13

Expectations, Visions and Imaginaries

A Subtle Force in Transition Processes

HARALD ROHRACHER AND KORNELIA KONRAD

13.1 Introduction

Questions of socio-technical sustainability transitions, and of sustainability in general, are deeply rooted in ideas of temporality and relations to the future. Notions such as expectations, visions or imaginaries may appear as rather ephemeral phenomena in shaping socio-technical change, in contrast to more tangible forms of exerting power such as law, regulation, financial power, technological path dependencies and the like. However, expectations and visions, not least those that become shared and widely acknowledged in innovation and policy circles and in public media, constitute a subtle, but influential and often forceful element in mobilising, legitimising and guiding transition processes. Expectations and visions have been shown to be a key element in innovation processes in general (Borup et al., 2006). Arguably, their role is particularly relevant for radical niche technologies and transition processes, as for these it is all the more important to imagine futures that differ from current socio-technical regimes and established technologies. Widely shared expectations and visions may even function as 'prospective structures' that actors treat as structures of the future, and by coordinating activities towards these imagined structures, may actually create them (Van Lente, 1993; Van Lente & Rip, 1998).

In the field of transition studies, early work on niche formation and Strategic Niche Management has quickly identified the importance of expectations on the future performance of novel technologies, their future environment and potential to address societal problems, in contrast to theories that mainly consider the current performance and system environment (Kemp et al., 1998; Schot, 1998). Governance-oriented work has turned this insight into an instrumental approach with transition visions being a core element in Transition Management, which are supposed to align and guide diverse stakeholders in the governance of transition processes (Kemp & Loorbach, 2006; Rotmans et al., 2001). Similarly, the approach of technological innovation systems (TIS) highlights visions and expectations as an important element in influencing the direction of search (Bergek et al., 2008).

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A more explorative use of future visions can be found in work on socio-technical scenarios that taps into the expanding understanding of transition dynamics for investigating possible future transition pathways. More recently, we see a turn to less visible elements in anticipatory dynamics around transition processes, namely in the burgeoning field of studies that reveal the different socio-technical imaginaries that structure future-oriented discourses and that shape what is considered as desirable and possible directions for transition processes and niche developments (Jasanoff & Simmet, 2021; Mutter & Rohracher, 2022). Questions of visions and expectations have also found renewed interest in recent discussions about transformative and mission-oriented innovation policies and the challenge of directionality (Bergek et al., 2023; Weber & Rohracher, 2012). Broadly spoken, visions and expectations are part of a range of anticipatory practices (Berten & Kranke, 2022) where discourses can be strategically framed (Lempiälä et al., 2019) as a means to perform authority and power (Beck & Mahony, 2018; Berten & Kranke, 2022), but at the same time are shaped by historically grown cultural repertoires (Lempiälä et al., 2019).

In the following, we explicate in more detail how the role of expectations, visions, scenarios and imaginaries has been discussed throughout the unfolding sustainability transitions research (Markard et al., 2012; Truffer et al., 2022) with a focus on the main conceptual perspectives and on how different forms of socio-technical futures feature in the dynamics and governance of transitions. We illustrate these more general dynamics by pointing to studies on transitions in the energy domain and by discussing in more depth the case of hydrogen technologies. In a concluding section, we highlight current debates and emerging research.

13.2 Historical and Thematic Development

13.2.1 Key Concepts: Visions, Expectations and Imaginaries

Though sometimes used almost interchangeably, visions, expectations and socio-technical imaginaries highlight different dimensions of how we relate to the future. While collective expectations can be understood as 'statements about future conditions or developments that imply assumptions about how likely these are supposed to be and that travel in a community or public space' (Konrad et al., 2017), visions refer to more or less coherent packages of potential future states sketching out a future 'world' (Berkhout, 2006; Eames et al., 2006), while not necessarily including assessments of likelihood or plausibility. Socio-technical imaginaries in turn are defined as 'collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology.' (Jasanoff & Kim, 2015: 4)

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Socio-technical imaginaries and expectations share the collective nature, while visions and imaginaries the holistic character.

The performative role of expectations as an element in the discursive and real-world construction and shaping of technologies has been studied in some detail. In particular, it has been shown how collective expectations that have become part of a social repertoire and shared discourse mobilise and legitimate support, be it financial or otherwise, and serve as a coordinating element for heterogeneous actors, such as innovation, policy or societal actors. Expectations guide the direction of innovation activities, and in the case of still ill-defined emerging technologies feature in the sense-making process of gradually defining the 'identity' of a certain technology or innovation field (van Lente & Rip, 1998). Despite its value for governing innovations or transitions, the sociology of expectations also takes a critical stance with regard to expectations that turn out overly optimistic with time, often resulting in hype-disappointment cycles, or close off the consideration of alternatives (Brown, 2003).

In contrast to the often highly dynamic development of expectations in socio-technical change, visions and particularly imaginaries are often part of the explanation of durability and of the development of broad 'directionalities' of change. Particularly in the context of transition management, visions are 'seen as devices for specifying a desired end-state in the form of a particular socio-technical regime' (Berkhout, 2006: 300) and are associated with a range of governance tools such as scenario development, backcasting or technology roadmaps. At the same time one needs to 'recognise that the development of a coherent vision for future regime transformation is far from unproblematic, and that there are likely to be multiple visions' (Smith et al., 2005: 1500). Accordingly, storylines and frames articulating different visions are often contested and actors trying to enact particular pathways of change engage in 'framing struggles' (Kriechbaum et al., 2023; Rosenbloom et al., 2016).

13.2.2 Expectations and the Shaping of Strategic Niches

By definition, niche technologies do not easily fit into established socio-technical regimes and their performance, especially with regard to commonly valued criteria, is typically low, while the future development is still uncertain. Niche technologies would generally stand a difficult chance against more established technologies, if they were evaluated on the basis of current performances and current selection environments only. Thus, expectations and promises about future prospects are extremely important, as technologies are also evaluated against their expected future potential. Furthermore, it matters how the future context is envisaged, for instance, the future regulatory environment, and thus, which

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criteria a technology is supposed to measure up with in the more or less distant future (Schot et al., 1994).

