitate two-way communication between researchers and members of the public in order to foster an environment of trust (Grinbaum and Politi 2019).

The availability of platforms for the expression of ethical concerns held by various stakeholder groups is seen as crucial in order to analyse what normative factors should be taken into account, with adequate attention paid to culturally specific norms. This can be done through formal debate in institutionalised contexts (as in the formation of policy at the global, European, or national levels) or through informal channels (Meijer and van de Klippe, 2020). Participatory and open public engagement activities, for instance, are frequently used to involve various groups of persons who may have a more casual role in the development of research. It is imperative that these initiatives prioritise openness, transparency, and accountability of procedures, as well as the explicit consideration of the concerns of disadvantaged stakeholder groups.

2.2.2 Science education

Despite the close connection between science education and public engagement, the science education key places more emphasis on critically examining the various ways that citizens can "comprehend and express opinions about science, as well as the ability to contribute to 'doing science'" (Talmon-Gros and Teichler, 2015). Theoretical grounding of the public engagement key also influences the theoretical foundation of this key, most notably the transition from a false premise of science literacy and scientific education toward one of co-production (Meijer and van de Klippe, 2020).

2.2.3 Gender equality

Three goals are outlined in the gender equality key for the EC's operationalization of RRI[2]:

1. Ensuring that research teams are evenly split between men and women. This is done to overcome structural disparities in research teams' gender composition, which has historically been dominated by men. It is significant that this target highlights both the overall balance and the gender balance at various institutional and management levels within the R&I ecosystem.

2. Decision making settings need to be more gender-balanced and equal. This implies that if panels, working groups, or other decision-making spaces are formed, gender equality must be considered.

3. The gender perspective should be included in R&I material. This will raise the overall quality of RRI outcomes and increase their relevance. Additionally, this integration will address the systemic undervaluation of gender-specific issues in knowledge creation.

In theory, the gender equality key of RRI expands beyond the EC's definition. In a social constructivist perspective, gender is seen as something that is created and maintained via performance rituals (e.g. Butler, 1990). Recognizing that gender is socially constructed necessitates paying attention to the ways in which gender categories are reinforced in everyday life. This also compels us to consider the interconnectedness of gender

[2] European Commission (EC). https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/democracy-and-rights/gender-equality-research-and-innovation_en

with other structural categories such as age, socioeconomic class, race/ethnicity, disability, sexual orientation, etc. Consequently, gender equality should be advanced through an intersectional lens to gender within the conceptual model (Hancock, 2007).

2.2.4 Open access

EC (2020) describes open access as "the global movement towards making research findings freely available to readers". The rationale for making research available to the public without a fee is generally premised on the idea that doing so will accelerate the development of a more efficient R&I system. It is anticipated that this may be achieved by making research results more easily accessible to public and private sector institutions and actors that could use them. Starting in 2012, the EC encouraged all Member States to make publicly available the findings of any research that received public funding (European Commission, 2012). Since then, the EC has adopted a more visionary model of open science, one that goes well beyond just envisioning the results of research being made publicly available. This would necessitate, where needed, greater disclosure of research methods and findings. Accordingly, the idea of open access was based on the overarching policy concept of open science and attempted to draw attention to the absence of institutional regulations, procedures, tools, and circumstances that would promote the publication of research methods and results (Van Den Eynden, 2014).

2.2.5 Governance

There are several facets of science and innovation policy that are highlighted under the governance key of RRI. First, “governance” was considered as consisting of “any form of coordination” (Groves, 2017), acknowledging that a larger view of governance involves the formulation of objectives, constructing methods, and assessing the success of the undertaken steps to achieving the specified goals. It is acknowledged that governance extends beyond the state, with the importance placed on the fact that it may and does take place at the level of particular institutions (including non-profits, universities, research funding organisations, and more). In addition, it is noted that governance occurs in a variety of social circumstances, some of which are more explicit than others, and that it is not limited to the form of rules for guidance or regulation (Gluckman & Wilsdon, 2016).

Each of the other keys of RRI is affected by the systems of governance in operation. Because of this, it's important to see how governance in one sense affects the other keys. Tools such as public deliberation methodologies, lay enrolment within expert committees, transparency guides, and structures encouraging multidisciplinary collaboration are among those recommended for supporting RRI, and they are all broadly in tune with a form entitled "anticipatory governance" (Barben et al., 2008).

2.2.6 Public engagement

Public engagement seeks to co-create the future of science and technology together with individuals and civil society groups, by including as many previously unconnected actors as possible (EC, 2019). Investigative literature on how the public interacts with science and technology is vast, multi-dimensional, and sometimes controversial. Given that one of the goals of RRI is to better align innovation with society, public engagement is considered a central element of the theory and practice of RRI.

2.3 Four dimensions of responsible innovation (AIRR)

While the underlying principles of RRI have been defined in a variety of ways by different authors, they all have one thing in common: the desire to draw on a wide range of viewpoints --both scholarly and public-- to better understand and address the unidentified biases and assumptions that shape technological progress. If

technologically advanced societies are also experimental ones, then RRI discussions should focus on how to increase citizen participation in decision-making about production and collaborative experimentation. Critics have pointed to the need to incorporate the ethical and political significance of an inherently unpredictable future into RRI in their attempts to define what such growth in democratic power may entail. Concepts like anticipation, reflexivity, inclusion, and responsiveness have been advanced as central to RRI by academics, research funding agencies, and policy actors who have engaged with this concept (Stilgoe et al., 2013). The anticipation-inclusion-reflexivity-responsiveness (AIRR) framework (Owen et al., 2013; Stilgoe et al., 2013) is one conceptualization of RRI; transparency is sometimes included as a fifth feature (Ravn et al. 2015). The AIRR framework is based on a line of questions (Table 1) that have emerged as crucial in public discussions regarding cutting-edge fields of science and technology (Stilgoe et al., 2013).

Each dimension in the AIRR framework has been briefly explained below but readers may refer to Stilgoe et al. (2013) for more a detailed description of the terms, conceptual and policy background, mechanisms and approaches that might articulate the dimension in practice and offer criteria and conditions for effective innovation governance.

Table 1 -Lines of questioning on responsible innovation (Source: Stilgoe et al., 2013).

Product questions	**Process questions**	**Purpose questions**
How will the risks and benefits be distributed?	How should standards be drawn up and applied?	Why are researchers doing it?
What other impacts can we anticipate?	How should risks and benefits be defined and measured?	Are these motivations transparent and in the public interest?
How might these change in the future?	Who is in control?	Who will benefit?
What don't we know about it?	Who is taking part?	What are they going to gain?
What might we never know about?	Who will take responsibility if things go wrong?	What are the alternatives?
	How do we know we are right?	

2.3.1 Anticipation

Fundamentally future-oriented, R&I has enormous potential to shape and influence our collective future (Grinbaum and Groves 2013). This necessitates anticipation: a contemplation of the future that involves theorising on the wide-ranging effects of current R&I activities and a reflection of our values and roles in these practices (Schomberg 2013; Owen et al. 2012; Stilgoe et al. 2013).

Anticipation is not the same as predicting the future, but rather relates to describing and analysing both intentional and potential (but unintentional) impacts under economic, social, or environmental contexts (Owen et al. 2012). Scenario planning, ethical technology assessment (eTA), vision analysis, constructive technology assessment, and anticipatory approaches to governance have been developed in the past to think forwards in science and technology (Klaassen et al., 2017). To avoid reinforcing certain visions and turning them into predefined guidelines or trajectories, these tools not only aid stakeholders in communicating their expectations, but also give ways to examine alternate outcomes and consequences that would otherwise be disregarded. Knowing how current dynamics and values affect the development of R&I is crucial for foresight. That's why

it's important to consider not only the possible outcomes of scientific achievements and what may go wrong but also the motives of those involved and the roles they play (Owen et al. 2012).

2.3.2 Inclusion

Inclusion refers to the expansion of R&I dialogues from top-down governance mechanisms and the increased inclusion of a wider variety of stakeholders (including the public) through small-group procedures and other means (Ravn et al., 2015). Incorporating stakeholder viewpoints into technology development has been recommended as a means of enhancing stakeholder confidence in the innovation process (Asveld et al. 2015). As examples of different approaches, Wickson and Carew (2014) cited the purposeful use of transdisciplinary processes, publicly and actively seeking critical feedback, and enabling transformational mutual learning. Citizen panels, focus groups, lay representation of governance groups, and user-centred design are all techniques that promote inclusion (Stilgoe et al. 2013).

2.3.3 Reflexivity

If irresponsibility in R&I is a symptom of the innovation ecosystem, then both individuals and institutions must reflect on their value systems and work together to strengthen the community's reflexive abilities. At the institutional level, reflexivity is defined by Stilgoe et al. (2013) as "holding a mirror up to one's activities, commitments and assumptions, being aware of the limits of knowledge and being mindful that a particular framing of an issue may not be universally held". The usefulness of various sources of information and views is enhanced through the process of reflexivity, or rather reflexive learning, which entails both "awareness into the assumptions which tacitly affect our understandings and interactions" (Chilvers, 2012).

2.3.4 Responsiveness

Responsiveness refers to the ability of institutions to reflect and respond to new knowledge, emerging perspectives, views and norms (Stilgoe, 2013). Extracting over a shared understanding in the literature, Nielsen (2016) defines responsiveness as: "the ability of one actor to develop an answer (response) and react (respond) to external developments caused either by other actors (stakeholders in R&I) or the natural environment". From this perspective, societal challenges can be seen as opportunities for positive social and economic change, which, according to RRI, can be achieved through innovations so long as there are (ongoing) efforts to discuss and define the societal "right impacts" and "right processes" for putting them into action (Zwart et al., 2014).

Being responsive also refers to the interaction between innovators and other members of society. In this connection, cooperation and proactiveness are highlighted by actors' shared responsibility for shaping and guiding innovation in the direction of achieving the "correct impacts" (Sonck et. Al, 2017). This definition rules out practices like unidirectionally "pushing" information about new technologies to the public or "drawing" vital knowledge or confidence regarding acceptability from the public (Lee & Petts, 2013).

A list of key objectives, strategy proposals, and indicative techniques alongside the four dimensions of RRI is given in Annex 1.

3. A Review of existing tools and indicators to assess and monitor CE projects

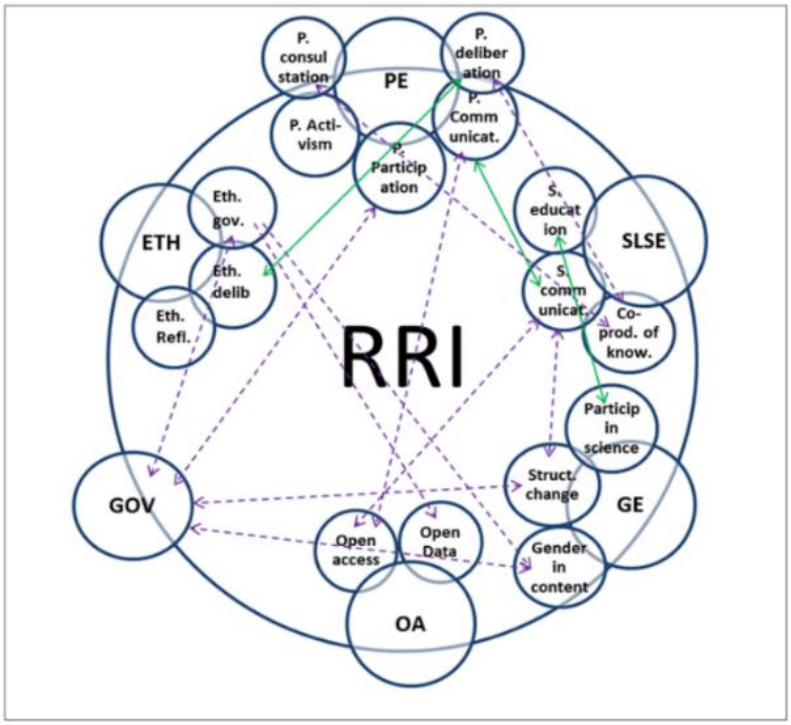
3.1 MoRRI - Monitoring the Evolution and Benefits of Responsible Research and Innovation

The European Research Area's (ERA) first comprehensive effort to design, implement, and evaluate an RRI monitoring system was the Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI) project (2014-2018). The MoRRI project, which can be seen as representing the summative evaluation approaches in RRI, created a conceptual framework and method based on the EC's current definition and framework of RRI to assess and measure the scope, benefits and problems of RRI within the ERA. In that context, an RRI monitoring system was established (Meijer et al., 2016), comprised of more than 36 indicators which were based on a study of literature on the six RRI keys which make up the EC's operationalization of RRI. The indicators are listed in Annex 2.

