



Co-producing transformative visions for Europe in 2100: A multi-scale approach to orientate transformations under climate change

Katharina Hölscher^{a,*}, Niki Frantzeskaki^{a,b}, Jill Jäger^c, Ian Holman^d,
Simona Pedde^e

^a Dutch Research Institute for Transitions (DRIFT), Faculty of Behavioural and Social Sciences, Erasmus University Rotterdam, the Netherlands

^b Section Spatial Planning, Geosciences Faculty, Utrecht University, the Netherlands

^c Independent Expert, Vienna, Austria

^d Cranfield University, United Kingdom

^e Wageningen University, the Netherlands

ARTICLE INFO

Keywords:

Climate change

Vision

Envisioning

Sustainability transition

Transformation

Scenarios

Pathways

ABSTRACT

Achieving sustainability and resilience transformations under climate change requires transformative and multi-scale visions to stimulate coherent thinking and action towards radically alternative futures. We present our approach to co-produce transformative visions contextualised in different regions across Europe, while exploring emergent 'pan-European' vision elements to guide transformative climate action across scales. We co-produced visions with stakeholders in four case studies: European, national (Scotland), transboundary river basin (Iberia) and two municipalities (Hungary). All visions share core aspirations for good living, justice and social and environmental wellbeing in Europe, while allowing contextualised interpretation to remain meaningful in view of context-specific needs, priorities, cultural perceptions and aspirations. The visions point to areas where deep transformations are required: in service provisioning from critical infrastructures like energy, food, health and education, and in lifestyles and governance. We discuss two key methodological considerations for the co-production of transformative visions across multiple scales. Firstly, the application of a systematic and comprehensive framework across all scales provided a guide to compare and ensure coherence between visions across multiple scales. Secondly, the creation of transformative spaces to co-produce the visions with stakeholders supported critical reflections and learning about the radical and multi-dimensional changes necessary in different regions in Europe.

1. Introduction

While climate change has been a scientifically proven and societally acknowledged problem for several decades, global emissions are still rising and societies struggle to adapt to the impacts of climate change (IPCC, 2018; Roberts et al., 2018; UNEP, 2019). Many scientists and policymakers agree on the need for fast and decisive changes in existing production and consumption processes, technologies, market patterns, individual values and behaviours to address the underlying root causes of the multiple sustainability

* Correspondence to: DRIFT, Erasmus University Rotterdam, Burgemeester Oudlaan 50, 3062 PA Rotterdam, the Netherlands.
E-mail address: holscher@drift.eur.nl (K. Hölscher).

challenges our world faces today (Otto et al., 2020; EEA 2019; Steffen et al., 2018). However, research and policy debates about solutions mainly continue to optimise business-as-usual and give negative renditions about future risks, threats and hard choices. The Paris Agreement has given an important impetus for radical change by setting the clear target to keep global temperature increase to “well below 2 °C above pre-industrial levels” (UN, 2015: 3). Yet climate mitigation and adaptation are often still framed as burden sharing rather than opportunities for enhancing overall social and environmental wellbeing (Bai et al., 2016). The European Green Deal is an ambitious strategy to achieve climate neutrality by 2050, tying in multiple goals such as equity and recovery from the COVID-19 pandemic (European Commission, 2019; Dupont et al., 2020). However, the Green Deal’s treatment of sustainability side-lines crucial environmental and social issues with a focus on maximising economic growth (Eckert & Kovalevska, 2021; Oberthür & Dupont, 2021), thus resembling similar shortcomings of the Sustainable Development Goals (SDGs) (Eisenmenger et al., 2020; UN, 2016). In addition, in view of deepening societal divides, a challenge is to anchor goals like the SDGs or Green Deal in society (Oberthür 2021).

The reactive approach to addressing societies’ systemic and persistent sustainability challenges is one of the main reasons why current action is not transformative enough. As Donella Meadows expressed more than two decades ago: “If we don’t know where we want to go, it makes little difference that we make great progress” (Meadows, 1996). Rather than persevering with problems and dilemmas or solutions that worked in the past, visions articulate compelling and positive images about a far-away future and serve as an endpoint to stimulate transformative thinking about pathways and solutions to achieve these aspirations (Constanza, 2000; Wiek & Iwaniec, 2014). Visions help in debating the interrelations between different goals and interests and addressing them in synergy (Iwaniec et al., 2014; Schultz et al., 2007). This makes visions important tools and reference points for inspiring, assessing, directing and designing strategic action in the short- and mid-term to facilitate systemic change in the long-term (Miller et al., 2015; Pereira et al., 2018). The co-production of visions can empower people by changing how they understand the world and what they deem possible, thus building shared purpose and capacities for shaping the reality inherent in their imagination (Chapin & Knapp, 2014; O’Brien et al., 2014; Pereira et al., 2018). Visions are also instrumental and can solicit political, financial and public support for specific solutions (Sovacool et al., 2020).

In this paper, we present our approach to co-producing transformative visions that could stimulate radical and multi-dimensional action to address climate change and exploit opportunities for sustainability and resilience at multiple scales in Europe. While visions are increasingly acknowledged for their usefulness as future reference points, methodological challenges related to generating transformative and multi-scale visions need addressing. Firstly, visions that were developed in the past often focus on isolated issues and technologies, emphasise economic growth over social and environmental wellbeing and rely on those actors and institutions responsible for current unsustainability problems (Bai et al., 2016; Bennett et al., 2016). With those limitations, visions cannot inspire transformative pathways that achieve radical changes and resolve trade-offs among individual goals (Eisenmenger et al., 2020).

Box 1

. IMPRESSIONS multi-scale case studies.

Europe.

Over 500 million people live in the vast and diverse continent of Europe. The climate ranges from the sub-arctic parts of Scandinavia to the Mediterranean. The European case study focused on the inter-dependent risks and opportunities posed by high-end climate change and socio-economic change for people, land use, water and biodiversity across Europe. It aimed to support national and European stakeholders and decision-makers in incorporating these high-end scenarios into their risk management and climate adaptation strategies.

Scotland.

This case study focused on adapting to the impacts of high-end scenarios on the economic and land-based sectors of Scotland, UK. Scotland’s rural economy is a key part of the identity of Scotland. Climate and socio-economic changes have potential implications for Scotland’s reforestation targets; growth patterns for commercial tree species; tourism activity; the spread of Lyme disease; as well as hydrological patterns and their implications for aquatic ecosystems.

Iberia.

The river basins of the Iberian Peninsula are particularly vulnerable to climate change. The Iberian case study focused on the Tagus river basin, one of five river basins shared between Portugal and Spain, which faces multiple challenges for the management of transboundary water resources and sensitive social-ecological systems. The case study aimed to support decision-makers in incorporating high-end climate change and socio-economic change scenarios into key strategies, such as Integrated River Basin Management and ecosystem-based approaches to land management.

Hungary.

Hungary is one of the most vulnerable countries to climate change in Europe. Extreme events, including droughts, floods, heavy rainfalls and heat waves, have become more frequent and intense over recent decades. The Hungarian case study focused on the impacts of high-end climate change and socio-economic change in two medium-sized cities: Szekszárd and Veszprém. It aimed to support stakeholders in incorporating these high-end scenarios in their present development strategies and adaptation measures.

Secondly, the links from local to global goals and actions need to be more explicit (Stafford-Smith et al., 2017; Willaarts et al., 2019). Achieving global goals, such as the SDGs, the Paris Agreement or regional goals like the European Green Deal, relies on their translation to national, regional and local scales – arguably the scales at which their implementation will be most critical (Breuer et al., 2019; Stafford-Smith et al., 2017). A particular challenge in visioning is dealing with regional differences, including different effects of climate change, cultural values and resource bases (Breuer et al., 2019; Hoff, 2018).

Our research question is as follows: how can multi-scale visions be co-produced to articulate the context-relevant aspirations guiding the necessary transformative actions across multiple decision-making scales to address climate change and exploit opportunities for sustainability and resilience? To respond to this question, we have applied a methodological approach to co-produce transformative visions and link them at multiple scales together with stakeholders in different regions in Europe. Our hypothesis is that, on the one hand, transformative visions define climate mitigation and adaptation not as isolated goals, but as part of the radical societal transformations needed to achieve a desirable future (Tàbara et al., 2018; Hölscher et al., 2019a). On the other hand, multi-scale visions, which are developed at several scales and linked to one another, can maintain relevance across multiple decision-making scales and facilitate communication among stakeholder groups, while highlighting cross-scale interactions and differences (cf. Biggs et al., 2007).

The article proceeds as follows. We first introduce our methodology for co-producing and integrating transformative visions across scales in Section 2. In Section 3, we present the visions generated in our case studies and analyse whether they are transformative and whether they provide a shared direction across multiple scales in Europe. We then discuss several lessons for the co-production of transformative visions across multiple scales in Section 4. In Section 5, we summarise our main conclusions and implications for further research that not only arrives at transformative visions but also contributes to bringing them to realisation.

2. Methodology: co-producing and integrating transformative visions across scales in Europe

This section describes our envisioning methodology, including the steps to co-produce and integrate visions at multiple scales and regions in Europe: European, national (Scotland), transboundary river basin (Iberia) and local in two municipalities (Hungary) (see Box 1 for a summary of the case studies). We sought to develop transformative visions that are customised to the case studies and able to orient and align transformations to sustainability and resilience for different socio-economic and climate scenarios across scales. We define visions as normative reference points that describe a desirable system state at a specific moment in a far-away future (i.e. in 2100).

Our envisioning methodology was part of a participatory process design within the European FP7 project IMPRESSIONS (www.impressions-project.eu; Holman et al., 2020; Harrison et al., 2019; Tàbara & Frantzeskaki, 2018). IMPRESSIONS sought to advance understanding of the impacts of, and vulnerabilities to, high-end climate and socio-economic scenarios in Europe and to co-produce transition pathways to mitigate, adapt to and cope with undesirable impacts and exploit opportunities for sustainability and resilience in the long-term. We define high-end climate scenarios as those with significantly greater levels of climate change than +2 °C, thus demonstrating unequivocal climate change, and accompanied by corresponding socio-economic changes (Holman et al., 2020).

