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Comments & Views

Towards methodological diversity in sustainability transitions research? Comparing recent developments (2016–2019) with the past (before 2016)

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ABSTRACT

The sustainability transitions research field continues to broaden rapidly, engaging scholars from a wide variety of disciplinary backgrounds. As highlighted in the STRN research agenda, transitions research relies on a broad range of methodological approaches; yet the methodological diversity of transitions studies has remained somewhat limited. In this article, we investigate if this verdict still applies to transition studies published since 2016. While our findings suggest that the recent literature became methodologically more diverse especially with regard to theoretical frameworks and research questions, other methodological dimensions continue to suggest a lack of diversity. Based on our literature review we propose three particularly promising areas for further diversifying future research on socio-technical transitions towards sustainability: theoretical bridging, novel methods, and multi-scalarity across multiple sectors.

1. Introduction

Research on socio-technical transitions towards sustainability has experienced an enormous increase in publication output during the last two decades (see [Fig. 1](#)). Looking at just the past four years (2016–2019), the number of Scopus listed journal articles on sustainability transitions has doubled since 2016, reaching an annual output of almost 450 articles in 2019. This growth of the transitions literature is accompanied by an increasing engagement of scholars from different research disciplines ([Köhler et al., 2019](#)). However, using the ‘transitions research onion’ framework to delineate different methodological dimensions, [Zolfagharian et al. \(2019\)](#) found that, for the core of the transitions literature published before 2016, the methodological underpinnings of the field were rather underdeveloped and narrow.

Given the recent dynamics and disciplinary expansion of the field we investigate if research on sustainability transitions is also diversifying methodologically, as [Köhler et al. \(2019\)](#) postulated in the current transitions research agenda. For this assessment we compare the state of the art of methodologies applied in transition studies between 2016 and 2019 with the assessment of the methodological diversity of the field before 2016 done by [Zolfagharian et al. \(2019\)](#). We close with reflections on the analytical scope of the ‘transition research onion’, apparent methodological shortcomings in the field and thus promising areas for future research.

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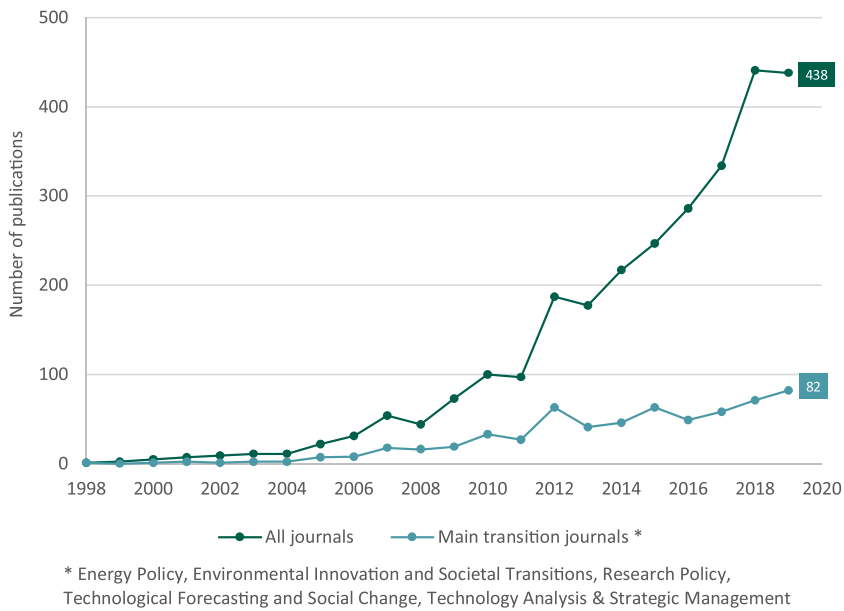


Fig. 1. Publication trend in sustainability transitions research (applying Markard et al. (2012) search criteria in Scopus).