An essential point to emphasise is the overlapping nature of the keys; it follows that there are probably connections between the various indicators used to measure different keys. Figure 1 depicts the potential interconnections and overlaps between the various keys and the indicators used to measure them. The solid arrows in Figure 1 denote connections that were directly evaluated during indicator generation, whereas the dashed arrows denote connections that require more theoretical investigation. It is possible to tell if the relationship between the indicators/keys is unidirectional or bidirectional based on the direction of the arrows, which represent the supposed flow of causality between the linkages.

Figure 1 - Existing and potential interlinkages between RRI keys in MoRRI, Source: (European Commission, 2015a) MoRRI Progress Report, D3.2.

The indicators developed in MoRRI have been subject to criticism by researchers and representatives from research funding organisations in terms of reliability and coverage, initiating discussions aimed at the development of a new form of assessment which would focus on the transformative potential of the indicators rather than their representational accuracy (Klippe, 2022). For example, there is little opportunity to acquire knowledge from the set of questions when asked in the context of closed-response questionnaires or surveys as it is implemented in MoRRI. Closed answer surveys, questionnaires, and other highly quantitative approaches for monitoring RRI run the risk of justifying constrained interpretations of its application and construction. A detailed analysis of the MoRRI indicators with a critique of risks in their implementation can be found in Wooley et al. (2020). The project Super MoRRI is based on the reflection on what should be improved from MoRRI (ibid.) around the question: "how might the results of MoRRI be discussed in a



participatory way to instigate further institutional change?" The project focuses on the divergence between (national, institutional, disciplinary, etc.) contexts in the relevance or interpretation of the six RRI keys,and investigates what components of RRI have been excluded as a consequence of selecting these keys. Accordingly, Super MoRRI emphasises the transformational potential of monitoring and evaluation while making use of the chance to leverage current tools that have been created in the context of other RRI projects. Indeed, during these more open evaluation activities, questionnaires or metrics might be employed and generated for later analysis to facilitate institutional learning.

3.2 RRI Tools Project

The RRI Tools project, supported by the European Union's Seventh Framework Programme (2007-2013), is another significant attempt to transform major guiding concepts of RRI into a compilation of best practices to support academics and practitioners. An online platform of RRI-related tools has been established as part of the RRI tools project to facilitate dialogue and education about the concept and its application.

In the RRI tools project, conceptualization of the RRI dimension is described as diverse and inclusive, anticipatory and reflective, open and transparent, and responsive and adaptive. Engagement of all social actors, gender equality, science literacy and education, open access, and ethics are the five pillars of this approach; governance is included as a sixth pillar (Ravn et al. 2015). The dimensions of RRI defined by the RRI Tools Project are based on AIRR, however, redefined to cover the process requirements determined by the project: (1) Diversity and Inclusion, (2) Anticipation and Reflection, (3) Openness and Transparency, and (4) Responsiveness and Adaptive Change. The definitions are very similar to those of Stilgoe et al. (2013). Diversity and Inclusion refer to the early participation of a broad variety of stakeholders and audiences in the discursive and decision-making activities that take place throughout R&I processes. Anticipation and reflection are the understanding of how the dynamics of R&I create the future, imagining the effects of plausible and alternative R&I futures, and reflecting on (alternative) issue definitions, preferred solutions, and underlying values, assumptions, and beliefs. The honest and transparent representation of R&I processes in society is referred to as openness and transparency. The ability to alter current thought and behaviour patterns as well as overarching organisational structures and systems in response to shifting conditions, new information and value perspectives, viewpoints, and concerns is referred to as responsiveness and adaptive change (Klaassen et al., 2017). Over a detailed analysis of the tool provided on the project website[3], we mapped the principal framework of the RRI Self-Reflection Tool with AIRR dimensions. The findings are presented in Table 2.

Table 2 – A mapping of RRI Self-Reflection Tool with AIRR dimensions

	Anticipation	**Responsiveness**	**Inclusion**	**Reflexivity**
Ethics	Codes of conduct for research integrity Anticipating the benefits and risks	Actions to prevent potentially harmful impacts on the public or the environment	Stakeholder involvement in decision making Acknowledging different values, interests and ideals	Codes of conduct for research integrity

[3] https://rri-tools.eu/self-reflection-tool

Gender	Having specific actions and criteria for evaluating gender equality	Addressing gender equality R&I practices (sex and gender considered in research topics, methodology, data, dissemination activities…)	Having a gender equality plan Gender equality practices (gender-balanced teams and management positions, family-friendly work spaces, equal salary guarantees and contract conditions...)	Identifying and avoiding gender stereotypes in activities Avoiding biased attitudes, treatments and discrimination
Open Access	Transparency of the work ownership and the outcomes	Practising open science	Sharing the results of the work with all actors involved or affected Ensuring accessibility to communication activities	Implementing open access policies Transparency of framework conditions (structures for feedback and decision trails, overview of financial means and expenditures, declaration of interests and affiliations of all actors...)
Public Engagement	Public discussion sessions	Ensuring that stakeholders understand and accept their roles and the objectives of their engagement Including stakeholders' views in actions Receiving ongoing input and feedback from stakeholders	Engaging stakeholders and public in decision making Collaboration of diverse stakeholders through co-creation methods Partnering with other venues to offer R&I experiences	Leveraging social media to promote reflection Understanding effects of engagement activities on public participants and on the R&I processes Evaluating the significance of engagement activities on R&I processes
Governance	Being open to emerging societal needs	Responding to emerging knowledge perspectives, views, and norms Investing resources to make innovations more responsive to societal needs and concerns	Making policies and strategies open and transparent to all actors Creating/implementing structures that enable engagement	Changing the research plan, if needed, in response to unforeseen results RRI-related training
Science Education	Conferring on different values, needs and perceptions, such as health inequality, animal welfare, fair investment. Making room for deliberations on how to frame R&I questions	Increasing stakeholder awareness that R&I can create solutions affecting their daily lives	Encouraging stakeholder participation in R&I	Supporting citizens in making informed decisions

3.3 A review of RRI Tools and projects aiming the private sector

As the CE transition process will likely be led by private companies, this section focuses on indicators of RRI as implemented in the private sector.

Although a large body of RRI literature stresses the need for partnerships with industry and private firms to ensure that R&I results are both environmentally and socially responsible, there is little enthusiasm on the part of the business sector (Silva et al., 2018). Timmermans (2017) reports that just 10% of those engaged in RRI had any sort of corporate affiliation. The following factors have been proposed as explanations for business owners' disengagement: (1) RRI lacks definition and clarity due to the variety of similar concepts and approaches (e.g. social innovation, sustainable innovation, open innovation); (2) RRI emphasises science and technological development and fails to address important stages of the innovation lifecycle (e.g. commercialization); (3) the RRI concept has been implemented primarily in the context of publicly funded research, with little effort to adapt and operationalize it for the business sector; (4) organisations in the commercial and industrial sectors are viewed more as targets than collaborators on RRI initiatives (Silva et al., 2018). Therefore, it is maybe not unexpected that industry is not paying more attention to the current discussions of RRI. This is a major concern since the creation of new technologies frequently necessitates substantial capital expenditures and the knowledge, talent, and experience of those working in the industrial sector.

The primary distinction between RRI and more conventional approaches to the social contract between innovation and society, such as Corporate Social Responsibility (CSR) models, is in the importance placed on involvement and the methods used to develop it. RRI affirms outward-looking engagement as the central means of making innovation practices more reflexive and of understanding what it is for innovation to be socially responsive, whereas traditional CSR has attributed a significant role in making business more socially responsive to inward-looking codes of conduct (Groves, 2017). RRI places more emphasis on the early stages of a product's creation and life cycle, and therefore on the R&I stages, as opposed to CSR activities, which often apply to a company's entire conduct (Gurzawska & Porcari, 2016; Chatfield et al., 2017).

RRI relates to two fundamental business challenges: the worldwide battle to innovate to preserve competitive advantage and the effort to maintain public business confidence. RRI integrates essential business concerns into societal challenges, making it a potential avenue for enterprises to manage these issues for the wellbeing of individuals, communities, countries, regions, and global society (Martinuzzi, 2018). By systematically preventing problems before they become urgent, directing innovation capacity toward areas with significant potential for positive social impact, and leveraging multi-stakeholder networks for the development of systemic solutions to grand societal challenges, it may help businesses regain public trust and legitimacy. Accordingly, several projects and toolkits have been developed for the engagement of RRI in research and advocacy in business. Below, the most prominent examples of such actions and projects are briefly discussed.

The PRISMA project’s goal is to coordinate and support action dedicated to exploring and promoting RRI in the industry. PRISMA suggests that the decision to support RRI within an organisation should come from the top management and be implemented across the board. Even if strong management support is required, the presence of an RRI promoter at other levels of a company (a bottom-up method) is desirable and can be employed as a complement to the top-down approach (Porcari et al., 2020).