Strategic Niche Management (SNM) as an early field in transition research has studied the processes how radical technologies that do not fit into established regime structures unfold (Hoogma et al., 2002; Kemp et al., 1998; Schot & Geels, 2008; Smith & Raven, 2012). As a key feature, niches have been defined as protected spaces that shield such still emerging technologies from regular selection pressures. Expectations and promises on the potential of niche technologies to perform well in the future are one of the forms of creating such protected spaces. Expectations about the future are an important reason why actors are willing to support and invest in niches (Geels, 2004: 912).

SNM has identified three interrelated processes on which the development of such niches depends: alongside the formation of actor networks and the articulation of learning processes, the negotiation and alignment of expectations is one of them. Changes in expectations may thus be important for understanding how technology trajectories unfold, either due to learning processes or shifting actor constellations in a niche, or due to niche-external developments, such as newly emerging regime problems. For instance, Geels and Raven (2006) have related the ups and downs in the developments of Dutch biogas plants to these dynamics. In addition, it has been highlighted that negotiation and alignment (and contestation) are political processes that depend on power relationships between actors that are more or less influential in shaping expectations (Raven et al., 2008).

In understanding the concrete processes of how expectations influence niche innovations, transition research has drawn on work in the sociology of expectations (Borup et al., 2006). In particular, the concept of hype-disappointment cycles had an important impact on studying niche and transition dynamics. While some studies focused on the implications of hype and disappointment for strategies of innovation actors (Budde et al., 2012; Konrad et al., 2012), others compared the expectation patterns of multiple niche innovations or innovations entering regime structures (Alkemade & Suurs, 2012; Kriechbaum et al., 2021), or studied how expectations on multiple niche technologies (Bakker et al., 2012; Melton et al., 2016; Verbong et al., 2008) or networks of expectations spanning niche, regime and landscape levels (Budde et al., 2012; Budde & Konrad, 2019) compete or support each other. Expectations and discursive frames can go through different phases along technological lifecycles and the unfolding of transitions, from a phase of large frame variation to the emergence of more coherent collective expectations linked to dominant designs, or phases of discontinuity where established frames and expectations are replaced by new ones (Kaplan & Tripsas, 2008; Kriechbaum et al., 2023). Expectations and visions are thus not only important during the emergence of new socio-technical configurations, but also play a crucial role in the stabilisation and destabilisation of incumbent regimes.

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With a view on competition between expectations, the role of expectations as a strategic element in the politics of technologies becomes apparent. Expectations are communicated strategically by niche and regime actors to support or undermine particular technologies. A specific interest has been on how policy contributes to the formation and dynamics of expectations and how policy actors deal with the dynamics of expectations, for example by either following successive hype dynamics of different technologies, such as different alternative fuel technologies (Melton et al., 2016), or rather as going against these cycles and introducing a stabilising element in the support for certain technologies, such as hydrogen or smart meters (Budde & Konrad, 2019; Hielscher & Kivimaa, 2019), which may, however, also be seen as a form of lock-in, if the supported technologies lose legitimacy, as in the case of biofuels in the UK (Berti & Levidow, 2014).

13.2.3 Visions and Imaginaries in Transition Processes

Guiding visions and processes of 'envisioning' have been an important element in Transition Management, a governance approach building on insights from transition theory that aims at fostering sustainable transitions in concrete empirical domains, such as energy, agriculture or health (Loorbach, 2007, 2022; Loorbach & Rotmans, 2010). Here the motivating, guiding and coordinating role of shared expectations and visions is actively mobilised as a governance tool. Transition visions are developed by a heterogenous group of social actors assembled in a transition arena, need to be supported broadly and serve as a reference point to develop more specific transition images and pathways that provide guidance on different ways how such a long-term vision of a sustainable energy, agriculture or health sector may be realised. Typically, visions are 'moralised' as advocates attempt to attach them to widely shared values, or contrast them with undesired outcomes (Berkhout, 2006: 309). Wesche et al. (2024) show how similarities in visions are crucial for the 'cooperation among actors from different niches and the emergence of strong coalitions in socio-technical transitions' (p.2). In this way, the possible contribution of, for instance, different niche innovations can be explored, as part of an envisioning process and in practical transition experiments, while keeping the long-term goal in view.

However, creating coherent visions of the future is far from unproblematic as these visions may be multiple, contested and potentially competing (Geels et al., 2019; Smith et al., 2005). Depending on the learning experiences in the unfolding transition experiments, the transition pathways may be adjusted over time. As Elzen et al. (2004) put it in an early text of transition research, such a 'learning-by-doing' related to vision building is an important element of the steering philosophy in transition management: the 'articulation of future visions, setting up experiments to learn about the feasibility of visions, and the evaluation

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and adjustments of visions.' (p.12) Transitions can be understood as a participatory goal-seeking process where both transition goals and visions change over time (Rotmans et al., 2001: 23). The convergence of visions through the alignment of expectations and activities of different actor groups is thus rather an achievement that emerges during transitions, than something that can be planned from the outset. (Geels & Schot, 2007: 402)

Smith et al. (2005: 1506) point out how visions about future system innovations can fulfil a number of important functions in transition processes, even if the endpoint of these developments is contested: Visions can map a possibility space and identify a realm of plausible alternatives; they can act as a problem-defining tool; they can provide a stable frame for target-setting and monitoring progress; they can specify relevant actors and bind together communities of practice or interest; and they can be crucial for mobilising capital and other resources. Guiding visions play an important role in the strategies of actors attempting to influence socio-technical change and to discursively stabilise and institutionalise desired future developments.

