



An RRI Indicator System for Supporting Renewable Energy Innovation

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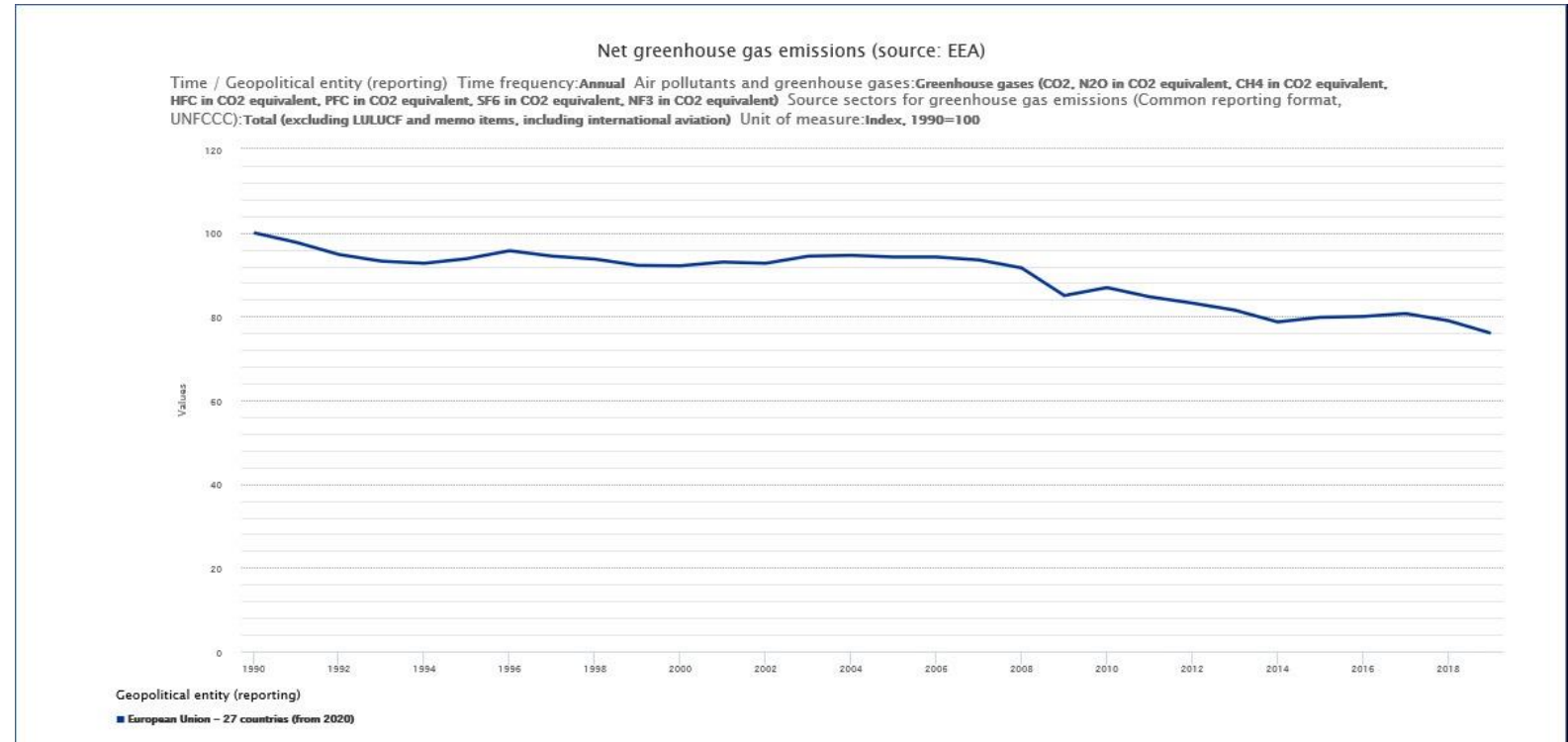
Observation

- Are renewable energy technologies uncontroversial? Not quite..
 - Raw materials: availability and mode of extraction
 - LIBs contain critical metals: cobalt and graphite → supply risk, risk of price increase, competing use
 - The choice of mines is limited (child labor?)
 - Protection of the environment and species
 - The recycling rates are still very low
 - Production of lithium: vast amounts of water, environmentally harmful chemicals, evaporation ponds and processing plants consume land and chemical waste is not disposed of in an environmentally friendly manner.
 - Safety risk
 - Socio-Economic: Unequal distribution of benefits / burdens, Jobs
 - Job losses in certain industries and regions?
 - Low-wage labor
- Issues to be taken into consideration (early) in the innovation process.