In IMPRESSIONS, the key purpose of the visions was to guide the development of context-specific transition pathways within different high-end scenarios to address climate change and achieve sustainability and resilience. We build on transition management (Frantzeskaki et al., 2020; Frantzeskaki et al., 2018; Loorbach, 2010) and scenario typologies literature stemming from the landmark paper of Börjeson et al. (2006) to define visions, scenarios and pathways. Visions are *desired* states in the future ('where we want to be'). Scenarios explore internally consistent *plausible* futures ('where we might be heading'), depending on what and how drivers of change develop (O'Neill et al., 2017; Alcamo et al., 2001). Pathways consist of strategies and actions towards a desired state in the future to respond to impacts within scenarios and proactively shape transformations ('how to get to a desired future') (Leach et al., 2010; Rosenbloom, 2017). Accordingly, in our view the climate science community uses the concepts of scenarios and pathways

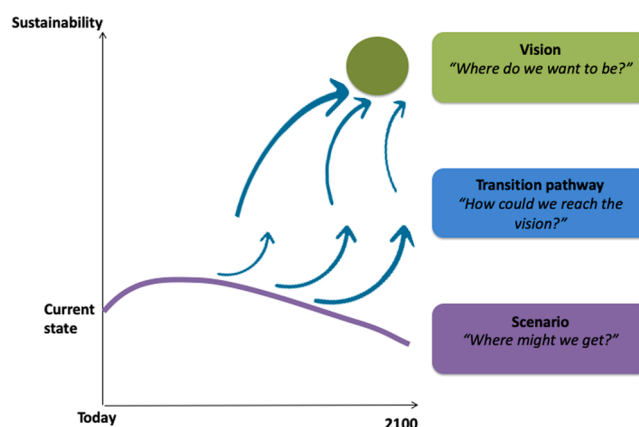


Fig. 1. Illustrative schematic of how normative visions, exploratory scenarios and transition pathways are linked (Adapted from: Pedde et al., 2020).

inconsistently: the pathways concept is used to describe actions (Wise et al., 2014) as well as scenario trends such as the Shared Socioeconomic Pathways (SSPs) and Representative Concentration Pathways (RCPs) (IPCC 2019). In summary, our methodology integrates *visions* as a normative reference point in the future, *exploratory scenarios*, building on SSP and RCP combinations, that provide the future socio-economic and climate contexts for achieving the visions, and *transition pathways* as progressive courses of action to respond to the scenarios and achieve the visions (Fig. 1). For an overview of socio-economic scenarios see Kok et al. (2019); Pedde et al. (2019); Pedde et al. (2019); for climate scenarios and impact modelling Harrison et al. (2019); Papadimitriou et al. (2019); for pathways Frantzeskaki et al. (2019); Hölscher et al. (2017); (2018); Hölscher et al. (2020); Tàbara, Cots et al. (2018).

We first outline the guiding framework for developing and analysing transformative visions (Section 2.1), followed by our step-by-step approach for co-producing and integrating visions at multiple scales (Section 2.2).

2.1. Guiding framework for co-producing and analysing transformative visions across scales

We developed a guiding framework for co-producing and analysing transformative visions that are customised to the case studies and able to orient transformations to sustainability and resilience under high-end scenarios. We distinguish between criteria for visions that are (a) transformative and (b) multi-scale (Table 1).

Across these criteria, we selected the framework of planetary and social boundaries' developed by Kate Raworth (2012) and building on Rockström et al. (2009) as a general structuring approach. We chose this framework because it defines a comprehensive set of social and biophysical boundaries conforming with the notion of strong sustainability, thus prompting questioning of the status quo and of multi-dimensional changes necessary. Based on the multiple categories of the framework, we could use it to structure and cluster the different vision statements we collected from the stakeholders within each individual case study, also identifying gaps and contradictions. Additionally, the framework was used as an organising framework to identify similarities and differences between visions across case studies, thus structuring the integration of visions across scales. Table 3 below presents the framework categories and corresponding vision statements from all the case studies.

(a) Transformative vision criteria

We define visions as transformative when they stimulate and guide thinking and action towards radically alternative sustainable futures (Bai et al., 2016; Pereira et al., 2018; Tàbara & Frantzeskaki, 2018).

Transformative visions need to *comply with sustainability values* (Bennett et al., 2016; Eisenmenger et al., 2020; Frantzeskaki & Tefrati, 2016). While only vaguely defined and disputed, the concept of sustainability functions as a 'generative concept' to debate and assess inter- and intragenerational equity, environmental integrity, human well-being and economic feasibility (Durrant et al. 2017). We posit the idea of strong sustainability arguing that sustainability needs to enable human well-being for all while remaining within precautionary limits of the Earth system and sub-systems – i.e. planetary boundaries (Raworth, 2017; Steffen et al., 2015).

Transformative visions are *counter-hegemonic*: they encapsulate a narrative of a future that is radically different from the present (Bai et al., 2016; Bennett et al., 2016; Sovacool et al., 2020). Transformative change requires an explicit questioning and challenging of existing hegemonic systems (including knowledge, thinking, approaches, structures) and creating new questions, ways of thinking and action rather than quick and incremental fixes of system pathologies (Eisenmenger et al., 2020; Wiek & Iwaniec, 2014).

Finally, transformative visions encompass *multi-dimensional* disruptive changes of cultural, behavioural, institutional, technological, economic, environmental and political system elements (Frantzeskaki & Tefrati, 2016; Wiek & Iwaniec, 2014). This also means that visions are not about individual goals, such as climate mitigation and adaptation, but instead cover multiple goals and aspirations and present the individual parts of a desirable state as interconnected rather than independent.

(b) Multi-scale vision criteria

We define visions as multi-scale when they are embedded in a specific context while providing coherent orientations across scales. By 'scale' we mean the spatial extent of a particular visioning exercise (cf. Biggs et al., 2007). In a multiscale visioning exercise, visions are developed at several scales – in our research the scales are defined by the case studies – and linked to one another.

Firstly, multi-scale visions need to be *contextualised*, meaning that they are embedded and meaningful in their context. Integrating the knowledge of stakeholders enables the vision to be context-relevant, to stimulate shared ownership and ensure accountability (Hölscher et al., 2019; Wiek & Iwaniec, 2014). Considering context dynamics requires that recent developments including existing visioning work, pilot projects and emergent initiatives from communities are taken explicitly into consideration (Frantzeskaki & Tefrati, 2016).

Secondly, visions need to be *coherent across scales* to be relevant at multiple scales (Hoff, 2018). This does not mean that all individual goals and targets have to be the same at all scales; visions developed at different scales and in different contexts define goals and targets within a shared overarching guiding framework, thus systematically promoting mutually reinforcing actions across scales to create synergies that support achieving the defined goals and minimising contradictions and trade-offs (ibid.; Wiek & Iwaniec, 2014; Glass & Newig, 2019).

2.2. Steps to co-produce transformative visions across scales

Following the transition management approach for envisioning (Frantzeskaki & Tefrati, 2016), our envisioning process

Table 1
Criteria for transformative and multi-scale visions.

Criteria	Description
(a) Transformative vision criteria	
Compliance with sustainability values	Coherent goals for inter- and intragenerational equity, environmental integrity, human well-being and economic feasibility within planetary boundaries (Eisenmenger et al., 2020; Raworth, 2017; Steffen et al., 2015)
Counter-hegemonic	Description of a future that is radically different from the present, building on critically questioning and challenging existing and hegemonic systems and creating new questions, ways of thinking and action (Eisenmenger et al., 2020; Sovacool et al., 2020; Wiek & Iwaniec, 2014)
Multi-dimensional	Implication of multi-dimensional changes of cultural, behavioural, institutional, technological, economic, environmental and political system elements across multiple systems (Frantzeskaki & Tefrati, 2016; Wiek & Iwaniec, 2014)
(a) Cross-scale vision criteria	
Contextualised	Linked to context dynamics and developments and including local and tacit knowledge (Frantzeskaki & Tefrati, 2016; Pereira et al., 2018; Wiek & Iwaniec, 2014)
Coherence across scales	Goals and targets at individual scales comply with overarching sustainability values, promote synergies and minimise contradictions and trade-offs (Glass & Newig, 2019; Hoff, 2018; Wiek & Iwaniec, 2014).

encompassed three main co-production steps: (a) formulating guiding principles, (b) creating and consolidating the vision, and (c) comparing and aligning visions across scales. This paper focuses on these envisioning steps – for a comprehensive summary of the IMPRESSIONS process steps and the positioning of the envisioning process see Frantzeskaki et al. (2020), Hölscher et al. (2017) and Holman et al. (2020)¹

Our envisioning approach was a highly iterative and participatory process, combining surveys, workshops and preparatory and analytical work by the interdisciplinary research team. Active participation of actors with a stake in and future concern about the issue is crucial (Frantzeskaki & Tefrati, 2016; O'Brien et al., 2014; Pereira et al., 2018). For each case study (Europe, Scotland, Iberia and Hungary) stakeholders were carefully selected using the methodology of Gramberger, Zellmer, Kok, and Metzger (2015) to ensure that we had a gender-balanced range of stakeholders from different societal groups (decision-making, business and industry, civil society organisations), age groups, sectors (e.g. water, agriculture, energy, finance, mobility), and, where relevant, geographical regions. The workshop organisers jointly agreed on specific quota for each stakeholder category per case study. For example, for all case studies the quota for gender participation was no less than 30% of male and female participants per workshop. Other quotas differed between case studies, e.g. government representatives were highly relevant for the first workshop in the Hungarian case study so the quota was set at a minimum 20% of stakeholders. Once the quota for each stakeholder group was set, a list of potential invitees was compiled. During each phase of the invitation process the workshop organisers monitored the quota to make sure that if an invitee declines the invitation, they are substituted with someone that fulfils the same criteria. Overall, only 5 out of 143 quota were not fulfilled (3.5%), mainly as a result of last minute cancellations. Table 2 presents an overview of the case study-specific stakeholder participation steps vis-à-vis the envisioning steps and the final number of participants. As far as possible, the same stakeholders participated in all workshops, but in case of cancellations replacements were made as discussed above. A final workshop brought together representatives from each case study and in this workshop, the commonalities and differences between the individual visions were discussed to arrive at a shared cross-scale vision for Europe.

Step 1: Formulating guiding principles.

The objective of this step was to identify a suite of principles that describe desired system outcomes for 2100, its desirable operations and the services it will deliver (Frantzeskaki & Tefrati, 2016; Rogers & Bazerman, 2008; Schultz et al., 2007). In this step, core values of participants surface and are negotiated to arrive at shared principles that work in synergy (Frantzeskaki & Tefrati, 2016). The outcome of this step was a list of transformative guiding principles that give tangible orientations in terms of explicit desires, assumptions, beliefs and paradigms for a sustainable future (Wiek & Iwaniec, 2014).

To collect the guiding principles, we asked the stakeholders in each case study in mini-workshops or by survey to write down statements about what they want for their case study region in 2100. It was important that they could express their ideas freely, but we informed them about what we understand as a vision and what are common vision elements to provide generic guidance.

Step 2: Creating and consolidating the vision.

The objective of this step was to create the vision narrative and images to express agreed future desires and wishes, as well as to consolidate the vision following iteration with the stakeholders. The outcome of this step was a comprehensive narrative description and visualisation of a shared vision of all stakeholders (Evans 2017; Miller et al., 2015; O'Brien and Meadows 2013). As visions are never final, modifications of the visions were always possible to ensure general agreement and to take on board the learning that had taken place (Bai et al., 2016; Ravetz, 2000).

