



Innovation studies, social innovation, and sustainability transitions research: From mutual ignorance towards an integrative perspective?

Attila Havas^{a,*}, Doris Schartinger^b, K. Matthias Weber^c

^a Institute of Economics, Centre for Economic and Regional Studies & AIT Austrian Institute of Technology, Center for Innovation Systems and Policy, postal address: KRTK, 1097 Budapest, Tóth Kálmán u. 4, Hungary

^b AIT Austrian Institute of Technology, Center for Innovation Systems and Policy, Austria

^c AIT Austrian Institute of Technology, Center for Innovation Systems and Policy, Austria & Université Gustave Eiffel, LISIS, France

ARTICLE INFO

Keywords:

Goal-orientated transformative change
An integrative analytical framework
Innovation studies
Social innovation research
Sustainability transitions research
Focussed literature review

ABSTRACT

This article is a first attempt towards building an integrative analytical framework to study goal-orientated transformative change (GOTC) processes, defined as system-transforming processes that are guided by the ambition to resolve current or expected future societal challenges. GOTC can only start once a broad range of possible goals are considered by key stakeholders and major relevant actors are committed to act. Hence, there is a need for widening the scope of the current, partial conceptual models to consider the co-evolutionary interactions between technology, economy, and society to better understand and effectively guide and/or assess GOTC. This claim is based on our focussed review of Innovation Studies, Social Innovation, and Sustainability Transitions research. We offer four building blocks for a new, integrative framework to analyse GOTC: its overarching goal; objects, types, and levels of change; mechanisms of change; and a set of criteria to assess change.

1. Introduction

1.1. A new take on innovation and transformative change

Transformative change has attracted growing interest in various strands of innovation research in recent years. In this article we focus on the confluence of three main strands of innovation research – namely *innovation studies* (IS), *social innovation* (SI) research, and *sustainability transitions* (ST) studies – and their contributions to better understand goal-orientated transformative change (GOTC) processes in society. The focus on transformative change has become prominent in the context of the ‘normative’ or ‘strategic’ turn in innovation policy (Daimer et al., 2012; Weber and Rohracher, 2012). By evolving at times in conjunction with and at other times in separation from one other, these three strands of innovation research might provide complementary underpinnings for an integrative approach to better understand transformation processes.

The notions of transformation and transition have been debated extensively (Geels and Schot, 2007; Hölscher et al., 2018; Truffer et al., 2022). The key term of this article is *goal-orientated transformative change in society*, defined as system-transforming processes that

* Corresponding author.

E-mail address: attila.havas@krtk.hu (A. Havas).

are guided by the ambition to resolve current or expected future societal challenges of various kinds. This notion is sufficiently open to capture a variety of goals, which innovation and transformation are meant to contribute to, as well as to accommodate different conceptual understandings of how changes come about. These goals should be identified in normative political and societal dialogues about the priorities that (democratic) societies deem of vital importance for their future. Such goals should not be taken for granted as was the case with past innovation policies striving for economic growth, or still is the case in some strands of literature that privilege, for instance, environmental, social, or sustainability goals.

In recent years, intense discussions have focussed on matters of sustainability as an umbrella goal – for good reasons. Yet not only may there be alternative ways of formulating societal goals and visions, but also our understanding of what we mean by sustainability evolves and is perpetually re-negotiated. For instance, for a few years now, the UN Sustainable Development Goals have tended to supersede the previous three-dimensional framing of social, environmental, and economic sustainability. In the future there will certainly be novel challenges necessitating transformation in society. They may range from novel S&T discoveries (e.g., in response to new possibilities of enhancing human capacities and extending lifetime) to widening social gaps (in relation to justice, equity and societal cohesion) and new geopolitical cleavages and conflicts. Initial stark glimpses of the latter can already be observed and their critical impacts felt. We thus need to be able to integrate such new challenges into our thinking about transformative societal changes.

We opt to speak of transformations rather than transitions, because we also include in our perspective disruptive changes that significantly differ from transitions, understood as relatively smooth change processes. Transformations can be largely out of social control, or purposefully governed, that is, goal-orientated change processes. We consider bottom-up processes of emergence as well as top-down change processes driven by, and thus open to, transformative diversity (Stirling, 2011). In brief, the term transformations cover a broader range of change processes than transitions.

1.2. Research questions, approach, and structure

Our work is guided by three research questions. What are the similarities, differences, and complementarities in the basic conceptual underpinnings of the above three strands of innovation research? How – relying on which building blocks – have the three strands conceptualised transformation processes? Which of these building blocks can be used when devising an integrative analytical framework to study GOTC processes? Such an integrative framework would be essential to provide guidance for policy-makers and other practitioners when devising, monitoring and evaluating GOTC processes.

In the following section we briefly outline the methods used for addressing these research questions. We also check in section 2 whether there is a comprehensive conceptual framework available that integrates these three strands of literature, or at least some first attempts that we can draw upon. Such traces of integrative attempts are analysed by a set of focussed literature reviews, searching for publications that (i) combine key concepts from all three strands (the ‘trio’), and those that (ii) combine elements from two of these strands (‘duos’). Our hypothesis has been that while there are ‘duo’ combinations that address at least certain aspects of the envisaged conceptual framework, hardly any paper combines all three strands. The literature review has confirmed our hypothesis, and thus the need for the analyses in the remainder of the article. In section 3 we highlight the key features of innovation as proposed and analysed by the three strands, that is, the principal purpose of innovation, typical main actors, and their interactions; the objects, types, and levels of change; the sources and types of knowledge produced and utilised; and the definition and measurement of success. These fundamentals of innovation provide the basis for looking more in-depth into how the three strands analyse diffusion processes and transformation dynamics (section 4). We present four building blocks of an integrative perspective to analyse transformative change in society in section 5, along four key features: i) rationales, overarching goal, and specific objectives of change; ii) objects, types, and levels of change; iii) processes and mechanisms of change; and iv) a set of criteria to assess transformative change. In the concluding section we assess the state-of-the-art in the three stands as seen from the angle of an integrative analytical framework, identify normative implications and highlight directions for future research.

2. Analytical approach and methods

The main objective of our article is to offer novel conceptual contributions, not a bibliometric analysis or a fully-fledged literature review of the IS, SI, and ST strands of literature.¹ Hence, we draw on a semi-systematic or focussed literature review as a starting point. A semi-systematic literature review aims at identifying relevant research traditions and attempts to build a meta-narrative from there (Snyder, 2019). In contrast, systematic literature reviews – the method developed in clinical science to analyse the results of randomised controlled trials – aim at identifying effect sizes (Wong et al., 2013). To identify the relevant body of recent literature we have searched ScienceDirect. This has the advantages of being an important academic data base and warranting good retrieval and reproducible qualities. This approach also has its limitations: ScienceDirect concentrates on journal articles – published by the largest publisher in the research fields we focus on –, neglecting mere abstracts, conference papers, and most books. Furthermore, we thereby restrict our analysis to anglophone literature, neglecting a long tradition of SI research by authors publishing in French and Spanish. We purposefully limited our search to the major journals in the relevant research fields (Table 1). A Google Scholar search with the same search terms has confirmed that we have not overlooked highly cited papers that meet our criteria.

¹ For thorough bibliometric analyses and literature reviews consult, e.g., Fagerberg et al. (2012a) on business innovation, Edwards-Schachter and Wallace (2017), Manjon et al. (2022), and van der Have and Rubalcaba (2016) on social innovation, and Köhler et al. (2019), Truffer et al. (2022), and Zolfagharian et al. (2019) on sustainability transitions.

Table 1
Search terms and results.

Search terms	Number of articles with these search terms in ScienceDirect*	Number of articles with these search terms in the selected journals	Number of articles retained for our analyses
("sustainability transition" OR "sustainability transformation") AND ("societal change" OR "social change" OR "mission-orientated" OR "goal-orientated")	39	27 in EIST, ERSC, JoCP, RP, TFSC, Global Environmental Change, and Ecological Economics	7
"social innovation" AND (transformat OR transition OR "mission-orientated" OR "goal-orientated" OR "social change")	91	39 in EIST, ERSC, JoCP, RP, TFSC	13
("innovation system" OR "innovation studies") AND (transformat OR transition OR "mission-orientated" OR "goal-orientated")	273	165 in EIST, ERSC, JoCP, RP, TFSC, and Technovation	50
"social innovation" AND ("innovation system" OR "innovation studies") AND sustainability AND (transformat OR transition OR "mission-orientated" OR "goal-orientated" OR "social change")	1	1	1
Total	404	232**	71**

Legend: Standard set of journals: EIST, Environmental Innovation and Societal Transitions; ERSC, Energy Research and Social Science; JoCP, Journal of Cleaner Production; RP, Research Policy; TFSC, Technological Forecasting and Social Change.

Notes: * In the title, abstract or author-specified keywords in articles published in 2010–2022.

** There were overlaps between the yields of the above four search rounds.

Defining the relevant search terms implied several challenges. First, it is difficult to tell apart social innovation from other types of innovation (Section 3.1). Second, most papers on business (or technological business) innovation use merely the term “innovation”. Third, in line with the previous challenge, searching for “technological innovation” mainly results in literature on social innovation as there is a productive research community that juxtaposes these two types of innovations. Fourth, “innovation” as a search term is unsuitable to identify articles on business innovation as this term is also part of “social innovation”. Finally, the combination of “business innovation” and “transformation” leads to a specific stream that explores the role of start-ups in transformation processes.

Having run several ‘pilot’ searches, we found that the literature on *business innovation* – technological, as well as non-technological (OECD, 2005, 2018) – is best covered when we use “innovation studies” OR “innovation system” as search terms. As for *social innovation*, naturally we used “social innovation” as a search term, while for *sustainability transition* we used “sustainability transition” and “sustainability transformation”. To identify the so-called ‘duo’ and ‘trio’ papers, we checked if these search terms – together with related ones, see Table 1 – appear in the title, abstract or author-specified keywords in articles published in 2010–2022. The only ‘trio’ paper we found is a case study (Augenstein, 2015), using key terms from the three strands of the literature, but not offering an integrative analytical framework.

The combination of the search strings listed in Table 1 yielded 404 papers, reduced to 232 by considering only articles published in key journals (Fagerberg et al., 2012a) in these fields of research. We allocated these 232 articles amongst ourselves: all abstracts were assessed for their relevance by at least two authors. We excluded articles that i) were primarily historic; ii) focussed on catch-up dynamics; or iii) on policy programmes. We preferred review articles and articles with a meta-perspective over case studies but did not exclude the latter. Eventually we retained 67 articles.

We extended this focussed literature survey with inward and outward citations, the outcomes of previous literature reviews (Havas, 2016a; Fagerberg et al., 2012a, 2012b; Howaldt et al., 2014; Köhler et al., 2019; Manjon et al., 2022; Truffer et al., 2022; van der Have and Rubalcaba, 2016), as well as major handbooks (Dodgson et al. 2014; Dosi et al. 1988; Fagerberg et al. 2005; Hall and Rosenberg, 2010; Moulaert et al., 2013).

Drawing on the above sources we identified conceptual foundations for the role of different types of innovation in transformation processes in IS, SI, and ST research. Further, we selected the key features of innovation processes to characterise these three strands of literature in Section 3.

3. Key features of innovation: basic similarities and substantial differences in the three strands of research

A fundamental common property of IS, SI, and ST research is that they all analyse innovation processes.² Further, innovation and change are often analysed from the vantage point of desirable outcomes and impacts. Beyond these basic properties, their further key features are distinct: (i) the impetus to innovate, and thus the principal purpose of innovations, the main actors, and their interactions in innovation processes; (ii) the objects and levels of change; (iii) the sources, types, and forms of knowledge (co-)produced, utilised, and exchanged; and (iv) how success and impacts are defined and measured. We discuss below how these issues are addressed in the

² Godin (2015) offers a comprehensive, critical assessment of the notion of innovation by analysing its meanings over time, its diverse uses, and the contexts in which the concept evolved.

three strands.³ Given space limits, we cover neither models of innovation in the three strands of literature, nor the concepts of innovation systems and innovation ecosystems.

3.1. The principal purpose of innovation

Although many scholars studying SI juxtapose social and technological innovations, a different distinction is appropriate in our view: one based on the *principal purpose* of innovation activities. When the principal purpose is improving the performance of a firm, we can speak of *business innovation* (Havas, 2016a; Windrum et al., 2016). When innovation is aimed at tackling a societal problem or creating new societal opportunities, actors are engaged in *social innovation*.

Following a slightly different argument, business and social innovations are also distinguished by Pol and Ville (2009). Havas and Molnár (2020) define social innovation as follows: “Social innovations are novel initiatives or novel combinations of known solutions, aimed at tackling a societal problem or creating new societal opportunities, applied in practice.” It is worth noting that we are faced with a plethora of rather diverse SI definitions. For example, 76 definitions are reviewed in Edwards-Schachter et al. (2012), 12 ‘archetypal definitions’ are considered in Benneworth and Cunha (2015), 252 definitions are identified in Edwards-Schachter and Wallace (2017), while 10 definitions are presented in Bulakovskiy (2021). This diversity of definitions and approaches is assessed critically by Solis-Navarrete et al. (2021), van der Have and Rubalcaba (2016), and Wittmayer et al. (2022).

A societal problem is caused and reproduced by social forces. These social forces – institutions (‘the rules of the game’), social networks, and cognitive frames – are key building blocks of the extended social grid model developed to analyse social innovations (Ziegler et al., 2019). For example, having a disability is not a social problem on its own, but in societies where people with a disability are marginalised, it is a social problem.

Hybrid innovations – that follow a business logic, and thus use business practices, methods, and organisational forms when addressing societal problems – are also of vital importance. Examples include new goods and services provided on a market basis by firms employing people living with various types of disadvantages. These firms are social enterprises.⁴

Finally, as the name of ST literature clearly indicates, the principal purpose of innovation activities studied by this stream is to serve *sustainability transitions*, which are comprehensive change processes of entire socio-technical systems, orientated towards the goal of sustainability.

Hence, we distinguish the *purpose* of innovation (the ambition pursued) and its *nature or object* (what is being changed by innovation activities). Both technological changes and non-technological ones (Section 3.2) can serve business or societal purposes, as well as sustainability transitions. Institutions (rules of the game) often co-evolve with new technologies and business models, but also change – and indeed, need to be changed – through social innovation and sustainability transition processes. Social innovations and sustainability transitions aim at altering social practices, social structures and networks, and cognitive frames.

The *principal actors* in business innovation processes are existing or newly established firms. In contrast, there are no archetypal actors in SI processes: a wide variety of actors need to co-operate to tackle a societal problem (Edwards-Schachter and Wallace, 2017; Havas and Molnár, 2020; Howaldt et al., 2014). Naturally, societal actors play a prominent role. A wide range of actors and stakeholders contribute to ST innovations at niche and regime levels. This widening of the range of actors is coherent with the learning-based approach to innovation and the perspective that several co-evolving elements need to be changed for transitions to materialise (Jørgensen, 2012; Suleiman, 2021). Typically, ‘outsiders’ and other non-incumbent actors are in the driving seat of niche innovations, but their relationship with incumbent actors is of crucial importance (Steen and Weaver, 2017).

3.2. Objects, types, and levels of change

The objects of *business innovations*, that is, what is being changed, are wide-ranging. Single innovations can be technological in their nature: goods (products and services), and production processes; or non-technological ones: organisational forms, management, marketing, and financial methods and solutions, and business models. Systemic innovations refer to the emergence of, or changes in, technological systems and techno-economic paradigms. IS scholars have developed various classifications concerning the types and levels of change. One of the best known was originally developed in the 1980s (Freeman and Perez, 1988; Perez, 1983, 2010). Both technological and non-technological innovations can be *incremental* or *radical*. At a deeper level, when a ‘bundle’ of radically new products, services, and/or production equipment and processes is introduced, a *new technological system* is emerging. A new technological system deeply affects several existing economic sectors at the same time or creates new sectors. The diffusion of technological innovations necessitates financial and organisational innovations, new cognitive frames, behavioural changes, and amended or new curricula for the education and training system. Hence, a new technological system is a system, indeed: its elements on their own, or in isolation, would not be sufficient to induce significant changes. When all crucial elements of an economic system – major inputs, decisive technologies, business models and processes, the structure of the economy (both in terms of its sectoral composition and the structure of supply and demand), the interactions amongst businesses, the mindset of decision-makers, the behaviour and preferences of consumers – are being fundamentally changed, we speak of the emergence of a *new techno-economic paradigm*. Clearly, that is a lengthy and cumbersome process, with substantial economic and social costs.