Observation

- Small reductions in greenhouse gas emissions
- Energy transition innovations have to:
 - be effective
 - experience a high level of social acceptance
 - → implemented widely



Problem

- Innovations → positive perception
 - long-term prosperity
 - support greenhouse gas reductions
- However, undesirable consequences:
 - environmental destruction, e.g. raw materials for batteries
 - violate human rights
 - negative employment effects
 - undesirable distributional effects (Giuliani, 2018)
 - limits their societal benefits and social acceptance
 - "innovation is neither inherently good nor self-regulatory"

Solution approach

- RRI indicator system:
 - Raise problem awareness → adapt organizational routines (innovation processes)
 - Important because:
 - (1) Decisions in the R&D process lock-in future environmental and social impacts (Bhander et al., 2003);
 - (2) early in the innovation process, more flexibility for environmental and social concerns (Owen et al., 2013);
 - (3) Separatio of environmental and social impact research
from the innovation process, assessment and regulation is reactive only (Owen and Goldberg, 2010; Wender et al., 2014).
- Implement an innovation process that is more aligned with RRI criteria.



Solution approach

- Challenges and limitations:
 - High degree of uncertainty regarding the outcome, "true uncertainty" (Knight, 1921)
 - Partly chaotic, non-linear and spontaneous process
 - “Traditionally”, RRI has been applied to potential breakthrough technologies, e.g. nanotechnology
 - RRI often neglects innovation as a systemic phenomenon (Owen, 2019)
- Possibilities of process planning and estimation of consequences are limited
- However, by applying an RRI indicator system:
 - implement processes in such a way as to increase the probability that an innovation process and its outcome will be more socially desirable.

RRI operationalization

Previous work

“One might wonder how what is supposedly one concept can lead to such diverse constructs.”

van de Poel (2019)

- To assess the RRI-alignment of innovation processes and resulting products we require a suitable operationalization approach
- There are already different sets of indicators in the RRI context, which vary significantly in their characteristics
 - Different goals
 - Different units of assessment
 - Different types of assessment

Reference	Unit of assessment	Assessor	Aim of assessment	Based on	Indicators	Type of measurement
<i>Ravn, Nielsen and Mejlgaard (2015)</i>	Country	Independent assessor	Monitoring; comparison	EU Keys	36	Quantitative
<i>Ravn, Nielsen and Mejlgaard (2015)</i>	Country	Independent assessor	Monitoring; comparison	EU Keys	36	Quantitative
<i>Strand et al. (2015)</i>	RRI initiatives	Independent assessor	Monitor and assess the impacts of RRI initiatives	EU Keys	83	Quantitative
<i>Flipse et al. (2015)</i>	Project (within a company)	Self-assessment	Monitoring; decision support for managers	AREA Framework	30	Qualitative
<i>Stahl et al. (2017)</i>	Company	RRI researchers; Self-assessment	Assessing RRI level, monitoring	AREA Framework	14	Qualitative
<i>Heras & Ruiz-Mallén (2017)</i>	Research/Teaching Institutes	Self-assessment	Monitoring; comparison	EU Keys & Own	86	Qualitative
<i>Otero-Hermida & García-Melón (2018)</i>	Research Institutes	Self-assessment; Independent assessor	Monitoring	EU Keys (Gender Equality)	23	Quantitative
<i>Tharani et al. (2019)</i>	Company	Self-assessment	Learning	AREA Framework	43	Qualitative
<i>Verburg, Rook, and Pesch (2019)</i>	Employee (in a company)	Self-assessment	Assessing RRI level	AREA Framework	7	Qualitative
<i>Yaghmaei et al. (2019)</i>	Project	Self-assessment	Monitoring	AREA Framework	43	Qualitative
<i>Nazarko (2020)</i>	Company	Self-assessment	Monitoring; decision support for managers	EU Keys	53	Qualitative/Quantitative