The research team reviewed the stakeholders' vision statements collected in their workshops 'post-it' notes and survey responses, to ensure that they complied with the formal definition of a vision as a desirable future endpoint (rather than describing steps on the way), as well as the transformative vision criteria (Section 2.1; Table 1). We then iteratively clustered and synthesised the statements into commonly recognised themes based on the dimensions of the planetary and social boundaries' framework (Raworth, 2012). Using that framework, it was also possible to identify disagreements and significant elements missing from the vision. We then produced

¹ The IMPRESSIONS Information Hub also summarises the envisioning process: http://www.highendsolutions.eu/page/creating_visions.

Table 2
Overview of stakeholder participation in iterative visioning steps in the case studies.

Envisioning steps	Stakeholder engagement	Objective	Europe	Scotland	Hungary	Iberia
(a) Formulating guiding principles	Vision survey / Mini-workshop	Collect input on vision statements	Vision survey in January 2016 19 responses	Mini-workshop September 2015 17 stakeholders	Mini-workshop in February/March 2016 45 stakeholders	Vision survey in June 2016 16 responses (9 from Portuguese, 7 from Spanish stakeholders)
(b) Creating and consolidating the vision	Stakeholder workshop #1	Present and validate vision Discuss missing elements, inconsistencies	February 2016 23 stakeholders	April 2016 22 stakeholders	June 2016 24 stakeholders	September 2016 23 stakeholders (10 Portuguese, 13 Spanish stakeholders)
	Vision survey / Mini workshop	Validate changes made to the vision based on workshop #1	January 2017 15 responses	March 2017 6 responses	Mini-workshop in December 2016 10 stakeholders; Survey March 2017, 7 responses	June 2017 13 responses (7 from Portuguese, 6 from Spanish stakeholders)
	Stakeholder workshop #2	Discuss assessment of vision, synergies and trade-offs Opportunity to adapt vision	May 2017 17 stakeholders	June 2017 12 stakeholders	May 2017 30 stakeholders	September 2017 16 stakeholders (9 Portuguese, 7 Spanish stakeholders)
I Comparing and aligning visions across scales	Cross-scale stakeholder workshop	Discuss and integrate visions across scales	April 2018 29 stakeholders (10 from Europe, 8 from Scotland, 4 from Hungary, 7 from Iberia)			

visualisations of the visions and vision statements that were printed as posters and used in the discussions about pathways to achieve the vision.

In a first workshop in each case study, the vision was presented and openly discussed with the stakeholders: Does everyone agree with the narrative of “the world we want”? Any contradictions, concerns and missing elements found during the analysis were discussed. Throughout the workshop series, which also served to generate transition pathways to achieve the vision (Frantzeskaki et al., 2019; Hölscher et al., 2017), the stakeholders were offered the opportunity to continuously reflect on and adapt the vision.

the research team individually reviewed the notes and recordings from the discussions and agreed how this input added to and/or changed the initial version of the vision.

After the first workshop, the research team individually reviewed the collected ad-verbatim, notes and recordings from the discussions and collectively agreed how this input added to and/or changed the initial version of the vision. The proposed changes and additions were checked against the criteria for transformative visions (Section 2.1). The stakeholders were asked via a survey to verify the modifications made following this analysis, and in a follow-up workshop could again revisit the vision, as an iterative learning and co-production process. [Supplementary Material A](#) gives an overview of the visions generated per case study after this step.

Step 3: Comparing and aligning visions across scales.

This step sought to analyse and debate visions across scale, to explore the extent to which the visions are coherent. Our main aim was to generate agreement on an emergent pan-European vision with loosely coupled multi-scale visions allowing for contextual differences (cf. Biggs et al., 2007). It was important to bring stakeholders from each case study together to clarify the values, needs and wants at the different scales (ibid.).

The research team compared the visions across scales, and identified similarities and differences across case studies per vision categories – i.e. dimensions of the planetary and social boundaries’ framework. The results were presented to and discussed with a selection of stakeholders from all case studies at a cross-scale workshop. This served to explore context-specific characteristics and priorities as well as what a shared and integrated European vision could look like. The discussion focussed on vision elements in the Scottish, Iberian and Hungarian visions that were not explicitly covered in the European vision, and vice versa, and agreement was reached on whether they should be included in a European vision and what wording should be used. [Supplementary Material B](#) gives an overview of the comparison of visions.

3. Results: transformative visions for Europe in 2100?

In this section, we present the visions we have co-produced together with stakeholders at different scales and in different regions within Europe. We co-produced four visions for 2100 – one vision for each case study – that include the shared aspirations of the stakeholders in the forms of a vision narrative, statements and images. [Table 3](#) provides an overview of key vision statements from the case studies per vision category (drawing on the categories of the social and planetary boundaries’ framework, see [Section 2.2](#)). [Supplementary Material A](#) presents all complete visions including narrative and visualisation. Here, we present the visions in terms of whether they are indeed transformative and provide shared directions across multiple scales in Europe following the criteria defined in [Table 1](#).

Table 3
Representative extracts from the vision narratives of the four case studies.

Vision category	European vision	Scottish vision	Hungarian vision	Iberian vision
Planetary Boundaries				
Ecosystems and nature protection	<p>“All environmental systems [...] maintain their integrity and capacity to regulate basic matter, energy and ecological cycles”</p> <p>“Biodiversity is not declining”</p> <p>“The population and economy respect the planetary boundaries”</p>	<p>“Everybody can enjoy a green environment”</p> <p>“space for essential environmental services [...] in every catchment”</p> <p>“New species have become emblems of Scotland”</p> <p>“People [...] live a valuable life in balance with nature”</p>	<p>“species resistant to climate change are used”</p> <p>“urban environment is clean, healthy and continuously improving”</p> <p>“Nature conservation”</p> <p>“no overconsumption and travel with high ecological footprint”</p> <p>“Industrial emissions of air pollutants are near zero”</p> <p>“Material consumption has been reduced [and] produce little or no waste”</p>	<p>“Natural resources, such as water, soil, biodiversity and air, are managed sustainably and strictly protected”</p> <p>“Humans live in harmony with nature”</p>
Waste and pollution	<p>“chemical, biological and other (e.g. solid waste) pollution is almost non-existent”</p> <p>“Atmospheric pollution has been cut by 95% compared to the level of 2010”</p>			<p>“maximum reuse, recycling and recirculation of materials”</p>
Carbon emissions	<p>“The CO₂-concentration in the atmosphere is stabilized at 450 ppm CO₂ eq.”</p>	<p>“Scotland has a low-carbon and climate-resilient economy”</p>		<p>“All economic activity is carbon neutral”</p>
Economy and resources	<p>“Resources are used efficiently based on a closed loop perspective”</p>	<p>“focus of the economy is on producing and consuming what is important in life”</p>	<p>“Shorter supply chains”</p> <p>“economy is sustainable and preserves values”</p> <p>“corporate social responsibility is high”</p> <p>“Sustainable tourism [...] is booming”</p> <p>“value of production is not measured in GDP, with a representation of full lifecycle costs”</p>	<p>“strict environmental and social responsibility standards”</p> <p>“sustainable economy [...] with minimum impact on natural ecosystems”</p> <p>“more green industries and less dependence on tourism”</p>
Sustainable land-use	<p>“large spaces for agriculture, nature, water buffering, productive open space and recreation”</p>	<p>“equitable land ownership”</p> <p>“land use is driven by public choices and priorities”</p>	<p>“distribution of the population is based on the carrying capacity”</p> <p>“diverse land ownership”</p> <p>“Urbanization is kept under control”</p>	<p>“Land use management and planning promote the socio-economic sustainability of the region”</p>
Food, water and energy				
Sustainable energy production and consumption	<p>“Europe is energy self-sufficient”</p> <p>“Energy is produced and consumed in the most intelligent, sustainable, non-polluting ways with no environmental impact and with zero CO₂ emissions”</p> <p>“Europe exports renewable energy technologies to other countries”</p> <p>“high-energy-efficiency housing”</p>	<p>“Energy is produced locally and owned by communities”</p> <p>“less than 1% of energy derived from fossil fuels”</p>	<p>“energy supply is environmentally friendly and sustainable, relying at least 60% on renewables (solar, geothermal, wind, wood)”</p> <p>“Energy supply is decentralized”</p> <p>“Energy efficiency has been increased”</p> <p>“Hungary has total energy independence”</p> <p>“Energy storage is highly efficient”</p> <p>“all modern buildings are at least self-sufficient with respect to energy supply”</p>	<p>“100% renewable energy”</p> <p>“no more investment in fossil fuels”</p> <p>“no dependence on external energy supply”</p> <p>“Iberia is the major (solar) energy producer for Northern European countries”</p> <p>“Housing construction [...] achieve practically zero energy consumption”</p>
Transport	<p>“Terrestrial transport systems are powered primarily by electricity and hydrogen”</p> <p>“use of sustainable (public) means of transportation”</p>	<p>“The low-carbon economy is supported by smarter physical mobility and better virtual ‘mobility’”</p>	<p>“Transport is environmentally friendly and energy efficient”</p> <p>“emphasis on walking, cycling, water transport and electric vehicles”</p> <p>“dense public transport system, entirely run on renewables and widely used”</p>	<p>“Transport is 100% electrical”</p>
Food and agriculture	<p>“Sustainable agriculture and fisheries provide food security for all”</p> <p>“more attentive to the quality of their food rather than the quantity”</p> <p>“urban agriculture”</p>	<p>“Scotland has food security while being a low-carbon economy”</p> <p>“Food is produced sustainably with a low-carbon footprint”</p> <p>“Water use for agriculture is</p>	<p>“large scale organic farming and self-sufficiency based on kitchen gardens”</p> <p>“Consumption of locally produced organic food”</p> <p>“urban inhabitants are able to</p>	<p>“Everybody enjoys safe food and Iberia has food security”</p> <p>“production and consumption of meat has been reduced substantially”</p> <p>“consumption of local, seasonal and organic</p>

(continued on next page)

Table 3 (continued)

