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Abstract: In this Policy brief, we provide an overview of a recently published report by the European Environment Agency: 'Sustainability transitions: policy and practice', which we co-authored. We discuss the report's context and rationale, namely as part of a knowledge brokering process initiated at the EEA since 2015 and intended to explore the practical implications of transitions research for policy. We outline the report's 10 key messages, which concern core processes, stages and change mechanisms, key cross-cutting themes, and governance-related challenges for steering transition processes. We also reflect on the report's findings and the broader knowledge development process, identifying a number of topics the transitions community could further investigate, and highlighting challenges and opportunities for science-policy interactions.

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1   Introduction

Faced with unprecedented climate and biodiversity crises, policymakers are ever more receptive to the insights from transitions research. Within Europe, the need to transform core societal systems is increasingly acknowledged in the language and logic of strategic policy documents, for example the EU's proposed long-term strategy for a climate-neutral Europe (EC, 2018) and the 'Political guidelines for the next European Commission' (EC, 2019). At the same time, dispersed actions across society are further increasing the pressure on public authorities to promote transitions, while also opening a space for more ambitious government action. Alongside increasingly vocal climate protests and social activism, new forms of experimentation (local initiatives, urban action, new business models, etc.) offer the potential for more sustainable solutions and systems.

As a result of these shifts, the key question for policymakers is no longer whether or why transitions are needed, but how to make them happen. Governments are thus increasingly eager for knowledge and evidence that can help them rethink public policies and institutions. In this context, transitions research is entering mainstream policy. While there have been earlier examples seeking to translate transitions research into actionable knowledge (e.g. OECD, 2015), these have multiplied in recent years, with transitions researchers interacting in multiple international science-policy arenas (e.g. IPCC, IPBES).

We here focus specifically on the relationship between the transitions research community and the European Environment Agency (EEA), which has recently intensified. Recognising the need to strengthen links between transitions research and policy, the EEA has engaged with a variety of academic communities since 2015, seeking to develop a more solutions-oriented knowledge base. This work has culminated in a new report *Sustainability transitions: policy and practice* (EEA, 2019), which represents the EEA's most recent effort to explore the practical implications of transitions research in a way that is relevant and accessible for policy audiences.

As co-authors of this report, we use this policy brief to provide an overview of the EEA report structure and content (section 2) and to offer reflections about its implications for the state of knowledge in sustainability transitions research and for science-policy interactions (section 3).

2   Report structure and contents

Textbox 1 provides an overview of the report structure. Part 1 of the report provides the foundation for understanding sustainability transitions, explaining the systemic nature of Europe's environmental and sustainability challenges, using established EEA and Eurostat data and indicators. It uses the Multi-Level Perspective as an overarching framework to identify entry points where governance interventions can facilitate systemic change. It also focuses attention on three domains – food, energy and mobility. Throughout the report, case studies and examples from these domains are used to clarify transitions concepts and exemplify challenges and responses in concrete ways. The report also puts particular emphasis on connecting to the realities of target audiences by continually highlighting links to established EU policies and processes.

The remainder of the report (chapters 3-12) distils insights from transitions research and other academic communities into a series of clear, concise and policy-relevant messages. Each chapter breaks the messages down into several key issues, outlines research insights, links to EU policy agendas, provides empirical illustrations, and identifies knowledge limitations. The ten sets of messages vary in character, reflecting the variety of governance challenges and opportunities linked to sustainability transitions.

Chapters 3-5 address core transition processes, stages and mechanisms of transition, discussing the policy mixes and other actions needed to stimulate and enable system innovation. Chapters 6-7 focus on

the role of cities and finance as potential enablers of sustainability transitions. Chapters 8-12 address governance-related challenges for steering transition processes.