2. Recent developments in methodological diversity

By adopting the search string of Zolfagharian et al. (2019), which draws on the review article by Markard et al. (2012) (see Appendix A), we identified 260 articles in Scopus published on sustainability transitions between 2016–2019 in the five main journals in the field (Environmental Innovation and Societal Transitions, Research Policy, Technological Forecasting and Social Change, Energy Policy and Technology Analysis & Strategic Management). Of these, we excluded 43 publications (17%) from the methodological analysis, as they are conceptual in nature. Compared with the period until 2015, the share of empirical studies increased by 20 percent, indicating that the research field is steadily maturing (Köhler et al., 2019). Accordingly, the subset of 217 empirical papers was examined using key methodological dimensions of Zolfagharian et al.’s ‘transition research onion’ framework.

We find that while the transitions literature before 2016 predominately focused on the explanation of (past) transitions (above 50%), current research questions have given greater attention to the role of actors (up from about 20% to almost 48%) as well as transition policies and pathways (up from over 30% to nearly 50%, see Fig. 2). With actors and their agency being key for socio-

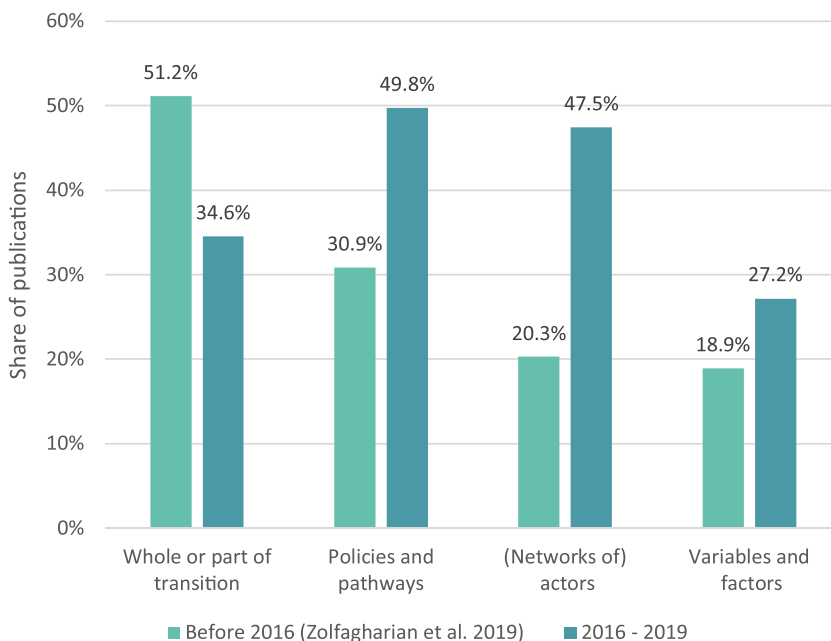


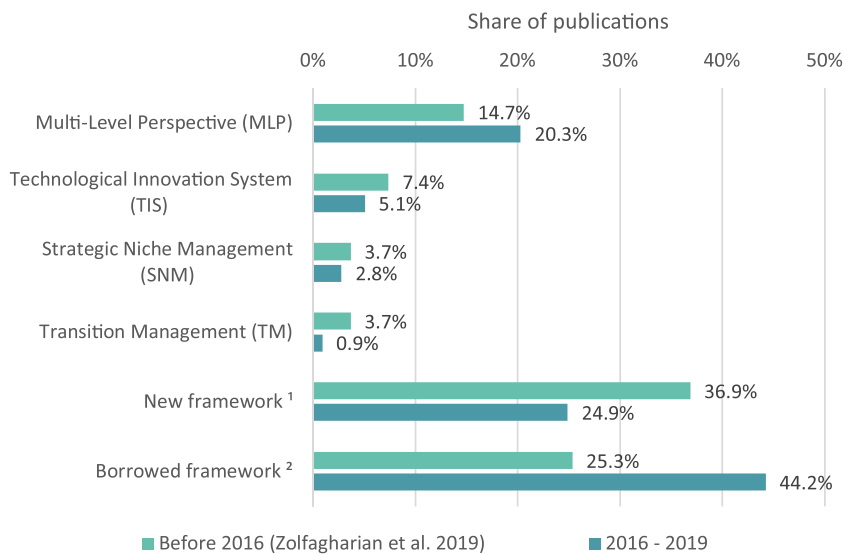
Fig. 2. Transitions research questions then (before 2016) and now (2016–19).