Visions play an important role at all levels of governance, from local and regional to national and global. As Späth and Rohracher (2010) show with the case of 'energy regions' in Austria, discourses about visions can connect different levels of governance and geographical scales and can become part of an emergent agenda for transformational change. However, creating, re-framing or contesting visions is but one element in this much more complex, conflict-ridden and dynamic process, which involves the creation and negotiation of societal and material structures as well. And even if broad visions, such as carbon neutrality, seem to converge, the governance consequences drawn by different groups or governance levels may still deviate from each other (Karhunmaa, 2019).

An increasingly used framework to map and analyse visions that are not only explicitly politically expressed but also implicitly enacted in socio-material practices and institutional structures, is the concept of socio-technical imaginaries. As Jasanoff and Kim (2015: 322) put it, the concept of imaginaries provides 'a powerful new angle on world making' with a 'focus on where transformative ideas come from, how they acquire mass and solidity, and how imaginations, objects and social norms (…) become fused in practice'. Typically such imaginaries have been analysed in relation to specific realms of science and technology policy at a national level, such as in the work of Jasanoff and Kim (2009) comparing imaginaries of nuclear power in the US and South Korea. Cross-national comparisons can be helpful to identify and shed light on the particularities of imaginaries which in contrast to policy agendas are less explicit, less issue-specific, less goal-directed, less politically accountable and less instrumental; they reside in the reservoir of norms and discourses, metaphors and cultural meanings out of which actors build their policy preferences.

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Mutter and Rohracher (2022: 89) identify four characteristics which are important for analysing the dynamics of imaginaries in transition processes: the potential boundedness of imaginaries to different spatial scales, not only the national level; the contested nature and varying internal coherence of imaginaries; the entanglement of imaginaries with the materiality of the technologies they refer to; and temporalities in the development of imaginaries. Trencher and van der Heijden (2019) show, for example, how national hydrogen imaginaries in Japan can create frictions as well as complementarities with regional visions of renewable energy futures, while Mutter and Rohracher (2022) analyse the contestations between regionally entrenched biogas imaginaries and powerful globalised future visions of electrification which shape the transition dynamics towards sustainable transport systems. Studying the energy transition requires a better understanding of the 'processes by which the futures of energy are imagined and produced, by whom, under what goals and circumstances, instrumentalities and mechanisms, and the moments at which they are contradicted and negotiated, and erased from or embedded within public discourse', Delina and Janetos (2018: 1) argue. Contestations and frictions between different imaginaries open spaces for politics and power dynamics which need to be navigated in transition processes. Not least, imaginaries are not just created at will but are deeply embedded in socio-material structures which in turn condition how we can think about the future. Mitchell's (2011) study of 'Carbon Democracy' and the way material qualities of oil, including its geographical concentration and socio-technical arrangements required for its extraction and distribution, enable and shape a political apparatus for its governance and in extension our way to perceive democracy, is a foremost example of this. A critical analysis of socio-technical imaginaries helps reveal how material and normative dimensions of future-making are bound together and how, for example, certain ideas of progress also animate visions of sustainable energy and thereby 'promote and foreground certain economic and social virtues and, reciprocally, background or demote others.' (Jasanoff & Simmet, 2021) The other way round, unpacking the stable socio-technical imaginary of coal-futures in Poland (Kuchler & Bridge, 2018) and the way it selectively draws on imaginaries of coal-fuelled national modernisation, can help understand the resistance to a sustainable energy transition even in the face of contradictory evidence.

13.2.4 Scenario-Building, Roadmapping and Other Anticipatory Practices Exploring and Shaping Transition Dynamics

The active and systematic work with visions and expectations as an element of transition governance has given rise to a broad range of 'futuring methods' such

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as scenario development, technology foresight and roadmapping, or modelling. Such methods also support an explorative and reflexive deliberation with stakeholders and societal actors as, for instance, suggested in Constructive Technology Assessment (Schot, 1992). A conceptual understanding of typical dynamics in transition processes helps to explore possible future transition pathways in a systematic manner. Typical patterns of multi-level dynamics, such as niche–regime interactions, impact of landscape developments or different types of transition pathways (Fraedrich et al., 2015; Geels & Schot, 2007) can be used to explore how a certain socio-technical system or particular niches may develop in different directions, depending on different conditions or strategies chosen.

Socio-technical scenarios are usually of a qualitative nature developing a narrative how a transition process may unfold. As Selin (2006: 1) puts it, 'scenarios are not intended to be truthful, but rather provocative and helpful in strategy formulation and decision-making.' The scope of the scenarios may typically be a sector or domain (Elzen et al., 2004; Hofman & Elzen, 2010), niche, or multiple regimes (Konrad et al., 2008). The collaborative development of scenarios can be a useful strategy to manage conflicting agendas and engage key stakeholders, for example, at local level, in dialogues on transition pathways (Magnusson et al., 2020).

Scenario techniques have also been combined with other future methods, for example modelling (Geels, 2020; McDowall, 2014) or Delphi methods (Szabó, 2020). Concepts for modelling transition pathways have significantly evolved during the past years. As Holtz et al. (2015: 55) point out, models can serve multiple purposes, from providing explicit, clear and systematic system representations to inferences about underlying factors of system dynamics or the facilitation of system experiments. Particularly when dealing with sustainability transitions, it is important that sectoral models, for example, of the energy system, are combined with qualitative scenarios of long-term policy and societal context development. Such an approach has been operationalised with the method of 'cross-impact analysis' for socio-technical energy scenarios (Weimer-Jehle et al., 2020) or as Formative Scenario Analysis which builds on storylines of broader societal developments (Burger et al., 2022). Also, Rogge et al. (2020) combine model-based analysis with insights from socio-technical transition analysis to develop socio-technical storylines that show how low-carbon transitions can be implemented and how specific transformative policy mixes can be applied to achieve these goals.