³ The main differences of the three strands of literature along these aspects are presented in Tables S1–S4, see an online Supplement at <http://dx.doi.org/10.13140/RG.2.2.31144.55049>.

⁴ Space limits prevent us from discussing hybrid innovations in the remainder of the article, but we refer to those at certain points.

Both incremental and radical single innovations are constantly introduced during the lifetime of a technological system or a technological paradigm. In turn, these systems continually undergo incremental changes (adjustments and refinements) and are replaced by new systems when radical innovations – coupled with other major changes – reach a critical mass.

Other classifications also stress that technological change occurs at different levels and is associated with different structural dynamics, notably the concepts of key technology (Foster, 1986), architectural innovation (Henderson and Clark, 1990), and general purpose technologies (Bresnahan, 2012; Lipsey et al., 2005).

Social practices, institutions, social networks, and cognitive frames are the most frequent objects of change in *SI processes*. These changes can be either incremental or radical and are likely to be perceived differently by diverse actors. As for *SI research*, the distinction between different levels of change is somewhat ‘subsumed’ in several definitions, ranging from the micro to the macro level. Changes at the *micro (and/or meso) level* are specified in the *SI* definitions offered, for example, by Andries et al. (2019); Rehfeld et al. (2015), the Young Foundation (2012); at the *meso and macro level* by Heiskala (2007); at the *micro and macro levels* by Moulaert et al. (2013); and in the *macro level structures* by Drucker (1957) and Godin (2012). While the level of change is not yet considered systematically as a separate analytical issue, attempts to summarise definitions under typologies of social innovation try to compensate for this (Schartinger et al., 2020). Despite some further attempts (Turker and Altuntas Vural, 2017; van Wijk et al., 2019) the issue is far from resolved and needs attention in future research to separate definitions of *SI* and levels of change. As for the latter, different angles are to be taken. Considering the micro, meso and macro levels is a must, no doubt. It is also self-explanatory that different types of societal problems can be tackled at different levels: at the level(s) of a community, a town or city, a region (inside a country), a country, or groups of countries. Thus, the interrelated angles of governance levels and geography need to be considered.

By definition, systemic changes are indispensable for *sustainability transitions* – complemented by all sorts of single innovations (technological and non-technological changes, both incremental and radical). *ST* research draws extensively on the multi-level perspective (MLP) that explores changes at three distinct levels: niche, regime, and socio-technical landscape (Geels, 2002; Geels and Schot, 2007). This framing has a major advantage: it allows investigation of interactions between change processes at two levels, while the third (landscape) level is largely considered as the external environment with its own dynamics. This provides a useful inroad to analysing the relationship between innovation processes (in niches) and transformation processes (of regimes). However, the notion of ‘levels’ has also been contested because it does not reflect a micro-meso-macro ordering but rather a distinction by temporal scales (Berkhout et al., 2004; response in Geels, 2011).

Another influential conceptual framing of innovation dynamics can be traced back to the notion of *technological innovation systems* (TIS) (Carlsson, 1997; Carlsson and Stankiewicz, 1991; Hekkert et al., 2007; Markard, 2020). The TIS framework, and the structural-functional research approach that is associated with it, has its strengths in the analysis of early-phase innovation dynamics, but is less explicit concerning the link to transformations or transitions. Innovation dynamics are understood as being driven by processes of cumulative causation between different TIS functions (Suurs and Hekkert, 2009). The interactions with complementary and competing TIS have been addressed in the analysis of transition dynamics (Purkus et al., 2018). Janssen et al. (2023) have extended the TIS approach to analyse missions as boundary objects in transformative arenas.

3.3. Sources, types, and forms of knowledge (co-)produced, utilised, and diffused

An essential claim of the *innovation systems approach* is that a successful innovation process requires different types of knowledge (codified and tacit; S&T and practical), stemming from various sources (R&D activities and practical experience) and these pieces of knowledge and experience are rarely – if at all – possessed by a single actor. Co-operation amongst these actors is, therefore, indispensable (Jensen et al., 2007; Mirzadeh Phirouzabadi et al., 2020; Powell and Grodal, 2005; Tziva et al., 2021) and can take many forms, ranging from a variety of B2B and business-academia collaborations (Havas, 2015; Perkmann et al., 2013) to value networks in more ecosystem-type interactions or consumer–producer networks (Clarysse et al., 2014; de Vasconcelos Gomes et al., 2018; Randelli and Rocchi, 2017).

Identifying the types and sources of knowledge is not a major issue in *SI research*⁵ but we can safely posit that both S&T and practical – often tacit – knowledge is crucial for *SI* processes, often with a stronger emphasis on practical knowledge. Scientific knowledge should include social science knowledge on societal challenges and their root causes. As a rather diverse set of knowledge and experience is required to tackle a societal problem, a broad array of actors need to collaborate in *SI* processes.

In *ST*, the sources of knowledge are as diverse as the actors involved. In line with the co-evolutionary model of change underpinning *ST*, co-creation of knowledge plays a decisive role. Given the high level of complexity of these inter-dependant learning processes, experimentation and joint learning are key, which is also why approaches from design thinking are popular in this strand. This does not, however, exclude the use of codified, S&T knowledge or collaboration with businesses that possess domain specific, relevant knowledge.

3.4. Defining and measuring ‘success’

A closely related issue to the principal purpose of innovation activities is success: what is considered success – and, in turn, who defines criteria for success and how? As for *business innovations*, both the *IS* and the management of innovation literature (Dodgson

⁵ Other authors, e.g., Benneworth and Cunha (2015) and Göransson et al. (2021), however, emphasise the role of universities.

et al., 2014), is straightforward: success at the micro level is improved firm performance, thanks to innovations. Success can materialise in enhanced productivity, increased sales, higher market share, new market entry or even creation, and higher profits. Success criteria are determined by a business logic. An important dilemma persists, though: the tension between short-term vs long-term performance. Improved performance in the longer run is certainly relevant from a strategic angle. Yet financial markets apply a strong pressure on managers to pursue short-term objectives to satisfy investors. Thus, it is a crucial issue which performance metrics are used by the board of a given firm and what weight is attached to indicators measuring short-term vs long-term performance. At a macro level, IS assumes that innovation activities enhance a given economy's international competitiveness (Aiginger et al., 2013; Fagerberg, 1996). It is contested, however, if competitiveness is a relevant concept beyond the level of products or firms (Krugman, 1994, 1996).

It is worth distinguishing 'success' vs impacts, both intended and unintended impacts: what is success for a firm, might have negative repercussions for other firms, people – employees or other social groups –, or the environment. The IS literature has assumed for a long time that business innovations have favourable impacts. This view is shared by many policy-makers. Business innovations are supposed to lead to improvements in goods' properties, firms' performance, people's health, and so forth. Ultimately, all these changes amount to an increase in the wealth of nations. It should be added, however, that business innovations, characterised as creative destruction, have a destructive element as well: incumbent firms need to adjust by abandoning or reorganising some of their previous activities, and thus shedding labour. It is a crucial feature of market economies that firms are driven out of business by more efficient competitors. The net impact is still assumed to be positive, given the advent and subsequent rise of new entrants.

This still widely held, optimistic assumption concerning the favourable impacts of business innovations has been questioned more recently.⁶ Probably the most widely known cases of destructive business innovations are those financial ones that have been introduced in the name of 'dispensing the risk', but in essence allowed a few, well-informed and well-positioned actors to achieve substantial profits while putting a huge burden on society (Soete, 2013: 141–142). The environmental burden of new products and technologies is also rather high in many cases.

As for social innovations, the bulk of SI definitions postulates a success, that is, positive societal impacts (Havas and Molnár, 2020). This is a rather severe methodological flaw: i) the impacts of any social innovation should be assessed *ex post*, on a case-by-case basis; and ii) these definitions exclude the existence of unsuccessful social innovations. Social innovation may also have a 'dark side' (Nicholls et al., 2015: 5–6). Clearly, no society is homogenous, not even those social groups that are marginalised and disempowered: their members still have their own values and views, and thus might perceive a certain change process and its effects in different ways. Moreover, a particular SI that improves the situation of some groups can affect other groups negatively – and not just because they perceive the improvement for other social groups as a relative worsening of their situation, but in some cases as an actual, 'neutrally measurable' impact, e.g., when their access to certain support schemes or services becomes more limited. Inadequate interventions can further aggravate the position of marginalised groups.⁷ For these reasons the measurement of social innovation activities and their impacts is a much more demanding task than measuring business innovations (Havas, 2016b). Hence, it is not surprising that we do not have even partially satisfactory methods, let alone a widely used set of indicators to measure SI processes (inputs, throughputs, and outputs), their outcomes, and impacts (Krlev and Terstriep, 2022; Mihci, 2020).

Ultimate success is understood in *ST research* as achieving transitions to (more) sustainable socio-technical or socio-economic systems. A range of historical studies have shown that such transitions are possible (cf. the extensive body of work by Geels and collaborators). Contemporary studies mainly focus on early phases of sustainability transitions, implying that 'success' needs to be understood more modestly, often in terms of the potential that an emerging experiment or niche development process may pave the way towards a genuine sustainability transition. The concept of transformative outcomes is helpful in this regard, as it focusses on short- to medium-term effects and processes that are essential for triggering subsequent transformative dynamics (Ghosh et al., 2021). The role of different types of failure in socio-technical transitions is explored by Turnheim and Sovacool (2020).

4. Key features of diffusion processes and transformation dynamics

The level of change, diffusion, and system transformation are related issues: it is possible and necessary to disentangle these phenomena, but it is equally important to understand their interlinkages. An obvious illustration of this claim is the Freeman-Perez typology of levels of change induced by business innovations, already introduced in Section 3.2. Further, innovations do not only impact the firms and other organisations that introduce these new solutions, but incremental changes are also required to adapt innovations to the new context when they are diffused. Transformation denotes changes at the level of systems. In this section first we discuss the diffusion of innovations and then present transformation mechanisms identified in the IS, SI, and ST literature.

4.1. Diffusion of innovations

Business innovations can only have impacts on entire economic sectors, regions, or national economies when they are diffused. Thus, diffusion is an important subject both in mainstream and evolutionary economics (Dosi and Nelson, 2010). The former paradigm

⁶ For a short overview of the literature stressing negative societal and environmental impacts of business innovations, see, e.g., Havas and Molnár (2020).

⁷ Two such examples are discussed in more detail in Havas and Molnár (2020), namely the negative impacts of microcredit schemes on poor people in several continents and the failed intervention to cease segregated education of Roma pupils in Hungary.

focusses on economic incentives of producers (to adopt a new production equipment, buy a licence or a new input) and consumers. It is a dynamic analysis as it examines a temporal process, but somewhat static in terms of the product characteristics and the set of capabilities needed to use new production equipment or consumer goods. The latter paradigm, on which the IS literature draws heavily, in contrast, stresses not only adoption but also the adaptation required when a new production equipment, process or method is introduced in a new environment or customers start using a new consumer good or service. Thus, it is a truly dynamic approach: both learning by the adopters and the changing properties of the new goods, processes, and methods are analysed. These also underline the interrelatedness of the level of change and diffusion: introducing an incremental innovation is likely to require minimal learning effort, as opposed to radical innovations that necessitate considerable learning and possibly ‘unlearning’ of old routines and obsolete knowledge as well.

The main features of diffusion processes can be captured by three stylised facts: (i) diffusion is a time-consuming process; (ii) its speed differs substantially by the innovations in question and also across countries; and (iii) an unknown, but probably significant proportion of innovations, even when introduced by some initial adopters, never diffuses widely, and thus ultimately ‘vanish’ (Dosi and Nelson, 2010; Foster, 1986; Geroski, 2000; Palm, 2022).

Given the noteworthy interest of economists in diffusion, several types of models have been developed (Dosi and Nelson, 2010; Stoneman and Battisti, 2010). The advanced versions take into account that new products are improved and adapted to new needs of new users in new contexts, and thus no ‘saturation point’ can be established. Together with the major changes in product characteristics their prices also change, leading to significant changes in their market share and eventually new producers enter the market in many cases.

Analysing the diffusion of *social innovations* is still in its infancy (Mulgan et al., 2007), compared to the IS literature, for understandable reasons. SIs are rather complex and diverse change processes; they cannot be boiled down to 3–4 major types. Hence, it would take significant time and effort to collect data on their diffusion processes, making it a prohibitively expensive exercise. Diffusion of SIs is mainly driven by devoted SI practitioners. The main channels are SI practitioners’ networks (both at a national level and internationally), trainings, workshops, and other discussion fora of SI ideas. Governments – at local, regional, or national levels – can also play a significant role. Other influential actors are NGOs (and social enterprises for hybrid innovation). For SI, the context is decisive, and thus an ‘easy and smooth adoption’ of a solution that works in a given context is out of question: it has to be substantially adapted to any new context to make it effective in tackling even a seemingly similar societal problem. Clearly, that requires extra intellectual and financial resources, efforts, and time (Davies and Simon, 2013; Moore et al., 2015; Voltan and De Fuentes, 2016; Westley et al., 2014).

In the *ST literature* the diffusion of innovations is an important mechanism underpinning transitions but given the co-evolutionary nature of socio-technical change, on which sustainability transitions reside, these diffusion processes are understood as being paralleled by complementary behavioural, organisational, or even institutional changes. Close attention is therefore paid to the processes of first and second order learning associated with the mutual adjustment of these co-evolving elements. The emphasis put on learning and shaping of innovations in niches is also tied to the ambition of exerting influence on, or even change, the prevailing regime (Sengers et al., 2021). Hence, the diffusion of innovations is seen as a tightly intertwined process, even more so than in innovation studies, with further changes in the properties of the innovation in question.

4.2. Transformation dynamics in the innovation studies literature

We have identified four types of transformation dynamics in the IS literature: (i) a widespread diffusion of new products and technologies; (ii) social acceptance of ‘green’ technologies; (iii) evolutionary and complex self-reinforcing dynamics; and (iv) the emergence of new technical systems and techno-economic paradigms. As the latter mechanism (Freeman and Perez, 1988; Perez, 1983, 2010) is discussed in Section 3.2, we provide a brief overview only of the former three mechanisms below.

4.2.1. Business innovation leading to transformation

The IS literature assumes that transformation is achieved through the prevalent diffusion of new – e.g., environmentally friendly – technologies, which eventually become dominant (Garud and Karnøe, 2003; Truffer and Coenen, 2012; van den Bergh et al., 2011; Weiss et al., 2021; Winkel and Radcliffe, 2014). Hence, discussions on transformation largely revolves around devices (e.g., cars, heating systems) and technologies (e.g., green technologies, such as solar or wind power). A focus on the diffusion of environmentally friendly products and technologies implies that the underlying institutions, social, cultural, or spatial structures are not fundamentally challenged (Augenstein, 2015; Zijlstra and Avelino, 2012); they remain largely the same while the technological artefacts are replaced, e.g., cars with an internal combustion engine by electric vehicles. Transformation can then be achieved by the sheer volume of replacement of key technologies (Foster, 1986).

