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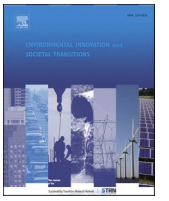

The future is present: Prefiguration in policy and technology experimentation

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ABSTRACT

The article adds to the theorisation of temporality within sustainability transitions by introducing the concept of prefiguration. Through two transport-related case studies, one technology experiment and one policy experiment, the article shows how prefiguration might elucidate the temporal aspects of experimentation. By employing the conceptual pair of ends-guided and ends-effacing prefiguration, the article shows how the future-orientation characterising much technology experimentation allows for the indeterminate deferment of politics, whereas experiments focusing on present-day transformations must contend with politics from the outset. As such, technology experiments are characterised by a temporal buffer which allows them to elicit considerable support without engaging with possible issues or contestations. In conclusion, the article suggests that more attention should be paid to experiments that practice ends-effacing prefiguration, as to better understand their characteristics and their capability to successfully facilitate meaningful sociotechnical change.

1. Introduction

Our end is a more sustainable future, but what present-day means can help achieve it? This question lies at the core of sustainability transitions research, and there is no shortage of prescribed means (e.g. Kemp et al., 1998; Geels, 2002; Rotmans et al., 2001). Technology experimentation is one of them: experiments with new technologies are considered an important tool for realising sociotechnical transitions (Sengers et al., 2019; Weiland et al., 2017). By facilitating the emergence of new and more sustainable technologies, the argument goes, it might be possible to transition towards a new sociotechnical system that is unburdened by the problems of the old one. However, this approach has been criticised for the presupposition that technology-induced problems can be solved through the application of more technology (e.g. Pestre, 2019). To counter the emphasis on technological innovation (Sengers et al., 2019), a nascent literature focuses on policy experimentation: temporary and spatially delimited policy interventions that seek to challenge established systems and practices (Kivimaa et al., 2017).

Technology experimentation and policy experimentation build upon a similar logic: by testing new arrangements in vivo, one might challenge the cognitive, institutional, and/or material obduracy associated with established sociotechnical arrangements (Schippl et al., 2022; Schot and Steinmueller, 2018; Sengers et al., 2019). However, policy experimentation and technology experimentation often operate upon different objects, encompass different subjects, and unfold over different time scales. The article focuses on the latter, crucial issue: although transitions scholars describe transitions research as 'strong on temporal issues' (Geels et al., 2018:

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27), the temporal aspect of experimentation remains under-theorised. Because experimentation is such a central concept in sustainability transitions research (Sengers et al., 2019), it is important to understand how experimental practices relate to time: what relationship is posited between present-day experimentation and desirable futures? Thus, in this article, I mobilise two case studies from the Norwegian transport sector to explore the temporal aspects of transition-related experimentation in more detail.

The two cases were chosen strategically. The first case focuses on Forus Shuttle, a project in which a private-public partnership tested an automated bus on a public road. The other case focuses on Oslo City Government's effort to create a car-free city centre. The cases were chosen because they represented relatively clear-cut examples of technology experimentation and policy experimentation and simultaneously diverged in their temporal orientation. These characteristics make the two cases excellent opportunities for exploring how the concept of prefiguration can help elucidate the temporal dynamics of policy and technology experimentation.

The article is organised as follows. First, I discuss the operationalisation of time in sustainability transitions research. Then, I lay out the main characteristics of technology experimentation, policy experimentation, and prefiguration. Thereafter, I present my methods, before using the two case studies to illustrate the merits of prefiguration as an analytical tool. Finally, I discuss the temporal dynamics of technology and policy experimentation and describe the usefulness of the concept of prefiguration in sustainability transitions research.

2. Time in sustainability transitions

Within sustainability transitions research, transitions are conceptualised as long-term processes that are thought to unfold over time spans of fifty years or more (Markard et al., 2012; for some counterexamples, see Sovacool, 2016). Indeed, the word 'transition' implies the temporal dimension. However, despite claims that transitions research has engaged thoroughly with the temporal dimension (e.g. Geels et al., 2018: 27), explicit discussion of temporal aspects is often quite limited (Grandin and Sareen, 2020: 75). Below, I discuss three dominant operationalisations of time.

First, there is the historical perspective (e.g. Geels, 2002; Schot and Kanger, 2018; Turnheim and Geels, 2012). Historical studies of technology have served as inspiration for both prescriptive and analytical perspectives within sustainability transitions (Geels, 2002; Kemp et al., 1998). The regimes and landscapes of the multi-level perspective also reflect the temporal dimension, in the sense that their relative obduracy makes them 'carriers of continuity' (Grandin and Sareen, 2020: 74). Historical studies are certainly useful, because they offer a view of processes that have been finalised. However, a historical perspective 'can certainly be instructive, but it is not necessarily predictive' (Geels and Sovacool, 2016: 236). Whereas past transitions have unfolded across decades, this does not determine the form or pace of on-going or future transitions (Sovacool, 2016).