Vision category	European vision	Scottish vision	Hungarian vision	Iberian vision
Water	<p>“Deep aquifers and fossil water are no longer exploited”</p> <p>“Potable water is provided through closed-loop systems”</p>	<p>responsible and less energy intensive”</p>	<p>produce a large part of what they need”</p> <p>“Health-centred water management”</p> <p>“protection of natural water bodies” “Floodplains regain their ecosystem functions”</p> <p>“ample supply of clean healthy drinking water”</p> <p>“Sewage is managed in a closed cycle”</p>	<p>products”</p> <p>“sustainable and natural agriculture”</p> <p>“clean rivers, lakes and reservoirs, re-naturalised water bodies”</p> <p>“all citizens have full access to clean and safe water”</p> <p>“Integrated Iberian water management”</p> <p>“balanced use of water for urban supply, agriculture, forestry and energy production”</p> <p>“reduced conflicts between different water users”</p>
Health and well-being				
Quality of life	<p>“All European citizens enjoy a high quality of life that does not compromise the future of generations”</p> <p>“Basic human needs [...] are met”</p>	<p>“inclusive society where everyone thrives”</p>		
Sustainable lifestyles	<p>“Sustainable and healthy living patterns”</p>	<p>“population understands and can make decisions on conflicts and trade-offs”</p> <p>“Individuals and communities engage with arts and culture and are creative”</p>	<p>“Active and healthy lifestyles”</p> <p>“awareness of the importance of values and morals [...] of sustainability”</p> <p>“Money is not considered to be the exclusive and only measure of value and success”</p>	<p>“new lifestyles that fit in more sustainable ways”</p> <p>“Rural and close-to-nature lifestyles co-exist with those relying on cutting-edge technologies”</p> <p>“People are tolerant and broad-minded”</p>
Community life	<p>“People live in strongly networked, small-scale, self-sufficient communities based on social equity and cooperation”</p>	<p>“communities living in low density areas with diversity and local equality”</p>	<p>“Community and local cultural life are strong”</p> <p>“free dissemination of community knowledge and best practices”</p> <p>“strong family ties and dedicated civil society organizations”</p>	<p>“Community activities are valued”</p>
Health care	<p>“Money is spent on prevention of illness and diseases”</p> <p>“Everybody has access to advanced health services regardless of their income”</p>	<p>“free access to [...] health services”</p> <p>“Health expenditure focusses on health not illness”</p>	<p>“sustaining health and prevention”</p> <p>“comprehensive basic healthcare system readily available for everyone”</p> <p>“widespread access to natural, traditional medicine”</p>	<p>“access to [...] health for all”</p> <p>“people care more about health and also make sure that the elderly, the children and the disabled are supported”</p>
Urban and rural life	<p>“high-density, medium-sized cities that use a minimum of space with a maximum of liveability and access to cultural highlights, near to open space and green, but also near to jobs, education and public transport”</p>	<p>“A better spread of public services allows people to choose between rural and urban living”</p> <p>“Nature is well integrated into all cities providing better living spaces”</p>	<p>“cities and rural communities retain their population”</p> <p>“balanced urban fabric with a lot of green areas and sustainable urban services”</p> <p>“harmonious relation between urban and rural communities”</p> <p>“cities are climate-adapted”</p>	<p>“Cities are smaller [...], energy self-sufficient, based on [...] circular economy models, eliminating waste production and improving air quality”</p> <p>“Urban planning applies sustainability criteria”</p> <p>“Abandonment and the deterioration of rural areas has been reduced”</p> <p>“equal opportunities between different areas”</p>
Income, education and jobs				
Meaningful employment and work-life balance	<p>“Europeans work fewer hours [...] and volunteer and share jobs more”</p> <p>“Many jobs are generated within the community and linked with achieving self-sufficiency”</p>	<p>“full employment”</p> <p>“Work allows people to fulfil their (social) potential”</p> <p>“working week has been reduced to 4 days, allowing people more time to make other contributions to society and connect better with nature”</p>	<p>“meaningful local employment [...] available for all”</p> <p>“total number of employed almost equals the total working age population”</p> <p>“Part time work, telecommuting, job sharing is available everywhere”</p>	<p>“meaningful jobs”</p> <p>“full employment”</p>

(continued on next page)

Table 3 (continued)

Vison category	European vision	Scottish vision	Hungarian vision	Iberian vision
Education	<p>“advanced and affordable education (on all levels)”</p> <p>“Research aims to advocate, communicate and practice a more holistic approach towards solving major scientific and societal challenges”</p>	<p>“free access to education”</p> <p>“allowing all people to develop their talents and make fully informed, democratic decisions”</p> <p>“Interdisciplinary education, research and innovation”</p>	<p>“Positive, long-term and systems thinking are embedded in formal and informal education”</p> <p>“education based on traditions, personal and collective responsibility, increasing creativity and problem-solving ability”</p> <p>“older people pass on knowledge to the younger generation”</p> <p>“Society appreciates different – modern as well as traditional – forms of knowledge”</p>	<p>“access to [...] education [...] for all”</p> <p>“flexible education system supports the development of carbon-neutral technology and professional activities”</p> <p>“Rich cultural activities promoting diversity and tolerance are included in all schools and at all levels”</p> <p>“guaranteed access to education”</p>
Resilience				
Crisis and risk management	<p>“Economies can rebuild swiftly”</p> <p>“Systems and plans for disaster risks are widely available and also applied for cultural heritage”</p> <p>“Europe acts pre-emptively and strives to prevent crises”</p> <p>“resilience of our coasts and river banks with respect to flooding”</p>			<p>“water management helps to mitigate extreme events, such as droughts and floods”</p> <p>“multiple mechanisms able to respond quickly to changing weather and extreme events”</p>
Adaptive capacity	<p>“Society is well prepared to adapt to the consequences of climate change in a flexible manner”</p> <p>“Resilient cities and resilient communities”</p>			<p>“All cities have adaptation plans”</p> <p>“Integrated adaptive management deals with environmental challenges”</p>
Solidarity	<p>“[Europe] stays unified in the face of internal and external challenges”</p> <p>“extreme losses are not carried by individuals but collectively”</p> <p>“Europeans impacted by climate change [...] are provided with assistance”</p>			<p>“Support is provided to those in need and refugees are welcomed”</p>
Voice, social equity and gender equality				
Equity and accessibility	<p>“true equity among citizens and societies”</p> <p>“Wealth is duly distributed, globally and regionally”</p> <p>“Poverty is eradicated”</p> <p>“Global (economic) equity and fair chances for previously lesser developed countries”</p>	<p>“Scotland in 2100 is a country of equality: Equality of gender, race, sexuality, age, (dis)ability and faith”</p> <p>“equality of opportunity to access the economy”</p> <p>“future generations are also treated equally in all decisions”</p> <p>“basic human rights are respected”</p> <p>“Access to justice is ensured”</p> <p>“appreciate the influx of immigration [as] part of a global community”</p> <p>“All people have an income adequate to satisfy their basic needs”</p>	<p>“social inequity is at an acceptable level”</p>	<p>“Men and women are paid and treated equally”</p> <p>“different cultural and regional identities are respected and accommodated”</p> <p>“fair income distribution including reasonable salary differences”</p> <p>“Human rights, human well-being and opportunities are universal”</p> <p>“Welfare and access to public services of all inhabitants are ensured”</p> <p>“new welfare model that is centred on wellbeing and social welfare”</p>
Social protection and human rights	<p>“A solidarity system transfers resources between younger and older generations”</p>		<p>“advanced social security system”</p> <p>“support for youth and the elderly is strong and public safety is maintained”</p> <p>“Society successfully handles differences and diversity”</p>	
Governance				
Sustainability-oriented governance	<p>“Sustainability is embedded as a fundamental investment criterion”</p> <p>“normative power exercised though standard setting, protection of environment and human health, and inclusive innovation”</p> <p>“Europe is a strong, peaceful and cohesive”</p>	<p>“Local governments are responsible for building</p>	<p>“Protection of the environment and climate is a priority”</p> <p>“subsidies and support for sustainable environmental management”</p> <p>“sustainability-oriented systems”</p> <p>“principle of subsidiarity”</p> <p>“significant taxation authority</p>	<p>“protection and management are incorporated into all policies”</p> <p>“sustainable long-term as well as short-term sustained options is the rule”</p> <p>“government is strong and enforces environmental and social laws”</p> <p>“Portugal and Spain are united with coordinated Iberian</p>

(continued on next page)

Table 3 (continued)

Vision category	European vision	Scottish vision	Hungarian vision	Iberian vision
Multi-level and subsidiary governance	<p>“allowing for national and regional diversity”</p> <p>“strong functional incentives to prioritise collective goals over individual ones”</p> <p>“citizens are positive about Europe”</p> <p>“regions are strongly interconnected, each with its own identity”</p>	productive relationships with the international community”	and policy-making powers are vested with local government” “decisions on local issues made locally”	governmental institutions” “Iberia is a coherent, diverse, developed and peaceful territory”
Good governance	<p>“Policy-making in any field is based on scientific evidence”</p> <p>“active mechanisms to counteract the concentration of wealth and power”</p> <p>“strong political accountability”</p>	“Fair democratic governance”	<p>“Corruption is minimal”</p> <p>“legal foundation of governance and institutions is stable and secure”</p> <p>“Elected municipal leaders are accountable”</p>	<p>“Laws are just and everyone is subjected to them”</p> <p>“good governance”</p> <p>“good leadership”</p> <p>“Public and private planning and management are transparent and democratic, but also flexible”</p>
Participation and active citizenry	<p>“democratic values that include all people”</p> <p>“All levels of civil society participate in decisions”</p> <p>“collaborations between scientists, engineers, governments, policy-makers, and other stakeholders”</p>	<p>“all people are empowered to take part in all levels of decision-making”</p> <p>“All are properly and fully informed about issues they are taking a decision on”</p>	<p>“participatory local governance”</p> <p>“many local civil initiatives”</p> <p>“direct communication between communities and local government”</p> <p>“decision-making on major developments requires strong civil society participation”</p>	<p>“highly politically engaged society, which understands the global societal challenges and is able to give their opinions”</p> <p>“Public participation and involvement are mandatory at all levels of decision-making”</p>
International cooperation		“Scotland is active in promoting and helping other countries to achieve their positive visions”	“twinning programme with other municipalities abroad”	“Iberia supports greater global cooperation and fosters solidarity, with respect for human rights”

3.1. How transformative are the visions?

All case study visions demonstrate shared ambitions for a sustainable, low-carbon and climate-resilient Europe that stand in stark contrast to the present situation. The visions demonstrate a shift from focussing on isolated climate mitigation and adaptation goals to combined goals for good living, justice and social and environmental wellbeing.

The visions are based on key sustainability values and promote the notion of strong sustainability, as shown by the emphasis on social and environmental goals rather than economic growth. There is a strong emphasis across visions on maintaining the integrity and capacity of environmental systems through a balance of preserving and using ecosystem services, reducing waste and pollution, carbon emissions and resource use. Biodiversity is not declining and humans live in harmony with nature. Resources are used efficiently based on a closed-loop perspective, producing little or no waste and low carbon emissions. Additionally, all visions emphasise a high quality of life, healthy and sustainable lifestyles, community life and equality among all citizens and societies. The European vision emphasises that basic human needs are met without compromising future generations. The fact that the visions highlight the interdependent nature of people-environment interactions and emphasise the importance of all sustainability values makes them transformational, since this requires strong sustainability governance at local, regional and pan-European scales.

The visions describe a future state that is radically different from the present situation, including low-carbon or, carbon-neutral economies, intermodal mobility, and local and community-based economies, and imply far-reaching changes in institutions, cultures, behaviours, and market patterns. For example, all case studies envision Europe and individual countries and regions as energy self-sufficient, with a high dependence on renewable energy sources. People are conscious about sustainability values and able to make informed decisions about lifestyle choices, reflecting an increasing sense of responsibility and a shift from individualism towards more collaborative societies. All visions emphasise voice, social equity and equality among all citizens and societies in terms of access to services, resources and decision-making with respect to age, gender, race, ethnicity, religion etc. Health care focuses on prevention and health, rather than on just the treatment of illness. Everybody has access to health services regardless of their income. The Hungarian vision highlights access to diverse health care facilities, including sport centres, and use of natural and traditional medicine.