Textbox 1: Report structure (EEA, 2019)

Part 1: Understanding sustainability transitions

1 The emergence of transitions research and policy

2 Transitions research and its implications for governance

Part 2: Enabling innovation and system change

3 Promoting transformative innovation and experimentation

4 Diffusion and upscaling of innovation

5 Disruption and system reconfiguration

6 Strengthening the role for cities and urban

7 Financing innovation and system change

Part 3: Managing complexities in transition processes

8 Visions, missions and targets to provide long-term directionality

9 Horizontal coordination of policies

10 Vertical coordination across levels of governance

11 Risks, unintended consequences and adaptive governance

12 Knowledge and skills for transitions governance

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3 Reflections and implications

In this section, we offer some reflections that emerged from our involvement in the development of the report and related activities, namely about under-investigated topics in transition research and possible implications of heightened science-policy interactions about transitions.

3.1 Under-investigated topics in transitions research

The process of surveying and assessing existing evidence enabled us to generate insights into the state of current knowledge in transitions studies and future knowledge frontiers.

Issues concerning core transitions processes, phases and mechanism are fairly well addressed within the transitions literature, which has developed a range of sophisticated concepts and analytical tools to approach the emergence and diffusion of path-breaking system innovation. Whole system reconfigurations, phase out and negative consequences in later stages have only recently become the object of more dedicated research and conceptualisation efforts. Concerning all processes considered in chapters 3-5, there is a general need for more balanced empirical evidence covering various geographical contexts, domains, and phases of transitions, but also different types of innovation (e.g. beyond technological innovation). Concerning their implications for policy and practice, we suggest that transition researchers could pay more attention to: 1) better explanations of the varied speeds at which transitions are unfolding in different domains and national settings, and 2) more thorough evaluations of relevant policy support mechanisms (notably about what works and what does not). These are central concerns of many research papers and projects, but their outcomes remain fragmented and currently beyond the reach of decision-makers.

Comparatively, issues concerning the role of cities, finance, and transitions governance are less systematically addressed within transitions studies. We briefly discuss under-investigated issues with regard to these three topic areas.

Urban transitions (chapter 6) have become a research object in themselves, notably as specific loci for innovation and whole system change, and because cities are emerging as critical actors in the polycentric

governance of sustainability challenges, with many of them developing ambitious visions. Yet recent evaluations of urban transition initiatives have become more critical about earlier hopes and expectations, finding "a widespread lack of evidence for transformative capacity" (Broto et al., 2019:449), "an implementation gap between cities' long-term sustainable visions and the short-term actions realised to achieve them" (Huxley et al., 2019:115), and that "[a]cross all cities studied, major gaps still remain in terms of developing social learning processes that involve systems thinking, sustainability foresight, as well as suitable approaches for embedding more radical innovations" (Wolfram, 2019:30). We therefore suggest that the transitions community should complement the (selective) focus on success cases with more critical and reflexive analyses of the substantial gap between promises and real action, implementation failures, and limited achievement of transformative results, as well as their uneven distribution (across contexts and domains).

Finance has not been a priority focus of transitions studies, although there are some promising investigations (Perez, 2013; Bolton et al., 2016; Falcone et al., 2018). This is surprising, given its essential role in supporting experimentation and innovation, (market) scaling and diffusion, and system transformation. Perhaps this relative neglect stems from a focus on change *processes* rather than enabling resources like finance. Or perhaps it is because the emergence of niche-innovations, which has long been a dominant focus of sustainability transitions research, does not require large amounts of financial support (which can mostly be provided by public sources). But as diffusion and system change become more prominent research topics (Geels and Johnson, 2018), the role of finance should receive more attention in transitions research, because the sums required to meet SDGs or climate goals are very large. Table 7.1 from our report reviews recent estimates for additional annual investments required to reach various global sustainability and climate goals, identifying figures ranging from $5 to $7 trillion for addressing SDGs globally, $0.55 to $1.7 trillion to limit global climate change to 2°C and $1.38 to $3.25 trillion to reach the 1.5°C target.