Second, there are visions and expectations. These are considered important tools for directing change in sustainability transitions (Kemp et al., 1998; Naber et al., 2017; Rotmans et al., 2001). Actors that share expectations are more capable of modulating on-going technological and political dynamics towards a specific future (Kemp et al., 1998) or set of futures (Kemp and Rotmans, 2005; Schot and Steinmueller, 2018). In this regard, time is operationalised in terms of a desired direction.

Third and finally, the emphasis on direction comes with an associated emphasis on acceleration. This emphasis clearly implies linearity: velocity and acceleration are both vectors, meaning that they have a direction. Hence, the question of acceleration is a question of how to reach a desired future sooner (Sovacool, 2016). Whereas the prospect of speeding up time might seem counter-intuitive, acceleration means speeding up processes in a specific direction. Indeed, this is important considering the urgency instilled by climate change, but it also comes with its own set of problems concerning inclusion and participation (Skjølsvold and Coenen, 2021).

The most common transitions frameworks are process theories, which refers to theories that emerge from the identification of historical patterns: for example, timing, sequences, and conjectures (Geels and Schot, 2007: 414–415). As a result, transition studies tend towards models which describe and/or prescribe stepwise or stagewise processes (Schot and Geels, 2008; Rotmans et al., 2001). Whereas the associated focus on co-evolutionary processes precludes a neat linearity, there is still a clear future-orientation in which present-day action is guided both by historical patterns and envisioned futures. As such, prescriptive frameworks such as strategic niche management and transition management tend to focus on opportunities over problems (though see Kungl and Geels, 2018; Roberts, 2017; Turnheim and Geels, 2012).

There have been attempts at theorising temporality within or adjacent to transitions research. A recent addition is the framework for understanding liminal technologies, defined as 'sociotechnical objects, knowledge or standards under development' (Suboticki and Sørensen, 2021: 158). This perspective suggests that the temporality of an on-going process might be better understood by viewing it through the lens of multiple frameworks and then 'juxtaposing the insights' (Suboticki and Sørensen, 2021: 169). By approaching transitions as liminal processes, attention may be turned to failure as an on-going process rather than a one-time event. For example, the development of electric vehicles and automated vehicles has failed repeatedly without being abandoned (Callon, 1980; Garud et al., 2010; Wetmore, 2003).

Causal patterns, insofar that they can be described as patterns at all (Ryghaug and Skjølsvold, 2021: 48), may also exhibit temporalities beyond cause-effect (Garud and Gehman, 2012; Steen, 2016; Turnheim and Geels, 2019). Consider the Norwegian adoption of electric vehicles. Throughout the 1990s, Norway implemented policies that were meant to foster a domestic electric vehicle industry. While the industry venture eventually failed, these policies remained in place and would turn out to be conducive to the adoption of electric vehicles throughout the 2010s (Skjølsvold and Ryghaug, 2020). Indeed, Skjølsvold and Ryghaug (2020: 239) suggest that such 'temporal echoes' may prove one way out of liminality (cf. Suboticki and Sørensen, 2021). Rather than having the past *determine* the future, the past may be a resource for path creation: portions of the past may be mobilised 'to generate new options' rather than 'to repeat or avoid what happened' (Garud et al., 2010: 770).

Whereas analyses using temporal echoes and liminal technologies can suggest possible courses of action, neither of the frameworks exhibit an explicitly strategic orientation. In this regard, Grandin and Sareen (2020) offer a useful approach: they suggest that dynamism should be emphasised over obduracy (Hommels, 2005) or momentum (Hughes, 1987) when studying sociotechnical transitions. They conceptualise structures as routinised repetitions, which, like transitions, implies a temporal dimension. This conceptualisation differs from 'traditional' transitions perspectives, in which landscapes and regimes are conceptualised in terms of stability and continuity. If structures are considered repetitions, then there is ample room for adding variation. Variations might include interventions that showcase new possibilities ('catalysation'), temporarily establish new practices ('revamping'), or make new practices durable ('routinisation'). Such variations may focus on structural, relational, and/or material aspects (Grandin and Sareen, 2020: 75–76). This approach also leaves room for agency: rather than having to overcome the 'heaviness' or path-dependency of a regime, it might be sufficient to interrupt its on-going repetition (see also Garud et al., 2010). The turn towards interruption suggests that long-term strategies are not the only means for changing existing sociotechnical systems: they can also be altered through present-day interventions. Building upon this insight, this article explores how to fruitfully operationalise the relationship between present actions and future goals.

To summarise, transitions research tends to discuss time in rather linear terms. Recent work has sought to move beyond this conception, whether by prescribing a multi-temporal framework, by eschewing linear cause-effect explanations of a technology or transition's success or failure, or by breaking up time in smaller portions. Building on these insights, the next section discusses the characteristics of technology and policy experimentation before introducing prefiguration as an alternative approach to temporality.

3. Technology and policy experiments for the future

Within sustainability transitions research, technological experimentation is considered key to the successful development and upscaling of sustainable technologies (Kemp et al., 1998; Naber et al., 2017). By establishing protected spaces ('niches'), underdeveloped and cumbersome technologies can be tried out without immediately being subjected to market pressures. Niches have been theorised to facilitate the co-evolution of emerging technologies and the regulatory environment where they are to be implemented.