While the visions underscore the need for far-reaching and decisive climate and sustainability action, some statements are questionable in terms of their radicality. For example, the Hungarian vision states that (by 2100) there are at least 60% renewables. The other case studies are more radical in terms of goal ambition; for example, the Iberian vision states that energy consumption is covered 100% by renewables and that Iberia is exporting energy and no longer invests in fossil fuels. The radicality, however, always needs to be examined while keeping the constraints and opportunities within the local context in mind.

In all case studies, the visions address multiple dimensions of sustainability (Table 3). Additionally, the visions embody fundamental changes across multiple dimensions including behaviours, cultures, lifestyles and production and consumption. Vision statements on income, education and jobs highlight diverse skill development and meaningful employment that allow people to fulfil their

Table 4
Comparison of visions for Europe, Scotland, Iberia and Hungary.

Vision categories	Shared vision statements	Case-specific additions	Differences
<i>Planetary boundaries</i>			
Ecosystems and nature protection	Respect planetary boundaries Balance in using and preserving ecosystem services People appreciate the environment and live in balance with nature		
Waste and pollution Emissions	Almost no pollution and waste Stabilisation of CO ₂ concentration		Hungary: no waste Scotland: low-carbon economy Iberia: All economic activity is carbon neutral
Economy and resources	Preservation and conservation of Europe's (and the world's) natural resources and environment Sustainable and efficient management of natural resources within a circular economy	Hungary: sustainable tourism Hungary: value of production is measured with a representation of full lifecycle costs Iberia: Natural resources are strictly protected	
Sustainable land-use	Sustainable land-use planning to combine multiple social and ecological functions and promote equal opportunities between different areas		
<i>Food, water and energy</i>			
Energy production and consumption	Europe is energy self-sufficient, with a high dependence on renewable energy sources Energy is produced and consumed in the most intelligent, sustainable, non-polluting ways	Scotland: energy is produced locally and owned by communities Hungary: energy supply is decentralised and Hungary has total energy independence Iberia: no dependence on external energy supply, major (solar) energy producer for Northern European countries Europe, Hungary and Iberia: energy self-sufficient buildings Scotland: smarter 'virtual' mobility Iberia: transport is 100% electrical	Europe: energy is produced and consumed with no environmental impact and zero CO ₂ emissions Iberia: 100% renewable energy; no more investment in fossil fuels Hungary: at least 60% renewables (solar, geothermal, wind, wood) Scotland: low-carbon and climate-resilient economy with less than 1% of energy derived from fossil fuels
Transport	Low-carbon transport and mobility Use of public transport and alternative mobility modes (e.g. walking, cycling, electric vehicles)		
Sustainable agriculture and food	Sustainable agriculture and fisheries Food security and safety for all	Europe and Hungary: urban agriculture Hungary: locally produced organic food Iberia: substantial reduction of meat production and consumption Scotland: sustainable water use in agriculture Hungary and Iberia: protection and re-naturalisation of water bodies Iberia: integrated Iberian water management	
Sustainable water use and safe water supply	Sustainable use of water Ample supply of clean, healthy potable water		
<i>Health and wellbeing</i>			
Quality of life	High quality of life Basic human needs met		
Sustainable lifestyles	Active and sustainable lifestyles and values	Scotland: Individuals and communities engage with arts and culture and are creative Iberia: Co-existing eco- and techno-lifestyles, people are tolerant	
Community life	Community and local cultural life are strong and diverse Local communities are self-sufficient with circular economies		
Health care	Sustainable healthcare system for all Health care is focused on prevention	Hungary: access to traditional medicine Iberia: people make sure that elderly, children and disabled are supported Scotland and Hungary: Green cities	
Urban and rural life	Cities use a minimum of space and ensure a maximum of liveability and access to culture, green space, jobs, education and zero-emission mobility Rural life is attractive and supported Harmonious relationship between urban and rural communities		
<i>Income, education and jobs</i>			

(continued on next page)

Table 4 (continued)

Vision categories	Shared vision statements	Case-specific additions	Differences
Meaningful employment and work-life balance	Availability of meaningful employment opportunities that allow people to fulfil their (social) potential Reduction of working hours and an increase of volunteering, job sharing and other contributions to society	Europe and Hungary: local employment opportunities	Hungary: number of employed almost equals the total working age population Iberia: full employment
Education	Guaranteed access to high quality education for all Education on sustainability values, tolerance and (practical) skills for a sustainable way of life	Europe: role of research for solving major scientific and societal challenges Hungary: combination of modern and traditional forms of knowledge Iberia: education supports development of carbon-neutral technology and professional activities	
Resilience Crisis and risk management		Europe: Acting pre-emptively to prevent crises Iberia: Flexibility, good leadership and adaptive management to ensure resilience to floods and droughts	
Adaptive capacity		Europe: resilient communities Europe, Hungary and Iberia: resilient and climate-adapted cities	
Solidarity		Europe and Iberia: losses and risks are carried collectively Iberia: refugees are welcomed	
Voice, social equity and gender equality			
Equity and accessibility	Equity among all citizens and societies All people have an income adequate to satisfy their basic needs	Scotland: future generations are also treated equally in all decision	Europe: wealth is duly distributed, poverty is eradicated Hungary: social inequity is at an acceptable level Iberia: fair income distribution including reasonable salary differences
Social protection and human rights	Social protection and support Human rights and opportunities are respected and universal	Scotland and Hungary: appreciating differences and diversity Iberia: new welfare model centred on wellbeing and social welfare	
Governance Sustainability-oriented governance	Sustainability is embedded as a fundamental investment criterion	Iberia: strong government is enforces environmental and social laws	
Multi-level and subsidiary governance	Europe is strong, peaceful and cohesive Subsidiary principles to make decisions locally Collective goals Respect for national and regional identities and diversity Transregional collaboration		
Good governance	Transparent, accountable, democratic and fair governance Leaders are accountable	Europe: New modes of governance for experimentation and based on scientific evidence Hungary and Iberia: minimal corruption	
Participation and active citizenry	All people are empowered to and take part in decision-making at all levels Many local civil initiatives		
International cooperation	Promotion of sustainability visions and human rights abroad		

(social) potential.

Particularly notable is the inclusion of a governance dimension in all case study visions, though a 'governance' category is not included in the planetary and social boundaries' framework. All visions include statements about governance that is based on sustainability and democratic values, trust, transparency, accountability, subsidiarity principles and international cooperation and collaboration. This demonstrates the importance the participants attributed to supportive governance and institutional structures to maintain sustainability ambitions and goals in the long term rather than being institutionally agnostic regarding what it takes to achieve sustainability in practice. Specifically, sustainability and natural resource protection are embedded as fundamental criteria in policy-making and economic activity. There is a high level of political awareness and engagement in society and a high level of participation at different levels of decision-making. The European vision emphasises the role of science in policy-making (e.g. scientific and finance data, integrated risk assessments). At the European scale, the European vision describes Europe as a strong, peaceful and

cohesive continent allowing for national and regional diversity, while countries and regions prioritise collective goals. Regions are strongly interconnected and integrated to respond to economic, environmental and social challenges. The Scottish, Hungarian and Iberian visions emphasise European and global cooperation based on solidarity, respect for human rights and tolerance for distinct identities. The Iberian vision highlights transboundary collaboration with coordinated Iberian governmental institutions, while cultural and regional identities are respected and accommodated. The visions for Scotland and Hungary advocate the principle of subsidiarity and strong local governments that also collaborate within the international community. The Hungarian vision additionally highlights the role of local civil initiatives within participatory local governance and accountability of elected municipal leaders.

Only the European and Iberian visions include statements on climate resilience and responding to other risks in a flexible and quick manner. In the European vision, Europe acts pre-emptively and strives to prevent crises; disaster risk management systems and plans are widely available and an appropriate level of protection is ensured in cities and in coastal areas and along river banks. People can react and self-organise rapidly in the case of disruptions. There is also a high level of solidarity: Europeans impacted by climate change (be it financially, physically or mentally) are provided with assistance. The Iberian vision emphasises improved water management to respond to droughts and floods.

3.2. Do the visions provide a shared direction across multiple scales in Europe?

Overall, whilst derived through independent processes, there is a high degree of commonality in the visions developed. All visions show similar core aspirations, including nature protection, reduction of pollution and waste, sustainable economies, community life, social cohesion and green cities. Differences relate mainly to different context-specific needs and priorities, but there are also some important divergences that can be related to different cultural perceptions and aspirations.

The high degree of commonality in the visions developed indicates an apparent pan-European agreement within the diverse stakeholder groups regarding the high-level societal goals of future policy (Table 4). Most of the (few) differences between the individual visions could be resolved during the cross-case workshop. For example, despite divergent interpretations of equity, all stakeholders agreed to interpret equity generically in terms of access to services and equality of opportunity in alignment with universal respect of human rights. The European and Scottish visions specify equality of opportunity to access the economy. The European vision states that the gap between the wealthy and the less-well-to-do groups in each country is lower than in 2016. The Scottish vision also includes future generations as being treated equally in all decisions made that affect the future. The Iberian vision emphasises mechanisms for social protection and support for children, disabled and the elderly. It envisions a new welfare model that allows development without economic growth. At the cross-scale workshop the issue of diversity was debated: it was agreed that diversity within an area as well as between areas needs to be respected.

The agreement on generic aspirations and values at the European scale is underpinned by context-specific additions that relate to different context needs, priorities and cultures. The European, Hungarian and Iberian visions include statements on sustainable water management that protects water quality and quantity and enables climate adaptation. In the cross-scale workshop, the Scottish stakeholders agreed on also including sustainable water use for the harmonised European vision. The Hungarian and Iberian visions especially emphasise water safety and strict environmental regulation and enforcement, including the protection and re-naturalisation of water bodies and, in Iberia, reduced conflicts between different water users due to balanced use. This reflects the extreme levels of water stress the region faces including conflicts between different water users.

The Scottish, Hungarian and Iberian visions include more specific goals and targets. This underscores how a shared European vision can be specified according to local or regional needs and priorities. The Scottish, Hungarian and Iberian visions emphasise local and decentralised energy production that is owned by communities. The Hungarian vision includes intermodal mobility (walking, cycling, water transport and electric vehicles, dense public transport systems). The Hungarian vision specifies 'no corruption' in their interpretation of good governance. The Hungarian and Iberian visions include a high level of corporate social responsibility, based on full lifecycle costs to measure the value of production (Hungary) and strict environmental and social responsibility standards (Iberia).