Because these sums far exceed public funding abilities, sustainability transitions will have to involve the reorientation of private financial flows. Our report discusses three layers of policy reform that may influence financial flows: a) adjustments in well-known policy tools (taxes, financial incentives, regulations, standards) that reorient investments, b) adjustments in institutional rules that alter formal expectations of financial actors (e.g. fiduciary duties of institutional investors and asset managers, disclosure responsibilities and accounting rules, standards and labels for sustainable financial products), c) deeper structural reforms that aim to reduce the profitability of short-term, speculative investments by introducing a financial transactions (Tobin) tax, banning certain forms of non-transparent financial products (such as credit default swaps or collateralised debt obligation), or changing the mandate of (western) central banks, from the narrow focus on price stability to wider sustainability objectives, which could involve purchases of green bonds, investments in low-carbon financial assets, or providing additional liquidity to companies interested in shifting to clean forms of production (Campiglio et al., 2018). To investigate these issues, transition scholars could benefit from insights from other fields such as finance and (environmental) economics.

With regard to the five governance challenges discussed in detail in Chapters 8-12, we also observe a relative fragmentation of research efforts and insights.

The transitions community has done some research on directionality, mostly by investigating the role of shared visions and expectations in technological innovation (Bakker and Budde, 2012; Van Lente, 2012; Sengers, 2016; Sovacool, 2019). But the community has done less research on policy missions and targets (Mazzucato, 2018), which is a challenging but important topic that raises fundamentally political questions about defining collective priorities (Schot and Steinmueller, 2018) – questions such as 'what future do we want?', 'what is the ultimate goal?', 'why do we want this future?' and 'why is this particular goal important?' (Schlaile et al., 2017).

Transitions research also has not systematically addressed topics like horizontal coordination between policy domains, vertical coordination between policy levels, and the management of risks and

unintended consequences – although these are central themes for public sector organisations and EU policymaking. Relatively new lines of enquiry within transitions research include the design and timing of policy mixes for transitions (Rogge and Reichardt, 2016), emergent forms of coordination for transition governance (Enhert et al., 2018), or the role of the strategic state (Johnstone and Newell, 2017). Such research directions imply a need for significant bridging with more policy-oriented scientific communities, which have long addressed issues like environmental policy integration, multi-level governance, and adaptive governance.

The issue of new knowledge and skills for the governance of transitions is also not addressed systematically by the transitions community, despite its recognised importance (van Mierlo and Beers, 2018). It is an important topic, however, because governing open-ended, uncertain, contested, disruptive change processes is very different from governing the efficient exploitation of relatively stable systems, which dominated in previous decades in many countries. Policymakers may need new skills to deal with a variety of stakeholders (beyond large firms), manage and evaluate experiments (including acknowledging inevitable failures), and monitor progress on multiple dimensions (not just costs). This implies a major opportunity to develop new indicators, evaluation procedures, and assessment tools that can help in governing transitions. Integrating diverse forms of knowledge in ways that can support policy and practice is also likely to require some transformation of existing knowledge infrastructures.

3.2   A changing science-policy interface

Developing the report also provided insights into science-policy interactions. Here we briefly discuss: 1) co-construction and iterative learning processes, 2) the value of empirical illustrations, 3) the role of boundary objects, 4) organisational adjustments in public bodies, and 5) trade-offs in bridging between science and policy.

First, the report is the outcome of a co-construction and learning process between researchers and the EEA over the past four years. This iterative process was not without its challenges. At the start, EEA project managers often struggled to interpret and apply transitions concepts, despite having ample understanding of sustainability challenges and integrated assessment approaches. In addition to revealing mismatches with existing skills, knowledge and routines, efforts to engage with transitions research highlighted the need to address issues that go beyond the traditional environment and climate domains. Transitions thinking was gradually internalised into EEA work through sustained interactions with transitions research communities (e.g. study visits to STRN conferences, EEA workshops, in-depth reviews of EEA outputs). Internally, the EEA developed a series of reports addressing different systems and themes, including energy systems (EEA 2016b, 2017b), food systems (EEA 2016a, 2017a), mobility systems (EEA 2016c), and transformative initiatives in EEA member countries (EEA and Eionet, 2016), as well as a detailed overview of theoretical perspectives on sustainability transitions (EEA, 2018). Developing these reports enabled the EEA to explore the analytical relevance of transitions approaches and generate buy-in from project teams. Meanwhile, the involvement and critical input of the EEA Scientific Committee (which since 2017 includes several transition scholars) helped refine the scope of EEA involvement with transitions approaches. Externally, the EEA mobilised its country network (Eionet) and policymakers in EU institutions to gather further input about how transitions approaches could be put to work, and to test how best to communicate relevant messages.