Diffusion occurs through market mechanisms and hence is based on rational decisions by individuals, following economic criteria (Cuerva et al., 2014; de Jesus et al., 2018; Rogers, 2003). Hence, this process of technology diffusion is rarely smooth, the characteristics of early adopters and early majority differ, and thus sales will not increase without further actions by the vendor (Geroski, 2000; Hojckova et al., 2020; Moore, 2002). Start-ups and entrepreneurs are often the carriers of innovative solutions. As sustainable entrepreneurs, they may become the key actors in transformation processes (Audretsch et al., 2022; Kuckertz et al., 2020; Long et al., 2019). Business model innovation is closely related, promoting access-based models, e.g., consumption of services (renting) instead of purchasing (owning) products (Ceschin, 2013; de Jesus et al., 2021).

The lead market concept acknowledges the role of multinationals in diffusion and concedes that characteristics of local markets may foster the emergence and success of certain innovations that then diffuse globally (Beise, 2001; Meyer-Krahmer and Regier, 1999),

or remain a local success (Quitrow et al., 2014).

4.2.2. Social acceptance

The focus of this stream of literature is often on the puzzling contradiction between a generally positive public attitude towards environment-friendly technologies, on the one hand, and their slow diffusion, on the other – exemplified by wind turbines or solar power (Wolsink, 2012; Wustenhagen et al., 2007). Citizens – beyond consumers –, NGOs, and the media then play an important role in determining whether an innovation will evolve into transformation or not. Social acceptance forms a part of legitimacy and the lack thereof has often been regarded as a factor hampering change processes (Bergek et al., 2008b). Transformation processes can also be reinforced by paying special attention to their social rather than just their economic benefits, as demonstrated by green technologies. Social acceptance criteria can also be translated into economic incentives (through subsidies) or regulatory requirements (emission standards).

4.2.3. Evolutionary and complex self-reinforcing dynamics

IS scholars have also considered more abstract models of how techno-economic changes occur. Evolutionary and neo-Schumpeterian economics have inspired innovation studies by focussing on the interplay of variation, selection, and retention mechanisms (Nelson and Winter, 1982), and how they lead to the formation of institutions and (technological) trajectories, interpreted as processes of emergence (Dosi et al., 1988).

Similar ideas had already been proposed earlier in relation to industrial dynamics. In the industry life cycle perspective, industrial transformation is part of overall transformation processes. In the early stage of an industry, technology is still evolving and changing rapidly; uncertainty is high, while entry barriers are low. There is no dominant design (Utterback and Abernathy, 1975); many design solutions co-exist (*variation*). The emergence of a dominant design is a turning point in the development of any industry (Abernathy and Utterback, 1978; Brem et al., 2016) and leads to *selection* processes: a specific design becomes dominant – a *de facto* industry standard – as it is accepted by innovators, competitors, and users alike (Suarez and Utterback, 1995).

Complex systems research has further enhanced this (co-)evolutionary line of reasoning and enabled an integration of micro- and meso-level perspectives. Network externalities exert significant impacts on the diffusion of technological business innovations and the formation of stable trajectories and standards – but can also cause lock-ins (Arthur, 1988). They can be seen as ‘demand-side economies of scale’ (Katz and Shapiro, 1986). The argument of network externalities is a crucial factor in analysing platform economics (Constantinides et al., 2018) or ecosystems (Hein et al., 2020; Thomas and Autio, 2019).

4.3. Transformation dynamics in social innovation studies

Social innovations are often embedded in agendas of changing social relationships more broadly, together with the institutional environments that shape these relationships. The pathways from a single social innovation to wider transformation have been analysed more systematically in recent years. We have identified four main lines of SI research addressing this issue: i) micro-level perspectives on how social innovations lead to more widespread changes in social practices; ii) spatial perspectives on how social innovations ‘travel’ and how they proliferate by becoming embedded in novel contexts; iii) changes in power relations; and iv) meso-level perspectives that conceive institutional change as the primary object of social innovations and thus as a trigger of transformative dynamics.

4.3.1. Social innovation causes transformation via changing social practices

SI studies assume that the relationship between social innovation and wider transformative change occurs via changes in social practices. While SI studies are not part of the social practice theory (SPT) *per se*, largely build on an interpretation of the latter. SPT understands social practices as “the nexus of doings and sayings bound by collective understandings, procedures and engagements based on habits and routines” (Castelo et al., 2021: 2; cf. Schatzki, 2002; Southerton et al., 2012; Warde, 2005). Often, the analysis of social practices concentrates on activities that are performed day-to-day, e.g., eating, moving, or shopping. Social practices are key social mechanisms that underpin or hamper transformation by reproducing, perpetuating, and transforming the practices (Schatzki, 2002; Shove and Walker, 2014; Svennevik, 2022).

Some social practices cause conflicts because they are unsustainable: they have negative effects like air pollution, greenhouse gas emission, noise, or resource depletion. These are mainly mobility practices involving private car use and taking short haul flights on a massive scale. SPT posits that social practices can change in three different ways (Watson, 2012) but do not mention social innovation.

SI scholars, in contrast, claim that underlying these changes in social practices is social innovation (Cajaiba-Santana, 2014; Howaldt et al., 2015). SI and their actors depart from existing trajectories based on mental maps, rules, routines, pathways, and mental models on politics, business, and society. Hence, SI may be a starting point for further social dynamics that lead to altered social practices and lifestyles, and thus drive transformative social change (Howaldt et al., 2014, 2017b; Krohn, 2005; Tarde, 2009). Merits of SI in this context are showing the way forward for novel solutions (Magnani and Osti, 2016), thereby often overcoming or addressing conflicts, as they experiment with novel ways of assembling and re-assembling heterogeneous pieces of experience and knowledge, finding strategic allies and developing constellations that address challenges and conflicts in the way of a sustainability transition. Changes in social practices can be partly technologically mediated and build on social innovation around new technologies (Adamo and Willis, 2022; Augenstein, 2015; Labanca et al., 2020). The debate is linked to ‘just’ transitions, stressing the need to consider conflicting values and interests and enable citizens to co-shape transition processes. Grassroots social innovations (Martin and Upham, 2016), empowerment and participation of citizens are perceived as main avenues for achieving sustainable developments (Manjon

et al., 2022).

However, transformative impact of social innovation is not straightforward: it is difficult to identify and measure; power relations change often only partly, and thus inequalities persist (Ziegler et al., 2019). Moreover, social innovation, given its “dark sides” (Nicholls et al., 2015), may introduce new inequalities.

4.3.2. Translocal diffusion of SI: adaptation and learning processes

Social innovations often start as grassroots innovations in a local context, like local sustainability initiatives, hence they are bound to their geographic context and local perspective of problems (van den Heiligenberg et al., 2022). At the same time some of these SIs are also connected to other local initiatives across the world. Loorbach et al. (2020) coined the term ‘translocal diffusion’ for local initiatives and networks that exchange, translate, and diffuse ideas across the globe. Pel et al. (2020) see their strength in the translocal connectivity that is stronger than their local embeddedness. They transport and circulate ideas and novel solutions over long distances, and hence form an international network held together by global movements, NGOs, associations, and scientific communities. They form a globally spread critical mass and translocal identity. Knowledge exchange happens more fluently compared to mere local initiatives, infiltrating local networks across continents via strong and weak ties. The translocal identity is a source of legitimacy and hence strength; at the same time they challenge, alter, or replace existing social structures (Avelino et al., 2019; Haxeltine et al., 2017; Loorbach et al., 2020), and may thus contribute to transitions as well.

4.3.3. Change of power relations: empowerment and disempowerment

Transformation is related to changes in power structures (Avelino et al., 2023). Empowerment is a distinguishing element (Windrum et al., 2016), a crosscutting issue (Howaldt et al., 2017a), or seen in relation to Sen’s capabilities approach (Ibrahim, 2017) in the SI literature. Empowerment is a strength of SI initiatives in the realm of environmental issues (Raj et al., 2022) also in the transformative SI perspective. Citizens are provided with alternatives (‘make the environmental-friendly choice the easy choice’), hence empowered to choose what and how they perform and change practices. This can introduce a sense of normative or social urgency necessary for transformation.

From a transformation perspective, empowerment of citizens and new actors goes along with disempowerment of incumbent actors. Disempowerment of actors and renunciation of structures involved in harmful activities to the environment is another important factor in achieving transformation (Avelino et al., 2019; Wittmayer et al., 2019). Pel et al. (2020) claim that certain types of SI ecosystems facilitate empowerment, understanding SI as the introduction of new social relations, while the notion of SI ‘ecosystems’ stresses the distributed nature of SI agency.

4.4. Transformation dynamics in sustainability transition studies

ST research has put an explicit emphasis on conceptualising transformative dynamics, drawing on evolutionary economics, complex systems thinking, and science and technology studies. A co-evolutionary understanding of social and technological change processes, as well as of institutional development has been of central importance in ST. Systems approaches – like TIS with its focus on structural and functional analysis – have inspired the understanding of how transition processes evolve. These meso-level frameworks have been embedded in a macro-level framework on deep transitions, multiple interconnected transitions, and global innovation systems. These approaches, however, are always tied to a specific normative orientation towards – mostly environmental – sustainability, thus leaving alternative normative framings aside.

4.4.1. Transitions from a multi-level perspective

The MLP emphasises socio-technical and institutional dimensions of sustainability transition. It argues that sustainability transitions require an interplay of micro-level niche developments and meso-level regime changes. Micro-level niche developments are not independent of each other, either: green technology alternatives of different maturity stages may compete for the same niche (Alkemade and Suurs, 2012; Magnusson and Berggren, 2018) and need to interact effectively with multiple other technologies (Andersen and Markard, 2020). Incumbents can also bring ‘defensive innovations’ to the market to contain the niche (Sovacool et al., 2017). The necessity to overcome path dependence is a key concern where multiple types of market evolution can play a role, beyond the incremental vs radical innovation dichotomy (Dijk et al., 2015). Policy-makers and (business) innovators are often active in informal coalitions with incumbents, promoting the current regime, thereby reinforcing lock-ins (Geels, 2004; Geels and Schot, 2010; Grin et al., 2011; Markard et al., 2012).

The MLP stream explicitly frames transitions as long-term processes that may start bottom-up, are non-linear, meander ‘forth and back’ and address a multitude of conflicts and problems. They require new governance structures, learning spaces, the interaction of social groups at different levels, including local citizen initiatives, social movements, user groups, and policy-makers, as well as businesses that develop more sustainable solutions and business models that can contribute to such a transition (a ‘whole of society’ approach). Geels and Schot (2010) characterise transitions as co-evolutionary and encompassing changes in socio-technical systems at multiple levels. The *niche level* provides a protective space for experimentation (Smith and Raven, 2012). The *regime level* offers more stability in that there are institutions, infrastructures, and a common understanding of problems and possible solutions. Moving novel socio-technical solutions from the niche to the regime level requires the embedding of novel solutions in institutional and organisational structures that may necessitate major changes. The destabilisation and redefinition of socio-technical regimes is considered an important element of transition strategies (Turnheim and Geels, 2012), as is the need to find exit strategies (‘exnovation’) for technologies and companies that are not in line with the emerging new regime. The third level, the socio-technical *landscape* provides even

stronger structuration but is beyond the influence of meso-level transitions (Geels, 2002).

ST scholars emphasise the tension between individual agency and institutional change, stressing the importance and manifold aspects that agency-based approaches have in sustainability transitions (Pesch, 2015; Rauschmayer et al., 2015), but also the need for a more differentiated perspective on the level of structuration of institutions (Fünfschilling and Truffer, 2014).

This basic characterisation of transition dynamics still faces many challenges (Smith et al., 2010) and was refined in the last two decades, for instance in terms of characterising different types of transition contexts and pathways (Geels and Schot, 2007; Smith et al., 2005) and inter-sectoral dynamics (Andersen et al., 2020). A more detailed account of the mechanisms underpinning the uptake and embedding of novel solutions has been provided by Sengers et al. (2021), who distinguish four main types of ‘generalisation pathways’ and Ghosh et al. (2021), who stress the importance of creating steppingstones towards both niche development and regime changes.

These lines of reasoning reflect ST studies’ strong emphasis on bottom-up learning processes, co-creation, and experimentation. Top-down strategies for changing regimes, e.g., by way of major institutional reforms is given less attention in ST.

4.4.2. Cumulative causation in technological innovation systems

Whereas innovation studies focus on diffusion of green innovations as a main mechanism of transformation, ST studies also emphasise the need for actively phasing out environmentally harmful technologies (Andersen and Gulbrandsen, 2020; Kivimaa and Kern, 2016; Koretsky and van Lente, 2020; Loorbach et al., 2017).

An alternative conceptualisation of (early) phase goal-orientated transformation dynamics has been developed drawing on the functions of Technological Innovation Systems (TIS) (Bergek et al., 2008a; Hekkert et al., 2007). Initially a rather static perspective, it has been ‘dynamised’ by proposing mutual reinforcements between the different TIS functions (‘motors of sustainable innovation’, Suurs and Hekkert, 2009). This builds on the notion of cumulative causation as a simplified interpretation of complexity-inspired mechanisms. Other – less widely used – approaches to capturing transformation dynamics are inspired by evolutionary and complex systems theory (Holtz et al., 2015; Rotmans and Loorbach, 2009; Safarzynska et al., 2012). The TIS perspective is mainly suitable for studying early phase transformation processes rather than far-reaching transitions; this deficit is addressed by several authors (Bergek, 2019; Dewald and Fromhold-Eisebith, 2015; Markard et al., 2015; Truffer and Coenen, 2012). A first attempt has recently been made to extend this framework to analyse ‘transformative’ missions as specific examples of goal-orientated transformations (Hekkert et al., 2020).

The debate on the politics and the political enforcement of policies and structural changes necessary for socio-technical transitions has become more prominent (Kern, 2015; Meadowcroft, 2009). Novel institutional arrangements and sectors need to be established before a transition can occur that may have social and spatial redistributive effects. They may lead to highly contested political processes that strongly influence transformation dynamics (Kern, 2015; Kern and Rogge, 2018).

4.4.3. Embedding in wider contexts of deep transitions

At the confluence of the multi-level perspective in ST research and techno-economic paradigm shifts in IS, the concept of deep transitions has been proposed as a macro-level transformation envelope and selection environment for interrelated socio-technical system transitions (Kanger and Schot, 2019; Schot and Kanger, 2018). Whereas techno-economic paradigm shifts and socio-technical transitions tend to be characterised by time spans of about 50–60 years, i.e., similar to Kondratieff’s long waves or what Perez (2010) calls great surges of development, ‘deep transitions’ refers to a succession of several such surges over a period of 200–250 years. Deep transitions are characterised by the emergence of a meta-regime that guides the directionality of socio-technical systems change over such long periods. The deep transitions framework helps study multi-system dynamics, the linkages between transformation of different socio-technical systems, and how their coherence could be achieved with the help of meta-rules.

With this long-term perspective, the deep transitions framework opens up the black box of socio-technical landscapes in the MLP framework and repositions techno-economic paradigm shifts in an even longer-term perspective. From this macro-level and long-term angle deep transitions are a bridge between IS- and ST-based perspectives on transformative change that promises to be fruitful for investigating inter-connected transformations of multiple systems, such as the energy, food, and water nexus.

4.5. Converging observations on transformation mechanisms across the three strands

Apart from the differences outlined above, there are considerations that are key in all three strands regarding transformation dynamics, with different nuances, however.

Context does matter. The consideration of the specific context, in which a transformation starts is decisive in all three strands. Yet, context is an ‘umbrella’ term, covering e.g., regional disparities in natural endowments, local infrastructure or institutions, or social structures specific to localities.

Networks and collaborations. Formation of networks, coalitions, collaborations, and other types of relationships between actors is crucial in all three strands (Caraça et al., 2009; Chesbrough, 2003; Freeman, 1991; Havas and Molnár, 2020; Köhler et al., 2019; Lundvall, 1988; Smith and Raven, 2012). Given the importance of collaborations amongst actors, the role of intermediaries and networking organisations has also gained attention (Kanda et al., 2019, 2020; Kivimaa, 2014; Kivimaa et al., 2019; Rohe and Chlebna, 2022; van Lente et al., 2020).