The only issue on which no agreement could be reached is the use of renewable energies to reduce emission reductions. The European case study aims to stabilise CO₂-concentration in the atmosphere at 450 ppm CO₂ equivalent, while the other case studies emphasise low-carbon and carbon-neutral economies to stabilise emissions. The Scottish vision states that less than 1% of energy is derived from fossil fuels, the Hungarian vision states that there are at least 60% renewables (solar, geothermal, wind, wood), and the Iberian vision states that Iberia has 100% renewables, is exporting energy and no longer invests in fossil fuels.

4. Discussion

While ambitious goals and strategies emerge from policy and science discourses, key limitations remain with regard to actually facilitating the long-term, radical and multi-dimensional changes needed to achieve sustainability and resilience. In this paper, we present how we have co-produced transformative visions at multiple scales in Europe. Specifically, our approach sought to generate visions that are contextualised to inform transformative decision-making at multiple scales while remaining coherent across scales.

Our results show that we were able to co-produce transformative visions that are contextualised in different regions in Europe, highlighting cross-scale interactions and differences while reflecting emergent 'pan-European' vision elements. All visions embody a radical departure from the present situation and combine multiple goals for good living, justice and social and environmental well-being. As such thus, they underscore the need for far-reaching and decisive climate and sustainability action. In addition, it was possible to integrate the individual visions under shared pan-European vision elements, while allowing context-specific differences. A main value of the visions we developed was that, in a next step, they could be used as goals: each case study vision provided a suitable

guide to develop sectoral and cross-sectoral transition pathways to put in place the changes needed for achieving a desirable world (Frantzeskaki et al., 2019; Hölscher et al., 2017), as well as to assess the effectiveness of the pathways in achieving the vision and synergies and trade-offs across vision elements and scales (Holman et al., 2020). Therefore, while envisioning is one phase of a much broader process, the results show its value as an essential first step to create changed understanding and commitment to bring about radical change (Moore et al., 2014; Pereira et al., 2018).

We discuss two key methodological elements that enabled us to co-produce transformative visions at multiple scales in Europe. Firstly, the application of a systematic and comprehensive framework across all scales provided a guide to compare and ensure coherence between visions across multiple scales (Section 4.1). Secondly, the creation of transformative spaces to co-produce the visions with stakeholders supported critical reflections and learning about the radical and multi-dimensional changes necessary in different regions in Europe (Section 4.2). For each element we discuss lessons and implications.

4.1. Employing a systematic framework to link multiple goals across scales

We applied a systematic framework, primarily drawing on the planetary and social boundaries' framework by Raworth (2012), to structure the envisioning process. This framework opened up discussions to identify changes needed across multiple dimensions and reveal gaps and disagreements, thus supporting the generation of shared transformative visions. Additionally, it served to categorise and compare the vision statements both within and across case studies and to facilitate communication among different stakeholder groups to identify similarities and differences.

Within case studies, using the planetary and social boundaries' framework to organise the guiding principles prompted a broader and inter-sectoral discussion about the future, making stakeholders consider multiple sectors and topics. In this way, the framework facilitated an opening up from isolated sectoral perspectives and climate mitigation and adaptation goals to stimulating thinking about desirable futures that combined multiple goals for good living, justice and social and environmental wellbeing. This is important because transformative visions need to be multi-dimensional, for example defining climate mitigation and adaptation as part of the radical societal transformations needed to achieve a desirable future (Tàbara et al., 2018; Hölscher et al., 2019a).

The inclusion of a governance dimension in all case study visions is particularly notable, given the lack of this dimension in the planetary and social boundaries' framework. This resonates with recent visions and climate governance scholarship that call for systemic, polycentric and learning-based governance approaches allowing for cooperation across scales and sectors (Bellinson & Chu, 2019; Hölscher & Frantzeskaki, 2020; Hughes et al., 2018; Kemmerzell, 2018). Along these lines, Eisenmenger et al. (2020) emphasise that visions have to acknowledge the contradictions of current institutions and explicitly focus on experiments, institutional innovation and a broad range of stakeholders to challenge the power of incumbent structures and institutions. Visions and agendas like the SDGs, which rely on those institutions and actors currently responsible for unsustainable trajectories, undermine the transformative potential. Therefore, the addition of governance indicates the need to address gaps in how governance, including actors and institutions, is currently able to address complex and long-term sustainability challenges.

Across case studies, the framework provided a structure to identify similarities and differences between the various visions and thus facilitate communication among the stakeholder groups from the different case studies to debate emerging 'pan-European' agreements during the cross-scale workshop. A main challenge for generating multi-scale visions is embracing complexity, inherent tensions and heterogeneity while seeking to ensure coherence and compatibility (cf. Wiek & Iwaniec, 2014). The participants emphasised the importance of generic overarching statements that can be interpreted and specified in different contexts to remain contextually relevant without losing their key meaning. An illustration of this 'nested' approach to cross-scale visions are the statements about climate mitigation: all stakeholders agreed on the Paris Agreement's goal at the European level, yet translated this into aspirations for low-carbon or zero carbon economies and lifestyles and green energy. Similarly, while all agreed on the statement to shift to a low-carbon economy at the European scale, what this low-carbon economy looks like can differ across regions.

Additionally, we linked the structural framework to the qualitative and quantitative assessment of the visions. Specifically, we sought to assess the efficacy of the transition pathways to achieve the vision under different uncertainty contexts and to identify synergies and trade-offs between vision statements and scales. To-date, there are no consistent frameworks to measure vision progress, also considering synergies and trade-offs between how strategies and actions deliver on different vision objectives. Modelling approaches support the assessment of synergies and trade-offs across targets and scales (Papadimitriou et al., 2019) but are challenged in their ability to simulate adequately or take account of many of the dimensions of the vision, particularly those related to governance and society. Thus, we formulated and quantified targets for vision statements in each vision category and combined qualitative (expert judgement-based) and quantitative (model-based) methods to assess the efficacy of the pathways in moving the scenarios to the vision for each case study (Holman et al., 2020; Hölscher et al., 2017). In this way, the (more objective) spatial quantification of a limited subset of vision indicators that could be modelled was complemented by (more subjective) aspatial expert judgement-based assessments of other vision dimensions to provide a fuller assessment of the efficacy of the pathways. Our assessment of the efficacy of the pathways in moving the scenarios towards the vision used the availability of capitals (human, social, manufactured, financial) as proxies of enablers for the different types of actions within the pathways. This provided a degree of consistency between qualitative and quantitative approaches. Through the efficacy assessment, we could discuss with stakeholders what additional actions might be needed to deliver the vision and ensure transparency of different choices.

4.2. Co-producing visions in transformative spaces for social learning

We sought to create 'transformative spaces' that would facilitate out-of-the-box-thinking and learning for shared and

transformative visions to emerge. According to [Pereira et al. \(2018\)](#), transformative spaces allow participants to “engage thoughtfully with the future and draw on their inherent capacity for storytelling”. We understand social learning as a process of generating new knowledge, which takes place in “communicative interaction” ([Beers et al., 2016](#)) and generates joint commitment and understanding about the problems at hand and possible solutions ([Fazey et al., 2018](#)).

The facilitation of social learning using transformative visions requires methods and approaches able to deal with the complexity and immensity of sustainability challenges and to stimulate reflexivity for getting beyond archetypical, generic narratives of the future ([Pereira et al., 2018](#)). In our envisioning processes, it was important to let the participants dream freely about their desirable future, yet to instil holistic and out-of-the-box thinking. Our method took care to not imply specific goals, but to present examples of other visions to provide inspiration, emphasise the long-term orientation of visions and facilitate open exchanges and critical discussions. During the workshops, we experienced participants who realised how current practices do not match their aspirations as depicted in the vision (that they have formulated) and questioning their understandings of the efficacy of existing institutions and policies.

Using the planetary and social boundaries’ framework to organise the guiding principles prompted a broader and inter-sectoral discussion about the future, making the stakeholders consider multiple sectors and topics that they hadn’t thought about before ([Section 4.1](#)). This approach contributed to both conceptual and social learning: participants had the opportunity to see their ideas and aspirations organised and placed into an integrative and forward-thinking framework, allowing them to learn about new concepts and how their ideas interconnect and contribute to a bigger picture.

Facilitating transformative spaces for social learning challenges the scientific community to develop collaborative skills and methods around solution-oriented research ([Bai et al., 2016](#); [Bartels & Wittmayer, 2018](#); [Hoff, 2018](#); [Pereira et al., 2018](#)). For instance, we had to make our respective concepts understandable for each other in the research team as well as for the stakeholders. Several methods are being developed to trigger transformative thinking and learning during envisioning, such as the inclusion of artists, role-playing or other open methods. These can be a simple yet effective way to connect participants to their creative side ([Heras & Tábara, 2016](#); [Pereira et al., 2018](#)) and to empower them to pursue actions towards the vision and thus overcome the ‘belief-behaviour gap’ manifest in the recognition of current unsustainable behaviour while not changing it ([O’Brien et al., 2014](#)). During the Iberian case study and the cross-scale workshops, envisioning was successfully supported by the interventions of artistic performances and role play ([Galafassi et al., 2018](#)). This served to make the complexity of climate change palpable, boost collective imagination and creativity. However, as generally evident in discussions around transdisciplinary and solution-oriented research, the skill development and time needed for novel methods and their development is often not accounted for in existing research and research funding institutions ([Fazey et al., 2018](#); [Hölscher et al., 2021](#)).

The selection of stakeholders to participate in our case studies likely contributed to the high levels of ambition in the visions. We selected stakeholders based on their engagement with sustainability – be it in policymaking, water management, media, civic engagement or research. Our rationale was to invite those that resemble ‘frontrunners’, who understand aspects of complex problems, have innovative ideas and/or engage in sustainable change, as building blocks for generating transformative visions and challenging business-as-usual ([Loorbach, 2010](#); [Wittmayer et al., 2012](#)). However, we recognise that the inclusion of frontrunners can cause a bias by involving actors that have similar values *a priori*. Ultimately, visions should serve to inspire action; for the realisation of visions, they have to transcend from the group that created them and become relevant for the communities that constitute ‘the context’ ([Hughes, 2013](#)) or ‘the regime’ ([Durrant et al., 2017](#)). It is therefore critical to identify ways to connect visions to broader societal values and communicate them to wider audiences who might not share the same values and ideas and might question the legitimacy of the visions. This is particularly pertinent as the long-term endpoints of our visions contrast existing shorter-term or current socio-political trends in many European countries. In this sense, our visions may be limited to a particular stakeholder group and a future challenge will be to generate and validate truly pan-European visions across more diverse groups of actors. In transformation research, establishing “relationships of trust with, for instance, incumbents in both industry and policy while maintaining a counter-hegemonic position is indeed a central tension” ([Hölscher et al., 2021: 14](#)).