Second, interactive engagement with policy audiences highlighted the value of using empirical examples and case studies to illustrate concepts and ideas in concrete ways. The report therefore mobilises the wealth of cases produced by transitions scholars in the last ten years, to illustrate specific processes and policy interventions (e.g. in mainstreaming organic food and the Swedish district heating transitions) or more comparatively to highlight differences and variety (e.g. Energiewende and Norwegian electric vehicle diffusion as different kinds of mission-oriented programmes; different phase-out patterns in lightbulbs, nuclear energy and coal). In practice, these provided important ways to ground discussions and further support the arguments put forward in the report.

Third, boundary objects play an important mediating role between different worlds, such as in the case science-policy interactions, because they are "both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (Star and Grisemer 1989:393). Ideal types such as diagrams and adaptable representations are particular kinds of boundary objects that can facilitate communication and translation between communities. Because the MLP and other transition representations (e.g. ideal-typical pathways and transition phases) have both logical robustness and interpretive flexibility, they proved to be appealing to policymakers – facilitating discussion of transition mechanisms and possible forms of governance intervention.

Fourth, developing science-policy interactions around new objects and framings not only requires the development of absorptive capacity within organisations (discussed above), but also organisational adjustments. For public organisations such as the EEA, this adjustment has involved a reorientation of its role as a knowledge broker, including a shift towards new kinds of knowledge and partnerships with research communities like STRN. At the national level, environment agencies in countries such as Germany, the Netherlands and Switzerland are also engaging with transition researchers and providing spaces where transitions concepts are being explored and operationalised. At the EU scale, the European Commission's Directorate-General for Research and Innovation has recently transformed its organisational structure to focus on the SDGs and created units to promote the uptake of transitions science across the organisation.

Lastly, interactions between research and policy entail challenges and trade-offs. Efforts to increase engagement with the worlds of policy and practice may require more synthetic research findings and approaches. This may affect conceptual rigour or nuance when seeking to represent fully the diverse analytical perspectives within transitions studies. Questions related to indicators and evaluation provide a case in point. On the one hand, the focus on qualitative evidence from single case studies can be seen as an obstacle to the development of systematic metrics for transitions – and may partly explain the reluctance of organisations like the OECD to further engage with system transitions (Diercks, 2019). On the other hand, recent experience from the field of Innovations Systems should serve as a cautionary tale. As Weber and Truffer (2017:108) noted:

> "the initial scientific ambitions of the IS approach degenerated somewhat in the policy discourse. This development can be exemplified by the increasing substitution of thorough comparisons of national innovation systems by standardized indicator-based benchmarking exercises, both by the OECD and the EC, which tended to neglect the qualitative dimensions of innovation systems. The scoreboards of the EU are a particularly noteworthy example (EC, 2015), which tends to lead to over-simplistic rankings of what were formerly thorough interpretations underpinned by a systemic understanding of research and innovation policy"

Inevitably, as transitions research further comes in contact with mainstream policy, such trade-offs and tensions are likely to intensify, and will raise questions about the appropriate distance and kind of relationship between science and policy (Gieryn, 1995). Concerning these issues, we agree with Sundqvist et al (2018), who suggest that rather than an exclusionary choice between further *integration* or *separation* of science and policy, we should remain fully aware that science-policy interactions are neither static, linear nor one-directional, but characterised by an 'irresolvable tension'.

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