Institutional change. Institutions are also deemed decisive but viewed in distinct ways. In IS, technologies and institutions co-evolve in evolutionary models of innovation. In the extended social grid model of SI institutions are at the core, in close interaction with networks and cognitive frames (Molnár and Havas, 2019; Ziegler et al., 2019). In other analyses they are the main object of change (Terstriep et al., 2020). Cajas-Santana (2014) interpret social innovation as the result of interactions amongst agency (actors) and

social systems (structures) as institutions. In *ST*, change from niche to regime goes hand in hand with institutional change (Hoogstraaten et al., 2020; Markard et al., 2016; Patterson, 2021). Existing institutions generally favour the incumbents, and hence produce stability (Galeano Galvan et al., 2020; Jacobsson and Johnson, 2000).

Infrastructure. Special attention is paid to infrastructure (and infrastructure technology) as a prerequisite of transformation in all three strands (Andersen, 2014; Barr, 2015; Geels, 2012; Smith and Raven, 2012).

5. An integrative perspective to analyse transformative change

We define *goal-orientated transformative change (GOTC)* as a closely interrelated set of fundamental changes at the level of a socio-technical or an entire socio-economic system, with changes simultaneously affecting its underlying technologies, business models, cognitive frames, institutions, business and social networks, as well as business and social practices, initiated by various types of actors to achieve a major overarching goal. These fundamental changes are fostered and complemented by radical innovations 'below' the system level, as well as millions of incremental changes at all levels. It must not be part of the definition to prejudge whether the intended overarching goal has been accomplished. That should be established by a thorough evaluation of a given GOTC process. That evaluation should also consider the likely different impacts on distinct social groups and businesses, at different stages of the change process. Another analytical task is to identify the intended and unintended elements of change in a transformative change process.

If we want to capture the variety of possible specific objectives and innovation activities within a broad GOTC process, as well as their cumulative impacts, an *integrative analytical framework is needed*. This framework, however, is missing. Several conceptual models have been developed so far in the *IS*, *SI*, and *ST* strands of literature to capture transformative change from their specific angle. They are all based on a limited number of underlying common claims about how changes evolve. Both *IS* and *ST* have built sophisticated theories of (transformative) change that draw on either evolutionary or complexity-based conceptual models. The evolutionary tradition of *IS* has focussed on *technology–economy* interactions to capture the emergence of novel trajectories and paradigms (Arthur, 1988; Dosi, 1982; Freeman and Perez, 1988). Complex adaptive system models have also been developed (Anderson and Arrow, 1988; Foster and Pyka, 2014; Lane et al., 2009). In *ST* research, too, co- and quasi-evolutionary models, both conceptual and quantitative, have been proposed to capture *technology–society* interactions and the interplay between niche developments and regime changes, with economic considerations being subordinate to sustainability goals (Köhler et al., 2020; Schot, 1992). The *SI* research strand has proposed various types of models, including stage models of *SI*, closely resembling the linear model of business innovation (Cunha and Benneworth, 2013; Mulgan, 2006), as well as co-evolutionary ones, highlighting the interactions amongst agency, social-political structures, and institutions (Cajaiba-Santana, 2014; Lawrence et al., 2014). The extended social grid model (Nicholls and Ziegler, 2019; Ziegler et al., 2019), another co-evolutionary model of *SI*, stresses that institutions, social networks, and actors' cognitive frames all need to be changed in an orchestrated, conscious way to make social innovation successful.

In line with our integrative ambition, we argue that there is a need for widening the scope of these (partial) conceptual models by combining their respective lenses and considering the co-evolutionary or complex interactions between *technology, economy, and society* in GOTC processes. This claim is crucial because transformative change requires thorough consideration of a broad range of possible societal goals, as well as the commitment of, and actions by, a wide spectrum of actors (entrepreneurs and businesses, public sector and civil society organisations, researchers in all sectors, and a critical number of citizens) to achieve the major overarching goal. These actors are bound to have rather different worldviews, aspirations, and interests that need to be captured, analysed, and explained in an integrative perspective on GOTC.

As a first attempt, we offer four building blocks for a new, integrative conceptual framework to analyse GOTC processes, keeping in mind that for an actual GOTC process there is a strong interdependence amongst the overarching goal, specific objectives, objects, types, levels, and processes of change. These should be understood as complementary elements or 'lenses' that together serve as a 'focussing device' (Lundvall, 2007; Robinson et al., 2021), through which analysts can explore and explicate change processes, rather than a standard 'process model' or a unitary 'normative' theory of transformative change.

In the next three sub-sections we introduce three building blocks that suggest aspects to be elaborated upon when building a new, integrative theory. These can be also pertinent when designing, implementing, monitoring, and analysing GOTC processes. We also highlight how different types of innovations – social, business, and hybrid innovations – in conjunction contribute to GOTC. The final sub-section considers the set of criteria to guide an *ex ante* evaluation, monitoring or *ex post* evaluation of these change processes as a fourth building block.

5.1. Rationales, overarching goal, and specific objectives of change

By definition, a GOTC process can only start once major actors have recognised the need for change and agreed on an overarching goal. This complex change process is composed of business, social, and hybrid innovations. Hence, fora and channels need to be created for dialogues and negotiations amongst the diverse actors and other stakeholders on i) what overarching goal to set and ii) how to accomplish their diverse – partly complementary, partly conflicting – objectives in the frame of the major overarching goal. Analysts and policy-makers, therefore, need to perceive transformative change processes both as knowledge creation and purpose production guiding transformation. This also implies that even the overarching goal might need to be amended during a transformative change process, let alone the specific objectives, i.e., these cannot be fixed politically – contrary to what is argued by some advocates of mission-orientated policies.

As for the 'single' innovations, the *initial impulse* comes from different sources. For *business innovations* the main driver is competition: firms feel the pressure to improve their products and services, as well as their production and business processes, and/or

introduce brand new goods and business models, enter new markets, or create new ones. For SIs the main driver is perceived societal needs or possibilities to create new societal opportunities. New initiatives – ideas for change – can come from a wide range of actors: internally from business, social, and hybrid innovators or externally from consumers of goods and services, beneficiaries of SI, NGOs caring about societal and environmental issues, as well as policy-makers. Both IS and ST research recognise the importance of technological as well as non-technological opportunities as important inspirations for innovation.

As for the objectives of ‘single’ innovations, different purposes of change processes are identified in the IS, SI, and ST literatures. Business innovations either react to new demands, or create new demand, and thus new markets, while SIs are directed towards (societal) needs (Hodgson, 2008). From a different angle, business innovations can be best understood in the frame of the growth paradigm, while from an SI perspective promotion of economic growth is not a prime concern. Further, SIs often address the dark sides of growth, e.g., housing problems and social tensions caused by mass industrialisation, leading to fast urbanisation, and thus declining quality of education, health, and social services, organised crime, on the one hand, and abandoned, declining regions, suffering from many types of socio-economic problems, on the other. The ST literature has opened a new discourse on green growth (Antal and Van Den Bergh, 2016). For other authors the explicit goal is degrowth (Kallis et al., 2018) and related approaches, e.g., responsible stagnation or a-growth (de Saille et al., 2020).

As for the types and sources of knowledge to be utilised, innovators – be they social, business, or hybrid innovators, or ‘change agents’ of sustainable transitions – can draw on their own ideas and knowledge, including tacit knowledge; codified knowledge stemming from the results of various types of R&D organisations; practical knowledge of other external actors; as well as various combinations of these sources.

When analysing GOTC processes, it is important to consider the specific objectives of diverse actors and at various levels of change, especially the potential tensions amongst them, as well as the different types and sources of knowledge (co-)produced, exploited, and diffused during these change processes.

5.2. Objects, types, and levels of change

As for the objects, types, and levels of change, a new, overarching taxonomy can be elaborated by drawing mainly on the concepts developed in the SI and ST strands (Section 3.2). The objects of change can be goods (products and services), social and business processes, methods and practices, organisational forms, institutions, and cognitive frames. As for the type of change it can be incremental or radical. Change can occur at the level of single goods, social and business methods and practices in niches; a technological system (a set of interrelated goods); a regime; or a techno-economic paradigm (i.e., an entire socio-economic system, with its underlying technologies, business models, cognitive frames, institutions, business and social networks).

These distinctions offer a comprehensive way to categorise and analyse innovations introduced during a GOTC process. These categories can contribute to identifying and assessing societal, economic, and environmental impacts as well.

5.3. Processes and mechanisms of change

To analyse change processes, we need to consider the actors engaged in different roles and capacities, the nature of processes, as well as the mechanisms that determine the nature of these processes.

The IS strand claims that while firms are in the driving seat of innovation processes, different types and pieces of knowledge are required for successful business innovations, possessed by different types of actors, and thus co-operation amongst these actors is a must. The main driver of business innovations is competition amongst firms, and thus market mechanisms play a decisive role. Yet non-market mechanisms must not be neglected either, especially when we want to understand knowledge creation processes and the diffusion and exploitation of knowledge. The main features of business innovation processes are i) a strong competitive pressure on the actors and ii) a productive tension between cooperation and competition amongst the actors. We should also keep in mind that the introduction of radical business innovations is a social process, *per se*, inside a firm, implying major organisational and procedural changes internally, as well as externally, amongst the users (in their social practices and social networks). Further, even a single radical business innovation can induce major changes inside a business sector, in other sectors, as well as in society. Changes are more fundamental and far-reaching when a new technological system or a new techno-economic paradigm is emerging.

In SI, the change process often seems initiated by civil society actors or ‘heroic’ social entrepreneurs, who then need to mobilise a network of local actors. These actors are highly perceptive of tensions and frictions in the system, have a strong view on the prevailing institutional setting and can identify or even create windows of opportunity and win-win situations for different types of stakeholders. In many cases there are tensions amongst the major players at the local level, especially when the SI initiative is not firmly embedded into the local social networks and/or strongly challenges the cognitive frames and power of influential local actors. These tensions may be caused more often by diverse views on possible solutions and their implementation rather than on the underlying objectives of an SI. Besides, there may be tensions between i) centrally set policy goals and tools vs local needs; ii) actors at different governance levels, as well as iii) micro- and macro-level institutions (considering both formal and informal ‘rules of the game’).

SI processes are driven by societal incentives for social innovators: they want to respond to societal needs. As business incentives do not play any role in pure SI, there is no competition amongst SI actors, and thus market mechanisms do not guide these change processes. Most SIs aim at diffusing a novel solution as widely as possible for the benefit of the social groups in need, not at excluding other SI actors from applying a new solution in their localities. While IPR and other methods are aimed at preventing the imitation of business innovations because easy, and thus fast and widespread imitation diminishes financial returns to the investments made by innovators, social innovators often encourage imitation (Windrum et al., 2016). However, as reputation plays a role for many social

innovators, reference to their solution is still of importance.

The *ST literature* considers a wide spectrum of impetus and mechanisms underpinning transition processes. They range from the entrepreneurship of inspired individuals via societal incentives to interactive learning in early phases of niche development. Resource-based considerations (Musiolik et al., 2012), experimentation, market formation, competition, along with collaboration and institutional change (van den Heiligenberg et al., 2017; Wicki and Hansen, 2017) also play a prominent role, as well as regulatory and demand-side forces in later phases of a transformative change. Besides collaboration, tensions arising from diverging directionalities, as well as inside and between networking organisations have been also analysed more recently (Heiberg and Truffer, 2022; Rohe and Chlebna, 2022). ST demonstrates the richness of mechanisms at play when moving from innovation to GOTC, though with an emphasis on a specific normative orientation towards sustainability.

In sum, the three strands provide complementary insights into processes and mechanisms that contribute to GOTC, and in particular the ambition to break existing path-dependences and create and stabilise new paths with their respective novel institutional and structural characteristics. IS stresses *competition* and the importance of the *diversity of knowledge* for innovation and transformative change; SI puts the emphasis on *societal needs* and the *diversity of actors and their objectives*; while ST highlights the *diversity of transformative mechanisms* leading from innovation to institutional and structural change. *For an integrative perspective, all these different ingredients are needed.*

Common to all three strands is the idea that *path-dependence* is a major force to slow down or block (transformative) change. The concept of path-dependence highlights the practical importance and repercussions of incremental changes along a given pathway that represents at the same time an approach, a framing, a regime, and a paradigm. Path-dependence implies contingent and non-reversible processes (David, 2007). It is tied to institutions, as pathways are associated with a set of established institutions in place. Most actors stick to established institutions by mainstreamed ways of framing and acting. IS, SI, and ST all argue for a need to overcome path-dependences, and hence for path-breaking and path-creating. The initial sparks that unleash processes of *path-breaking* and *path creation* are often systemic tensions resulting in major pressures, together with opportunities through new framings, technologies, and negotiation of win-win situations. Radical *business innovations*, for instance, are pathbreaking by definition and their diffusion creates new trajectories. The mode of organisation for this is the market. For *social innovations*, path-breaking institutional change is a fundamental aim (Nicholls and Ziegler, 2019; Terstriep et al., 2020; Ziegler et al., 2019). This is enacted by networks of actors where the combination of different approaches by these actors allows to develop new narratives of change and socially innovative concepts in ‘discursive resonance’ (Pel et al., 2020). The formation of networks is the dominant mode of organisation to achieve path-breaking institutional change. ST frames and facilitates path-breaking through multi-level governance processes that allow distributed learning and self-organisation processes along visions and missions, but without discarding the importance of market mechanisms and regulation for changing dominant regimes. The corresponding mode of organisation gives elements of soft governance a prominent role but suggests using this mode also for preparing harder governance instruments. *For an integrative perspective*, markets, networks, and hybrid governance (top-down and bottom-up; soft and hard) in combination are instrumental to affect transformative change, but their relative importance is likely to vary during the transformation process.

5.4. A set of criteria to assess change

Business innovations are driven by business logic, and thus outcomes and impacts are traditionally assessed by business considerations: whether productivity and efficiency are enhanced, and thus profits and shareholder value increased. More recently, though, aspects of corporate social responsibility, especially environmental impacts, are becoming important criteria when evaluating business innovations, investment opportunities, and performance, also under the umbrella of ESG (environmental, social, and governance). In some cases, however, these criteria are used in a tokenistic, superficial way.

Justice and equity, including global justice, are key issues for *social innovators*, as SIs are aimed at addressing unmet social needs, advancing social inclusion via fighting injustice and marginalisation. Bringing these social ambitions to the fore has been one of the most important contributions of SI research. These aspects now play a key role in the assessment of innovations and transformations. SIs are also inevitable to tackle environmental challenges, where justice should also be a major concern (Boelman and Heales, 2015). Lately, *just transition* has become an issue of growing interest in ST (Kanger et al., 2021), implying that ST is opening up its normative agenda and becoming more integrative.

From a new, *integrative perspective* we need to recognise that most change processes have major social impacts, whether intended or unintended, and thus these aspects should be considered when change processes are designed, implemented, and assessed. Nevertheless, it always depends on the *vested interests, power relations, values, and worldviews of major actors* which aspects are included in the set of criteria to assess the outcomes and impacts of transformative change processes. We should also keep in mind that the set of criteria to assess change is likely to be modified at least to some extent by the actors for various reasons – changes in the context, emergence of new technological opportunities, tensions during implementation, noticing unintended impacts – during the transformation process.

6. Conclusions

6.1. Three strands of literature: an assessment

We have reviewed the main conceptual frameworks of Innovation Studies (IS), Social Innovation (SI), and Sustainability Transitions (ST) research, with the intention to identify their main – similar and divergent – features in their approach to different types of

innovations and transformations. Our ambition has been to stress the need, and show the possibilities, for constructing an integrative perspective to better understand transformations as intentional change processes. We have distinguished different types of innovations by their principal purpose and discussed the typical main actors and their interactions; the objects, types, and levels of change; the sources and types of knowledge (co-)produced, utilised, and diffused during the change processes; and how success and impact are defined and measured in the three strands. We have also considered how diffusion and transformation mechanisms are understood.