Table 3 - Possible RRI Tools and Indicators that may contribute to RRI dimensions (Adapted from Van de Poel et al. (2017) and PRISMA[4] KPIs)

RRI Dimension	Possible Tools	KPIs	Example Quantitative parameters
Anticipation	Scenario building Scenario workshops Foresight studies Technology assessment Life cycle assessment	Anticipating social effects of innovations	Nr. of R&I/R&D projects per year where internal/external stakeholders were involved from the early stages in product development
			Nr. of consultancy initiatives with other innovators and external advisors to discuss and identify the social impacts of R&I/R&D projects
Inclusiveness	Stakeholder mapping Stakeholder engagement strategies Stakeholder dialogues Public dialogues User-centred design	Stakeholder engagement	Nr. of stakeholder engagement initiatives organized per year by the company
			Nr. of R&I/R&D projects per year where active stakeholder engagement is foreseen in R&I/R&D plans
			Nr. of R&I/R&D projects per year where engagement with end-users has been performed
		Gender diversity	Percentage of men and women involved in R&I/R&D function/teams in the company
Reflexivity	Codes of conduct Core values Embedded ethicists and social scientists	Awareness of moral values	Nr. of training sessions/meetings per year to learn and reflect on moral values connected to innovation strategy and core business
		Active monitoring of RRI impacts	Percentage of R&I/R&D projects per year that apply impact analysis strategies (e.g. risk management, ethical/social impact analysis, etc.)
			Formal external auditing procedures (at least on a yearly basis) are in place to monitor the non-financial values of the company
		Transparency and accountability about RRI-relevant choices	Formal communication strategy is established at company level to ensure most relevant RRI choices are explained in key company documents and/or the website
			Nr. of open access publications
			Nr. of patents per year aiming to integrate nonfinancial values.
Responsiveness	To values and needs: Value sensitive design Stage-gate approaches Sustainable design	Awareness of ethical issues	Nr. of training sessions/meetings per year aiming to reflect on integration of social and ethical values into specific R&I/R&D projects
		Learning mechanisms to address public and social values in product development	Nr. of user-centered approaches per year formally integrated into the company innovation model (e.g. user-centered design, co-creation)
	To new developments: Monitoring Gradual scaling-up Adaptive risk management Living labs and social experimentation Flexible and adaptive design	Embedding moral values in innovations	RRI principles formally integrated into the company's mission and vision (e.g. ethical code of conduct) Nr. of R&I/R&D projects per year where moral values are actively and included into innovation strategies and technological design

In an attempt to investigate how RRI concepts may be incorporated into the innovation processes of start-ups that focus on sustainability, Long et al. (2020) created a tool called responsible management of innovation (RMoI) that offers innovators a systematic means to recognize and take into account socio-ethical risks and possibilities. The RMoI tool incorporates a number of stages and draws on RI, technological philosophy, and design for usability ideas. Incorporating the Product Impact Tool (PIT) (Dorrestijn, 2017), which draws on ideas from philosophy of technology and design for usability, the RMoI tool further develops and expands

[4] https://www.rri-prisma.eu/

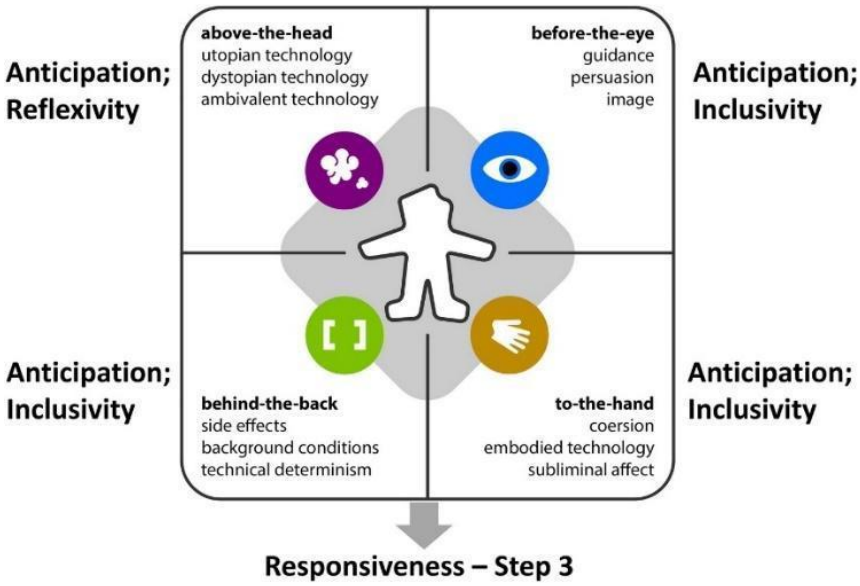
upon the principles of RRI (Long et al., 2020). They have also listed a range of methods that can be used to foresee socio-ethical problems in relation to possibilities (fixing societal problems) and risks (socio-ethical barriers) as in Table 3.

Table 4 – Methods of RRI, Source: Long et al. (2020)

Anticipation	**Inclusion**
Scenario thinking Value Mapping Ideation for business modelling	Crowdsourcing Collaborative business modelling Living lab structures Partnerships Consultancy of experts Focus groups Integrating views and opinions
Reflexivity	**Responsiveness**
Formal Evaluations Third party critical appraisal Informal (self-) assessment culture Knowledge-concept process mechanisms Empowered and open communication	Customising or mainstreaming Preventing organisational inertia Adjust/withdraw innovation Monitor external environment post innovation introduction

Since PIT was primarily developed in order to aid in anticipation, deliberation and reflexivity dimensions in product development, the RMol tool does not cover all aspects of R&I, as depicted in Figure 2.

Figure 2-Illustration of how R&I dimensions are incorporated into the Product Impact Tool. (Source: Long et al. (2020))



Fraaije and Flipse (2020) argue that the adoption of RRI dimensions in practice is hampered by a lack of understanding of how they interact. The need for integrated RRI has also been stressed by Stilgoe et al. (2013).

They agree that while certain RRI dimensions may complement one another, others may be in conflict with one another. For instance, higher reflexivity may result in greater inclusiveness, or vice versa. But these factors could also be in conflict with one another and lead to further disputes. Although it may be opposed by scientists who want to maintain their autonomy or who have already committed to certain paths, anticipation can promote more engagement (Stilgoe et al., 2013).

Under the assumption that RRI needed to be done in an integrated manner, Fraaije and Flipse (2020) created a framework for putting RRI into practice, based on an extensive literature reviewidentifying factors that indicate quality in responsible processes and products (qualifiers). They distinguished five process qualifiers of RRI (transparency, inclusion, reflexivity, anticipation and responsiveness) and three product qualifiers (societal relevance, market competitiveness and scientific quality). A summary of their suggested framework is given in Table 5.

Table 5 - Framework suggested by Fraaije and Flipse (2020) for putting RRI into practice

Dimension	**Qualifiers**
Transparency – communicates the bases of decisions and the distribution of the responsibilities to external publics.	Communicate transparently about assessment criteria Communicate transparently about the role of stakeholders Communicate transparently about any limitations with regard to transparency
Inclusion – takes in the societal aspects of an innovation, through e.g. stakeholder engagement.	Elicit meaningful contributions: Include many, diverse and fundamentally different stakeholder values Frame discussion together with stakeholders Empower stakeholders to contribute Allow product and process changes to occur in response to these contributions: Include stakeholders from the outset Include stakeholders for normative or substantive (rather than instrumental) reasons Retain a receptive attitude to feedback
Reflexivity – helps researchers to understand the social and ethical aspects of an innovation.	Recognize how personal values, scientific norms and institutional limitations shape decisions Challenge those drivers Gain understanding of how envisioned products impact and interact with society Gain understanding of how framing affects inclusion activities
Anticipation – provides an overview of possible outcomes and alternatives.	Define desirable societal (social, environmental, ethical and economic) impacts and outcomes Identify problematic societal impacts and outcomes Identify alternative routes to those impacts and outcomes Choose constructive and meaningful times to conduct anticipatory activities
Responsiveness – describes the making of responsible decisions in R&I.	Respond to societal values and perspectives Respond swiftly to changing values and perspectives Respond with substance
General recommendations – for RRI processes	Combine inclusive, reflexive, anticipatory activities Repeat inclusive, reflexive, anticipatory activities throughout the process Apply established methods Combine methods
Product – the desired outcomes of and necessary conditions for R&I.	Societal relevance: Product aims to make societal (social, sustainability) contributions Product respects relevant ethical norms Product is sufficiently concrete to be used in practice and in an equitable manner Viability: Product competes in current market economies Products are of high scientific quality

4. A critical discussion of CE literature under RRI dimensions:

The concept of CE as it stands today appears to prioritise economic aspects with primary benefits for the environment (either resource efficiency or environmental efficiency), and only implicit gains for social aspects. Only a limited number of authors emphasise the inclusion of social aspects in CE concepts, tools, and metrics. Korhonen et al. (2018) is an example of some of these voices; they stress the significance of incorporating a social objective within CE and identify the sharing economy, greater employment, and participative decisions as the key concerns to be covered. Kirchherr et al. (2017)'s definition[5] also suggests that a CE needs to promote "social equality". However, this is not intuitive, and it is open to dispute. Other authors, such as Borello et al. (2020), Padilla-Rivera et al. (2020), Inigo and Blok (2019), and Pansera et al. (2021), criticise CE for failing to explicitly address the social dimension. All of these authors agree and realise the importance of incorporating the social dimension into the CE agenda in order to support the global transition to a responsible CE. Thus, the transition to a CE must be seen via a socio-technological transition paradigm, in which existing production structures, business models, goods, and consuming behaviours undergo profound change. It would be crucial to check the plausibility of the necessary re-adjustment of human activities across various levels of analysis, including individuals, households, individual economic activities, economic sectors, and national economics, when developing scenarios for the transition to a CE. Incorporating the RRI into the CE could be a promising step toward achieving a responsible transition to a just CE in terms of diversity, inclusion, income and wealth distribution, employment and working conditions.

4.1 Anticipation in CE practices

One of the key components of RRI is the identification and consideration of potential future consequences and outcomes. Asking "what if" questions and being open to different alternatives are necessary for anticipation. In this dimension, it is crucial to consider potential futures systematically while comprehending the unforeseen and ambiguous mechanisms that control CE. As the generation of beneficial results for stakeholders is the goal of RRI, anticipation necessitates knowledge of the external environment and how it may interact with advances in the CE domain. For instance, how would CE affect social ideals like privacy and equality? For answering similar questions in a just transition to a CE, a sophisticated analysis is required. No matter whether a modelling/simulation-based approach or a data/experience-based approach is used, it necessitates a thorough understanding of the wider implications of CE. This is particularly more difficult for CE than a standard technological transition. The reasons are two-fold.

First, there is a high level of uncertainty in the socio-technical environment of CE. It is difficult to examine and evaluate circular systems' socio-economic and environmental effects holistically. The "Circular Economy System Diagram" from the Ellen MacArthur Foundation is a prime example of how discussions of the CE all too frequently depict the world as an engineering model with flows appearing to travel directly from consumer to collector to secondary processor to manufacturer back to consumer. The issue with this viewpoint is that it fails to recognize that CE is not just a limited domain technology, but a new economic system (Kirchherr et al., 2017). Between almost every stage in the CE, there is a market for final goods, end-of-life goods, unprocessed

[5] "*A circular economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating 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, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations.*"

scrap, semi-processed waste, recycled materials, refurbished products, second hand repaired items, and so on. This is significant because primary and secondary items directly compete in each of these marketplaces. Under this aspect, the CE seems promising because of the rivalry between primary and secondary commodities on the market; this competition gives rise to the possibility that primary goods and materials may be produced less as a result of secondary goods and materials. However, it also makes it harder to foresee how primary and secondary items would interact than an engineering diagram would imply (Zink and Geyer, 2017).

In other words, simply connecting waste streams from one process to inputs in another does not automatically assure reductions in environmental impact. Instead, it is necessary to look at the net consequences of increased secondary production by looking at all possible causal chains (Zink and Geyer 2016) in order to understand the impact of CE on the environment. Engineering models alone cannot predict the impacts of increased secondary production (the CE rebound). On the other hand, not all CE intentions are for the environment. For example, CE is generally viewed as a chance of arbitrage rather than ecology by profit-seeking companies. According to McKinsey & Company (2014), the most profits will be made, if secondary goods, components, and materials are marketed in a way that doesn't compete with current sales (i.e. primary manufacturing is not replaced). This indicates that just bringing the CE concept to free markets and profit-maximising businesses would almost certainly result in rebound. The early environmental benefits brought about by increased efficiency may be more than cancelled out by the total expansion of the economy (Korhonen et al., 2018). The resolution of this problem, the so-called Jevons paradox, is crucial to the successful implementation of a CE that does not have unintended negative consequences on the environment and society.