A scenario method which has frequently been applied in the context of sustainability transitions is the method of 'backcasting'. Here, the participative creation of a desirable (sustainable) future vision or normative scenario is followed by a reconstruction of steps and pathways leading towards that future (Quist & Vergragt, 2006). During the past years this method has been further refined and

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applied to different contexts, such as strategic planning and urban heat transitions (Pereverza et al., 2019).

Rooted in traditions of innovation policy, various methods of foresight exercises have been developed to articulate possible futures (van Lente, 2012). A diversity of foresight methods can be applied at different levels, as exemplified in Weber and Schaper-Rinkel's (2017) study on European sectoral foresight exercises. Other techniques such as technology roadmapping have been developed in the context of strategic decision-making in large companies, but have also been applied in the form of policy roadmaps to evoke future visions and plan long-term policies fostering sustainability transitions (Miedzinski et al., 2022). As a combination of envisioning processes, experimentation and design thinking involving a diversity of actors, methods such as urban living labs (Bulkeley et al., 2019) or policy labs (Trei et al., 2021) have increasingly gained traction in sustainability transition contexts. Hajer and Pelzer (2018) and Oomen et al. (2022) have suggested the concept of 'Techniques of Futuring' to highlight the practice-based, material and dramaturgical features of specific futuring practices and the conditions that enable them to become performative.

Increasingly, the role of institutionally embedded anticipatory practices, for example, supported by international organisations such as the IPCC, for authoritatively delineating visions has been highlighted, specifying their core features and thereby exercising 'world-making' power by defining political problems and devising solutions (Beck & Mahony, 2018; Berten & Kranke, 2022). For instance, different forms of climate modelling that generate the climate scenarios and pathways discussed in the Intergovernmental Panel on Climate Change (IPCC) have been forceful in prestructuring the imaginative and political space for climate governance. Beck and Mahoney (2018) have argued that changes in the modelling practices have created new performative effects. While climate scenarios initially projected the development of emissions based on societal trends, they now model pathways that explore the technical feasibility of ambitious emission targets. As a result, the initially merely explorative pathways turned into widely considered policy options, and with this also the speculative technologies the modelled pathways involve, such as negative emissions technologies. Such a 'politics of anticipation' (Beck & Mahony, 2018) is however not limited to public actors, but often pursued by multinational companies, for example, by providing global energy scenarios (Blondeel et al., 2024). The more general point here is that such institutionally embedded anticipatory practices, be they modelling-based approaches, structured qualitative scenario processes or negotiated strategic agenda documents and roadmaps have a special role in catalysing, solidifying and justifying expectations and visions that circulate in wider societal discourses (see Textbox 13.1).

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Textbox 13.1

Case Study: The Ups and Downs of Hydrogen Futures

The developments around hydrogen across the last decades are an illustrative example to showcase the subtle force of expectations, visions and imaginaries in transition processes.

Current hydrogen visions: Hydrogen is a central element in many of the current visions and related governmental and industrial strategies aimed at decarbonising different sectors such as the chemical and steel industry. The pressures on governments and current energy and industrial regimes to limit global warming, not the least due to international treaties such as the 'Paris Agreement', have created a space for renewed hydrogen visions and expectations. High hopes rest on so-called green hydrogen produced via electrolysis from large-scale deployment of renewables such as solar and wind, distributed via global supply chains connecting promising places of production with places of expected high consumption. These visions do not only imply radical transitions in energy systems and supply chains, but also in the envisaged use sectors as the highly emitting steel and chemical sectors. While these are mainly visions (only about 1% of hydrogen is currently produced from renewables[1]), the mobilising, guiding and coordinating role of expectations and visions is exemplified by the globally proliferating, often large-scale projects and mushrooming policy programmes.

Hype-disappointment cycles: The strong hopes in the potential of hydrogen for achieving decarbonisation goals are all the more remarkable when compared to the relative disinterest prevailing in the years before the Paris Agreement. This period was characterised by disappointment with former hydrogen and fuel cell hopes that had risen high around the early 2000s. Many countries and societal actors had stopped or reduced innovation efforts, with some exceptions such as Japan or Germany, which continued hydrogen and fuel cell support programmes throughout these years (Budde& Konrad, 2019; Trencher & van der Heijden, 2019).

Changing visions over time: It is important to note that expectations and 'pre-Paris' visions had a different focus: attention was centred on the transport and building sector and the role of fuel cells, be it in the form of fuel cell cars, buses, other vehicles or heat and power appliances for households (Bakker & Budde, 2012; Konrad et al., 2012). Fully renewables-based hydrogen was mostly not considered a feasible option. The currently favoured industry sectors were not part of common visions at the time, while today the use of hydrogen for the once central sectors has moved at best to the background of visions, testimony to the more general finding that transition visions are not static, but tend to be adapted over time (Kriechbaum et al., 2023). As shown for German policy, changes in hydrogen and fuel cell expectations and visions have been influenced by developments in the wider networks of expectations, including other

[1] www.irena.org/Energy-Transition/Technology/Hydrogen, accessed 30.6.2024.

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niche technologies, as well as expectations relating to future landscape and regime developments in related sectors (Budde & Konrad, 2019), pointing to the importance of multi-system dynamics (see chapter 10 of this volume).

Differences in socio-technical imaginaries: Besides changes over time, a key question is whether visions and imaginaries across societal actors align or are contested and whose visions may prevail. With the resurgence of interest in hydrogen, also studies into hydrogen imaginaries are emerging, showing that underneath the widely shared expectations on hydrogen as a fuel of the future, concrete visions, priorities and envisaged transition pathways diverge (Brauner et al., 2023; Dorn, 2024; Virens, 2024).