RRI operationalization

Problems of existing indicator sets

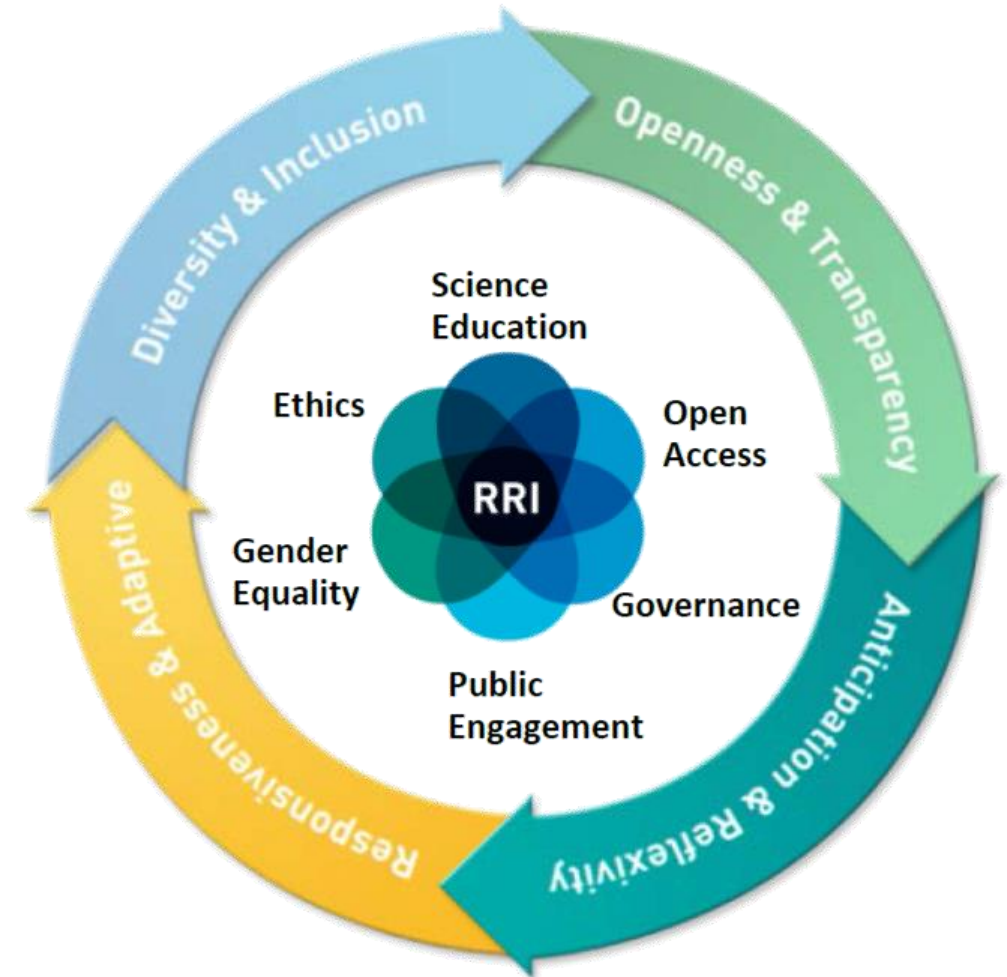
- Existing preliminary work that has created a basis for indicator development has not yet been taken up
- Reliability problems (van de Poel, 2019)
 - Problem is common in RRI context as attributes are often not objectively measurable
 - Van de Poel (2019): The subjectivity of the assessment can be reduced by providing a 'rubric' that offers guidance on how to score questions or items
- Lack of contextual indicators (Monsonís-Payá et al., 2017)
 - Existing indicator sets are rigid and lack contextual weighting
- Lack of a systemic structure
 - Largely individual, isolated indicators
 - Previous approaches are indicator sets rather than indicator systems

→ Aspects we want to consider when creating the RRI Indicator System

Indicator set creation

Process indicators

- The quality criteria developed in the RRI Tools project (Kupper et al, 2015) form the basis for the development of the process indicators.
 - The quality criteria represent essential features of research and innovation practices that should be taken into account in assessment, monitoring or (self-)evaluation tools in the RRI context
 - For the creation of the indicator sets, quality criteria were examined and (where possible) clustered.
 - The indicator specifications are taken from the literature or were formulated based on guiding questions formulated in the RRI Tools project