Second, the scope of CE practices is too broad to capture in an anticipation model. Numerous definitions of the CE appear to disregard social implications (they also tend to overemphasise positive over negative impacts), and stress mainly economic problems, while simplifying the environmental factor (Geissdoerfer et al., 2017). Kirchherr et al. (2017) found that economic growth was the most often cited objective among the practitioners, whereas social components like equality and the welfare of future generations were rarely addressed. Similarly, Murray et al. (2017) note that current CE research is essentially mute on the social dimension. There is also a lack of agreement on what these social advantages are, how they may be realised, and how the CE can eventually contribute to sustainable development, all of which only serves to deepen this neglect (Clube and Tennant, 2020). Although CE has a number of potential advantages for society, it is unclear how the CE concept, instruments, and social effect are conceptually related (Padilla-Rivera et al., 2020). This also makes it almost impossible to thoroughly predict social effects of the CE adoption on the stakeholder groups e.g. who wins and who loses, by which mechanism of power? Moreover, the most important aspect of anticipation, the time dimension, is excluded from most CE discussions (Geissdoerfer et al., 2017). Kirchherr et al. (2017) reported that only a single definition (by Geng et al., 2013) out of 114 CE definitions reviewed, takes time into account.

Another open question in understanding the potential socio-economic and environmental impacts of the CE is in its geographical scale. For example, there are still a lot of questions about whether adopting CE techniques in the "Global South" will have a good impact on sustainable development, job creation, and economic growth. Where the driving force towards a CE for the EU countries are the scarcity of the natural resources and environmental sustainability, for low- and middle-income countries, that may be "extracting value" from garbage as a source of secondary materials to provide incomes, create jobs, and eliminate poverty (Wright et al., 2019). Despite opportunities associated with CE transition in terms of generating wealth from waste especially among poor, marginalised communities, CE transition potentially entails negative outcomes such as environmental health risks particularly on vulnerable groups, especially women and children.

These issues present difficulties for CE research, innovation, and broader diffusion of CE practices with respect to anticipating and avoiding any negative effects. In this setting, the ceteris paribus condition ("all other things being equal"), which is used in the modelling of many engineering systems, rarely holds, and uncertainty increases as soon as we try to understand the mechanisms in the transition to a CE as a highly complicated system with several intricately interconnected subsystems. In this context, the anticipatory measures in RRI would undoubtedly be helpful in bringing some of the forthcoming difficulties to light and giving CE practices the depth and systemic thought, they need to facilitate the transition to a sustainable system (Reike et al., 2018). Even though the anticipatory component of RRI has been disputed, with some arguing that such future anticipation is speculative and doesn't adequately mitigate the dangers of uncertainty (Groves, 2015), a broad system transformation like the one maintained by the CE would always include some uncertainty. Indeed, there are many causes of uncertainty in CE systems; nevertheless, concentrating on these sources may allow for the delay of actions that are necessary for a just CE transition. Uncertainty is not merely an issue of lacking data or models; it is also a problem of ignorance, which may be decreased with more research and the participation of different stakeholders, cultures, and practices (Kovacic et al., 2019). Even though it may not be feasible to fully anticipate the environmental, social, and economic impacts of CE on all impacted groups due to the complexities of the system, rather than being neglected, uncertainties in CE transition must be examined, both of drivers of effects and of benefits associated with policy alternatives, in a consistent and methodical manner. Therefore, integrating RRI's anticipatory measures will undoubtedly assist in addressing the wider implications of the CE transition process (Inigo and Blok, 2019).

Nevertheless, utmost precaution is necessary in linking RRI with CE in order avoid the misleading assumption that CE will bring broader societal benefits as long as the transition process has been responsible. It would be naive to think that technology creators are aware of every impact of their research. The developers of technology are often taken by surprise by unfavourable side effects (Wright et al., 2011). The initial response to uncertainty is the Precautionary Principle (PP), which suggests stopping any innovation if full scientific knowledge of its consequences is not known. However, PP is probably not the best approach, due to being overly restrictive for developments, particularly in terms of policy making, limiting key technical and economic breakthroughs due to potential implications. Yet, the EU strategy heavily relies on the 'Innovation Principle'. Therefore, RRI represents a middle ground between the PP and the Innovation Principle to some extent (Jenkins et al., 2020).

Moreover, even though anticipation is a core element in RRI, the question of how to deal with uncertainties, particularly when the realisations are different than the expected outcomes, remains a focus of academic and policy debate. Current RRI literature lacks concepts and models for investigating the broader societal impact of innovations and a comprehensive analysis of how to comprehend and manage the societal and environmental effects of economic growth (Jakobsen et al., 2019). As a result, research on a just CE transition would probably benefit from interaction with the other areas of innovation and technology assessment studies, which also investigates topics such as, innovation and inequality (Cozzens & Thakur, 2014), inequality in the allocation of innovation benefits (Fløysand & Jakobsen, 2011), social life-cycle assessment (S-LCA) (Jørgensen et al., 2008), constructive technology assessment (CTA) (Schot and Rip, 1997; Rip, 2018), future-oriented technology analysis (Haegeman et al., 2013), value sensitive design (Friedman et al., 2013), anticipatory life-cycle assessment (Wender et al., 2014), and ethical technology assessment (eTA) (Palm and Hansson, 2006).

4.2 Inclusion in CE practices

An important lesson from RRI is the value of involving the appropriate stakeholders. A stakeholder is defined as “a major decision maker, actor, or sector that may benefit or suffer as a result of the change in question” (Sherman & Ford, 2014, p421). Due to the multi-scale nature of the CE, there are numerous stakeholders in the transition to a CE. By addressing diverse groups' specific needs and experiences, localised networks emerge as collaborative platforms that can influence transition plans and actions. Collaborative discussions should cultivate political groups in order to gain legal recognition of self-determination on a global scale (Urdezo et al., 2022). When significant interactions among policymakers, industry, and society groups are established, the necessary technical, financial, and political resources may initiate a just CE transformation.

A just CE should aim to identify all relevant parties, i.e., a wide range of agents and consequently, a wide range of liabilities. Furthermore, as many people as possible should be informed of the findings of an evaluation of CE practices. The specific social groups to be addressed determine the involvement and communication tactics. Future technology design and selection shouldn't be limited to a well-educated and articulate elite. Furthermore, increasing stakeholder engagement in decision-making extends beyond direct interactions with public entities and the business sector. Scientists, public society, and non-profit groups have several opportunities for enhancing cooperation for a just transition to CE. Establishing trust is essential to understanding and incorporating the diverse needs and roles of different stakeholders in establishing collaborations and local leadership in this process.

However, effective stakeholder engagement is difficult for a number of reasons. First, interactions between stakeholders are generally limited in size and scope. When looking at a project or a CE practice as a whole, it may be easy to overlook important issues about power relations and regulations. Inclusion can bring the opportunity to talk about the broader impact of changes brought about in pursuit of CE, but the conversations are more likely to be limited if they aren't relevant at a broader scale. This could mean two things: first that important questions can't be asked, and second, that researchers overestimate how much reflexivity can change their behaviour and norms.

Second, and maybe more importantly, over the course of the CE transition, involving stakeholders raises the issue of representation. The tools used to help people get involved don't always try to include people who represent "the whole society" (Van Lente et al., 2017). Instead, they focus on people who have a more immediate stake in the issues being talked about. But it's hard to say whether the invited actors have the same concerns and interests as those who aren't there. The criteria for the variety of groups included is interesting, but it doesn't help much in real life, especially for new concepts like CE whose publics haven't been formed yet. This could make these inclusion exercises less valid when public money or public decisions are at stake. More seriously, RRI doesn't consider which opinions to include, how to deal with the variety of ethically bound beliefs and values, and, more specifically, what to do when two different values (or conflicted opinions) can't be incorporated at the same time (Correljé et al., 2015). There may also exist strong power asymmetries in the current neoliberal world of misallocated governance. Therefore, stakeholder engagement should be seen as a critical component of the governance of innovation rather than as a replacement for policies and guidelines (Jenkins et al., 2020).

It's even more challenging to engage stakeholders effectively in developing nations, due to high levels of poverty, a lack of knowledge about adaptation options, a lack of understanding of risk, weak institutions, a lack of funding, and conflicting interests to address more urgent problems related to poverty and underdevelopment. According to Barnet and O'Neil (2010), disruptive pathways can occur when coping mechanisms lead to high

opportunity costs, diminished incentives, an unfair burden on the most vulnerable, or an increase in environmental problems. It is crucial to address these complex underlying factors in stakeholder engagement and CE transition interventions because vulnerability is primarily caused by a large and dynamic set of factors (Sherman and Ford, 2014).

In this context, RRI can be seen as an attempt to build a public sphere (Pearson et al., 2016) where different actors can debate and shape the process of transition to a just CE. The ethical aspect of this process is the process of critical reflection on the goals and values that CE is supposed to realise. One benefit of this approach is that it helps justify the choice of the key action points, which can be seen as contributing to the building of a *CE public sphere* in which a well-informed public can take part. With this reflection in mind, the criteria for choosing the methodology should be legitimate in terms of promoting the general goal of contributing to the construction of a CE public sphere, either directly through engagement with the public or indirectly through the production of materials that can be used to contribute to public debate about a just CE transition. In this situation, including stakeholders by making the CE transition process more open and reflective, would not only raise awareness about the issues in societal transformation towards a CE (Inigo and Blok, 2019), but also can help to lower social costs, which are frequently generated by negative societal impacts of conflicts between diverse stakeholders (Mies and Gold, 2021).

4.3. Reflexivity in CE practices

A third dimension in which RRI can be seen as a support for a just transition to CE transition relates to reflexivity: a reflection about the societal circumstances for reassessment of the practices and adjustment of the initiatives, but also about values and purposes. Reflexivity also comprises actors' ability to assess the success of their efforts and the numerous - and potentially unintended - consequences of their actions, and to adapt appropriately. Reflexivity is also highly related to “anticipation” since it also reflects the anticipatory capacity to deal with unexpected occurrences.

As discussed in the anticipation section, CE has many open issues in tackling economic, political, and sociocultural issues that may hamper a true reflexivity exercise in the transition period. First and foremost, the business environment that shapes the CE transition has been shaped by unequal power relations in a way that does not allow for the realization of a robust reflexive practice. CE transition is mostly led by global supply chains, which are currently under the authority of powerful nations and multinational corporations, and they are likely to keep taking up the resources and capital they require, escalating already existing inequities even in a circular system. Global lead enterprises, especially major purchasers or producers from the Global North, appear to be positioned to play a significant role in managing the transition to CE as rule-setters (Hofstetter, 2021). The negotiating power of these few giant enterprises are likely to be higher in the case of a conflict among the stakeholders on social and economic benefits (or harms) of CE associated decisions. Due to the economic bottom line taking precedence over other interests, the major role played by these enterprises in the CE transition may make it more difficult for other society actors to participate fully in the transition process. Furthermore, the move to a CE will need significant resources, requiring both public and private sector investments, but the tools to evaluate which firms or projects to support are immature. The transition trajectories may get trapped in ways that worsen power dependencies, widen the gap between high-income and low-income nations, cause rebound effects, or fail to take actions needed for strong sustainability (ibid.).

Second, as criticised widely by the academic literature (Korhonen et al., 2018; Kirchherr et al., 2017; Inigo and Blok, 2019, Pansera et al. 2021), one risk in the transition to a CE is that the stakeholders become too focused on the technicalities of CE and lose sight of the larger goals, or lose sight of the potential societal

implications of adopting the proposed technology — in short, the stakeholders may fail to exercise reflexivity when considering the development's goals and objectives. To prevent this, RRI suggests use of socio-technical scenarios, which can be used to motivate stakeholders to consider the societal consequences of their decisions about CE related projects and investments. Socio-technical scenarios put the emphasis on a variety of potential scenarios and on avoiding sticking on a specific instance of future. RRI places a strong focus on broadening the viewpoints of many stakeholders, encouraging reflection and learning, and (in the long run) starting co-evolving processes between technology and society (Pearson et al., 2016).