Institutionally embedded anticipatory practices: As indicated, an important driver for the emergence of the renewed hydrogen hype has been the Paris Agreement. Specific anticipatory practices played an important role in underpinning this process, including forms of climate modelling that generate the climate scenarios and pathways discussed in the Intergovernmental Panel on Climate Change (IPCC), as explained above. While Beck and Mahony (2018) discussed how these practices helped to put negative emissions technologies on global policy agendas, arguably a similar point can be made for hydrogen technologies. While low-carbon hydrogen plays a minor role in the 5th IPCC report as a longer-term option (IPCC, 2014), hydrogen-based technologies feature way more prominently in the 6th IPCC report (IPCC, 2023).

Exploratory scenarios building on transition theory: Beyond these highly politicised circles, scholars have drawn on transition theory for creating qualitative socio-technical scenarios as a means to openly explore and assess possible hydrogen futures, partly combining those with modelling approaches (Eames & McDowall, 2010; Espegren et al., 2021; McDowall, 2014).

13.3 Ongoing Debates and Emerging Research

As our previous sections have shown, many of the approaches within the sociology of expectations, socio-technical imaginaries or methods of futuring such as scenarios, foresight exercises or policy labs have a long tradition (sometimes in other contexts than sustainability transition studies), but are still further developed, refined and operationalised. In discussing these themes, we have tried to show the continuum from early developments to ongoing debates. In this concluding section, we want to complement these topics by touching on some emerging themes in a rather eclectic fashion without pretending to cover the whole range of new developments.

A transition-related discourse which received a lot of public attention in recent years is the discussion about mission-oriented innovation policies. Schot and Steinmueller (2018) speak of a 3rd generation of transformative innovation

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policies, and Mazzucato (2018) has introduced these mission-policy concepts at the European Union level. Defining, operationalising and implementing long-term visions and goals in such missions (Geels et al., 2019) and creating directionality of transformative change (Weber & Rohracher, 2012) is one of the big questions related to the theme of visions and expectations. Attempts to create directionality in addressing societal challenges have been empirically studied at urban and regional levels (Parks, 2022; Tödtling et al., 2022), but also in national mission-oriented innovation programmes (Grillitsch et al., 2019), at sectoral levels such as transport (Schippl & Truffer, 2020), or in relation to the challenge of 'deep transitions' (Johnstone & McLeish, 2020; Kemp et al., 2022). Bergek et al. (2023) identified eight challenges which need to be dealt with in this respect: 'handling goal conflicts, defining system boundaries, identifying realistic pathways, formulating strategies, realising destabilisation, mobilising relevant policy domains, identifying target groups, and accessing intervention points.'

A further research strand drawing on studies of expectations and visions in sustainability transitions is the study of narratives of change and the storytelling as a strategy in fostering transitions. Narratives are different from expectations or imaginaries in that they fill the gap between imaginaries and the present course of action, but they also guide our access to the past and align some elements of the past with the imagined future (Bazzani, 2022). Stories in energy and climate research can both serve as artefacts to be investigated in terms of content, relationships and power, or they can be used to communicate with and engage audiences (Moezzi et al., 2017). While storytelling is used in scenario development and design practices, its use remains undertheorised (Raven & Elahi, 2015). Also 'fictional representations' can have an important role in future studies, whether by providing a diversity of 'ways of knowing' and alternative ways the future can be understood, or by tapping into unconsciously held assumptions and implicit understandings (Bina et al., 2020). Fiction, art and performances can be mobilised as a participatory form of world-building 'that allows for new ways of knowing, and new ways of being, in relation to post-fossil transitions' (Stripple et al., 2021: 87).

Last, we want to name the role of visions and imaginaries as an element of conflict, contestation and power which have gained increased analytical attention in transition studies (e.g. Avelino, 2017; Madsen et al., 2022; Yuana et al., 2020). While Avelino (2017) asks to analyse power relations implied in sustainability visions, Madsen et al. (2022) point to the way visions and discourses are mobilised along various 'axes of contestation' in transition processes. Questions of power, conflict and justice in sustainability transitions are deeply entangled with the way they are represented in and mobilised through visions and imaginaries of the actor groups involved in these processes. Along with the other current debates

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highlighted in this section, this underlines how concepts of visions, imaginaries and expectations are cutting across different themes and dimensions of sustainability transitions research and can be of great analytical value for gaining a more nuanced understanding of transformative change and strategies to make the governance of sustainability transitions more effective.

References

Alkemade, F., Suurs, R. A. A., 2012. Patterns of expectations for emerging sustainable technologies. *Technological Forecasting and Social Change* 79(3), 448–56.

Avelino, F., 2017. Power in sustainability transitions: Analysing power and (dis)empowerment in transformative change towards sustainability. *Environmental Policy and Governance* 27(6), 505–20.

Bakker, S., Budde, B., 2012. Technological hype and disappointment: Lessons from the hydrogen and fuel cell case. *Technology Analysis & Strategic Management* 24(6), 549–63.

Bakker, S., van Lente, H., Engels, R., 2012. Competition in a technological niche: The cars of the future. *Technology Analysis & Strategic Management* 24(5), 421–34.

Bazzani, G., 2022. Futures in action: Expectations, imaginaries and narratives of the future. *Sociology* 57(2), 382–97.

Beck, S., Mahony, M., 2018. The politics of anticipation: The IPCC and the negative emissions technologies experience. *Global Sustainability* 1, e8.

Bergek, A., Hellsmark, H., Karltorp, K., 2023. Directionality challenges for transformative innovation policy: Lessons from implementing climate goals in the process industry. *Industry and Innovation* 30(8), 1110–39.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., Rickne, A., 2008. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy* 37, 407–29.

Berkhout, F., 2006. Normative expectations in systems innovation. *Technology Analysis & Strategic Management* 18(3/4), 299–311.

Berten, J., Kranke, M., 2022. Anticipatory global governance: International organisations and the politics of the future. *Global Society* 36(2), 155–69.

Berti, P., Levidow, L., 2014. Fuelling expectations: A policy-promise lock-in of UK biofuel policy. *Energy Policy* 66(0), 135–43.