technical systems change (Kern and Rogge, 2016; Wittmayer et al., 2017) and policies playing a key role in redirecting and speeding up socio-technical change (Kanger et al., 2020; Kern et al., 2019), a stronger emphasis on these topics is welcomed.

When it comes to *transition theories* our analysis finds that the four transition-focused theoretical frameworks (MLP, TIS, SNM, TM) together cover an unchanged share of approximately 30 percent of empirical studies (see Fig. 3). Unpacking this a bit further confirms the dominance of the Multi-Level Perspective (MLP) which remains unchallenged and was even applied more widely (up from roughly 15%–20% of studies). At the same time, papers draw less frequently than before on the Technological Innovation System (TIS), Strategic Niche Management (SNM) and Transition Management (TM) frameworks, which are also considered “major conceptual developments in the field” (Markard et al., 2012: 957). The percentage of transition studies using at least one of these three frameworks decreased from just under 15 to nearly 9 percent.

Nowadays, almost half of the published work includes borrowed/not transition-focused frameworks originally developed in other disciplines (e.g. innovation ecosystem approach) compared to a quarter of studies before 2016. This trend underlines the increasing interdisciplinary character of transitions research. Without neglecting the crucial role of the main theoretical frameworks, the use of alternative concepts to study transition processes – i.e. theoretical pluralisation – might enrich the field substantially (Hopkins et al., 2020).

Indeed, our analysis shows that approximately one fourth of the studies develop new frameworks by combining concepts and theories across disciplines (e.g. integration of MLP and discourse theory); however, the development of such new frameworks decreased by 12 percentage points, implying that less emphasis is being placed on the further refinement of existing frameworks by integrating concepts from other fields. While these developments could be interpreted as maturation of the field, they could also indicate a limited willingness of scholars newly entering the field from other disciplines to engage with and build upon established socio-technical transition frameworks. Consequently, the transitions community is becoming more diverse theoretically, but we argue that harnessing such increased diversity would require increased efforts in bridging and integrating old and new theoretical frameworks.



¹ designed by the authors by combining concepts and theories from disciplinary perspectives

² originally developed in other disciplines and then used to study transition problems

Fig. 3. Theoretical transition frameworks then (before 2016) and now (2016–19).