Present CE strategies do not adequately address the concerns of trade inequality. There is rising concern in the literature about the CE being predominantly employed as a protectionist approach to achieve economic advantage over other nations, rather than as a tool to meet concerns for sustainable development, given the present geopolitical environment (Barrie and Schröder, 2021). Developed nations import raw resources extensively from low-income nations. CE affects trade flows on basic raw materials, including extraction in foreign nations (Kettunen et al., 2019). Ideally, reducing resource demand will alleviate environmental strain in developing nations, improving environmental sustainability. However, exporting raw materials remains crucial to the economies of many low- and middle-income countries. The transition to circularity is likely to have a negative impact on such countries that heavily rely on 'linear' industries like mining, the production of non-repairable fast-moving consumer goods, textiles, and agriculture, as well as the export of these goods to higher-income nations. If international commerce in established goods and manufactures falls in the medium to long term, these nations will require help from the international community through tailored aid programs (Schröder, 2020). A just CE must offer answers to the numerous problems at a global scale. Therefore, a just transition will be shaped in large part by international collaboration to develop efficient and equitable governance institutions and policy coordination at regional, national, and local levels. As a response, it will be necessary to develop and implement multilateral technical assistance programs, especially to aid low- and middle-income nations.

4.4 Responsiveness in CE practices

The final dimension, responsiveness, refers to the ability of institutions to reflect and respond to new knowledge, emerging perspectives, views, and norms (Stilgoe et al., 2013). From this perspective, societal challenges can be seen as opportunities for positive social and economic change, which, according to RRI, can be achieved through innovations so long as there are (ongoing) efforts to discuss and define the societal "right impacts" and "right processes" for putting them into action (Zwart et al., 2014). Responsiveness also poses the fundamental question of how to govern innovation and thus CE initiatives. The major debate over how to make CE more responsive is whether the transition process could be made adaptable enough to take into account shifting contextual factors and observed immediate impacts. Although the process of anticipating the potential scenarios in a more open discussion of some important decisions through RRI, there is concern that such discussions might only result in the justification of decisions that have already been made rather than the more reflexive task of actually considering changing the project's objectives or results.

Thinking about larger socio-technical systems that might have an impact on the development and dissemination of the CE is another factor for responsiveness. Understanding such pathways is a key way to gauge the degree to which CE can be adapted at various stages of its socio-technical development and implementation. RRI may assist a fair CE transition by encouraging partners to be responsive and sensitive to potential social, economic, and environmental effects and/or misconceptions in the process. Technically focused initiatives run the risk of stakeholders mistakenly assuming that just outlining the development's advantages to external parties will convince them to use its offerings (Pearson et al., 2016). Through exposure to probable

misconceptions and even hostile responses, the stakeholders can be prepared for the reality of achieving societal impacts of the innovations, which can be a more complicated process than stakeholders may first assume.

5. A framework for a Responsible CE

This section outlines the design of a conceptual framework that would integrate RRI into the CE transition process to develop a shared understanding of the concepts, techniques, and instruments necessary to produce positive societal impacts, or motivate the 'right' processes to achieve just and fair CE goals. Figure 1 presents a schematic illustration of the conceptual framework we propose. The procedural part of the framework is very similar to those widely used for supporting the governance of transition processes. However, the overall framework is based on the 'Responsible CE Principles', which revolve around the AIRR dimensions.

RRI may support a just CE by addressing the growing concerns about the societal benefits at all levels. First, we argue that RRI, particularly under the framework of AIRR dimensions, may successfully define the values and visions that will shape the implementation of CE practices. As discussed in the previous section, RRI will build the grounds for understanding the potential impacts of both current and future developments, reflect the societal circumstances for reassessment of the practices, and respond accordingly in an inclusive manner. This support may arise in all territorial/governance levels, provided that it reflects the --maybe not common, but agreed-- values and visions of the society.

Actions and policies are necessary for the transition to a just CE and targets have a vital role in guiding this transition. Existing CE targets focus primarily on technical measures (i.e., those adopted by governments and organisations), examine specific indicators (e.g., targets on recycled materials), have a limited geographical focus, and refer to specific sectors or industries (e.g., energy or waste management) (Morseletto, 2020). Responsible CE principles guide the development of the targets for a just CE transition to produce positive societal impacts, by asking: which targets represent the societal and ethical values in the transition towards a CE? In this context, novel objectives are developed considering requirements and challenges in the economy and society. These are then elaborated by stakeholders from a variety of perspectives, including resources, operating models, industries, or CE strategies, regardless of economic sectors or geographical boundaries.

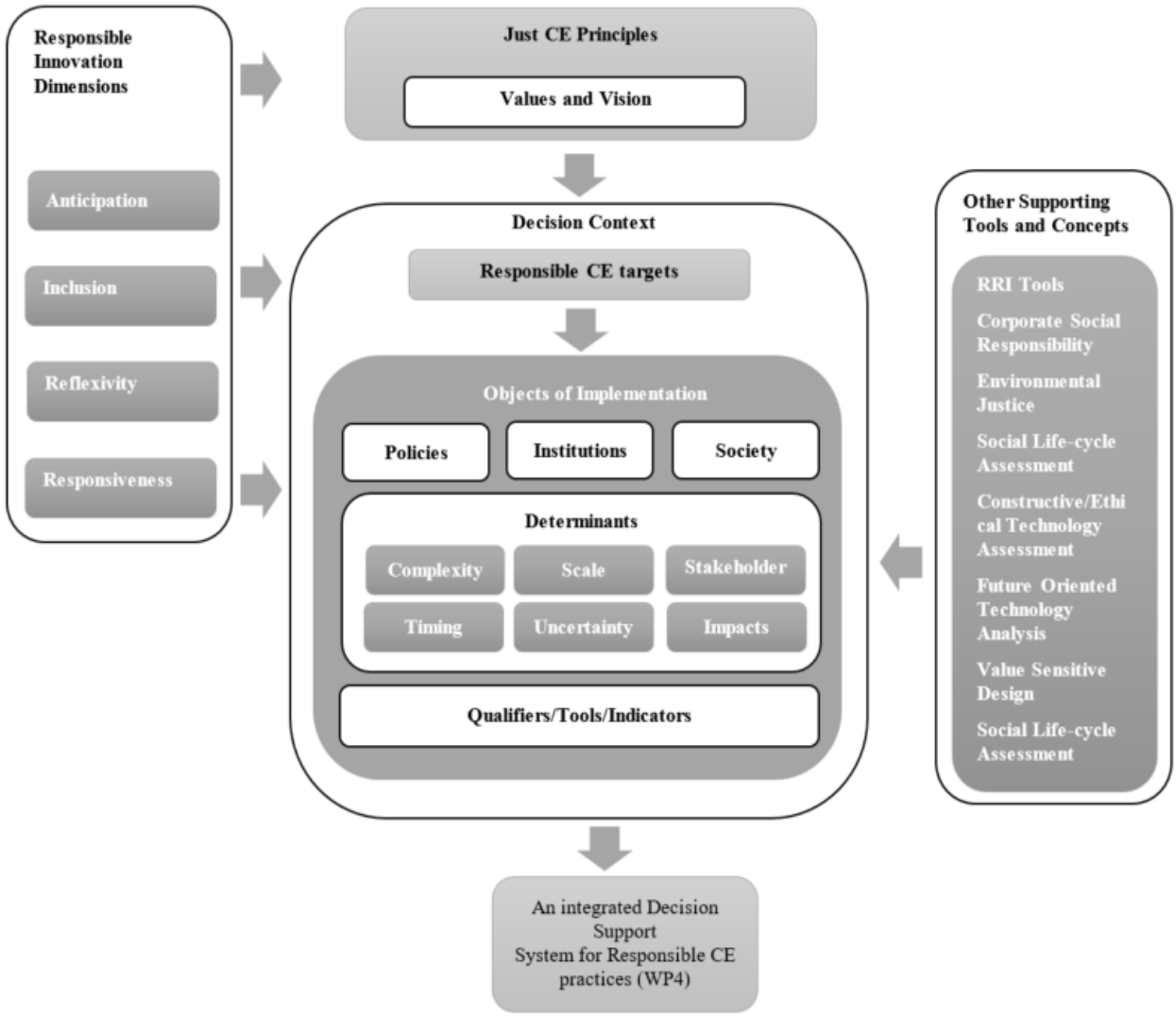
Therefore, at the next level, RRI displays concern about the targets of CE; it initiates a discussion about how CE might be achieved in an ethical, inclusive, and democratic manner. Similar to the values and vision, the responsible CE targets will largely vary according to the decision context it represents. RRI starts conversations on 'desirable' societal targets since it focuses on issues like how to guarantee the 'good' social outcomes from the CE transition. We acknowledge that CE targets are defined by the boundaries set by a long list of stakeholder groups, which may also vary significantly according to the sector it is implemented in, and other factors. In relation to the CE, the framework also constitutes several decision contexts and can have different objectives. Various stakeholders in the CE transition process can effectively be grouped under three categories: policy makers, institutions, and society. In the transition to a CE, the needs, interests, means, and objectives of these groups will be different as well as their responsibilities and action capabilities. Particularly, based on which stakeholder sets the targets, we expect to see many variations in the definition of "just" CE goals. However, we believe that, once defined by the agreed values and visions, the goals will lead to a concurred set of targets. Here, RRI helps create platforms for reflection and involvement in the decision-making mechanisms in the CE transition process. The motivations behind CE and its possible consequences need to be discussed in more depth. Connected to this is the fact that it's crucial for individuals who are impacted by the associated developments to be a part of thoughtful discussions, not just those who are actively engaged in the process. RRI may also be

used to redefine the idea of responsibility in CE. RRI advocates for an extended range of legitimate stakeholders with the ability to guide CE transition processes. Von Schomberg (2008) frames this notion as collective responsibility, which is a larger understanding of the players accountable for ensuring the positive impacts of CE transition activities.

Moreover, the decision context is bounded by various determinants, such as uncertainty or complexity, as discussed in Section 3. In the final level, even though it may not be feasible to fully anticipate the environmental, social, and economic impacts of CE on all impacted groups due to the complexities of the system, RRI ensures that, rather than being neglected, uncertainties in the CE transition must be examined consistently and methodically; both in terms of drivers of effects, and the benefits associated with policy alternatives. The framework, therefore, suggests shaping the decision context under 'Responsible CE Principles', encouraging stakeholder engagement in decision-making, such that scientists, public society, and non-profit groups have multiple opportunities for enhancing cooperation for a just transition to CE. The transition to a CE can only move forward and be as inclusive as possible with well-designed public policies.

Next to the AIRR principles, the framework benefits from an interaction with the other tools and concepts such as RRI Tools (based on the six keys defined by the EC), environmental justice, social life-cycle assessment (S-LCA), and future-oriented technology analysis. The list in Figure 1 is not exhaustive, and can be extended, but it shows examples of major tools and concepts that may support policy making and organisations both in terms of technical and conceptual aspects. For example, organisations may highly benefit from the tools and techniques suggested by the relatively longer studied and more implemented concept, CSR, which aims at ensuring corporations' domestic and international business actions are guided by moral principles and adhere to the highest ethical standards. Similarly, S-LCA can be a very useful tool to evaluate the effects of CE (Reinales et al., 2020).