Bina, O., Inch, A., Pereira, L., 2020. Beyond techno-utopia and its discontents: On the role of utopianism and speculative fiction in shaping alternatives to the smart city imaginary. *Futures* 115, 102475.

Blondeel, M., Price, J., Bradshaw, M., Pye, S., Dodds, P., Kuzemko, C., Bridge, G., 2024. Global energy scenarios: A geopolitical reality check. *Global Environmental Change* 84, 102781.

Borup, M., Brown, N., Konrad, K., van Lente, H., 2006. The sociology of expectations in science and technology. *Technology Analysis & Strategic Management* 18(3/4), 285–98.

Brauner, S., Lahnaoui, A., Agbo, S., Böschen, S., Kuckshinrichs, W., 2023. Towards green hydrogen? A comparison of German and African visions and expectations in the context of the H2Atlas-Africa project. *Energy Strategy Reviews* 50, 101204.

Brown, N., 2003. Hope against hype-accountability in biopasts, presents and futures. *Science & Technology Studies* 16(2), 3–21.

Budde, B., Alkemade, F., Weber, K. M., 2012. Expectations as a key to understanding actor strategies in the field of fuel cell and hydrogen vehicles. *Technological Forecasting and Social Change* 79(6), 1072–83.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 22:25:47, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009437318.018

Budde, B., Konrad, K., 2019. Tentative governing of fuel cell innovation in a dynamic network of expectations. *Research Policy* 48(5), 1098–112.

Bulkeley, H., Marvin, S., Palgan, Y. V., McCormick, K., Breitfuss-Loidl, M., Mai, L., von Wirth, T., Frantzeskaki, N., 2019. Urban living laboratories: Conducting the experimental city? *European Urban and Regional Studies* 26(4), 317–35.

Burger, P., Emmenegger, R., Sohre, A., 2022. Energy futures as societal futures: Co-evolutionary scenarios linking futures of society and decarbonized energy systems in Switzerland 2050. *Futures* 140, 102955.

Delina, L., Janetos, A., 2018. Cosmopolitan, dynamic, and contested energy futures: Navigating the pluralities and polarities in the energy systems of tomorrow. *Energy Research & Social Science* 35, 1–10.

Dorn, F. M., 2024. Towards a multi-color hydrogen production network? Competing imaginaries of development in northern Patagonia, Argentina. *Energy Research & Social Science* 110, 103457.

Eames, M., McDowall, W., 2010. Sustainability, foresight and contested futures: Exploring visions and pathways in the transition to a hydrogen economy. *Technology Analysis & Strategic Management* 22(6), 671–92.

Eames, M., McDowall, W., Hodson, M., & Marvin, S., 2006. Negotiating contested visions and place-specific expectations of the hydrogen economy. *Technology Analysis & Strategic Management* 18(3–4), 361–374.

Elzen, B., Geels, F. W., Green, K. (eds), 2004. *System Innovation and the Transition to Sustainability*. Edward Elgar, Cheltenham.

Espegren, K., Damman, S., Pisciella, P., Graabak, I., Tomasgard, A., 2021. The role of hydrogen in the transition from a petroleum economy to a low-carbon society. *International Journal of Hydrogen Energy* 46(45), 23125–38.

Fraedrich, E., Beiker, S., Lenz, B., 2015. Transition pathways to fully automated driving and its implications for the sociotechnical system of automobility. *European Journal of Futures Research* 3(1), 11.

Geels, F., Turnheim, B., Asquith, M., Kern, F., Kivimaa, P., 2019. *Sustainability Transitions: Policy and Practice*. European Environment Agency (EEA), Luxembourg.

Geels, F. W., 2004. From sectoral systems of innovation to socio-technical systems. Insights about dynamics and change from sociology and institutional theory. *Research Policy* 33, 897–920.

Geels, F. W., 2020. Micro-foundations of the multi-level perspective on socio-technical transitions: Developing a multi-dimensional model of agency through crossovers between social constructivism, evolutionary economics and neo-institutional theory. *Technological Forecasting and Social Change* 152, 119894.

Geels, F. W., Raven, R. P. J. M., 2006. Non-linearity and expectations in niche-development trajectories: Ups and downs in dutch biogas development (1973–2003). *Technology Analysis & Strategic Management* 18(3/4), 375–92.

Geels, F. W., Schot, J., 2007. Typology of sociotechnical transition pathways. *Research Policy* 36, 399–417.

Grillitsch, M., Hansen, T., Coenen, L., Miörner, J., Moodysson, J., 2019. Innovation policy for system-wide transformation: The case of strategic innovation programmes (SIPs) in Sweden. *Research Policy* 48(4), 1048–61.

Hajer, M. A., Pelzer, P., 2018. 2050: An energetic Odyssey: Understanding 'Techniques of Futuring' in the transition towards renewable energy. *Energy Research & Social Science* 44, 222–31.

Hielscher, S., Kivimaa, P., 2019. Governance through expectations: Examining the long-term policy relevance of smart meters in the United Kingdom. *Futures* 109, 153–69.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 22:25:47, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009437318.018

Hofman, P. S., Elzen, B., 2010. Exploring system innovation in the electricity system through sociotechnical scenarios. *Technology Analysis & Strategic Management* 22(6), 653–70.

Holtz, G., Alkemade, F., de Haan, F., Köhler, J., Trutnevyte, 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. *Environmental Innovation and Societal Transitions* 17, 41–58.

Hoogma, R., Kemp, R., Schot, J., Truffer, B., 2002. *Experimenting for Sustainable Transport. The Approach of Strategic Niche Management*. Spon Press, London.

IPCC (ed), 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer(eds.)]*. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

IPCC, 2023. Summary for Policymakers, in: Intergovernmental Panel on Climate, C. (Ed), *Climate Change 2022 – Mitigation of Climate Change: Working Group III Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, pp. 3–48.