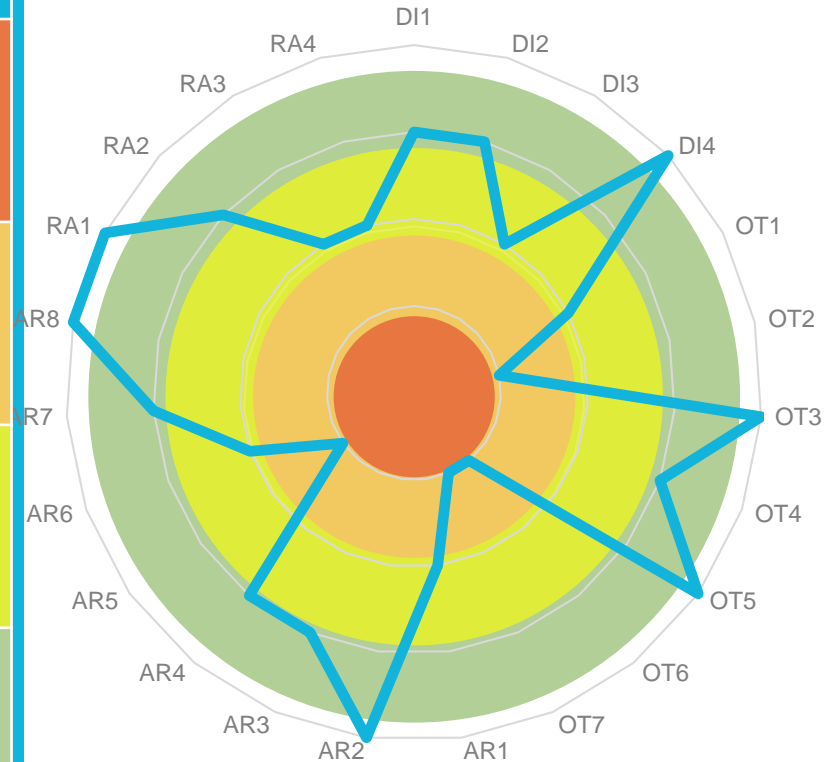


Indicator set creation

Process indicators

Diversity and Inclusion		Anticipation and Reflection	
DI1	Stakeholder engagement in the innovation process	AR1	Analysis of background and current situation
DI2	Regularity and systematicity of stakeholder engagement	AR2	Cosideration of diverging problem definitions
DI3	Diversity of stakeholder engagement methods	AR3	Anticipating potential futures
DI4	Institutional diversity	AR4	Consideration and Monitoring of ethical aspects and values
Openness and Transparency		AR5	Consideration and Monitoring of legal aspects
OT1	Information on practice details (Objectives, Methods, Finances and Interests) regarding R&D	AR6	Consideration and Monitoring of societal aspects and values
OT2	Policies on open access and information sharing	AR7	Consideration and Monitoring of environmental aspects and values
OT3	Attribution of roles and influence of involved actors and stakeholders	AR8	Exploration of underlying values, assumptions and choices
OT4	Dissemination and Sharing of preliminary, intermediate and final results	Responsiveness and Adaptive Change	
OT5	Identification of uncertainties and limitations	RA1	Incorporating feedback
OT6	Lines of delegation, ownership and accountability	RA2	Ability to change after internal reflective practice and external feedback
OT7	Openness to critical scrutiny	RA3	Implementation of evaluation strategies
		RA4	Actor's ability to adapt their role and responsibilities

RA1 Incorporating feedback
Incoming feedback is not incorporated into the R&I process
Incoming feedback is incorporated without clear methods or procedures
There are consistent ideas about how to incorporate feedback
Methods for incorporating feedback have been explored and implemented into the R&I process.



Indicator set creation

Product indicators

- The RRI product dimension captures products in relation to overarching and specific normative anchor points (von Schomberg, 2013)
- According to von Schomberg, these normative anchor points should be:

Ethical acceptability	Sustainability	Social desirability
<i>Compliance with the fundamental values of the EU charter on fundamental rights (right for privacy, etc.)</i>	<i>Contributing to the EU's objective of sustainable development.</i>	<i>Meeting the normative anchor points of the Treaty on EU</i>