Figure 3 - Conceptual Framework for a Responsible CE



Finally, the decision context also includes the qualifiers, tools, and indicators that may be used to implement the actions and policies and comparatively assess their impact on the CE transition process. CE assessment tools have come under scrutiny for many of the reasons already discussed above. In particular, it has been questioned how far tools which narrowly focus on 'circularity' as the goal itself can engender a transition to a desirable future (Moraga et al., 2019; Corona et al., 2019). Rebound effects aside (Zink and Geyer, 2017), it appears now to be commonly accepted that assessment of circularity must be complemented with a broader consideration of sustainability (Ellen MacArthur Foundation & ANSYS Granta, 2019, Oliveira et al., 2021). Yet, studies which assess these broader frameworks point towards a lack of attention given towards social dimensions, which when they appear are usually reduced to shallow quantitative indicators such as employment numbers (Padilla-Rivera, 2020; Calzolari et al., 2022).

A variety of other social development and RRI tools also provide a good basis to identify relevant tools and indicators to be the primary tools promoting a CE with the greatest social advantages. A commonly contested element in the literature relating to sustainability assessment more broadly relates to how such tools should be

developed and deployed in a manner which engages and empowers communities and marginalised actors (Turcu 2013; Kaika 2017). By embedding the AIRR principles into the development of such tools we become cognizant of the pitfalls we must navigate in order to produce and operationalise these in a responsible manner.

6. Conclusion

The CE has been generally presented as a technology-based set of solutions that would be able to combine the imperative of economic expansion that characterises the capitalist mode of production, with environmental concerns. Nevertheless, such a framing of circularity remains highly contested. According to an increasing number of scholars, this manifestation of CE is likely to be scientifically unsound, it over emphasises the role of technology and it almost totally neglects the social aspects of transition such as gender, labour and global environmental justice. The framework we propose here explicitly challenges the dominant framing of CE by drawing on the principles of RRI. It aims to provide conceptual guidance to imagine a just CE transition on one hand, to strike a balance between the desire to allow for additional options and for other points of view to be taken into account, as well as the necessity to deal with complexity for operational issues and policy support, on the other. Therefore, the framework encourages alternate thinking and reflection. Because democratic decision-making processes may entail society's norms, theories of equality, winner/loser settings, power distribution, and other factors that make determining an optimum impossible, the choice is made from among a set of alternative options evaluated in the intellectual concern of increasing reflexivity. Thus, the goal of the framework is to give methodologically sound and socially justified guidance to industry, society, and policymakers to consider and implement procedures that open alternatives and simplify the challenges of anticipation and inclusiveness. Our proposed approach is not meant to be a silver bullet for a just transition to CE, but instead participates in and aspires to positively inform a developing discourse on CE within the context of the notion of RRI. By questioning the boundaries around the CE transition process, and focusing on its outcomes, we hope to facilitate a better understanding of patterns that could underpin the CE from the macro to micro levels of environmental, social, ethical and fairness value.

Annex 1 - RRI's Key Objectives, Strategies and Techniques

A list of key objectives, strategy proposal, indicative techniques alongside the four dimensions of RRI. Adapted from Stilgoe et al. 2013 and Carbajo and Cabeza (2019).

Dimension	Key objectives	Strategies	Indicative techniques and approaches	Factors affecting implementation
Anticipation	Determining desired impacts and outcomes of innovation	Monitoring the innovation environment Identifying and understanding societal and/or environmental needs Determining the outputs and impacts Determining the social, environmental and/or economic value	Foresight studies Technology assessment Horizon scanning Scenario building Vision assessment Socio-literary techniques Life cycle assessment	Engaging with existing imaginaries Participation rather than prediction Plausibility Investment in scenario-building Scientific autonomy and reluctance to anticipate
	Preventing or mitigating negative impacts	Monitoring the innovation environment Assessing risks and impact of the innovation Assessment of possible negative consequences of the innovation		
	Development of roadmaps for impact	Developing forward and backward scenarios Developing and determining roadmaps Aligning business strategies with the impact vision		
Reflexivity	Actions and responsibilities	Third party critical appraisal inclusion Informal (self-) assessment culture inclusion	Multidisciplinary collaboration and training Embedded social scientists and ethicists in laboratories Ethical technology assessment Codes of conduct Moratoriums Embedded ethicists Core Values	Rethinking moral division of labour Enlarging or redefining role responsibilities Reflexive capacity among scientists and within institutions Connections made between research practice and governance
	Values and motivations	Prioritization of values and motivations Thinking about the effect of specific values on innovation governance and on its outcome(s) Determining how to deal with incompatible values and/or motivations		
	Knowledge and perceived realities	Scrutinizing the presence, absence and subjectivity of information Assessment of the knowledge and abilities Becoming aware of different perceived realities between actors Reframing of problems and solutions		
Inclusion	Involvement of stakeholders at different stages	Living lab inclusion Community involvement Focus groups Formal role of the end-user in the company Crowdsourcing Alliances with NGOs Expert involvement for epistemic problems External research and evaluation Multi-stakeholder involvement activities	Consensus conferences Citizens' juries and panels Focus groups Science shops Deliberative mapping Deliberative polling Lay membership of expert bodies User-centred design Open innovation Stakeholder mapping strategies Stakeholder engagement strategies Stakeholder dialogues Public dialogues User-centred design	Questionable legitimacy of deliberative exercises Need for clarity about, purposes of and motivation for dialogue Deliberation on framing assumptions Ability to consider power imbalances Ability to interrogate the social and ethical stakes associated with new science and technology Quality of dialogue as a learning exercise
	Provision of resources and capital	Bridging and bonding with experts Official role in firm for users and focus group with wider public Crowdsourcing User-driven innovation Community visiting Representation of stakeholders for anticipation		

	Raised commitment and contribution	Balancing transparency and openness in relationships and the innovation process Receiving inputs from external actors Fair relationships regarding the tasks and returns for stakeholder input Role recalibrations as roles change over time and need to be readjusted Working with actors sharing the same values Working with actors with different values		
Responsiveness	Making sure that one can respond to changes in the environment	Mainstreaming/customizing to satisfy stakeholder needs Prevent or overcome organisational inefficiencies Collaboration for fast and effective response	Constitution of grand challenges and thematic research programmes Regulation Standards Open access and other mechanisms of transparency Niche management Value-sensitive design Sustainable design Moratoriums Stage-gates Alternative intellectual property regimes Gradual scaling-up Adaptive risk management Living labs and social experimentation Flexible and adaptive design	Strategic policies and technology 'roadmaps' Science-policy culture Institutional structure Prevailing policy discourses Institutional cultures Institutional leadership Openness and transparency Intellectual property regimes Technological standards
	Actual response to changing environments	Defining nature, pace and impact based on interactions with the innovation system Changing the environment		
	Addressing grand challenges	Responding to social issues Responding to environmental issues Responding to economic issues Preventing detrimental effects		
	Mutual responsiveness	Aligning stakeholder interests with the overall innovation objective Investment of resources by involved stakeholders Willingness to recalibrate the roles and responsibilities for sustaining stakeholder relationships		

ANNEX 2 – MoRRI Indicators

36+ RRI indicators from the MoRRI Project. Source: Meijer et al. (2016). Monitoring the evolution and benefits of responsible research and innovation (MoRRI)–a preliminary framework for RRI dimensions & indicators.

RRI Dimension	Indicator Code	Indicator Title
Gender Equality	GE1	Share of research-performing organisations with gender equality plans
	GE2	Share of female researchers by sector
	-GE2.1	Share of female researchers – all sectors
	GE2.2	Share of female researchers – business enterprise sector
	GE2.3	Share of female researchers – government sector
	GE2.4	Share of female researchers – higher education sector
	GE3	Share of research-funding organisations (RFOs) promoting gender content in research
	GE4	Dissimilarity index
	-GE4.1	Dissimilarity index: higher education sector
	-GE4.2	Dissimilarity index: government sector
	GE5	Share of research-performing organisations (RPOs) with policies to promote gender in research content
	GE6	Glass ceiling index
	GE7	Gender wage gap
	-GE7.1	Gender wage gap – academic professions
	-GE7.2	Gender wage gap – technicians and associate professionals
	GE8	Share of female heads of research performing organisations
	GE9	Share of gender-balanced recruitment committees at research-performing organisations
	GE10	Share of female inventors and authors
	-GE10.1	Share of female authors

	-GE10.2	Share of female inventors
Science literacy and science education	SLSE1	Importance of societal aspects of science in science curricula for 15 to 18-year-old students
	SLSE2	RRI-related training at higher education institutions
	SLSE3	Science communication culture
	SLSE4	Citizen science activities in research performing organisations
	-SLSE14.1	Organisational memberships in ECSA
	-SLSE4.2	Citizen science publications
Public engagement	PE1	Models of public involvement in science and technology decision-making
	PE2	Policy-oriented engagement with science
	PE3	Citizen preferences for active participation in science and technology decision making
	PE4	Active information search about controversial technologies
	PE5	Public engagement performance mechanisms at the level of research performing organisations
	PE6	Dedicated resources for public engagement
	PE7	Embedment of public engagement activities in the funding structure of key public research-funding agencies
	PE8	Public engagement elements as evaluative criteria in research proposal evaluations
	PE9	Research and innovation democratisation index
	PE10	National infrastructure for involvement of citizens and societal actors in research and innovation
Open access	OA1	Open access literature
	-OA1.1	Share of open access publications
	-OA1.2	Citation scores for OA publications
	OA2	Data publications and citations
	OA3	Social media outreach/take-up of open access literature

	-OA3.1	Ratio of OA and non-OA publications used on Twitter
	-OA3.2	Ratio of OA and non-OA publications used on Wikipedia
	OA4	Public perception of open access
	OA5	Funder mandates
	OA6	Research-performing organisations' support structures for researchers as regards incentives and barriers for data sharing
Ethics	E1a	Ethics at the level of research-performing organisations
	E1b	Ethics at the level of research-performing organisations (composite indicator)
	E2	National ethics committees' index
	E3a	Research-funding organisations' index
	E3b	Research-funding organisations' index (composite indicator)
Governance	GOV1	Use of science in policymaking
	GOV2	RRI-related governance mechanisms within research-funding and performing organisations
	GOV3	RRI-related governance mechanisms within research-funding and performing organisations – composite index

ANNEX 3 – RRI Tools List

Tool Name	Related RRI Keys	Related RRI Dimensions	Target User	Aim	Comments
The RRI Toolkit	All	All	Extended[6]	To raise awareness, training, and disseminating and implementing RRI	A self-reflection tool based on a number of open-ended questions. Useful for creating awareness on RRI, however the assessment process is highly dependent on the evaluator and the results are not comparable. More of a process oriented approach rather than the final impact of research.
Perform Researchers Toolkit	All	All	RPO	To develop performance-based activities that explored RRI and the human dimension of science	Addresses only researchers. Mainly a training tool for early stage researchers.