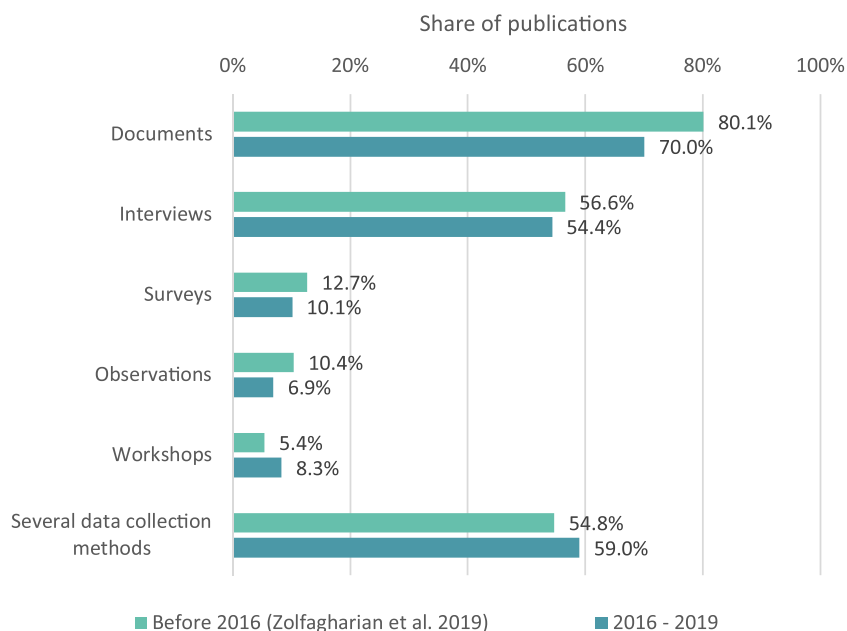


Fig. 4. Data collection methods and sources then (before 2016) and now (2016–19).

Despite the identified shifts concerning research questions and diversification of theoretical frameworks, neither *research methods* nor the *data sources* used to empirically study transition problems have changed significantly since 2016 (see Fig. 4). With a share of more than 80%, qualitative research designs continue to dominate the field over quantitative and mixed-method approaches. Simultaneously, the usage of documents (70%) and interviews (approx. 54%) has remained at almost the same high level, followed by workshops, observations and surveys with a share of about 10 percent each. Given this background, it is not surprising that qualitative data analysis techniques, especially grounded theory and qualitative content analysis (e.g. Becker et al., 2018; Weisenfeld and Hauerwaas, 2018), still prevail. This may indicate that the transitions research field continues to struggle to connect with disciplines leaning more on quantitative methods (Alkemade, 2019) and to generate generic insights beyond single cases (Köhler et al., 2019). However, quantitative and mixed-methods research, although less commonly used, offer promising prospects for sustainability transition studies as they already cover a variety of analytical approaches ranging from social network analysis, foresight and scenario modelling to Q methodology and (statistical) analysis (e.g. Cantner et al., 2016; Falcone et al., 2018; Gruszka, 2017; Papachristos and Adamides, 2016).

Finally, it should be noted that between 2016 and 2019 the application of cross-sectional research designs increased (from representing just 12%–30%), corresponding with a drop of longitudinal studies to 70 percent. This also corresponds with our earlier observations of a decrease of research questions which are concerned with (whole or part of) past transitions. Beyond the time framing, methodological diversity is likely to be influenced by spatial and sectoral dimensions; however, these are not yet considered in the ‘transition research onion’. Attention to spatial and sectoral coverages reveal that between 2016 and 2019 more than three quarters of all empirical publications dealt with energy transitions and the vast majority (80%) have a national focus. This is in line with the results of the review by Markard et al. (2012), indicating a certain continuity over the years.

3. Outlook

Based on this update of methodological patterns in socio-technical transition studies we offer some reflections on promising areas for future research for the STRN community.

First, future transition research should utilise a diversity of frameworks to analyse sustainability transitions (Sovacool and Hess, 2017). This, however, will require a critical engagement with established, new and borrowed frameworks to study socio-technical transition processes, and dedicated efforts in bridging diverse theories, concepts and approaches. A case in point are attempts to improve transition theorizing by harnessing organization theories (van Mossel et al., 2018) or policy process theories (Kern and Rogge, 2018).

Second, data collection and analytical methods ought to be diversified to better reflect the complexity of sustainability transitions and the inter- and transdisciplinary nature of the field. Although Zolfagharian et al. (2019) highlighted action research as a fruitful method to be applied in transitions research, none of the reviewed articles published between 2016–2019 explicitly use this approach. Therefore, we urge transitions scholars to reflect on their role in research processes, and to consider the stronger use of action research methods. At the same time, however, some studies are already applying promising alternative methods, such as modelling (Li and

Strachan, 2017), big data (Giest and Mukherjee, 2018) or gaming approaches (Heinonen et al., 2017), and such trends would be welcomed to continue.