Indicator set creation

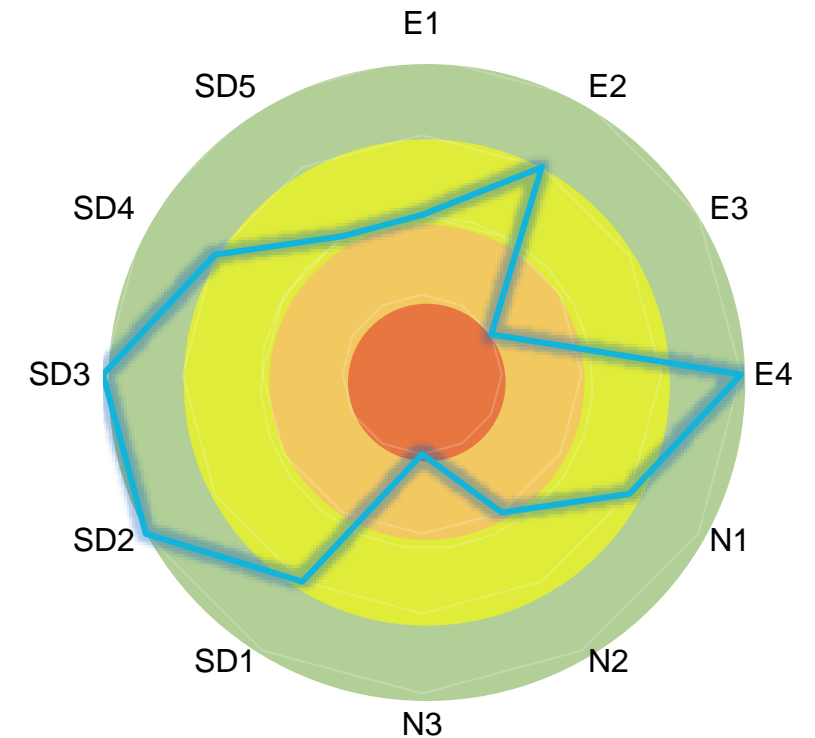
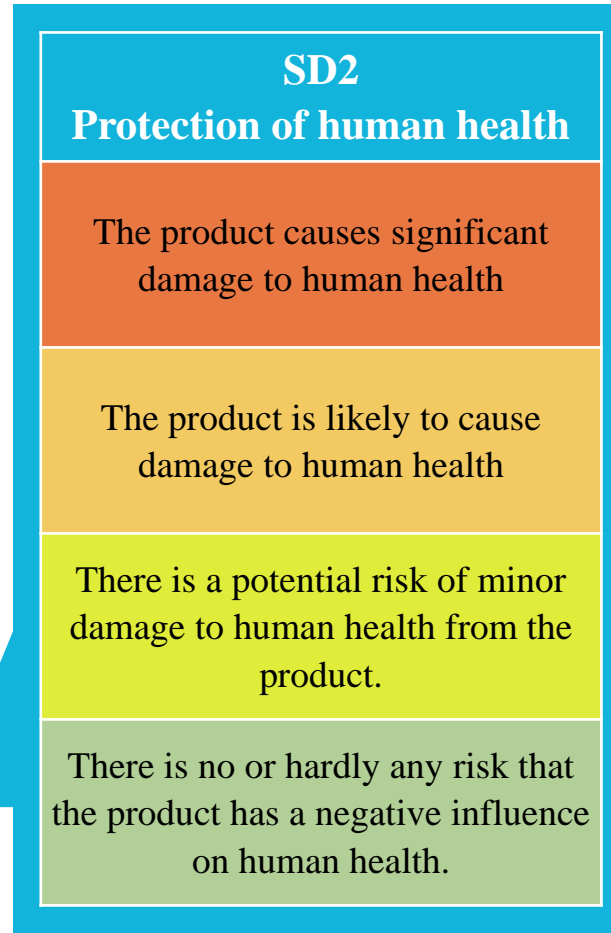
Product indicators

- 12 product indicators assigned to 3 dimensions

	<i>Ethical acceptability</i>
E1	<i>Dignity rights evaluation</i>
E2	<i>Freedom rights evaluation</i>
E3	<i>Equality rights evaluation</i>
E4	<i>Solidarity rights evaluation</i>

	<i>Sustainability</i>
S1	<i>Economic Sustainability</i>
S2	<i>Social Sustainability</i>
S3	<i>Environmental Sustainability</i>

	<i>Social desirability</i>
SD1	<i>Influence on quality of life</i>
SD2	<i>Protection of human health</i>
SD3	<i>Protection of the environment</i>
SD4	<i>Social justice</i>
SD5	<i>Scientific and technological progress</i>



Indicator system conception

Outlook

- Aspects to consider:
 - Literature refers to the interrelatedness between product and process levels (von Schomberg, 2013; Kupper et al., 2015)
 - Rigidity of indicators: At least on process level, not all indicators might be of the same relevance
 - Indicator set is still rather generic → Contextual situation should be taken into account (Wickson & Carew, 2014)
- Possible solution: contextual weighting of process indicators
 - Weighting based on a comparisons between all possible pairs of individual indicators for each dimension
 - Analytic Hierarchy Process (AHP) as possible approach

Thank you for your attention!

Conclusion & Outlook

- Acceptance problems with renewable energy technologies can hinder the achievement of current climate targets and also the success of the energy transition
- Although we cannot create acceptance per se, RRI might help to design processes in such a way as to increase the probability that an innovation process and its outcome will be socially desirable and accepted
- A tool is required to check the RRI-conformity of both innovation processes and products
- Existing operationalisation approaches form a good basis for the development of a suitable indicator system
- The operationalisation approach presented here builds on this and is intended to support the integration of the RRI concept more strongly into research and development activities in the future.