Jasanoff, S., Kim, S.-H., 2009. Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva* 47(2), 119–46.

Jasanoff, S., Kim, S.-H. (eds), 2015. *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. University of Chicago Press, Chicago.

Jasanoff, S., Simmet, H. R., 2021. Renewing the future: Excluded imaginaries in the global energy transition. *Energy Research & Social Science* 80, 102205.

Johnstone, P., McLeish, C., 2020. World wars and the age of oil: Exploring directionality in deep energy transitions. *Energy Research & Social Science* 69, 101732.

Kaplan, S., Tripsas, M., 2008. Thinking about technology: Applying a cognitive lens to technical change. *Research Policy* 37(5), 790–805.

Karhunmaa, K., 2019. Attaining carbon neutrality in Finnish parliamentary and city council debates. *Futures* 109, 170–80.

Kemp, R., Loorbach, D., 2006. Transition management: A reflexive governance approach, in: Voß, J.-P., Bauknecht, D., Kemp, R. (Eds), *Reflexive Governance of Sustainable Development*. Edward Elgar, Cheltenham, pp. 103–30.

Kemp, R., Pel, B., Scholl, C., Boons, F., 2022. Diversifying deep transitions: Accounting for socio-economic directionality. *Environmental Innovation and Societal Transitions* 44, 110–24.

Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: The approach of strategic niche management. *Technology Analysis & Strategic Management* 10(2), 175–95.

Konrad, K., Markard, J., Ruef, A., Truffer, B., 2012. Strategic responses to fuel cell hype and disappointment. *Technological Forecasting and Social Change* 79(6), 1084–98.

Konrad, K., Van Lente, H., Groves, C., & Selin, C., 2016. 16 Performing and Governing the Future in Science and Technology. *The Handbook of Science and Technology Studies*, 465–93.

Konrad, K., Truffer, B., Voß, J.-P., 2008. Multi-regime dynamics in the analysis of sectoral transformation potentials: Evidence from German utility sectors. *Journal of Cleaner Production* 16(11), 1190–202.

Kriechbaum, M., Posch, A., Hauswiesner, A., 2021. Hype cycles during socio-technical transitions: The dynamics of collective expectations about renewable energy in Germany. *Research Policy* 50(9), 104262.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 22:25:47, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009437318.018

Kriechbaum, M., Terler, N., Stürmer, B., Stern, T., 2023. (Re)framing technology: The evolution from biogas to biomethane in Austria. *Environmental Innovation and Societal Transitions* 47, 100724.
Kuchler, M., Bridge, G., 2018. Down the black hole: Sustaining national socio-technical imaginaries of coal in Poland. *Energy Research & Social Science* 41, 136–47.
Lempiälä, T., Apajalahti, E.-L., Haukkala, T., Lovio, R., 2019. Socio-cultural framing during the emergence of a technological field: Creating cultural resonance for solar technology. *Research Policy* 48(9), 103830.
Loorbach, D., 2007. *Transition Management: New Mode of Governance for Sustainable Development*. International Books, Utrecht.
Loorbach, D., Rotmans, J., 2010. The practice of transition management: Examples and lessons from four distinct cases. *Futures* 42(3), 237–46.
Loorbach, D. A., 2022. Designing radical transitions: A plea for a new governance culture to empower deep transformative change. *City, Territory and Architecture* 9(1), 30.
Madsen, S., Miörner, J., Hansen, T., 2022. Axes of contestation in sustainability transitions. *Environmental Innovation and Societal Transitions* 45, 246–69.
Magnusson, T., Anderberg, S., Dahlgren, S., Svensson, N., 2020. Socio-technical scenarios and local practice – Assessing the future use of fossil-free alternatives in a regional energy and transport system. *Transportation Research Interdisciplinary Perspectives* 5, 100128.
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. *Research Policy* 41(6), 955–67.
Mazzucato, M., 2018. *Mission-Oriented Research & Innovation in the European Union. A Problem-Solving Approach to Fuel Innovation-Led Growth*. European Commission, Brussels.
McDowall, W., 2014. Exploring possible transition pathways for hydrogen energy: A hybrid approach using socio-technical scenarios and energy system modelling. *Futures* 63(0), 1–14.
Melton, N., Axsen, J., Sperling, D., 2016. Moving beyond alternative fuel hype to decarbonize transportation. *Nature Energy* 1(3), 16013.
Miedzinski, M., McDowall, W., Fahnestock, J., Rataj, O., Papachristos, G., 2022. Paving the pathways towards sustainable future? A critical assessment of STI policy roadmaps as policy instruments for sustainability transitions. *Futures* 142, 103015.
Mitchell, T., 2011. *Carbon Democracy. Political Power in the Age of Oil*. Verso, London.
Moezzi, M., Janda, K. B., Rotmann, S., 2017. Using stories, narratives, and storytelling in energy and climate change research. *Energy Research & Social Science* 31, 1–10.
Mutter, A., Rohracher, H., 2022. Competing transport futures: Tensions between imaginaries of electrification and biogas fuel in Sweden. *Science, Technology, & Human Values* 47(1), 85–111.
Oomen, J., Hoffman, J., Hajer, M. A., 2022. Techniques of futuring: On how imagined futures become socially performative. *European Journal of Social Theory* 25(2), 252–70.
Parks, D., 2022. Directionality in transformative innovation policy: Who is giving directions? *Environmental Innovation and Societal Transitions* 43, 1–13.
Pereverza, K., Pasichnyi, O., Kordas, O., 2019. Modular participatory backcasting: A unifying framework for strategic planning in the heating sector. *Energy Policy* 124, 123–34.
Quist, J., Vergragt, P., 2006. Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework. *Futures* 38(9), 1027–45.
Raven, P. G., Elahi, S., 2015. The new narrative: Applying narratology to the shaping of futures outputs. *Futures* 74, 49–61.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 22:25:47, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009437318.018

Raven, R. P. J. M., Heiskanen, E., Lovio, R., Hodson, M., Brohmann, B., 2008. The contribution of local experiments and negotiation processes to field-level learning in emerging (Niche) technologies: Meta-analysis of 27 new energy projects in Europe. *Bulletin of Science Technology Society* 28(6), 464–77.