For historical and sociological reasons these three strands have so far evolved in rather loose, sporadic interactions with each other, and thus possibilities for mutual learning have been seized to a limited extent only – despite their common fundamental intellectual quest to describe and understand intentional change processes. Our attempt to provide a structured characterisation and a ‘friendly critique’ of the three strands has yielded several lessons. While they each provide a perspective on goal-orientated transformation change processes (GOTC), these perspectives are partial. Further, each has its particular deficits.

Innovation studies still concentrates its analytical efforts first and foremost on business innovations, despite its ‘all-encompassing’ label. It is yet to be seen if efforts to open up and diversify can take root, strengthen and find a home in this paradigm. Compared to the other two strands, this paradigm would need to put more emphasis on considering a wider range of actors – investors, managers, researchers and engineers, users as co-producers of innovations, consumers, and policy-makers – and their respective cognitive frames as major drivers shaping innovation processes. As it is firmly rooted in business logic, the focus is on innovations as sources of commercial success. More recently, however, some studies consider the normative dimension, too: they recognise and assess – the often unintended – social and environmental impacts of business innovations, analyse their role in development and notice and critique ‘destructive creation’, beyond fanfaring ‘creative destruction’.

Social innovation research still lacks the level of conceptual sophistication that innovation studies and sustainability transitions research have achieved.⁸ It tends to downplay the role of science and technology as major drivers of social change, as well as that of top-down institutional changes in inducing innovation and transformation. Further, SI research does not distinguish different levels of change in a systematic, clear-cut way as the other two strands do. Measurement remains a largely unresolved task. This relative ‘underdevelopment’ is to a large extent due to intrinsic difficulties: the diversity, as well as the complex and complicated nature of SI processes and the social issues that SI initiatives attempt to tackle. We also need to realise – and accept – that not everything that is important can be measured, and not everything that can be measured is relevant.

Sustainability transitions research pursues a strongly normative agenda and tends to underrate the multitude of societal and business objectives that may guide and shape GOTC processes, as well as the transformative role of generic and disruptive technologies. This goes hand in hand with over-emphasising bottom-up learning processes and down-playing the influence of top-down impulses in triggering transformation processes. There is a greater variety of transformation strategies and pathways to be considered than those proposed by the ST literature.

These strengths and deficiencies strongly indicate that a meaningful combination of these three strands’ concepts and major achievements, as well as mutual learning amongst their scholars, is needed as a foundation for a deeper and more germane understanding of GOTC processes in economy and society. As a first attempt, we have offered four building blocks for a new, integrative conceptual framework to analyse GOTC processes. The first three highlight how social, business, hybrid, and ST innovations contribute in conjunction to GOTC and discuss the crucial properties of change to be considered: i) rationales, overarching goal, and specific objectives; ii) objects, types, and levels; as well as iii) processes and mechanisms of change. The fourth deliberates on the set of criteria to guide an ex ante evaluation, monitoring or ex post evaluation of these change processes.

6.1.1. Normative implications

A new, integrative approach is likely to facilitate a better understanding of normative issues and identification of further meaningful, desirable ambitions other than sustainability. Earlier the parlance used to be economically, socially, and environmentally sustainable development. Nowadays these ideas are enshrined in the UN’s the sustainable development goals (SDGs). This reframing suggests that we should not take ‘sustainability’ as given, as an ambition carved in stone. There may be possibilities to arrive at more meaningful normative ambitions, in particular in times when sustainability will certainly remain an important societal concern, but not the only vital one. We need transparent, more appropriate – and cost-efficient – approaches and methods for organising dialogues to discuss normative issues to arrive at a shared major overarching goal. Such dialogues can identify inevitable tensions amongst countries and social groups with different experience, worldviews, values, and ambitions. Participatory, systematic deliberations can assist the actors to arrive at shared visions and overarching goals, and then take orchestrated, effective actions.

6.1.2. Directions for future research

As a crucial step to construct an integrated theory, we also need to systematically analyse what models of innovation have been developed and exploited in the IS, SI, and ST literature. Drawing on evolutionary and complex systems models, a *problem to be tackled*, or a *new possibility/ solutions space* to be seized or created (Wanzenböck et al., 2020) would be the foundation stone of a future model of GOTC: what major issues are identified by the innovation actors and other stakeholders, using what fora, processes, and methods? Further modules of this theory would need to consider i) the *interactions amongst the actors* in their various activities: sensemaking;

⁸ It is also acknowledged by prominent SI scholars in a subtle way, in the meantime expressing an ambition to make SI a cornerstone of an “integrated theory of innovation”: “The development of a theoretically sound concept of social innovation is a precondition to elaborate an integrated theory of innovation and to direct empirical research to better understand the role of innovation in complex processes of social change and transformation.” (Howaldt and Schwartz, 2021: 53)

setting the overarching goal of transformative change; discussing and orchestrating specific objectives of business, social, and hybrid innovations; devising and introducing new solutions; learning, creating and disseminating new knowledge; assessing developments, revisiting – if necessary revising – the overarching goal of transformative change and the specific objectives of innovations; addressing the inevitable tensions amongst actors and between actors and other stakeholders; ii) the *interactions between the actors and the context* (the structure): the processes, mechanisms, and activities; iii) the *institutions* guiding and framing interactions amongst the actors, as well as between the actors and the context; as well as iv) *knowledge*: the available pool and the need to create new knowledge.⁹

The next step would be to compare the policy rationales – justifications for policy interventions – distilled from the various models of innovation applied in the three strands of literature. Together with a future theoretical model of GOTC, this would provide the basis to draw sound and comprehensive policy implications.

This more advanced version of an integrative analytical framework should then be ‘tested’ and refined by applying it to analyse real-life GOTC processes. That would be a demanding task not only in terms of time and resources, but also knowledge: it needs to be performed by a multi-disciplinary team to be comprehensive and thorough, and thus sound.

6.1.3. Tentative governance, policy, and practical implications

Our proposed integrative approach implies the strong need to i) orchestrate policy objectives and tools across policy domains, governance levels, and possibly jurisdictions, guided by the overarching goal of transformative change; ii) create space and mechanisms for policy experiments; iii) establish fora for normative dialogue amongst various types of innovators, policy-makers, and other stakeholders; and iv) develop the missing, but required capacities for transformative changes. Such a nuanced approach seems more appropriate for governing GOTC processes than pursuing a naïve belief in the ability to set clear goals, targets and timelines as suggested by some proponents of mission-orientated policies.

An integrative approach to GOTC can also underpin more effective strategies and activities for various types of actors (most notably businesses, social innovators, social entrepreneurs, NGOs, and citizens as individuals), as well as more effective public policies. The complementarities amongst the capabilities and their opportunities to act – e.g., when orchestrating changing technologies, infrastructures, social and business networks, cognitive frames, institutions, and social practices – need to be mobilised to set in motion GOTC processes. This is also why incumbent actors with their respective economic interests play a key role in transformation strategies: with their means they can foster change instead of using their power to prevent it. This insight has major *practical implications* for change agents who need to take into account several, if not all types of approaches currently treated in isolated ways in the three strands of literature in terms of theorising, policy-making, and acting.

CRediT authorship contribution statement

Attila Havas: Conceptualization, Methodology, Investigation, Visualization, Writing – original draft, Writing – review & editing. **Doris Schartinger:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. **K. Matthias Weber:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

Acknowledgements

We would like to thank the three anonymous reviewers, the editor, as well as Effie Amanatidou, Cristoph Brodnik, and Dimitrios Pontikakis for their constructive comments on previous versions of this article. Financial support from the National Research, Development, and Innovation Fund, Hungary (Grant no. 124858) is gratefully acknowledged. The funder has not been involved in study design; the collection, analysis, and interpretation of data; the writing of the article; or the decision to submit the article for publication.

References

Abernathy, W.J., Utterback, J.M., 1978. Patterns of industrial innovation. *Technol. Rev.* 80, 40–47.

⁹ We have made a first attempt to develop a graphic representation of this model, presented as a supplementary material to this article, available at <http://dx.doi.org/10.13140/RG.2.2.31144.55049>.

- Adamo, G., Willis, M., 2022. Technologically mediated practices in sustainability transitions: environmental monitoring and the ocean data buoy. *Technol. Forecast. Soc. Change.* 182, 121841. <https://doi.org/10.1016/j.techfore.2022.121841>.
- Aiginger, K., Bärenthaler-Sieber, S., Vogel, J., 2013. Competitiveness Under New Perspectives. WWWforEurope Working Papers no. 44. <https://www.econstor.eu/handle/10419/125699>.
- Alkemade, F., Suurs, R.A.A., 2012. Patterns of expectations for emerging sustainable technologies. *Technol. Forecast. Soc. Change.* 79 (3), 448–456. <https://doi.org/10.1016/j.techfore.2011.08.014>.
- Andersen, A.D., 2014. No transition without transmission: HVDC electricity infrastructure as an enabler for renewable energy? *Environ. Innov. Soc. Transit.* 13, 75–95. <https://doi.org/10.1016/j.eist.2014.09.004>.
- Andersen, A.D., Gulbrandsen, M., 2020. The innovation and industry dynamics of technology phase-out in sustainability transitions: insights from diversifying petroleum technology suppliers in Norway. *Energy Res. Soc. Sci.* 64, 101447. <https://doi.org/10.1016/j.erss.2020.101447>.
- Andersen, A.D., Markard, J., 2020. Multi-technology interaction in socio-technical transitions: how recent dynamics in HVDC technology can inform transition theories. *Technol. Forecast. Soc. Change* 151, 119802. <https://doi.org/10.1016/j.techfore.2019.119802>.
- 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. Transit.* 34, 348–351. <https://doi.org/10.1016/j.eist.2019.11.009>.
- Anderson, P.W., Arrow, K.J., Pines, D. (Eds.), 1988. *The Economy As an Evolving Complex System*. CRC Press, Boca Raton.
- Andries, P., Daou, A., Verheyden, L., 2019. Innovation as a vehicle for improving socially vulnerable groups' access to basic provisions: a research note on the development of a questionnaire module. *Res. Policy* 48 (1), 281–288. <https://doi.org/10.1016/j.respol.2018.08.017>.
- Antal, M., Van Den Bergh, J.C.J.M., 2016. Green growth and climate change: conceptual and empirical considerations. *Clim. Policy.* 16 (2), 165–177. <https://doi.org/10.1080/14693062.2014.992003>.
- Arthur, B., 1988. Competing Technologies: An Overview, in: Dosi et al. (eds), pp. 590–607.
- Audretsch, D.B., Belitski, M., Caiazza, R., Günther, C., Menter, M., 2022. From latent to emergent entrepreneurship: the importance of context. *Technol. Forecast. Soc. Change.* 175, 121356. <https://doi.org/10.1016/j.techfore.2021.121356>.
- Augenstein, K., 2015. Analysing the potential for sustainable e-mobility – the case of Germany. *Environ. Innov. Soc. Transit.* 14, 101–115. <https://doi.org/10.1016/j.eist.2014.05.002>.
- Avelino et al., this issue 2023.
- Avelino, F., Wittmayer, J.M., Pel, B., Weaver, P., Dumitru, A., Haxeltine, A., Kemp, R., Jørgensen, M.S., Bauler, T., Ruijsink, S., 2019. Transformative social innovation and (dis)empowerment. *Technol. Forecast. Soc. Change.* 145, 195–206. <https://doi.org/10.1016/j.techfore.2017.05.002>.
- Barr, S., 2015. Beyond behaviour change: social practice theory and the search for sustainable mobility. In: Kennedy, E.H., Cohen, M.J., Krogman, N. (Eds.), *Putting Sustainability into Practice*. Edward Elgar, Cheltenham, pp. 91–108. <https://doi.org/10.4337/9781784710606.00015>.
- Beise, M., 2001. *Lead markets: Country-specific success factors of the global diffusion of innovations*. Springer Science & Business Media, Physica, Heidelberg.
- Benneworth, P., Cunha, J., 2015. Universities' contributions to social innovation: reflections in theory & practice. *Eur. J. Innov. Manag.* 18 (4), 508–527. <https://doi.org/10.1108/EJIM-10-2013-0099>.
- Bergek, A., 2019. Technological innovation systems: a review of recent findings and suggestions for future research. In: Boons, F., McMeekin, A. (Eds.), *Handbook of Sustainable Innovation*. Edward Elgar, Cheltenham, pp. 200–218.
- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., Rickne, A., 2008a. Analyzing the functional dynamics of technological innovation systems: a scheme of analysis. *Res. Policy.* 37 (3), 407–429. <https://doi.org/10.1016/j.respol.2007.12.003>.
- Bergek, A., Jacobsson, S., Sandén, B.A., 2008b. 'Legitimation' and 'development of positive externalities': two key processes in the formation phase of technological innovation systems. *Technol. Anal. Strateg. Manag.* 20, 575–592. <https://doi.org/10.1080/09537320802292768>.
- Berkhout, F., Smith, A., Stirling, A., 2004. Socio-technological regimes and transition contexts. In: Elzen, B., Geels, F.W., Green, K. (Eds.), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy*. Edward Elgar, Cheltenham, pp. 48–75.
- Boelman, V., Heales, C. (Eds.), 2015. *Social Innovation Strategies – Regional Report*. SI-DRIVE Research Paper, TU Dortmund. <https://si-drive.eu/wp-content/uploads/2018/03/D3.6-SI-DRIVE-Global-Region-Report-2015.pdf>.
- Brem, A., Maier, M., Wimschneider, C., 2016. Competitive advantage through innovation: the case of Nespresso. *E. J. Innov. Manag.* 19, 133–148. <https://doi.org/10.1108/EJIM-05-2014-0055>.
- Bresnahan, T., 2012. *Recombination, Generality, and Re-Use: The Rate and Direction of Inventive Activity Revisited*. Univ. Chic. Press, Chicago.
- Bulakovskiy, M., 2021. Building Local Ecosystems for Social Innovation: A Methodological Framework. <https://doi.org/10.1787/bef867cd-en>.
- Cajaiba-Santana, G., 2014. Social innovation: moving the field forward. A conceptual framework. *Technol. Forecast. Soc. Change.* 82, 42–51. <https://doi.org/10.1016/j.techfore.2013.05.008>.
- Caraça, J., Lundvall, B.-Å., Mendonça, S., 2009. The changing role of science in the innovation process: from Queen to Cinderella? *Technol. Forecast. Soc. Change.* 76 (6), 861–867. <https://doi.org/10.1016/j.techfore.2008.08.003>.
- Carlsson, B. (Ed.), 1997. *Technological Systems and Industrial Dynamics*. Kluwer Academic Publishers, Dordrecht.
- Carlsson, B., Stankiewicz, R., 1991. On the nature, function and composition of technological systems. *J. Evol. Econ.* 1, 93–118. <https://doi.org/10.1007/BF01224915>.
- Castelo, A.F.M., Schäfer, M., Silva, M.E., 2021. Food practices as part of daily routines: a conceptual framework for analysing networks of practices. *Appetite.* 157, 104978. <https://doi.org/10.1016/j.appet.2020.104978>.
- Ceschin, F., 2013. Critical factors for implementing and diffusing sustainable product-service systems: insights from innovation studies and companies' experiences. *J. Clean. Prod.* 45, 74–88. <https://doi.org/10.1016/j.jclepro.2012.05.034>.
- Chesbrough, H.W., 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press, Boston.
- Clarysse, B., Wright, M., Bruneel, J., Mahajan, A., 2014. Creating value in ecosystems: crossing the chasm between knowledge and business ecosystems. *Res. Policy.* 43 (7), 1164–1176. <https://doi.org/10.1016/j.respol.2014.04.014>.
- Constantinides, P., Henfridsson, O., Parker, G.G., 2018. Introduction—platforms and infrastructures in the digital age. *Inf. Syst. Res.* 29 (2), iii–vi. <https://doi.org/10.1287/isre.2018.0794>.
- Cuerva, M.C., Triguero-Cano, Á., Córcoles, D., 2014. Drivers of green and non-green innovation: empirical evidence in Low-Tech SMEs. *J. Clean. Prod.* 68, 104–113. <https://doi.org/10.1016/j.jclepro.2013.10.049>.
- Cunha, J., Benneworth, P., 2013. Universities' contributions to social innovation: towards a theoretical framework, paper presented at Cities as seedbeds for innovation. In: Annual Conference of the European Urban Research Association (EURA), Enschede, 3–6 July 2013.
- Daimler, S., Hufnagel, M., Warnke, P., 2012. Challenge-oriented policy making and innovation systems theory: reconsidering systemic instruments. In: Fraunhofer, ISI (Ed.), *Innovation System Revisited: Experiences from 40 Years of Fraunhofer ISI Research*. Fraunhofer.
- David, P.A., 2007. Path dependence: a foundational concept for historical social science. *Clometrica.* 1 (2), 91–114. <https://doi.org/10.1007/s11698-006-0005-x>.
- Davies, A., Simon, J., 2013. How to grow social innovation: a review and critique of scaling and diffusion for understanding the growth of social innovation. In: 5th International Social Innovation Research Conference, 2–4 September 2013, Oxford. <https://www.youngfoundation.org/our-work/publications/how-to-grow-social-innovation/>.
- de Jesus, A., Lammi, M., Domenech, T., Vanhuysse, F., Mendonça, S., 2021. Eco-innovation diversity in a circular economy: towards circular innovation studies. *Sustainability* 13 (19), 10974. <https://doi.org/10.3390/su131910974>.
- de Jesus, A., Mendonça, S., 2018. Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecol. Econ.* 145, 75–89. <https://doi.org/10.1016/j.ecolecon.2017.08.001>.
- de Saille, S., Medvecky, F., van Oudheusden, M., Albertson, K., Amanatidou, E., Birabi, T., Pansera, M., 2020. *Responsibility Beyond Growth: A Case For Responsible Stagnation*. Bristol University Press, Bristol.