Ideally, transformative spaces are continuous, because envisioning should be viewed as a process rather than a result, involving the iterative revisiting of developed visions and integrating new values and knowledge, the translation of visions into strategies and actions, and the evaluation of how these strategies and actions contribute to delivering the vision. It is important that visions are constantly adjusted to account for the learning and changes that occurred, especially as transformations are impossible to predict ([Pereira et al., 2018](#)). One issue that warrants continuous reflection about created visions is that visions always resemble notions of the past as well as contemporary challenges, trends and discourses. Many statements in our case study visions indeed reflect state-of-the-art ideas and debates prevalent in Europe, including circular economy, urban farming and green cities, as well as existing problems like corruption and the refugee crisis in Europe. Currently, globalisation, the digital revolution and multiple social and technological innovations are transforming how humans interact with each other and the environment, giving rise to new institutions, values and practices ([Avelino et al., 2017](#); [Dorr, 2017](#); [Pereira et al., 2018](#)). We regularly revisited the visions and collected additions or adjustments, but this ended with our project.

5. Conclusions

Visions are important tools to guide long-term changes towards sustainability and overcome disparate societies, yet they are still underused in scientific and policy discourses. In particular transformative visions that can guide transformations towards sustainability and resilience in a coherent way across multiple scales are missing. For example, while intensified climate geopolitics in the EU has reinforced demand for a proactive ‘grand climate strategy’ ([Oberthür & Dupont, 2021](#)), even the laudable European Green Deal favours business-as-usual and economic growth and does not consider goals and strategies beyond 2050.

We presented an envisioning approach to co-produce transformative and multi-scale visions for sustainability and resilience under climate change. A key value of our approach is that we could generate a shared European vision to provide an overarching direction and inspiration, while allowing contextualised interpretation to remain meaningful in different contexts. Frameworks and concepts like sustainability and planetary boundaries, as well as co-production methods for social learning are important ingredients for generating shared and transformative visions that are translated to context priorities and needs, as well as for unveiling synergies and trade-offs across vision objectives and scales.

A common challenge of visions is to bridge between the descriptions of desirable futures and concrete actions, which inevitably engenders a reality check regarding what is possible (Sovacool et al., 2020; Wiek & Iwaniec, 2014). The core agreements across the visions point to areas where deep transformations are required: in service provisioning from critical infrastructures like energy, food, health and education, and in lifestyles and governance. This calls for radical shifts and new patterns of action, organisation and knowledge production. One way forward is to integrate new ideas about governance, actors and institutions into the formulation of visions as a way to link to how and by whom changes to achieve the vision will be made possible.

Acknowledgements

The authors thank colleagues of the IMPRESSIONS project, in particular David J. Tàbara and Paula Harrison, and the many stakeholders who participated so enthusiastically in the project. IMPRESSIONS was funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under Grant Agreement Number 603416.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.futures.2022.103025](https://doi.org/10.1016/j.futures.2022.103025).

References

- Avelino, F., Wittmayer, J. M., Kemp, R., & Haxeltine, A. (2017). Game-changers and transformative social innovation. *Ecology and Society*, 22(4), 41. <https://doi.org/10.5751/ES-09897-220441>
- Bai, X., van der Leeuw, S., O'Brien, K., et al. (2016). Plausible and desirable futures in the Anthropocene: A new research agenda. *Global Environmental Change*, 39, 351–362. <https://doi.org/10.1016/j.gloenvcha.2015.09.017>
- Bartels, K., & Wittmayer, J. M. (Eds.). (2018). *Action Research in Policy Analysis: Critical and Relational Approaches to Sustainability Transitions*. Oxfordshire: Routledge.
- Beers, P., van Mierlo, B., & Hoes, A.-C. (2016). Toward an Integrative Perspective on Social Learning in System Innovation Initiatives. *Ecology and Society*, 21(1), 33. <https://doi.org/10.5751/ES-08148-210133>
- Bellinson, R., & Chu, E. (2019). Learning pathways and the governance of innovations in urban climate change resilience and adaptation. *Journal of Environmental Policy & Planning*, 21(1), 76–89. <https://doi.org/10.1080/1523908X.2018.1493916>
- Bennett, E. M., Solan, M., Biggs, R., McPhearson, T., Norström, A. V., Olsson, P., & Xu, J. (2016). Bright spots: seeds of a good Anthropocene. *Frontiers in Ecology*. <https://doi.org/10.1002/fee.1309>
- Biggs, R., RaudseHearne, C., Atkinson-Palombo, C., Bohensky, E., Boyd, E., Cundill, G., et al. (2007). Linking futures across scales: a dialog on multiscale scenarios. *Ecology and Society*, 12(1), 17. (<http://www.ecologyandsociety.org/vol12/iss1/art17/>).
- Börjeson, L., Höjer, M., Dreborg, K.-H., Ekvall, T., & Finnveden, G. (2006). Scenario types and techniques: towards a user's guide. *Futures*, 38(7), 723–739. <https://doi.org/10.1016/j.futures.2005.12.002>
- Breuer, A., Janetschek, H., & Malerba, D. (2019). Translating Sustainable Development Goal (SDG) Interdependencies into Policy Advice. *Sustainability*, 11, 2092. <https://doi.org/10.3390/su11072092>
- Chapin, F. S., III, & Knapp, C. N. (2014). Sense of place: a process for identifying and negotiating potentially contested visions of sustainability. *Environmental Science & Policy*, 53, 38–46. <https://doi.org/10.1016/j.envsci.2015.04.012>
- Constanza, R. (2000). Visions of alternative (unpredictable) futures and their use in policy analysis. *Conserv Ecol*, 4, 5–22.
- Dorr, A. (2017). Common errors in reasoning about the future: Three informal fallacies. *Technological Forecasting & Social Change*, 116, 322–330. <https://doi.org/10.1016/j.techfore.2016.06.018>
- Dupont, C., Oberthür, S., & von Homeyer, I. (2020). The Covid-19 crisis: a critical juncture for EU climate policy development. *Journal of European Integration*, 42(8), 1095–1110. <https://doi.org/10.1080/07036337.2020.1853117>
- Eckert, E., & Kovalevska, O. (2021). Sustainability in the European Union: Analyzing the Discourse of the European Green Deal. *Journal of Risk and Financial Management*, 14, 80. <https://doi.org/10.3390/jrfm14020080>
- EEA, European Environment Agency, 2019, The European environment – state and outlook 2020. Available at: <https://www.eea.europa.eu/publications/soer-2020>.
- European Commission. (2019). *The European Green Deal. COM, 2019, 640*.
- Eisenmenger, N., Pichler, M., Krenmayr, N., Noll, D., Plank, B., Schalmann, E., Wandl, M.-T., & Gingrich, S. (2020). The Sustainable Development Goals prioritize economic growth over sustainable resource use: a critical reflection on the SDGs from a socio-ecological perspective. *Sustainability Science*, 15, 1101–1110. <https://doi.org/10.1007/s11625-020-00813-x>
- Fazey, I., Schöpke, N., Caniglia, G., Patterson, J., Hultman, J., Van Mierlo, B., Säwe, F., Wiek, A., Wittmayer, J., & Aldunce, P. (2018). Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. *Energy Research & Social Science*, 40, 54–70. <https://doi.org/10.1016/j.erss.2017.11.026>
- Frantzeskaki, N., & Tefrati, N. (2016). A transformative vision unlocks the innovative potential of Aberdeen City, UK. In D. Loorbach, J. M. Wittmayer, H. Shiroyama, J. Fujino, & S. Mizuguchi (Eds.), *Governance of Urban Sustainability Transitions. European and Asian Experiences* (pp. 49–68). Tokyo: Springer.
- Frantzeskaki, N., Hölscher, K., Wittmayer, J. M., Avelino, F., & Bach, M. (2018). Transition management in and for cities: introducing a new governance approach to address urban challenges. In N. Frantzeskaki, K. Hölscher, M. Bach, & F. Avelino (Eds.), *Co-creating sustainable urban futures. A primer on applying transition management in cities* (pp. 1–40). Tokyo: Springer.
- Frantzeskaki, N., Hölscher, K., Holman, I. P., Pedde, S., Jaeger, J., Kok, K., & Harrison, P. A. (2019). Transition pathways to sustainability in greater than 2°C climate futures of Europe. *Regional Environmental Change*, 19, 777–789. <https://doi.org/10.1007/s10113-019-01475-x>
- Frantzeskaki, N., Hölscher, K., Holman, I., Harrison, P. A., 2020, Operationalising Transition Management for navigating high-end climate futures. In: Hölscher, K., Frantzeskaki, N. (eds.) *Transformative climate governance. A capacities perspective to systematise, evaluate and guide climate action*. Palgrave Macmillan, pp.315–358.