Rogge, K. S., Pfluger, B., Geels, F. W., 2020. Transformative policy mixes in socio-technical scenarios: The case of the low-carbon transition of the German electricity system (2010–2050). *Technological Forecasting and Social Change* 151, 119259.

Rosenbloom, D., Berton, H., Meadowcroft, J., 2016. Framing the sun: A discursive approach to understanding multi-dimensional interactions within socio-technical transitions through the case of solar electricity in Ontario, Canada. *Research Policy* 45(6), 1275–90.

Rotmans, J., Kemp, R., Van Asselt, M., 2001. More evolution than revolution: Transition management in public policy. *Foresight* 3(1), 15–31.

Schippl, J., Truffer, B., 2020. Directionality of transitions in space: Diverging trajectories of electric mobility and autonomous driving in urban and rural settlement structures. *Environmental Innovation and Societal Transitions* 37, 345–60.

Schot, J., Geels, F. W., 2008. Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management* 20(5), 537–54.

Schot, J., Hoogma, R., Elzen, B., 1994. Strategies for shifting technological systems: The case of automobile system. *Futures* 26(10), 1060–76.

Schot, J., Steinmueller, W. E., 2018. Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy* 47(9), 1554–67.

Schot, J. W., 1992. Constructive technology assessment and technology dynamics: The case of clean technologies. *Science, Technology & Human Values* 17(1), 36–56.

Schot, J. W., 1998. The usefulness of evolutionary models for explaining innovation. The case of the Netherlands in the nineteenth century. *History and Technology* 14, 173–200.

Selin, C., 2006. Trust and the illusive force of scenarios. *Futures* 38, 1–14.

Smith, A., Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy* 41(6), 1025–36.

Smith, A., Stirling, A., Berkhout, F., 2005. The governance of sustainable socio-technical transitions. *Research Policy* 34, 1491–510.

Späth, P., Rohracher, H., 2010.'Energy regions': The transformative power of regional discourses on socio-technical futures. *Research Policy* 39(4), 449–58.

Stripple, J., Nikoleris, A., Hildingsson, R., 2021. Carbon ruins: Engaging with post-fossil transitions through participatory world-building. *2021* 9(2), 87–99.

Szabó, D., 2020. Driverless, or carless future? Socio-technical scenarios of autonomous urban mobility in the Czech Republic. *Transactions on Transport Sciences* 11(1), 5–17.

Tödtling, F., Trippl, M., Desch, V., 2022. New directions for RIS studies and policies in the face of grand societal challenges. *European Planning Studies* 30(11), 2139–56.

Trei, D. T., Hornung, J., Rychlik, J., Bandelow, N. C., 2021. From political motivation to scientific knowledge: Classifying policy labs in the science-policy nexus. *European Planning Studies* 29(12), 2340–56.

Trencher, G., van der Heijden, J., 2019. Contradictory but also complementary: National and local imaginaries in Japan and Fukushima around transitions to hydrogen and renewables. *Energy Research & Social Science* 49, 209–18.

Truffer, B., Rohracher, H., Kivimaa, P., Raven, R., Alkemade, F., Carvalho, L., Feola, G., 2022. A perspective on the future of sustainability transitions research. *Environmental Innovation and Societal Transitions* 42, 331–39.

Van Lente, H., 1993. *Promising Technology: The Dynamics of Expectations in Technological Developments. PhD Thesis* – University of Twente. Eburon.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 22:25:47, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009437318.018

van Lente, H., 2012. Navigating foresight in a sea of expectations: Lessons from the sociology of expectations. *Technology Analysis & Strategic Management* 24(8), 769–82.

Van Lente, H., Rip, A., 1998. Expectations in technological developments: An example of prospective structures to be filled in by agency, in: Disco, C., Van der Meulen, B. (Eds), *Getting New Technologies Together*. Walter de Gruyter GmbH & Co, Berlin, pp. 203–29.

Verbong, G. P. J., Geels, F. W., Raven, R. P. J. M., 2008. Multi-niche analysis of dynamics and policies in Dutch renewable energy innovation journeys (1970–2006): Hype-cycles, closed networks and technology-focused learning. *Technology Analysis & Strategic Management* 20(5), 555–73.

Virens, A., 2024. Green hydrogen futures: Tensions of energy and justice within sociotechnical imaginaries. *Energy Research & Social Science* 114, 103587.

Weber, K. M., Rohracher, 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. *Research Policy* 41(6), 1037–47.

Weber, K. M., Schaper-Rinkel, P., 2017. European sectoral innovation foresight: Identifying emerging cross-sectoral patterns and policy issues. *Technological Forecasting and Social Change* 115, 240–50.

Weimer-Jehle, W., Vögele, S., Hauser, W., Kosow, H., Poganietz, W.-R., Prehofer, S., 2020. Socio-technical energy scenarios: state-of-the-art and CIB-based approaches. *Climatic Change* 162(4), 1723–41.

Wesche, J. P., Negro, S. O., Brugger, H. I., Eichhammer, W., Hekkert, M. P., 2024. The influence of visions on cooperation among interest organizations in fragmented socio-technical systems. *Environmental Policy and Governance* 34(2), 152–65.

Yuana, S. L., Sengers, F., Boon, W., Hajer, M. A., Raven, R., 2020. A dramaturgy of critical moments in transition: Understanding the dynamics of conflict in socio-political change. *Environmental Innovation and Societal Transitions* 37, 156–70.

Downloaded from https://www.cambridge.org/core. UNIVERSIDAD AUTONOMA METROPOLITANA, on 17 Nov 2026 at 22:25:47, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009437318.018