- de Vasconcelos Gomes, L.A., Figueiredo Facin, L., Salerno, M.S., Kazuo Ikenami, R., 2018. Unpacking the innovation ecosystem construct: evolution, gaps and trends. *Technol. Forecast. Soc. Change*. 136, 30–48. <https://doi.org/10.1016/j.techfore.2016.11.009>.
- Dewald, U., Fromhold-Eisebith, M., 2015. Trajectories of sustainability transitions in scale-transcending innovation systems the case of photovoltaics. *Environ. Innov. Soc. Transit.* 17, 110–125. <https://doi.org/10.1016/j.eist.2014.12.004>.
- Dijk, M., Orsato, J.R., Kemp, R., 2015. Towards a regime-based typology of market evolution. *Technol. Forecast. Soc. Change*. 92, 276–289. <https://doi.org/10.1016/j.techfore.2014.10.002>.
- Dodgson, M., Gann, D.M., Phillips, N. (Eds.), 2014. *The Oxford Handbook of Innovation Management*. Oxford University Press, Oxford.
- Dosi, G., 1982. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. *Res. Policy*. 11 (3), 147–162. [https://doi.org/10.1016/0048-7333\(82\)90016-6](https://doi.org/10.1016/0048-7333(82)90016-6).
- Dosi, G., Nelson, R.R., 2010. Technical Change and Industrial Dynamics as Evolutionary Processes. In: Hall, B.W., Rosenberg, N. (Eds.), pp. 51–127. [10.1016/S0169-7218\(10\)01003-8](https://doi.org/10.1016/S0169-7218(10)01003-8).
- Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G., Soete, L. (Eds.), 1988. *Technical Change and Economic Theory*. Pinter, London.
- Drucker, P.F., 1957. *Landmarks of Tomorrow: A report On the New "Post-Modern" World*. Harper and Brothers, New York.
- Edwards-Schachter, M., Matti, C.E., Alcántara, E., 2012. Fostering quality of life through social innovation: a living lab methodology study case. *Rev. Policy Res.* 29 (6), 672–692. <https://doi.org/10.1111/j.1541-1338.2012.00588.x>.
- Edwards-Schachter, M., Wallace, M.L., 2017. 'Shaken, but not stirred': sixty years of defining social innovation. *Technol. Forecast. Soc. Change*. 119, 64–79. <https://doi.org/10.1016/j.techfore.2017.03.012>.
- Fagerberg, J., 1996. Technology and competitiveness. *Oxford Rev. Econ. Policy*. 12 (3), 39–51. <https://doi.org/10.1093/oxrep/12.3.39>.
- Fagerberg, J., Fosaas, M., Sappasert, K., 2012a. Innovation: exploring the knowledge base. *Res. Policy*. 41 (7), 1132–1153. <https://doi.org/10.1016/j.respol.2012.03.008>.
- Fagerberg, J., Landström, H., Martin, B.R., 2012b. Exploring the emerging knowledge base of 'The Knowledge Society'. *Res. Policy*. 41 (7), 1121–1282. <https://doi.org/10.1016/j.respol.2012.03.007>.
- Fagerberg, J., Mowery, D.C., Nelson, R.R. (Eds.), 2005. *The Oxford Handbook of Innovation*. Oxford University Press, Oxford.
- Foster, J., Pyka, A., 2014. Introduction: co-evolution and complex adaptive systems in evolutionary economics. *J. Evol. Econom.* 24, 205–207. <https://doi.org/10.1007/s00191-014-0339-7>.
- Foster, R.N., 1986. Working the S-curve: assessing technological threats. *Res. Manag.* 29, 17–20. <https://doi.org/10.1080/00345334.1986.11756976>.
- Freeman, C., 1991. Networks of innovators: a synthesis of research issues. *Res. Policy*. 20 (5), 499–514. [https://doi.org/10.1016/0048-7333\(91\)90072-X](https://doi.org/10.1016/0048-7333(91)90072-X).
- Freeman, C., Perez, C., 1988. Structural crises of adjustment, business cycles and investment behaviour. In: Dosi, G. et al. (Eds.), pp. 38–66.
- Fünfschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes—conceptual foundations from institutional theory. *Res. Policy*. 43 (4), 772–791. <https://doi.org/10.1016/j.respol.2013.10.010>.
- Galeano Galvan, M.G., Cuppen, E., Taanman, M., 2020. Exploring incumbents' agency: institutional work by grid operators in decentralized energy innovations. *Environ. Innov. Soc. Transit.* 37, 79–92. <https://doi.org/10.1016/j.eist.2020.07.008>.
- Garud, R., Karnøe, P., 2003. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. *Res. Policy*. 32 (2), 277–300. [https://doi.org/10.1016/S0048-7333\(02\)00100-2](https://doi.org/10.1016/S0048-7333(02)00100-2).
- Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Res. Policy*. 31 (8–9), 1257–1274. [https://doi.org/10.1016/S0048-7333\(02\)00062-8](https://doi.org/10.1016/S0048-7333(02)00062-8).
- Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems – Insights about dynamics and change from sociology and institutional theory. *Res. Policy*. 33 (6–7), 897–920. <https://doi.org/10.1016/j.respol.2004.01.015>.
- Geels, F.W., 2011. The multi-level perspective on sustainability transitions: responses to seven criticisms. *Environ. Innov. Soc. Transit.* 1 (1), 24–40. <https://doi.org/10.1016/j.eist.2011.02.002>.
- Geels, F.W., 2012. A socio-technical analysis of low-carbon transitions: introducing the multi-level perspective into transport studies. *J. Transp. Geogr.* 24, 471–482. <https://doi.org/10.1016/j.jtrangeo.2012.01.021>.
- Geels, F.W., Schot, J., 2007. Typology of sociotechnical transition pathways. *Res. Policy*. 36 (3), 399–417. <https://doi.org/10.1016/j.respol.2007.01.003>.
- Geels, F.W., Schot, J., 2010. The dynamics of socio-technical transitions: a socio-technical perspective. In: Grin, J., Rotmans, J., Schot, J. (Eds.), *Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*. Routledge, London, pp. 10–103.
- Geroski, P.A., 2000. Models of technology diffusion. *Res. Policy*. 29 (4–5), 603–625. [https://doi.org/10.1016/S0048-7333\(99\)00092-X](https://doi.org/10.1016/S0048-7333(99)00092-X).
- Ghosh, B., Kivimaa, P., Ramirez, M., Schot, J., 2021. Transformative outcomes: assessing and reorienting experimentation with transformative innovation policy. *Sci. Public Policy*. 48 (5), 739–756. <https://doi.org/10.1093/scipol/scab045>.
- Godin, B., 2012. *Social Innovation: Utopias of Innovation from c.1830 to the Present*. Project on the Intellectual History of Innovation. Working Paper No. 11. Montreal.
- Godin, B., 2015. *Innovation Contested: The Idea of Innovation Over the Centuries*. Routledge, London.
- Göransson, B., Donati, L., Wigren-Kristoferson, C., 2021. Introduction to the special issue on universities and social innovation. *Technol. Forecast. Soc. Change*. 173, 121186. <https://doi.org/10.1016/j.techfore.2021.121186>.
- Grin, J., Rotmans, J., Schot, J., 2011. On patterns and agency in transition dynamics: some key insights from the KSI programme. *Environ. Innov. Soc. Transit.* 1 (1), 76–81. <https://doi.org/10.1016/j.eist.2011.04.008>.
- Hall, B.H., Rosenberg, N. (Eds.), 2010. *Economics of Innovation*. Amsterdam, North-Holland.
- Havas, A., 2015. Types of knowledge and diversity of business-academia collaborations: implications for measurement and policy. *Triple Helix*. 2 (1), Paper 12. <https://doi.org/10.1186/s40604-015-0023-4>.
- Havas, A., 2016a. Recent Economic Theorising On innovation: Lessons for Analysing Social Innovation. University of Oxford, Oxford. <https://doi.org/10.2139/ssrn.2938513>. CRESSI Working papers No. 27/2016.
- Havas, A., 2016b. Social and business innovations: are common measurement approaches possible? *Foresight and STI Gov.* 10 (2), 58–80. <https://doi.org/10.17323/1995-459X.2016.2.58.80>.
- Havas, A., Molnár, Gy., 2020. A Multi-Channel Interactive Learning Model of Social Innovation. CERS-IE Working Papers 2020/24. <https://ssrn.com/abstract=3621381>.
- Haxeltine, A., Pel, B., Wittmayer, J., Dumitru, A., Kemp, R., Avelino, F., 2017. Building a middle-range theory of Transformative Social Innovation; theoretical pitfalls and methodological responses. *Eur. Public Soc. Innov. Rev.* 2, 59–77. <https://doi.org/10.31637/epsir.17-1.5>.
- Heiberg, J., Truffer, B., 2022. Overcoming the harmony fallacy: how values shape the course of innovation systems. *Environ. Innov. Soc. Transit.* 42, 411–428. <https://doi.org/10.1016/j.eist.2022.01.012>.
- Hein, A., Schrieck, M., Riasanow, T., Setzke, D.S., Wiesche, M., Böhm, M., Krcmar, H., 2020. Digital platform ecosystems. *Electron. Mark.* 30, 87–98. <https://doi.org/10.1007/s12525-019-00377-4>.
- Heiskala, R., 2007. Social innovations: structural and power perspectives. In: Hääläinen, T.J., Heiskala, R. (Eds.), *Social Innovations, Institutional Change and Economic Performance*. Edward Elgar, Cheltenham, pp. 52–79.
- Hekkert, M., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M., 2007. Functions of innovation systems: a new approach for analysing technological change. *Technol. Forecast. Soc. Change*. 74 (4), 413–432. <https://doi.org/10.1016/j.techfore.2006.03.002>.
- Hekkert, M., Janssen, M.J., Wesseling, J.H., Negro, S.O., 2020. Mission-oriented innovation systems. *Environ. Innov. Soc. Transit.* 34, 76–79. <https://doi.org/10.1016/j.eist.2019.11.011>.
- Henderson, R.M., Clark, K.B., 1990. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. *Adm. Sci. Q.* 35 (1), 9–30. <https://doi.org/10.2307/2393549>.