Third, we argue for a greater awareness of both the sectoral and spatial coverage of empirical studies, which so far have been neglected in the ‘transition research onion’. Yet, different sectoral structures with their diverse and increasingly interconnecting socio-technical systems may necessitate adapted research designs (Andersen et al., 2020; Rosenbloom, 2020). Similarly, with global industry and transition dynamics being locally and regionally embedded, the multi-scalarity of sustainability transitions deserves more attention (Binz et al., 2020; Coenen et al., 2012; Truffer et al., 2015). Therefore, we agree with others that more research is needed that goes beyond the national level and embraces the multi-scalarity of transition dynamics, which could build, for example, on evolving theorizing about global regimes (Fuenfschilling and Binz, 2018), regional lead markets for environmental innovation (Losacker and Liefner, 2020) or multi-layered innovation systems (Binz and Truffer, 2017).

In conclusion, we argue that the methodological diversity of transition studies has increased significantly over the period 2016–2019. Arguably, as the field advances, further diversification, but also consolidation, should be guided by pressing research questions of our time on how to accelerate transitions towards more sustainable systems of production and consumption.

Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A

Based on the review articles by Zolfagharian et al. (2019) and Markard et al. (2012), we identified the relevant literature by using the following search string in Elsevier’s Scopus database:

((REFTITLE ({Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management}) AND REFPUBYEAR = 1998) OR (REFTITLE ({Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study}) AND REFPUBYEAR = 2002) OR (REFTITLE ({On the nature, function and composition of technological systems}) AND REFPUBYEAR = 1991) OR (REFTITLE ({Understanding carbon lock-in}) AND REFPUBYEAR = 2000) OR (REFTITLE ({More evolution than revolution: Transition management in public policy}) AND REFPUBYEAR = 2001) OR (REFTITLE ({From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory}) AND REFPUBYEAR = 2004) OR (REFTITLE ({The governance of sustainable socio-technical transitions}) AND REFPUBYEAR = 2005) OR (REFTITLE ({Typology of sociotechnical transition pathways}) AND REFPUBYEAR = 2007) OR (REFTITLE ({The diffusion of renewable energy technology: An analytical framework and key issues for research}) AND REFPUBYEAR = 2000) OR (REFTITLE ({Bricolage versus breakthrough: Distributed and embedded agency in technology entrepreneurship}) AND REFPUBYEAR = 2000) OR (REFTITLE ({The past and future of constructive technology assessment}) AND REFPUBYEAR = 1997) OR (REFTITLE ({Functions of innovation systems: A new approach for analysing technological change}) AND REFPUBYEAR = 2007) OR (REFTITLE ({Transforming the energy sector: the evolution of technological systems in renewable energy technology}) AND REFPUBYEAR = 2004) OR (REFTITLE ({Strategies for Shifting Technological Systems: The Case of the Automobile System}) AND REFPUBYEAR = 1994) OR (REFTITLE ({The politics and policy of energy system transformation - Explaining the German diffusion of renewable energy technology}) AND REFPUBYEAR = 2006) OR (REFTITLE ({Analyzing the functional dynamics of technological innovation systems: A scheme of analysis}) AND REFPUBYEAR = 2008) OR (REFTITLE ({Technological innovation systems and the multi-level perspective: towards an integrated framework}) AND REFPUBYEAR = 2008) OR (REFTITLE ({CAUTION! Transitions ahead: politics, practice and sustainable transition management}) AND REFPUBYEAR = 2007) OR (REFTITLE ({Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective}) AND REFPUBYEAR = 2005)) AND (TITLE-ABS-KEY ((sustainab* OR environmental* OR bio* OR renewable OR socio-technical) AND (transition OR transform* OR “system innovation” OR “radical innovation” OR shift OR change))) AND (LIMIT-TO (EXACTSRCTITLE, “Energy Policy”)) OR LIMIT-TO (EXACTSRCTITLE, “Technological Forecasting And Social Change”) OR LIMIT-TO (EXACTSRCTITLE, “Environmental Innovation And Societal Transitions”) OR LIMIT-TO (EXACTSRCTITLE, “Research Policy”) OR LIMIT-TO (EXACTSRCTITLE, “Technology Analysis And Strategic Management”)) AND (LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016)).