[6] Individual Researchers; Research Performing Organisations; Research Funding Organisations; Industry; Civil Society Actors; Policy-Makers; Investors; Legislators

PRISMA-RRI Roadmap	All	All	Industry	A roadmap and list of KPIs companies can use to implement RRI in their innovation and social responsibility strategies,	A very comprehensive tool. See: Table 3.
Product Impact Tool	All	All	Industry	To assess the impact of technical products on humans, society and the environment.	Over an interactive tool, provides guidance, background information, and examples for companies for product impact assessment
SDG Action Manager B-Impact Assessment	All	All	Industry	To enable businesses to take action on the SDGs through 2030 To compare self-performance against comparable data sets on non-economic areas	Provides a very detailed analysis of the company's actions related to SDG goals. Not directly related to RRI but many dimensions overlap with RRI concepts.
Circular Transition Indicators	Governance	Anticipation and Reflection	Industry	To help businesses in different industries to measure and improve their circular performance	Focuses only on technical/environmental indicators for activities related to CE
Future-Fit Business Benchmark	All	All	Industry	To guide companies and investors to create value for themselves and society	Mainly related to SDGs. Very comprehensive and detailed. However, suggested fitness indicators are generally oversimplified.
Licara NanoScan	Public Engagement	All	Industry	To assess and weigh benefits and risks of nanomaterials and nano-products along the materials' or products' entire lifecycle	Based on Risk Assessment and Life Cycle Assessment using no quantitative data
Gender Equality Diagnostic Tool	Gender Equality	All	Extended	To analyse the status of gender equality and pinpoint gender equality gaps within the organisation	One dimensional: gender Process focused
ORBIT Self-Assessment Tool	All	All	Extended	To provide a self-assessment based on a five-point Likert scale survey	A good reference for defining RRI indicators. Can be considered as a guide more than an assessment (See Orbit action plan generator)
Orbit RRI Maturity Assessment	All	All	Extended	To synthesise different perspectives on RRI with a view to providing an overarching perspective on the level of RRI maturity across projects or organisations	Based on a self-assessment over impact of the project on SDGs (negative or positive)
Societal Readiness Level Thinking Tool	All	All	Research Performing Organisations	To offer practical guidance for researchers who wish to mature the societal readiness of their work, building on RRI keys and principles	Limited applicability to research operations.
COMPASS Self-Check Tool	All	All	Industry	To help SMEs assess where their company stands, how they compare to peers, and what they can do to make their innovation practices more responsible	A self-assessment tool based on application of RRI practices (such as codes of conduct) in SMEs. Generally applicable. Does not contain strict measures.
ISO 26000 Social Responsibility	All	All	Extended	To provide guidance on how businesses and organisations can operate in a socially responsible way.	A guide that promotes respect and responsibility based on known reference documents. No assessment.
NCCPE EDGE Tool	Public Engagement	Inclusion	Extended	To assess an institution's support for public engagement	Very simple, process based. Based on self-assessment over a four level scale for each of the defined nine public engagement topics.
GENDER-NET IGAR Tool	Gender Equality	All	Research Performing Organisations	To integrate gender aspects into research	A guide for integrating gender aspects in research. Classified over 9 field of research. Energy, environment, and materials can be applied to CE.

Measuring Impact of Citizen Science (MICS)	All	All	Extended	To provide metrics and instruments to evaluate citizen-science impacts on the environment and society	Provides a good set of questions classified under the topics: society, governance, economy, science and technology, and the environment. The results are very well presented over graphics.
SDG Impact Assessment Tool	All	All	Extended	To assess impact of solutions, research activities, organisations, projects or other initiatives on the SDGs.	The assessment is done for each SDG according to the six categories: Direct positive, Indirect positive, No impact, Direct negative Indirect negative, More knowledge needed. Gives a visualisation of the assessment as a result.
OECD Toolkit for Mainstreaming & Implementing Gender Equality	Gender Equality	All	Policy makers	To guide in implementing the OECD Recommendation on Gender Equality in Public Life.	Divided into four pillars - government, parliament, judiciary and public administration. Focus on the gender representation in processes but not on impact of actions. Not very relevant to CE.
WEP Gender Gap Analysis	Gender Equality	All	Industry	To promote gender equality in the private sector	Focuses on gender equality in the workplace.
EIGE Gender Mainstreaming Toolkits	Gender Equality	All	Extended	To integrate a gender perspective into the preparation, design, implementation, monitoring and evaluation of policies, regulatory measures and spending programmes	A step-by-step framework for Gender Impact Assessment. Does not provide measures.

References

Asveld, L., Ganzevles, J., & Osseweijer, P. (2015). Trustworthiness and responsible research and innovation: The case of the bio-economy. *Journal of Agricultural and Environmental Ethics*,*28*(3), 571–588. https://doi.org/10.1007/s10806-015-9542-2.

Barben, D., Fisher, E., Selin, C., & Guston, D. H. (2008). 38 Anticipatory Governance of Nanotechnology: Foresight, Engagement, and Integration. *The handbook of science and technology studies*, *979*.

Barnett, J., & O'Neill, S. (2010). Maladaptation. Global environmental change – human and policy. Dimensions, 20, 211–213

Barrie, J., & Schröder, P. (2021). Circular Economy and International Trade: a Systematic Literature Review. Circular Economy and Sustainability, 1-25.

Borrello, M.; Pascucci, S.; Cembalo, L. Three propositions to unify circular economy research: A review. Sustainability 2020, 12, 4069

Butler, J., & Trouble, G. (1990). Feminism and the Subversion of Identity. *Gender trouble*, *3*(1).

Calzolari, T., Genovese, A., & Brint, A. (2022). Circular Economy indicators for supply chains: A systematic literature review. Environmental and Sustainability Indicators, 13, 100160. https://doi.org/10.1016/j.indic.2021.100160

Carbajo, R., & Cabeza, L. F. (2019). Sustainability and social justice dimension indicators for applied renewable energy research: A responsible approach proposal. *Applied Energy*, *252*, 113429.

Chatfield, K., Borsella, E., Mantovani, E., Porcari, A., & Stahl, B. C. (2017). An investigation into risk perception in the ICT industry as a core component of responsible research and innovation. *Sustainability*, *9*(8), 1424.

Chilvers, J. 2012. Reflexive engagement? Actors, learning, and reflexivity in public dialogue on science and technology. Science Communication 35 (3): 283–310.

Clube, R. K., & Tennant, M. (2020). The Circular Economy and human needs satisfaction: Promising the radical, delivering the familiar. Ecological Economics, 177, 106772.

Corona, B., Shen, L., Reike, D., Rosales Carreón, J., & Worrell, E. (2019). Towards sustainable development through the circular economy—A review and critical assessment on current circularity metrics. Resources, Conservation and Recycling, 151, 104498. https://doi.org/10.1016/j.resconrec.2019.104498

Correljé, A., Cuppen, E., Dignum, M., Pesch, U., Taebi, B. Responsible Innovation in Energy Projects: Values in the Design of Technologies, Institutions and Stakeholder Interactions. E.J. Koops, I. Oosterlaken, H.A. Romijn, T.E. Swierstra, J. Van den Hoven (Eds.), Responsible Innovation 2: Concepts, Approaches and Applications, Springer International Publishing, Berlin (2015), pp. 183-200

Cozzens, S., & Thakur, D. (Eds.). (2014). Innovation and inequality: Emerging technologies in an unequal world.

Dorrestijn, S. (2017). The Product Impact Tool. *Design for Behaviour Change: Theories and practices of designing for change*.

Ellen MacArthur Foundation & ANSYS Granta. (2019). Circularity Indicators: An Approach to Measuring Circularity. Methodology. 2019 Revision. Ellen MacArthur Foundation.

European Commission (2012). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012H0417&rid=1

European Commission (2019) (EC).https://ec.europa.eu/research/participants/data/ref/h2020/other/guides_for_applicants/h2020-swafs-21-18-policy-briefing_en.pdf

European Commission (2020). https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science/open-access_en

Fløysand, A., & Jakobsen, S. E. (2011). The complexity of innovation: A relational turn. Progress in Human Geography, 35(3), 328-344.

Fraaije, A., Flipse, S. M. (2020) Synthesizing an implementation framework for responsible research and innovation, Journal of Responsible Innovation, 7:1, 113-137, DOI: 10.1080/23299460.2019.1676685:

Friedman, B., Kahn Jr, P.H., Borning, A., & Huldtgren, A. Value sensitive design and information systems

Geissdoerfer, M.; Savaget, P.; Bocken, N.M.P.; Hultink, E.J. The Circular Economy—A new sustainability paradigm? J. Clean. Prod. 2017, 143, 757–768.

Genovese, A., & Pansera, M. (2021). The circular economy at a crossroads: technocratic eco-modernism or convivial technology for social revolution?. *Capitalism Nature Socialism*, *32*(2), 95-113.

Geng, Y., Sarkis, J., Ulgiati, S., & Zhang, P. (2013). Measuring China's circular economy. *Science*, 339(6127), 1526-1527.

Gluckman, P., & Wilsdon, J. (2016). From paradox to principles: where next for scientific advice to governments?. *Palgrave Communications*, *2*(1), 1-4.

Grinbaum, A., & Groves, C. (2013). What is "responsible" about responsible innovation? Understanding the ethical issues. *Responsible innovation: Managing the responsible emergence of science and innovation in society*, 119-142.

Grinbaum, A., & Politi, V. (2019). Comparative study of the Ethics key. *Project title: Responsible Research and Innovation in Practice (RRI-Practice) Grant Agreement no: 709637 Funding Programme: Horizon 2020 Project Coordinator: Oslo Metropolitan University (OsloMet), Norway*, 16.

Groves, C. (2015). The bomb in my backyard, the serpent in my house: environmental justice, risk, and the colonisation of attachment. *Environmental Politics*, 24(6), 853-873.

Groves, C. (2017). Review of RRI Tools Project, http://www. rri-tools. eu. *Journal of Responsible Innovation*, *4*(3), 371-374.

Gurzawska, A., & Porcari, A. (2016). Models for Ethics Assessment and Guidance in Industry (SATORI Project Deliverable 4.1).

Haegeman, K., Marinelli, E., Scapolo, F., Ricci, A., & Sokolov, A. (2013). Quantitative and qualitative approaches in Future-oriented Technology Analysis (FTA): From combination to integration?. Technological Forecasting and Social Change, 80(3), 386-397.

Hancock, A. M. (2007). Intersectionality as a normative and empirical paradigm. *Politics & Gender*, *3*(2), 248-254.

Harris, S., Martin, M., & Diener, D. (2021). Circularity for circularity's sake? Scoping review of assessment methods for environmental performance in the circular economy. Sustainable Production and Consumption, 26, 172–186. https://doi.org/10.1016/j.spc.2020.09.018

Homrich, A. S., Galvão, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. Journal of Cleaner Production, 175, 525–543. https://doi.org/10.1016/j.jclepro.2017.11.064

Hofstetter, J. S., De Marchi, V., Sarkis, J., Govindan, K., Klassen, R., Ometto, A. R., ... & Vazquez-Brust, D. (2021). From sustainable global value chains to circular economy—different silos, different perspectives, but many opportunities to build bridges. Circular Economy and Sustainability, 1(1), 21-47.

Inigo, E. A., V. Blok. 2019. "Strengthening the Socio-Ethical Foundations of the Circular Economy: Lessons from Responsible Research and Innovation." Journal of Cleaner Production 233: 280–291.

Jakobsen, S. E., Fløysand, A., & Overton, J. (2019). Expanding the field of Responsible Research and Innovation (RRI)–from responsible research to responsible innovation. European Planning Studies, 27(12), 2329-2343.

Jenkins, K. E., Spruit, S., Milchram, C., Höffken, J., & Taebi, B. (2020). Synthesising value sensitive design, responsible research and innovation, and energy justice: A conceptual review. Energy Research & Social Science, 69, 101727.

Jørgensen, A., Le Bocq, A., Nazarkina, L., & Hauschild, M. (2008). Methodologies for social life cycle assessment. The international journal of life cycle assessment, 13(2), 96-103.