- Hodgson, G.M., 2008. An Institutional and Evolutionary Perspective on Health Economics. *Cambridge J. Econ.* 32 (2), 235–256. <https://doi.org/10.1093/cje/bem033>.
- Hojckova, K., Ahlberg, H., Morrison, G.M., Sandén, B., 2020. Entrepreneurial use of context for technological system creation and expansion: the case of blockchain-based peer-to-peer electricity trading. *Res. Policy*. 49 (8), 104046 <https://doi.org/10.1016/j.respol.2020.104046>.
- Hölscher, K., Wittmayer, J.M., Loorbach, D., 2018. Transition versus Transformation: what's the difference? *Environ. Innov. Soc. Transit.* 27, 1–3. <https://doi.org/10.1016/j.eist.2017.10.007>.
- Holtz, G., Alkemade, F., de Haan, F., Köhler, J., Trutnevte, E., Luthe, T., Halbe, J., Papachristos, G., Chappin, E., Kwakkel, J., Ruutu, S., 2015. Prospects of modelling societal transitions: position paper of an emerging community. *Environ. Innov. Soc. Transit.* 17, 41–58. <https://doi.org/10.1016/j.eist.2015.05.006>.
- Hoogstraaten, M.J., Frenken, K., Boon, W.P., 2020. The study of institutional entrepreneurship and its implications for transition studies. *Environ. Innov. Soc. Transit.* 36, 114–136. <https://doi.org/10.1016/j.eist.2020.05.004>.
- Howaldt, J., Butzin, A., Domanski, D., Kaletka, C., 2014. Theoretical Approaches to Social Innovation – A Critical Literature Review. SI-DRIVE Research Paper. TU Dortmund. https://si-drive.eu/wp-content/uploads/2014/11/D1_1-Critical-Literature-Review_final.pdf.
- Howaldt, J., Kaletka, C., Schröder, A., 2017a. Social Entrepreneurs: important Actors within an Ecosystem of Social Innovation. *Eur. Public Soc. Innov. Rev.* 1 (2) <https://doi.org/10.31637/epsir.16-2.4>.
- Howaldt, J., Kopp, R., Schwarz, M., 2015. Social innovations as drivers of social change—exploring Tarde's contribution to social innovation theory building. In: Nicholls, A., Simon, J., Gabriel, M. (Eds.), *New Frontiers in Social Innovation Research*. Palgrave Macmillan, London, pp. 29–51. https://doi.org/10.1057/9781137506801_2.
- Howaldt, J., Schröder, A., Butzin, A., Rehfeld, D. (Eds.), 2017b. Final Report of the SI-DRIVE Project. <https://www.si-drive.eu/final-report-of-the-si-drive-project-published/>.
- Howaldt, J., Schwartz, M., 2021. Social innovation and social change. In: Howaldt, J., Kaletka, C., Schröder, A. (Eds.), *A Research Agenda For Social Innovation*. Edward Elgar, Cheltenham, pp. 39–57. <https://doi.org/10.4337/9781789909357.00010>.
- Ibrahim, S., 2017. How to build collective capabilities: the 3C-model for grassroots-led development. *J. Hum. Develop. Capabil.* 18 (2), 197–222. <https://doi.org/10.1080/19452829.2016.1270918>.
- Jacobsson, S., Johnson, A., 2000. The diffusion of renewable energy technology: an analytical framework and key issues for research. *Energy Policy*. 28, 625–640. [https://doi.org/10.1016/S0301-4215\(00\)00041-0](https://doi.org/10.1016/S0301-4215(00)00041-0).
- Janssen, M., Wesseling, J., Torrens, J., Weber, K.M., Penna, C., Klerkx, L., 2023. Missions as boundary objects for transformative change: understanding coordination across policy, research and stakeholder communities. *Sci. Public Policy*. 50 (3), 398–415. <https://doi.org/10.1093/scipol/scac080>.
- Jensen, M.B., Johnson, B., Lorenz, E., Lundvall, B.-Å., 2007. Forms of knowledge and modes of innovation. *Res. Policy*. 36 (5), 680–693. <https://doi.org/10.1016/j.respol.2007.01.006>.
- Jørgensen, U., 2012. Mapping and navigating transitions—the multi-level perspective compared with arenas of development. *Res. Policy*. 41 (6), 996–1010.
- Kallis, G., Kostakis, V., Lange, S., Muraca, B., Paulson, S., Schmelzer, M., 2018. Research on degrowth. *Annu. Rev. Environ. Resour.* 43, 291–316. <https://doi.org/10.1146/annurev-environ-102017-025941>.
- Kanda, W., del Río, P., Hjeltn, O., Bienkowska, D., 2019. A technological innovation systems approach to analyse the roles of intermediaries in eco-innovation. *J. Clean. Prod.* 227, 1136–1148. <https://doi.org/10.1016/j.jclepro.2019.04.230>.
- Kanda, W., Kuisma, M., Kivimaa, P., Hjeltn, O., 2020. Conceptualising the systemic activities of intermediaries in sustainability transitions. *Environ. Innov. Soc. Transit.* 36, 449–465. <https://doi.org/10.1016/j.eist.2020.01.002>.
- Kanger, L., Schot, J., 2019. Deep transitions: theorizing the long-term patterns of socio-technical change. *Environ. Innov. Soc. Transit.* 32, 7–21. <https://doi.org/10.1016/j.eist.2018.07.006>.
- Kanger, L., Schot, J., Sovacool, B.K., van der Vleuten, E., Ghosh, B., Keller, M., Kivimaa, P., Pahker, A.K., Steinmueller, W.E., 2021. Research frontiers for multi-system dynamics and deep transitions. *Environ. Innov. Soc. Transit.* 41, 52–56. <https://doi.org/10.1016/j.eist.2021.10.025>.
- Katz, M.L., Shapiro, C., 1986. Technology adoption in the presence of network externalities. *J. Polit. Econ.* 94, 822–841. <http://www.jstor.org/stable/1833204>.
- Kern, F., 2015. Engaging with the politics, agency and structures in the technological innovation systems approach. *Environ. Innov. Soc. Transit.* 16, 67–69. <https://doi.org/10.1016/j.eist.2015.07.001>.
- Kern, F., Rogge, K., 2018. Harnessing theories of the policy process for analysing the politics of sustainability transitions: a critical survey. *Environ. Innov. Soc. Transit.* 27, 102–117. <https://doi.org/10.1016/j.eist.2017.11.001>.
- Kivimaa, P., 2014. Government-affiliated intermediary organisations as actors in system-level transitions. *Res. Policy*. 43 (8), 1370–1380. <https://doi.org/10.1016/j.respol.2014.02.007>.
- Kivimaa, P., Kern, F., 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Res. Policy*. 45 (1), 205–217. <https://doi.org/10.1016/j.respol.2015.09.008>.
- Kivimaa, P., Boon, W., Hyysalo, S., Klerkx, L., 2019. Towards a typology of intermediaries in sustainability transitions: a systematic review and a research agenda. *Res. Policy*. 48 (4), 1062–1075. <https://doi.org/10.1016/j.respol.2018.10.006>.
- 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., Rohrer, 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. Transit.* 31, 1–32. <https://doi.org/10.1016/j.eist.2019.01.004>.
- Köhler, J., Raven, R., Walrave, B., 2020. Advancing the analysis of technological innovation systems dynamics: introduction to the special issue. *Technol. Forecast. Soc. Change*. 158, 120040 <https://doi.org/10.1016/j.techfore.2020.120040>.
- Koretsky, Z., van Lente, H., 2020. Technology phase-out as unravelling of socio-technical configurations: cloud seeding case. *Environ. Innov. Soc. Transit.* 37, 302–317. <https://doi.org/10.1016/j.eist.2020.10.002>.
- Krlev, G., Terstriep, J., 2022. Pinning it down? Measuring innovation for sustainability transitions. *Environ. Innov. Soc. Transit.* 45, 270–288. <https://doi.org/10.1016/j.eist.2022.11.005>.
- Krohn, W., 2005. Einleitung. In: Groß, M., Hoffmann-Riem, H., Krohn, W. (Eds.), *Realexperimente. Ökologische Gestaltungsprozesse in Der Wissensgesellschaft*. transcript, Bielefeld, pp. 11–26.
- Krugman, P.R., 1994. Competitiveness: a dangerous obsession. *Foreign Aff.* 73 (2), 28–44. <https://doi.org/10.2307/20045917>.
- Krugman, P.R., 1996. Making sense of the competitiveness debate. *Oxford Rev. Econ. Policy*. 12 (3), 17–25. <https://doi.org/10.1093/oxrep/12.3.17>.
- Kuckertz, A., Berger, E.S.C., Brändle, L., 2020. Entrepreneurship and the sustainable bioeconomy transformation. *Environ. Innov. Soc. Transit.* 37, 332–344. <https://doi.org/10.1016/j.eist.2020.10.003>.
- Labanca, N., Pereira, Á.G., Watson, M., Krieger, K., Padovan, D., Watts, L., Moezzi, M., Wallenborn, G., Wright, R., Laes, E., Fath, B.D., Ruzzenenti, F., De Moor, T., Bauwens, T., Mehta, L., 2020. Transforming innovation for decarbonisation? Insights from combining complex systems and social practice perspectives. *Energy Res. Soc. Sci.* 65, 101452 <https://doi.org/10.1016/j.erss.2020.101452>.
- Lane, D., van der Leeuw, S., Pumain, D., West, G. (Eds.), 2009. *Complexity Perspectives in Innovation and Social Change*. Springer, Berlin.
- Lawrence, T.B., Dover, G., Gallagher, B., 2014. Managing Social Innovation. In: Dodgson, M., Gann, D.M., Phillips, N. (Eds.), pp. 316–334.
- Lipsey, R.G., Carlaw, K.I., Bekar, C.T., 2005. *Economic transformations: General Purpose Technologies and Long-Term Economic Growth*. Oxford University Press, Oxford.
- Long, T.B., Blok, V., Coninx, I., 2019. The diffusion of climate-smart agricultural innovations: systems level factors that inhibit sustainable entrepreneurial action. *J. Clean. Prod.* 232, 993–1004. <https://doi.org/10.1016/j.jclepro.2019.05.212>.
- Loorbach, D., Frantzeskaki, N., Avelino, F., 2017. Sustainability transitions research: transforming science and practice for societal change. *Annu. Rev. Environ. Resour.* 42, 599–626. <https://doi.org/10.1146/annurev-environ-102014-021340>.

- Loorbach, D., Wittmayer, J., Avelino, F., von Wirth, T., Frantzeskaki, N., 2020. Transformative innovation and translocal diffusion. *Environ. Innov. Soc. Transit.* 35, 251–260. <https://doi.org/10.1016/j.eist.2020.01.009>.
- Lundvall, B.-Å., 1988. Innovation as an Interactive Process: From User-Producer Interaction to the National System of Innovation. In: Dosi, G., Freeman, C., Nelson, R. R., Silverberg, G., Soete, L. (Eds.), pp. 349–369.
- Lundvall, B.-Å., 2007. Innovation System Research and Policy: Where it Came from and Where it Might Go. *GLOBELICS Working Paper Series*, No. 2007-01.
- Magnani, N., Osti, G., 2016. Does civil society matter? Challenges and strategies of grassroots initiatives in Italy's energy transition. *Energy Res. Soc. Sci.* 13, 148–157. <https://doi.org/10.1016/j.erss.2015.12.012>.
- Magnusson, T., Berggren, C., 2018. Competing innovation systems and the need for redeployment in sustainability transitions. *Technol. Forecast. Soc. Change.* 126, 217–230. <https://doi.org/10.1016/j.techfore.2017.08.014>.
- Manjon, M.-J., Merino, A., Cairns, I., 2022. Business as not usual: a systematic literature review of social entrepreneurship, social innovation, and energy poverty to accelerate the just energy transition. *Energy Res. Soc. Sci.* 90, 102624 <https://doi.org/10.1016/j.erss.2022.102624>.
- Markard, J., 2020. The life cycle of technological innovation systems. *Technol. Forecast. Soc. Change.* 153, 119407 <https://doi.org/10.1016/j.techfore.2018.07.045>.
- Markard, J., Hekkert, M., Jacobsson, S., 2015. The technological innovation systems framework: response to six criticisms. *Environ. Innov. Soc. Transit.* 16, 76–86. <https://doi.org/10.1016/j.eist.2015.07.006>.
- Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. *Res. Policy.* 41 (6), 955–967. <https://doi.org/10.1016/j.respol.2012.02.013>.
- Markard, J., Wirth, S., Truffer, B., 2016. Institutional dynamics and technology legitimacy – a framework and a case study on biogas technology. *Res. Policy.* 45 (1), 330344 <https://doi.org/10.1016/j.respol.2015.10.009>.
- Martin, C.J., Upham, P., 2016. Grassroots social innovation and the mobilisation of values in collaborative consumption: a conceptual model. *J. Clean. Prod.* 134, 204–213. <https://doi.org/10.1016/j.jclepro.2015.04.062>.
- Meadowcroft, J., 2009. What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy Sci.* 42, 323–340. <https://doi.org/10.1007/s11077-009-9097-z>.
- Meyer-Krahmer, F., Reger, G., 1999. New perspectives on the innovation strategies of multinational enterprises: lessons for technology policy in Europe. *Res. Policy.* 28 (7), 751–776. [https://doi.org/10.1016/S0048-7333\(99\)00019-0](https://doi.org/10.1016/S0048-7333(99)00019-0).
- Mihci, H., 2020. Is measuring social innovation a mission impossible? *Innovation: The European J. Soc. Science Res.* 33 (3), 337–367. <https://doi.org/10.1080/13511610.2019.1705149>.
- Mirzadeh Phirouzabadi, A., Juniper, J., Savage, D., Blackmore, K., 2020. Supportive or inhibitive? — Analysis of dynamic interactions between the inter-organisational collaborations of vehicle powertrains. *J. Clean. Prod.* 244, 118790 <https://doi.org/10.1016/j.jclepro.2019.118790>.
- Molnár, Gy., Havas, A., 2019. Trajectories of social innovation: tackling marginalization with a complex approach. In: Nicholls, A., Ziegler, R. (Eds.), *Creating Economic Space For Social Innovation*. Oxford University Press, Oxford, pp. 175–207. <https://doi.org/10.1093/2Foso/2F9780198830511.003.0007>.
- Moore, G.A., 2002. *Living On the Fault Line: Managing for Shareholder Value in Any Economy*. HarperBusiness, New York.
- Moore, M.-L., Riddell, D., Vocisano, D., 2015. Scaling out, scaling up, scaling deep: strategies of non-profits in advancing systemic social innovation. *J. Corp. Citizsh.* 58, 67–84. <https://doi.org/10.9774/GLEAF.4700.2015.ju.00009>.
- Moulaert, F., MacCallum, D., Hillier, J., 2013. Social innovation: intuition, precept, concept, theory and practice. In: Moulaert, F., MacCallum, D., Mehmood, A., Hamdouch, A. (Eds.), *The International Handbook On Social Innovation: Collective Action, Social Learning and Transdisciplinary Research*. Edward Elgar, Cheltenham, pp. 13–24.
- Mulgan, G., 2006. The process of social innovation. *Innov. Technol. Gov. Glob.* 1 (2), 145–162. <https://doi.org/10.1162/itgg.2006.1.2.145>.
- Mulgan, G., Ali, R., Halkett, R., Sanders, B., 2007. In and Out of Sync: the Challenge of Growing Social Innovations. <https://youngfoundation.org/wp-content/uploads/2013/03/In-and-out-of-sync-the-challenge-of-growing-social-innovations-Sept-2007.pdf>.
- Musioli, J., Markard, J., Hekkert, M., 2012. Networks and network resources in technological innovation systems: towards a conceptual framework for system building. *Technol. Forecast. Soc. Change.* 79, 1032–1048. <https://doi.org/10.1016/j.techfore.2012.01.003>.
- Nelson, R.R., Winter, S.G., 1982. *An Evolutionary Theory of Economic Change*. Harvard University Press, Cambridge, MA.
- Nicholls, A., Simon, J., Gabriel, M., 2015. Introduction: Dimensions of Social Innovation. In: Nicholls, A., Simon, J., Gabriel, M. (Eds.), *New Frontiers in Social Innovation Research*. Palgrave Macmillan, London, pp. 1–26.
- Nicholls, A., Ziegler, R., 2019. The extended social grid model. In: Nicholls, A., Ziegler, R. (Eds.), *Creating Economic Space For Social Innovation*. Oxford University Press, Oxford, pp. 3–31. doi:10.1093/2Foso/2F9780198830511.003.0001.
- OECD, 2005. *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3rd ed. OECD, Paris.
- OECD, 2018. *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation*, 4th ed. OECD, Paris.
- Palm, A., 2022. Innovation systems for technology diffusion: an analytical framework and two case studies. *Technol. Forecast. Soc. Change.* 182, 121821 <https://doi.org/10.1016/j.techfore.2022.121821>.
- Patterson, J.J., 2021. Remaking political institutions in sustainability transitions. *Environ. Innov. Soc. Transit.* 41, 64–66. <https://doi.org/10.1016/j.eist.2021.10.011>.
- Pel, B., Wittmayer, J., Dorland, J., Sogaard Jørgensen, M., 2020. Unpacking the social innovation ecosystem: an empirically grounded typology of empowering network constellations. *Innov. Eur. J. Soc. Sci. Res.* 33, 311–336. <https://doi.org/10.1080/13511610.2019.1705147>.
- Perez, C., 1983. Structural change and the assimilation of new technologies in the economic and social system. *Futures* 15 (5), 357–375. [https://doi.org/10.1016/0016-3287\(83\)90050-2](https://doi.org/10.1016/0016-3287(83)90050-2).
- Perez, C., 2010. *Technological revolutions and techno-economic paradigms*. Cambridge J. Econ. 34 (1), 185–202. <https://doi.org/10.1093/cje/bep051>.
- Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., Sobrero, M., 2013. Academic engagement and commercialisation: a review of the literature on university–industry relations. *Res. Policy.* 42 (2), 423–442. <https://doi.org/10.1016/j.respol.2012.09.007>.
- Pesch, U., 2015. Tracing discursive space: agency and change in sustainability transitions. *Technol. Forecast. Soc. Change.* 90, 379–388. <https://doi.org/10.1016/j.techfore.2014.05.009>.
- Pol, E., Ville, S., 2009. Social innovation: buzz word or enduring term? *J. Socio-Econ.* 38 (6), 878–885. <https://doi.org/10.1016/j.socce.2009.02.011>.
- Powell, W.W., Grodal, S., 2005. Networks of innovators. In: Fagerberg, et al. (Eds.), pp. 56–85. <https://doi.org/10.1093/oxfordhb/9780199286805.003.0003>.
- Purkus, A., Hagemann, N., Bedtke, N., Gawel, E., 2018. Towards a sustainable innovation system for the German wood-based bioeconomy: implications for policy design. *J. Clean. Prod.* 172, 3955–3968. <https://doi.org/10.1016/j.jclepro.2017.04.146>.
- Quitow, R., Walz, R., Köhler, J., Rennings, K., 2014. The concept of “lead markets” revisited: contribution to environmental innovation theory. *Environ. Innov. Soc. Transit.* 10, 4–19. <https://doi.org/10.1016/j.eist.2013.11.002>.
- Raj, G., Feola, G., Hajer, M., Runhaar, H., 2022. Power and empowerment of grassroots innovations for sustainability transitions: a review. *Environ. Innov. Soc. Transit.* 43, 375–392. <https://doi.org/10.1016/j.eist.2022.04.009>.
- Randelli, F., Rocchi, B., 2017. Analysing the role of consumers within technological innovation systems: the case of alternative food networks. *Environ. Innov. Soc. Transit.* 25, 94–106. <https://doi.org/10.1016/j.eist.2017.01.001>.
- Rauschmayer, F., Bauler, T., Schäpke, N., 2015. Towards a thick understanding of sustainability transitions—linking transition management, capabilities and social practices. *Ecol. Econ.* 109, 211–221. <https://doi.org/10.1016/j.ecolecon.2014.11.018>.
- Rehfeld, D., Terstiepe, J., Welschhoff, J., Alijani, S., 2015. Comparative Report on Social Innovation Framework. http://www.simpact-project.eu/publications/reports/SIMPACT_D11.pdf.
- Robinson, D.K.R., Schoen, A., Larédo, P., Molas Gallart, J., Warnke, P., Kuhlmann, S., Ordóñez-Matamoros, G., 2021. Policy lensing of future-oriented strategic intelligence: an experiment connecting foresight with decision making contexts. *Technol. Forecast. Soc. Change.* 169, 120803 <https://doi.org/10.1016/j.techfore.2021.120803>.
- Rogers, E.M., 2003. *Diffusion of Innovations*, 5th ed. Free Press, New York.