References

- Alkemada, F., 2019. Sustainable innovation research methods. In: Boons, F., Mcmeekin, A. (Eds.), *Handbook of Sustainable Innovation*. Edward Elgar Publishing, Cheltenham, Northampton, pp. 299–309.
- Andersen, A.D., Steen, M., Mäkitie, T., Hanson, J., Thune, T.M., Soppe, B., 2020. The role of inter-sectoral dynamics in sustainability transitions: a comment on the transitions research agenda. *Environ. Innov. Soc. Transitions* 34, 348–351. <https://doi.org/10.1016/j.eist.2019.11.009>.
- Becker, S.L., Franke, F., Gläsel, A., 2018. Regime pressures and organizational forms of community-based sustainability initiatives. *Environ. Innov. Soc. Transitions* 29, 5–16. <https://doi.org/10.1016/j.eist.2017.10.004>.

- Binz, C., Truffer, B., 2017. Global Innovation Systems—a conceptual framework for innovation dynamics in transnational contexts. *Res. Policy* 46, 1284–1298. <https://doi.org/10.1016/j.respol.2017.05.012>.
- Binz, C., Coenen, L., Murphy, J.T., Truffer, B., 2020. Geographies of transition—from topical concerns to theoretical engagement: a commentary on the transitions research agenda. *Environ. Innov. Soc. Transitions* 34, 1–3. <https://doi.org/10.1016/j.eist.2019.11.002>.
- Cantner, U., Graf, H., Herrmann, J., Kalthaus, M., 2016. Inventor networks in renewable energies: the influence of the policy mix in Germany. *Res. Policy* 45, 1165–1184. <https://doi.org/10.1016/j.respol.2016.03.005>.
- Coenen, L., Bennenworth, P., Truffer, B., 2012. Toward a spatial perspective on sustainability transitions. *Res. Policy* 41, 968–979. <https://doi.org/10.1016/j.respol.2012.02.014>.
- Falcone, P.M., Morone, P., Sica, E., 2018. Greening of the financial system and fuelling a sustainability transition: a discursive approach to assess landscape pressures on the Italian financial system. *Technol. Forecast. Soc. Change* 127, 23–37. <https://doi.org/10.1016/j.techfore.2017.05.020>.
- Fuenschiilling, L., Binz, C., 2018. Global socio-technical regimes. *Res. Policy* 47, 735–749. <https://doi.org/10.1016/j.respol.2018.02.003>.
- Giest, S., Mukherjee, I., 2018. Behavioral instruments in renewable energy and the role of big data: a policy perspective. *Energy Policy* 123, 360–366. <https://doi.org/10.1016/j.enpol.2018.09.006>.
- Gruska, K., 2017. Framing the collaborative economy —voices of contestation. *Environ. Innov. Soc. Transitions* 23, 92–104. <https://doi.org/10.1016/j.eist.2016.09.002>.
- Heinonen, S., Minkkinen, M., Karjalainen, J., Inayatullah, S., 2017. Testing transformative energy scenarios through causal layered analysis gaming. *Technol. Forecast. Soc. Change* 124, 101–113. <https://doi.org/10.1016/j.techfore.2016.10.011>.
- Hopkins, D., Kester, J., Meelen, T., Schwane, T., 2020. Not more but different: a comment on the transitions research agenda. *Environ. Innov. Soc. Transitions* 34, 4–6. <https://doi.org/10.1016/j.eist.2019.11.008>.
- Kanger, L., Sovacool, B.K., Noorköiv, M., 2020. Six policy intervention points for sustainability transitions: a conceptual framework and a systematic literature review. *Res. Policy* 49, 104072. <https://doi.org/10.1016/j.respol.2020.104072>.