Kaika, M. (2017). 'Don't call me resilient again!': The New Urban Agenda as immunology … or … what happens when communities refuse to be vaccinated with 'smart cities' and indicators. Environment and Urbanisation, 29(1), 89–102. https://doi.org/10.1177/0956247816684763

Klaassen, P., Kupper, F., Vermeulen, S., Rijnen, M., Popa, E., & Broerse, J. (2017). The conceptualization of RRI: An iterative approach. In *Responsible Innovation 3* (pp. 69-92). Springer, Cham.

Kettunen M, Gionfra S, Monteville M (2019) EU circular economy and trade: improving policy coherence for sustainable development. IEEP

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualising the circular economy: An analysis of 114 definitions. Resources, conservation and recycling, 127, 221-232.

Klaassen, P., Kupper, F., Vermeulen, S., Rijnen, M., Popa, E., & Broerse, J. (2017). The conceptualization of RRI: An iterative approach. In *Responsible Innovation 3* (pp. 69-92). Springer, Cham.

Van der Klippe, W. From MoRRI to SUPER MoRRI, https://super-morri.eu/from-morri-to-super_morri-monitoring-as-reflection-and-learning-not-representation-and-control/

Korhonen, J., Nuur, C., Feldmann, A., & Birkie, S. E. (2018). Circular economy as an essentially contested concept. Journal of Cleaner Production, 175, 544–552. https://doi.org/10.1016/j.jclepro.2017.12.111

Kovacic, Z., Strand, R., & Völker, T. (2019). The circular economy in Europe: Critical perspectives on policies and imaginaries. Routledge.

Lee, R. G., & Petts, J. (2013). Adaptive governance for responsible innovation. Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society, (august), 143–164

Lonca, G., Muggéo, R., Imbeault-Tétreault, H., Bernard, S., & Margni, M. (2018). Does material circularity rhyme with environmental efficiency? Case studies on used tires. Journal of Cleaner Production, 183, 424–435. https://doi.org/10.1016/j.jclepro.2018.02.108

Long, T. B., Blok, V., Dorrestijn, S., & Macnaghten, P. (2020). The design and testing of a tool for developing responsible innovation in start-up enterprises. Journal of Responsible Innovation, 7(1), 45-75.:

Lowe, B. H., & Genovese, A. (2022). What theories of value (could) underpin our circular futures? Ecological Economics, 195, 107382. https://doi.org/10.1016/j.ecolecon.2022.107382

Martinuzzi, A., Blok, V., Brem, A., Stahl, B., & Schönherr, N. (2018). Responsible research and innovation in industry—Challenges, insights and perspectives. *Sustainability*, *10*(3), 702.

McKinsey & Company. 2014. Moving toward a circular economy. https://www.mckinsey.com/business-functions/sustainability/our-insights/moving-toward-a-circular-economy. Accessed July 2022.

Meijer, I., Mejlgaard, N., Woolley, R., Rafols, I., & Wroblewski, A. (2016). Monitoring the evolution and benefits of responsible research and innovation (MoRRI)–a preliminary framework for RRI dimensions & indicators.

Meijer, I., & van de Klippe, W. (2020). Monitoring Responsible Research and Innovation in the European research area: The MoRRI project. In *Assessment of Responsible Innovation* (pp. 171-195). Routledge

Mies, A., & Gold, S. (2021). Mapping the social dimension of the circular economy. Journal of Cleaner Production, 321, 128960.

Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., de Meester, S., & Dewulf, J. (2019). Circular economy indicators: What do they measure? Resources, Conservation and Recycling, 146, 452–461. https://doi.org/10.1016/j.resconrec.2019.03.045

Morseletto, P. (2020). Targets for a circular economy. Resources, Conservation and Recycling, 153, 104553.

Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: an interdisciplinary exploration of the concept and application in a global context. *Journal of business ethics*, 140(3), 369-380.

Nielsen, M. V. (2016). The concept of responsiveness in the governance of research and innovation. *Science and Public Policy*, *43*(6), 831-839.

Oliveira, M., Miguel, M., van Langen, S. K., Ncube, A., Zucaro, A., Fiorentino, G., Passaro, R., Santagata, R., Coleman, N., Lowe, B. H., Ulgiati, S., & Genovese, A. (2021). Circular Economy and the Transition to a Sustainable Society: Integrated Assessment Methods for a New Paradigm. Circular Economy and Sustainability, 1(1), 99–113. https://doi.org/10.1007/s43615-021-00019-y

Owen, R., Macnaghten, P., Stilgoe, J., (2012). Responsible research and innovation: From science in society to science for society, with society, Science and Public Policy, Volume 39, Issue 6, Pages 751–760,

Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2013). A framework for responsible innovation. In *Responsible innovation* (pp. 27–50): John Wiley & Sons, Ltd. Doi: https://doi.org/10.1002/9781118551424.ch2.

Padilla-Rivera, A., Russo-Garrido, S., & Merveille, N. (2020). Addressing the social aspects of a circular economy: A systematic literature review. Sustainability, 12(19), 7912.

Palm, E., & Hansson, S. O. (2006). The case for ethical technology assessment (eTA). Technological forecasting and social change, 73(5), 543-558.

Pansera, M., Genovese, A., & Ripa, M. (2021). Politicising Circular Economy: what can we learn from Responsible Innovation?. Journal of Responsible Innovation, 8(3), 471-477.

Pearson, J., Gianni, R., Ikonen, V., & Haick, H. (2016, December). From technology assessment to responsible research and innovation (RRI). In 2016 Future Technologies Conference (FTC) (pp. 1189-1198). IEEE.

Porcari, A., Pimponi, D., Borsella, E., Klaassen, P., Maia, M. J., & Mantovani, E. (2020). Supporting RRI uptake in industry: A qualitative and multi-criteria approach to analysing the costs and benefits of implementation. In *Assessment of Responsible Innovation* (pp. 117-144). Routledge.

Ravn, T., Nielsen, M. W., & Mejlgaard, N. (2015). Metrics and indicators of Responsible Research and Innovation Progress report D3.2. European Commission, Brussels

Reike, D., Vermeulen, W. J., & Witjes, S. (2018). The circular economy: new or refurbished as CE 3.0?—exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. Resources, Conservation and Recycling, 135, 246-264.

Reinales, D., Zambrana-Vasquez, D., & Saez-De-Guinoa, A. (2020). Social life cycle assessment of product value chains under a circular economy approach: a case study in the plastic packaging sector. *Sustainability*, *12*(16), 6671.

Ribeiro, B. E., Smith, R. D., & Millar, K. (2017). A mobilising concept? Unpacking academic representations of responsible research and innovation. *Science and engineering ethics*, *23*(1), 81-103.

Rip, A. (2018). Constructive technology assessment. In Futures of Science and Technology in society (pp. 97-114). Springer VS, Wiesbaden.

Roger, S., Spaapen, J., Bauer, M. W., Hogan, E., Revuelta, G., & Stagl, S. (2015). Indicators for promoting and monitoring responsible research and innovation: Report from the expert group on policy indicators for responsible research and innovation.

Urzedo, D., Pedrini, S., Hearps, C., Dixon, K., & van Leeuwen, S. (2022). Indigenous environmental justice through coproduction of mining restoration supply chains in Australia. *Restoration Ecology*, e13748.

Van de Poel, I., Asveld, L., Flipse, S., Klaassen, P., Scholten, V., & Yaghmaei, E. (2017). Company strategies for responsible research and innovation (RRI): A conceptual model. *Sustainability*, *9*(11), 2045.

Van den Eynden, V. (2014). Managing and sharing research data at an institutional level: incentives, strategies, policies.

Van Lente, H., Swierstra, T., & Joly, P. B. (2017). Responsible innovation as a critique of technology assessment. Journal of Responsible Innovation, 4(2), 254-261.:

Von Schomberg, R. (2013). A vision of responsible innovation.

Von Schomberg, R., & Hankins, J. (Eds.). (2019). *International handbook on responsible innovation: A global resource*. Edward Elgar Publishing.

Schot, J., & Rip, A. (1997). The past and future of constructive technology assessment. *Technological forecasting and social change*, 54(2-3), 251-268.

Schröder, P. (2020). Promoting a just transition to an inclusive circular economy. Royal Institute of International Affairs.

Sherman, M. H., & Ford, J. (2014). Stakeholder engagement in adaptation interventions: an evaluation of projects in developing nations. *Climate Policy*, 14(3), 417-441.

Silva, P., H., Lehoux, P., Miller, F. A., & Denis, J. L. (2018). Introducing responsible innovation in health: a policy-oriented framework. *Health research policy and systems*, *16*(1), 1-13.

Stilgoe, Jack, Richard Owen, and Phil Macnaghten. 2013. "Developing a Framework for Responsible Innovation." *Research Policy* 42 (9): 1568–1580.

Sonck, M., Asveld, L., Landeweerd, L., & Osseweijer, P. (2017). Creative tensions: mutual responsiveness adapted to private sector research and development. *Life Sciences, society and policy*, *13*(1), 1-24.

Talmon-Gros, L., & Teichler, T. (2015). Analytical report on the dimension of science literacy and scientific education.

Timmermans J. Mapping the RRI landscape: an overview of organisations, projects, persons, areas and topics. In: Asveld L, van Dam-Mieras R, Swierstra T, Lavrijssen S, Linse K, van den Hoven J, editors. Responsible Innovation 3 – A European Agenda? The Netherlands: Tilburg Law and Economic Center (TILEC); 2017. p. 21–47.

Turcu, C. (2013). Re-thinking sustainability indicators: Local perspectives of urban sustainability. *Journal of Environmental Planning and Management*, 56(5), 695–719. https://doi.org/10.1080/09640568.2012.698984

Velicu, I., & Barca, S. (2020). The Just Transition and its work of inequality. *Sustainability: Science, Practice and Policy*, 16(1), 263–273. https://doi.org/10.1080/15487733.2020.1814585

Wender, B. A., Foley, R. W., Hottle, T. A., Sadowski, J., Prado-Lopez, V., Eisenberg, D. A., ... & Seager, T. P. (2014). Anticipatory life-cycle assessment for responsible research and innovation. Journal of Responsible Innovation, 1(2), 200-207.

Wickson, F., & Carew, A. L. (2014). Quality criteria and indicators for responsible research and innovation: Learning from transdisciplinarity. *Journal of Responsible Innovation,1*(3), 254–273.

Woolley, R., Otero-Hermida, P., Mejlgaard, N., Ryan, T., Rommetveit, K., Strand, R., van de Klippe, W. (2020). Deliverable D1.2 (project deliverable Super-Morri), https://super-morri.eu/download/153/findings-and-deliverables/5179/d-1-2-strategic-development-plan-2020-24.pdf

Wright, C. Y., Godfrey, L., Armiento, G., Haywood, L. K., Inglesi-Lotz, R., Lyne, K., & Schwerdtle, P. N. (2019). Circular economy and environmental health in low-and middle-income countries. Globalisation and Health, 15(1), 1-5.

Wright, D., Gellert, R., Gutwirth, S., & Friedewald, M. (2011). Minimising Technology Ricks with PIAs, Precaution, and Participation. IEEE Technology and Society Magazine, 30(4), 47-54.

Zink, T., & Geyer, R. (2017). Circular economy rebound. Journal of Industrial Ecology, 21(3), 593-602.

Zwart H, Laurens L, van Rooij A. Adapt or perish? assessing the recent shift in the European research funding arena from 'ELSA' to 'RRI' *Life Sciences, Society and Policy.*

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