- Rohe, S., Chlebna, C., 2022. The evolving role of networking organizations in advanced sustainability transition. *Technol. Forecast. Soc. Change*. 183, 121916 <https://doi.org/10.1016/j.techfore.2022.121916>.
- Rotmans, J., Loorbach, D., 2009. Complexity and transition management. *J. Ind. Ecol.* 13 (2), 184–196. <https://doi.org/10.1111/j.1530-9290.2009.00116.x>.
- Safarzyńska, K., Frenken, K., van den Bergh, J.C.J.M., 2012. Evolutionary theorizing and modelling of sustainability transitions. *Res. Policy*. 41 (6), 1011–1024. <https://doi.org/10.1016/j.respol.2011.10.014>.
- Schartinger, D., Rehfeld, D., Weber, M., Rhomborg, W., 2020. Green social innovation – towards a typology. *Eur. Plan. Stud.* 28 (5), 1026–1045. <https://doi.org/10.1080/09654313.2019.1677564>.
- Schatzki, T.R., 2002. *The Site of the Social: A Philosophical Account of the Constitution of Social Life and Change*. Pennsylvania State University Press, University Park, PA.
- Schot, J., 1992. The policy relevance of the quasi-evolutionary model: the case of stimulating clean technologies. In: Coombs, R., Saviotti, P., Walsh, V. (Eds.), *Technological Change and Company Strategies*. Academic Press, University of Twente, Twente, pp. 185–200.
- Schot, J., Kanger, L., 2018. Deep transitions: emergence, acceleration, stabilization and directionality. *Res. Policy*. 47 (6), 1045–1059. <https://doi.org/10.1016/j.respol.2018.03.009>.
- Sengers, F., Turnheim, B., Berkhout, F., 2021. Beyond experiments: embedding outcomes in climate governance. *Environ. Plan. C: Politics and Space*. 39 (6), 1148–1171. <https://doi.org/10.1177/2399654420953861>.
- Shove, E. and Walker, G., 2014. What is energy for? Social practice and energy demand. *Theory Cult. Soc.* 31, 41–58. <https://doi.org/10.1177/0270263276414536746>.
- Smith, A., Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability. *Res. Policy*. 41 (6), 1025–1036. <https://doi.org/10.1016/j.respol.2011.12.012>.
- Smith, A., Stirling, A., Berkhout, F., 2005. The governance of sustainable socio-technical transitions. *Res. Policy*. 34 (10), 1491–1510. <https://doi.org/10.1016/j.respol.2005.07.005>.
- Smith, A., Voß, J.-P., Grin, J., 2010. Innovation studies and sustainability transitions: the allure of the multi-level perspective and its challenges. *Res. Policy*. 39 (4), 435–448. <https://doi.org/10.1016/j.respol.2010.01.023>.
- Snyder, H., 2019. Literature review as a research methodology: an overview and guidelines. *J. Bus. Res.* 104, 333–339. <https://doi.org/10.1016/j.jbusres.2019.07.039>.
- Soete, L., 2013. Is innovation always good? In: Fagerberg, J., Martin, B.R., Andersen, E.S. (Eds.), *Innovation Studies: Evolution and Future Challenges*. Oxford University Press, Oxford, pp. 134–144. <https://doi.org/10.1093/acprof:oso/9780199686346.003.0006>.
- Solis-Navarrete, J.A., Bucio-Mendoza, S., Paneque-Gálvez, J., 2021. What is not social innovation. *Technol. Forecast. Soc. Change*. 173, 121190 <https://doi.org/10.1016/j.techfore.2021.121190>.
- Southerton, D., Díaz-Mendez, C., Warde, A., 2012. Behavioural change and the temporal ordering of eating practices: a UK–Spain comparison. *Int. J. Sociol. Agric. Food*. 19, 19–36. <https://doi.org/10.48416/ijisaf.v19i1.233>.
- Sovacool, B., Noel, L., Orsato, J.R., 2017. Stretching, embeddedness, and scripts in a sociotechnical transition: explaining the failure of electric mobility at Better Place (2007–2013). *Technol. Forecast. Soc. Change*. 123, 24–34. <https://doi.org/10.1016/j.techfore.2017.05.037>.
- Steen, M., Weaver, T., 2017. Incumbents' diversification and cross-sectorial energy industry dynamics. *Res. Policy*. 46 (6), 1071–1086. <https://doi.org/10.1016/j.respol.2017.04.001>.
- Stirling, A., 2011. Pluralising progress: from integrative transitions to transformative diversity. *Environ. Innov. Soc. Transit.* 1 (1), 82–88. <https://doi.org/10.1016/j.eist.2011.03.005>.
- Stoneman, P., Battisti, G., 2010. The diffusion of new technology. In: Hall, B.H., Rosenberg, N. (Eds.), pp. 733–760. [https://doi.org/10.1016/S0169-7218\(10\)02001-0](https://doi.org/10.1016/S0169-7218(10)02001-0).
- Suarez, F.F., Utterback, J.M., 1995. Dominant designs and the survival of firms. *Strat. Manag. J.* 16 (6), 415–430. <https://doi.org/10.1002/smj.4250160602>.
- Suleiman, L., 2021. Blue green infrastructure, from niche to mainstream: challenges and opportunities for planning in Stockholm. *Technol. Forecast. Soc. Change*. 166, 120528 <https://doi.org/10.1016/j.techfore.2020.120528>.
- Suurs, R.A.A., Hekkert, M., 2009. Cumulative causation in the formation of a technological innovation system: the case of biofuels in the Netherlands. *Technol. Forecast. Soc. Change*. 76 (8), 1003–1020. <https://doi.org/10.1016/j.techfore.2009.03.002>.
- Svennevik, E.M., 2022. Practices in transitions: review, reflections, and research directions for a Practice Innovation System PIS approach. *Environ. Innov. Soc. Transit.* 44, 163–184. <https://doi.org/10.1016/j.eist.2022.06.006>.
- Tarde, G., 2009. *Die Gesetze der Nachahmung*. Suhrkamp, Frankfurt a. M.
- Terstiep, J., Rehfeld, D., Kleverbeck, M., 2020. Favourable social innovation ecosystem(s)? – An explorative approach. *Eur. Plan. Stud.* 28, 881–905. <https://doi.org/10.1080/09654313.2019.1708868>.
- The Young Foundation, 2012. *Defining Social Innovation*. TEPSIE project, The theoretical, Empirical and Policy Foundations, For Building Social Innovation in Europe. European Commission, DG Research, Brussels.
- Thomas, L.D.W., Autio, E., 2019. Innovation Ecosystems. <https://doi.org/10.2139/ssrn.3476925>.
- Truffer, B., Coenen, L., 2012. Environmental innovation and sustainability transitions in regional studies. *Reg. Stud.* 46 (1), 1–21. <https://doi.org/10.1080/00343404.2012.646164>.
- Truffer, B., Rohrer, H., Kivimaa, P., Raven, R., Alkemade, F., Carvalho, L., Feola, G., 2022. A perspective on the future of sustainability transitions research. *Environ. Innov. Soc. Transit.* 42, 331–339. <https://doi.org/10.1016/j.eist.2022.01.006>.
- Turker, D., Altuntas Vural, C., 2017. Embedding social innovation process into the institutional context: voids or supports. *Technol. Forecast. Soc. Change*. 119, 98–113. <https://doi.org/10.1016/j.techfore.2017.03.019>.
- Turnheim, B., Geels, F.W., 2012. Regime destabilisation as the flipside of energy transitions: lessons from the history of the British coal industry (1913–1997). *Energy Policy*. 50, 35–49. <https://doi.org/10.1016/j.enpol.2012.04.060>.
- Turnheim, B., Sovacool, B., 2020. Exploring the role of failure in socio-technical transitions research. *Environ. Innov. Soc. Transit.* 37, 267–289. <https://doi.org/10.1016/j.eist.2020.09.005>.
- Tziva, M., Negro, S., Kalfagianni, A., Hekkert, M., 2021. Alliances as system builders: on the conditions of network formation and system building in sustainability transitions. *J. Clean. Prod.* 318, 128616 <https://doi.org/10.1016/j.jclepro.2021.128616>.
- Utterback, J.M., Abernathy, W.J., 1975. A dynamic model of process and product innovation. *Omega*. 3 (6), 639–656. [https://doi.org/10.1016/0305-0483\(75\)90068-7](https://doi.org/10.1016/0305-0483(75)90068-7).
- van den Bergh, J.C.J.M., Truffer, B., Kallis, G., 2011. Environmental innovation and societal transitions: introduction and overview. *Environ. Innov. Soc. Transit.* 1 (1), 1–23. <https://doi.org/10.1016/j.eist.2011.04.010>.
- van den Heiligenberg, H.A.R.M., Heimeriks, G.J., Hekkert, M.P., Raven, R.P.J.M., 2022. Pathways and harbours for the translocal diffusion of sustainability innovations in Europe. *Environ. Innov. Soc. Transit.* 42, 374–394. <https://doi.org/10.1016/j.eist.2022.01.011>.
- van den Heiligenberg, H.A.R.M., Heimeriks, G.J., Hekkert, M.P., van Oort, F.G., 2017. A habitat for sustainability experiments: success factors for innovations in their local and regional contexts. *J. Clean. Prod.* 169, 204–215. <https://doi.org/10.1016/j.jclepro.2017.06.177>.
- van Lente, H., Boon, W.P.C., Klerkx, L., 2020. Positioning of systemic intermediaries in sustainability transitions: between storylines and speech acts. *Environ. Innov. Soc. Transit.* 36, 485–497. <https://doi.org/10.1016/j.eist.2020.02.006>.
- van der Have, R.P., Rubalcaba, L., 2016. Social innovation research: an emerging area of innovation studies? *Res. Policy*. 45 (9), 923–935. <https://doi.org/10.1016/j.respol.2016.06.010>.
- van Wijk, J., Zietsma, C., Dorado, S., de Bakker, F.G.A., Martí, I., 2019. Social Innovation: integrating micro, meso, and macro level insights from institutional theory. *Bus. Soc.* 58, 887–918. <https://doi.org/10.1177/0007650318789104>.

- Voltan, A., De Fuentes, C., 2016. Managing multiple logics in partnerships for scaling social innovation. *Eur. J. Innov. Manag.* 19 (4), 446–467. <https://doi.org/10.1108/EJIM-01-2016-0010>.
- Wanzenböck, I., Wesseling, J.H., Frenken, K., Hekkert, M.P., Weber, K.M., 2020. A framework for mission-oriented innovation policy: alternative pathways through the problem–solution space. *Sci. Public Policy*. 47 (4), 474–489. <https://doi.org/10.1093/scipol/scaa027>.
- Warde, A., 2005. Consumption and theories of practice. *J. Consumer Cult.* 5, 131–153. <https://doi.org/10.1177%2F1469540505053090>.
- Watson, M., 2012. How theories of practice can inform transition to a decarbonised transport system. *J. Transp. Geogr.* 24, 488–496. <https://doi.org/10.1016/j.jtrangeo.2012.04.002>.
- Weber, K.M., Rohrer, H., 2012. Legitimizing research, technology and innovation policies for transformative change: combining insights from innovation systems and multi-level perspective in a comprehensive ‘failures’ framework. *Res. Policy*. 41 (6), 1037–1047. <https://doi.org/10.1016/j.respol.2011.10.015>.
- Weiss, G., Hansen, E., Ludvig, A., Nybakk, E., Toppinen, A., 2021. Innovation governance in the forest sector: reviewing concepts, trends and gaps. *For. Policy Econ.* 130, 102506 <https://doi.org/10.1016/j.forpol.2021.102506>.
- Westley, F., Antadze, N., Riddell, D.J., Robinson, K., Geobey, S., 2014. Five configurations for scaling up social innovation: case examples of nonprofit organizations from Canada. *J. Appl. Behav. Sci.* 50, 234–260. <https://doi.org/10.1177/0021886314532945>.
- Wicki, S., Hansen, E.G., 2017. Clean energy storage technology in the making: an innovation systems perspective on flywheel energy storage. *J. Clean. Prod.* 162, 1118–1134. <https://doi.org/10.1016/j.jclepro.2017.05.132>.
- Windrum, P., Schartinger, D., Rubalcaba, L., Gallouj, F., Toivonen, M., 2016. The co-creation of multi-agent social innovations: a bridge between service and social innovation research. *Eur. J. Innov. Manag.* 19, 150–166. <https://doi.org/10.1108/Ejim-05-2015-0033>.
- Winkel, M., Radcliffe, J., 2014. The rise of accelerated energy innovation and its implications for sustainable innovation studies: a UK perspective. *Sci. Technol. Stud.* 27 (1), 8–33. <https://doi.org/10.23987/sts.55332>.
- Wittmayer, J.M., Backhaus, J., Avelino, F., Pel, B., Strasser, T., Kunze, I., Zuijderwijk, L., 2019. Narratives of change: how social innovation initiatives construct societal transformation. *Futures*. 112, 102433 <https://doi.org/10.1016/j.futures.2019.06.005>.
- Wittmayer, J.M., Hielscher, S., Fraaije, M., Avelino, F., Rogge, K., 2022. A typology for unpacking the diversity of social innovation in energy transitions. *Energy Res. Soc. Sci.* 88, 102513 <https://doi.org/10.1016/j.erss.2022.102513>.
- Wolsink, M., 2012. The research agenda on social acceptance of distributed generation in smart grids: renewable as common pool resources. *Renew. Sustain. Energy Rev.* 16, 822–835. <https://doi.org/10.1016/j.rser.2011.09.006>.
- Wong, G., Greenhalgh, T., Westhorp, G., Buckingham, J., Pawson, R., 2013. RAMESES publication standards: realist syntheses. *BMC Med.* 11, 21. <https://doi.org/10.1186/1741-7015-11-21>.
- Wustenhagen, R., Wolsink, M., Burer, M.J., 2007. Social acceptance of renewable energy innovation: an introduction to the concept. *Energy Policy*. 35 (5), 2683–2691. <https://doi.org/10.1016/j.enpol.2006.12.001>.
- Ziegler, R., Nicholls, A., Aro, J., van Beers, C., Chiappero-Martinetti, E., Edmiston, D., Havas, A., Heiskala, R., von Jacobi, N., Kubecko, K., van der Linden, M.J., Maestripietri, L., Mildenerberger, G., Molnár, Gy., Schimpf, G.-C., 2019. The extended social grid model revisited. In: Nicholls, A., Ziegler, R. (Eds.), *Creating Economic Space For Social Innovation*. Oxford University Press, Oxford, pp. 341–362. <https://doi.org/10.1093/2Foso/2F9780198830511.003.0013>.
- Zijlstra, T., Avelino, T., 2012. A socio-spatial perspective on the car regime. In: Geels, F.W., Kemp, R., Dudley, G., Lyons, G. (Eds.), *Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport*. Routledge, New York, pp. 160–179.
- Zolfagharian, M., Walrave, B., Raven, R., Romme, A.G.L., 2019. Studying transitions: past, present, and future. *Res. Policy*. 48 (9), 103788 <https://doi.org/10.1016/j.respol.2019.04.012>.