- Galafassi, D., Kagan, S., Milkoreit, M., Heras, M., Bilodeau, C., Juarez-Bourke, S., Merrie, A., Guerrero, L., Pétursdóttir, G., & Tàbara, J. D. (2018). Raising the Temperature: The Arts in a Warming Planet. *Current Opinion in Environmental Sustainability*, 31, 71–79. <https://doi.org/10.1016/j.cosust.2017.12>
- Glass, L.-M., & Newig, J. (2019). Governance for achieving the Sustainable Development Goals: How important are participation, policy coherence, reflexivity, adaptation and democratic institutions. *Earth System Governance*, 2, Article 100031. <https://doi.org/10.1016/j.esg.2019.100031>
- Gramberger, M., Zellmer, K., Kok, K., & Metzger, M. (2015). Stakeholder Integrated Research (STIR): a new approach tested in climate change adaptation research. *Climatic Change*, 128, 201–214. <https://doi.org/10.1007/s10584-014-1225-x>
- Harrison, P. A., Dunford, R. W., Holman, I. P., Cojocaru, G., Madsen, M. S., & Chen, P. Y. (2019). Differences between low-end and high-end climate change impacts in Europe across multiple sectors. *Reg Environ Change*, 19(3), 695–709. <https://doi.org/10.1007/s10113-018-1352-4>
- Heras, M., & Tàbara, J. D. (2016). Conservation theatre: mirroring experiences and performing stories in community management of natural resources. *Society & Natural Resources*, 29(8), 948–964.
- Hoff, H. (2018). Integrated SDG implementation – how a cross-scale (vertical) and cross-regional Nexus approach can complement cross-sectoral (horizontal) integration. In S. Hülsmann, & R. Ardakanian (Eds.), *Managing Water, Soil and Waste Resources to Achieve Sustainable Development Goals: Monitoring and Implementation of Integrated Resources Management* (pp. 149–163). Cham, Switzerland: Springer.
- Holman, I., Berry, P., Hölscher, K., Harrison, P.A., 2020. Climate governance and high-end futures in Europe. In: Hölscher, K., Frantzeskaki, N. (eds.) Transformative climate governance. A capacities perspective to systematise, evaluate and guide climate action. Palgrave Macmillan, pp. 285–314.
- Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What's the difference? *Environmental Innovation and Societal Transitions*, 27, 1–3. <https://doi.org/10.1016/j.eist.2017.10.007>
- Hölscher, K., Wittmayer, J. M., Avelino, F., & Giezen, M. (2019). Opening up the transition arena: An analysis of (dis)empowerment of civil society actors in transition management in cities. *Technological Forecasting and Social Change*, 145, 176–185. <https://doi.org/10.1016/j.techfore.2017.05.004>
- Hölscher, K., Frantzeskaki, N., Pedde, S., & Holman, I. (2020). Agency capacities to implement transition pathways under high-end scenarios. In K. Hölscher, & N. Frantzeskaki (Eds.), *Transformative Climate Governance. A Capacities Perspective to Systematise, Evaluate and Guide Climate Action* (pp. 381–416). Palgrave Macmillan.
- Hölscher, K., Wittmayer, J. M., Hirschnitz-Garbers, M., Olfert, A., Walther, J., & Schiller, G. (2021). Transforming science and society? Lessons from and for transformation research. *Research Evaluation*, 30(1), 73–89. <https://doi.org/10.1093/reseval/rvaa034>
- Hölscher, K., Frantzeskaki, N., Holman, I., Pedde, S., Juhasz-Horvath, L., Clarke, E., Schipper, K., Jäger, J. (2017). Adaptation and mitigation pathways, and synergy mechanisms between them, for the case studies. EU FP7 IMPRESSIONS Project Deliverable D4.2. Available at: http://www.impressions-project.eu/getatt.php?filename=D4.2.Adaptation_Mitigation_Pathways_FINAL_14335.pdf.
- Hölscher, K., Frantzeskaki, N., 2020. A transformative perspective on climate change and climate governance. In: Hölscher, K., Frantzeskaki, N. (eds.) Transformative climate governance. A capacities perspective to systematise, evaluate and guide climate action. Palgrave Macmillan, pp. 3–48.
- Hughes, N. (2013). Towards improving the relevance of scenarios for public policy questions: A proposed methodological framework for policy relevant low carbon scenarios. *Technological Forecasting & Social Change*, 80, 687–698.
- Hughes, S., Chu, E. K., & Mason, S. G. (2018). Climate change in cities, Innovations in multi-level governance. Springer. ISBN 978-3-319-65002-9.
- IPCC, 2018, Global warming of 1.5 °C. An special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Summary for Policymakers.
- Iwaniec, D. M., Childers, D. L., VanLehn, K., & Wiek, A. (2014). Studying, Teaching and Applying Sustainability Visions Using Systems Modeling. *Sustainability*, 6, 4452–4469. <https://doi.org/10.3390/su6074452>
- Kemmerzell, J. (2018). Innovations in European Climate Governance and their impact on local climate policy: an analysis of German major cities. In S. Hughes, E. K. Chu, & S. G. Mason (Eds.), *Climate Change in Cities, Innovations in Multi-Level Governance* (pp. 39–57). Springer. ISBN 978-3-319-65002-9.
- Kok, K., Pedde, S., Gramberger, M., Harrison, P. A., & Holman, I. P. (2019). New European socio-economic scenarios for climate change research: operationalising concepts to extend the shared socio-economic pathways. *Reg Environ Change*. <https://doi.org/10.1007/s10113-018-1400-0>
- Leach, M., Scoones, I., & Stirling, A. (2010). Governing epidemics in an age of complexity: Narratives, politics and pathways to sustainability. *Global Environmental Change*, 20(3), 369–377. <https://doi.org/10.1016/j.gloenvcha.2009.11.008>
- Loorbach, D. (2010). Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. *Governance: An International Journal of Policy Administration and Institutions*, 23(1), 161–183. <https://doi.org/10.1111/j.1468-0491.2009.01471.x>
- Meadows, H. D. (1996). Envisioning a sustainable world. In R. Costanza, O. Segura, & J. Martinez-Alier (Eds.), *Getting Down to Earth, Practical Applications of Ecological Economics* (pp. 117–126). Washington DC: Island Press.
- Miller, C. A., O'Leary, J., Gaffey, E., Stechel, E. B., & Dirks, G. (2015). Narrative futures and the governance of energy transitions. *Futures*, 70, 65–74.
- Moore, M.-L., Tjornbo, O., Enfors, E., Knapp, C., Hodbod, J., Baggio, J. A., Norström, A., Olsson, P., & Biggs, D. (2014). Studying the complexity of change: toward an analytical framework for understanding deliberate social-ecological transformations. *Ecology and Society*, 19(4), 54. <https://doi.org/10.5751/ES-06966-190454>.
- O'Brien, M., Hartwig, F., Schanes, K., Kammerlander, M., Omann, I., Wilts, H., Bleischwitz, R., & Jäger, J. (2014). Living within the safe operating space: a vision for a resource efficient Europe. *European Journal of Futures Research*, 2, 1–11. <https://doi.org/10.1007/s40309-014-0048-3>
- O'Brien and Meadows, M. (2013). Scenario orientation and use to support strategy development. *Technological Forecasting Social Change*, 80, 643–656.
- O'Neill, B. C., Kriegler, E., Kristie, L., et al. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, 42, 169–180.
- Oberthür, S., & Dupont, C. (2021). The European Union's international climate leadership: towards a grand climate strategy? *Journal of European Public Policy*, 28(7), 1095–1114. <https://doi.org/10.1080/13501763.2021.1918218>
- Otto, I. M., Donges, J. F., Cremades, R., Bhowmik, A., et al. (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. *PNAS*, 117(5), 2354–2364. <https://doi.org/10.1073/pnas.1900577117>
- Papadimitriou, L., Holman, I. P., Dunford, R., & Harrison, P. A. (2019). Trade-offs are unavoidable in multi-objective adaptation even in a post-Paris Agreement world. *Science of the Total Environment*, 696. <https://doi.org/10.1016/j.scitotenv.2019.134027>
- Pedde, S., Kok, K., Hölscher, K., Oberlack, C., Harrison, P. A., & Leemans, R. (2019b). Archetyping Shared Socioeconomic Pathways across scales: an application to Central Asia and European case studies. *Ecology and Society*, 24(4), 30. <https://doi.org/10.5751/ES-11241-240430>
- Pedde, S., Kok, K., Hölscher, K., Frantzeskaki, N., Holman, I., Dunford, R., Smith, A., & Jäger, J. (2019a). Advancing the use of scenarios to understand society's capacity to achieve the 1.5° target. *Global Environmental Change*, 56, 75–85. <https://doi.org/10.1016/j.gloenvcha.2019.03.010>
- Pereira, L. M., Hichert, T., Hamann, M., Preiser, R., & Biggs, R. (2018). Using futures methods to create transformative spaces: visions of a good Anthropocene in southern Africa. *Ecology and Society*, 23(1), 19. <https://doi.org/10.5751/ES-09907-230119>
- Ravetz, J. (2000). Integrated assessment for sustainability appraisal in cities and regions. *Environment Impact Assess Rev*, 20, 31–64.
- Raworth, K. (2017). *Doughnut Economics: Seven Ways to Think Like a 21st-century Economist*. White River Junction: Chelsea Green Publishing.
- Raworth, K., 2012, A safe and just space for humanity. Can we live within the doughnut? Oxfam Discussion Paper, <https://www.oxfam.org/sites/www.oxfam.org/files/dp-a-safe-and-just-space-for-humanity-130212-en.pdf>.
- Roberts, C., Geels, F. W., Lockwood, M., Newell, P., Schmitz, H., Turnheim, B., & Jordan, A. (2018). The politics of accelerating low-carbon transitions: Towards a new research agenda. *Energy Research & Social Science*, 44, 304–311. <https://doi.org/10.1016/j.erss.2018.06.001>
- Rockström, J., W. Steffen, K. Noone, Á. Persson, F.S. Chapin, III, E. Lambin, T.M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C.A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P.K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R.W. Corell, V.J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009, Planetary boundaries:exploring the safe operating space for humanity. *Ecology and Society* 14(2): 32. [online] URL: <http://www.ecologyandsociety.org/vol14/iss2/art32/>.
- Rogers, T., & Bazerman, M. H. (2008). Future lock-in: future implementation increases selection of "should" choices. *Organizational Behavior and Human Decision Processes*, 106(1), 1–20.

- Rosenbloom, D. (2017). Pathways: An emerging concept for the theory and governance of low-carbon transitions. *Global Environmental Change*, 43(19), 37–50. <https://doi.org/10.1016/j.gloenvcha.2016.12.011>
- Schultz, P. W., Nolan, J., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, 18, 429–434.
- Sovacool, B. K., Bergman, N., Hopkins, D., Jenkins, K. E. H., Hielscher, S., Goldthau, A., & Brossmann, B. (2020). Imagining sustainable energy and mobility transitions: Valence, temporality, and radicalism in 38 visions of a low-carbon future. *Social Studies of Science*, 50(4), 642–679. <https://doi.org/10.1177/0306312720915283>
- Stafford-Smith, M., Griggs, D., Gaffney, et al. (2017). Integration: the key to implementing the Sustainable Development Goals. *Sustainability Science*, 12, 911–919. <https://doi.org/10.1007/s11625-016-0383-3>
- Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, L., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sörlin, S. (2015). Planetary Boundaries: Guiding human development on a changing planet. *Science*, 347(6223), 1259855. <https://doi.org/10.1126/science.1259855>
- Steffen, W., Rockström, J., Richardson K. et al., 2018, Trajectories of the earth system in the Anthropocene. PNAS. www.pnas.org/cgi/doi/10.1073/pnas.1810141115.
- Tàbara, J. D., Cots, F., Pedde, S., Hölscher, K., Kok, K., Lobanova, A., Lourenco, T. C., Frantzeskaki, N., & Etherington, J. (2018b). Exploring Institutional Transformations to Address High-End Climate Change in Iberia. *Sustainability*, 10, 161. <https://doi.org/10.3390/su10010161>
- Tàbara, J. D., Frantzeskaki, N., Hölscher, K., Pedde, S., Lamperti, F., Christensen, J., Berry, P., Kok, K., Berry, P., & Jäger, J. (2018a). Positive tipping points in a rapidly warming world. *Current Opinion in Environmental Sustainability*, 31, 120–129. <https://doi.org/10.1016/j.cosust.2018.01.012>
- UN, 2015, Paris Agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf. Accessed: October 4, 2020.
- UN, 2016, Transforming our world: the 2030 Agenda for sustainable development. A/Res/70/1. <http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A.RES.70.1.E.pdf>. Accessed: October 4, 2020.
- UNEP, United Nations Environment Programme, 2019, Emissions Gap Report 2019. Available at: <https://www.unenvironment.org/interactive/emissions-gap-report/2019/>.
- Wiek, A., & Iwaniec, D. M. (2014). Quality criteria for visions and visioning in sustainability science. *Sustainability Science*, 9(4), 497–512. <https://doi.org/10.1007/s11625-013-0208-6>
- Willaarts, B., Magnuszewski, P., Palazzo, A., Parkinson, S., Mayor Rodriguez, B., Vinca, A., van Dijk, M., Langan, S., 2019, Bridging the gap across scales in scenario planning: Co-designing water-energy-land visions and pathways in transboundary basins. In: Scenario Forum Conference, 10–13 March 2019, Denver, USA.