- Kern, F., Rogge, K.S., 2016. The pace of governed energy transitions: agency, international dynamics and the global Paris agreement accelerating decarbonisation processes? *Energy Res. Soc. Sci.* 22, 13–17. <https://doi.org/10.1016/j.erss.2016.08.016>.
- Kern, F., Rogge, K.S., 2018. Harnessing theories of the policy process for analysing the politics of sustainability transitions: a critical survey. *Environ. Innov. Soc. Transitions* 27, 102–117. <https://doi.org/10.1016/j.eist.2017.11.001>.
- Kern, F., Rogge, K.S., Howlett, M., 2019. Policy mixes for sustainability transitions: new approaches and insights through bridging innovation and policy studies. *Res. Policy* 48, 103832. <https://doi.org/10.1016/j.respol.2019.103832>.
- Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Pel, B., Raven, R., Rohracher, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: state of the art and future directions. *Environ. Innov. Soc. Transitions* 31, 1–32. <https://doi.org/10.1016/j.eist.2019.01.004>.
- Li, F.G.N., Strachan, N., 2017. Modelling energy transitions for climate targets under landscape and actor inertia. *Environ. Innov. Soc. Transitions* 24, 106–129. <https://doi.org/10.1016/j.eist.2016.08.002>.
- Losacker, S., Liefner, L., 2020. Regional lead markets for environmental innovation. *Environ. Innov. Soc. Transitions* 37, 120–139. <https://doi.org/10.1016/j.eist.2020.08.003>.
- Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. *Res. Policy* 41, 955–967. <https://doi.org/10.1016/j.respol.2012.02.013>.
- Papachristos, G., Adamides, E., 2016. A retroductive systems-based methodology for socio-technical transitions research. *Technol. Forecast. Soc. Change* 108, 1–14. <https://doi.org/10.1016/j.techfore.2016.04.007>.
- Rosenbloom, D., 2020. Engaging with multi-system interactions in sustainability transitions: a comment on the transitions research agenda. *Environ. Innov. Soc. Transitions* 34, 336–340. <https://doi.org/10.1016/j.eist.2019.10.003>.
- Sovacool, B.K., Hess, D.J., 2017. Ordering theories: typologies and conceptual frameworks for sociotechnical change. *Soc. Stud. Sci.* 47, 703–750. <https://doi.org/10.1177/0306312717709363>.
- Truffer, B., Murphy, J.T., Raven, R., 2015. The geography of sustainability transitions: contours of an emerging theme. *Environ. Innov. Soc. Transitions* 17, 63–72. <https://doi.org/10.1016/j.eist.2015.07.004>.
- van Mossel, A., van Rijnsoever, F.J., Hekkert, M.P., 2018. Navigators through the storm: A review of organization theories and the behavior of incumbent firms during transitions. *Environ. Innov. Soc. Transitions* 26, 44–63. <https://doi.org/10.1016/j.eist.2017.07.001>.
- Weisenfeld, U., Hauerwaas, A., 2018. Adopters build bridges: changing the institutional logic for more sustainable cities. From action to workset to practice. *Res. Policy* 47, 911–923. <https://doi.org/10.1016/j.respol.2018.02.015>.
- Wittmayer, J.M., Avelino, F., van Steenberghe, F., Loorbach, D., 2017. Actor roles in transition: Insights from sociological perspectives. *Environ. Innov. Soc. Transitions* 24, 45–56. <https://doi.org/10.1016/j.eist.2016.10.003>.
- Zolfagharian, M., Walrave, B., Raven, R., Romme, A.G.L., 2019. Studying transitions: past, present, and future. *Res. Policy* 48, 103788. <https://doi.org/10.1016/j.respol.2019.04.012>.