Three processes have been theorised as conducive to successful technological experimentation (Kemp et al., 1998: 189–191). First, experimentation should build upon shared expectations regarding a technology, as discussed in Section 2. Ideally, the expectations should be credible, specific, and directed towards a societal problem that current technologies are unable to address. Second, experimentation should help to elicit learning, both regarding technical capabilities and the social and regulatory context in which the technology is intended to function. Third and finally, experimentation should be accompanied by network formation. A broad network is considered conducive to technology development, especially if the network includes actors capable of influencing both the technical capabilities of a technology and the regulatory environment surrounding it. If successfully configured, these three processes are thought to eventually facilitate the large-scale adoption of new and more sustainable technologies (Schot and Geels, 2008).

Policy experimentation has been gaining traction within transitions research (Kivimaa and Rogge, 2022). While there is no agreed-upon definition of the term, two approaches are discernible (Huitema et al., 2018: 154). The first approach emphasises controlled environments and hypothesis testing as essential components of policy experimentation (e.g. Abbott, 2017). The second approach emphasises the novel and tentative nature of experiments (Bernstein and Hoffman, 2018: 192; Voß and Simons, 2018). In this article, I understand policy experimentation as a deliberate and initially reversible intervention into society that is designed to challenge an established social order, while also being delimited in its temporal, physical and/or institutional extension (Kivimaa et al., 2017: 25). As with technological niches, policy experimentation is also expected to facilitate learning.

Voß and Simons (2018) suggest that policy experimentation may take shape as a back-and-forth between laboratory and field (i.e. society). Laboratories, here taken to include the economist's office, produce claims with epistemic authority, claims which are then mobilised in real-world policymaking in attempts to shape political order (Voß and Simons, 2018). This would suggest that policy experimentation is a case of co-production, in which scientific knowledge is mobilised to shape social order (Jasanoff, 2004; Voß and Simons, 2018). However, as experimentation is increasingly conducted in public (Marres and Stark, 2020; Ryghaug and Skjølsvold, 2021), scientific expertise is no longer a prerequisite for substantiating the claims that are produced (Rommetveit and Wynne, 2017; Weiland et al., 2017). Indeed, public experiments are often conducted by actors with vested interests in whatever technology or policy is being experimented with, which means that experiments are not neutral (Haugland and Skjølsvold, 2020; Voß and Simons, 2018).

In the context of decarbonisation experiments, Bernstein and Hoffmann (2018) identify two distinct approaches to the means and ends of experimentation. The first approach uses experiments to assess the ability of a measure (a technology, a policy) to contribute toward a pre-established goal. The second approach uses experiments as generative events, and then analyse their potential and politics after the fact (Bernstein and Hoffmann, 2018: 194). The emphasis on the relationship between present-day action and future goals evokes the concept of prefiguration.

3.1. Prefiguration: Ends-guidance and ends-effacement

Prefiguration refers to attempts by political organisations to embody their future goals, however utopian or idealistic, in their everyday activities (Boggs, 1977). The concept has traditionally been associated with radical political movements such as anarchism, feminism, and to some extent Marxism (Graeber, 2004; Rowbotham, 1979; Törnberg, 2021). Direct democracy and public deliberation are examples of prefigurative practices within these movements: the movements' emancipatory orientation means that prefiguration usually is directed towards establishing intensely democratic institutions and/or organisational principles (Graeber, 2004: 35). Despite prefiguration's roots in radical politics, prefigurative practices are employed across the political spectrum (Fians, 2022). This suggests

that rather than the politics and practices historically associated with the concept, the core content of prefiguration is its strategic orientation – that is, the posited relationship between present and future.

For this article, it is useful to distinguish between the narrow and broad conceptions of prefiguration. In its narrow conception, prefiguration refers to the development of revolutionary organisations that embody the same deliberative structures they want a post-capitalist future to contain (Raekstad, 2018: 362). In its broader conception, prefiguration refers to the present-day embodiment of 'those forms of social relations, decision-making, culture, and human experience that are the ultimate goal' (Boggs, 1977: 100). Whereas the broad conception has been criticised for diluting the concept's revolutionary potential (Cornell, 2016), it also makes the concept applicable to cases unrelated to revolutionary political practice. Furthermore, the broad conception allows for including elements that otherwise might not be considered part of prefigurative practices: for example, the material elements that help constitute the social.

Prefiguration has traditionally focused on social relations and organisational aspects (cf. Boggs, 1977). However, this emphasis overlooks the elements that make society durable: its material constituents (Latour, 1991). Rather than simply being the stage on which social relations play out, the built environment (including buildings, infrastructures, and technologies) may, and indeed often does embody specific social relations (Winner, 1980). As such, changes to the built environment may set the preconditions for how future societies can and even ought to be organised. Therefore, I find prefiguration to be an appropriate concept, even if the cases to be discussed do not practice radical democracy: to change the material world is to operate upon social relations (Marres and Stark, 2020).

In vivo experiments are a defining characteristic of both technology experimentation and policy experimentation (Kivimaa et al., 2017; Sengers et al., 2019). The core idea is that present-day experimental practices can help materialise specific futures (Marres and Stark, 2020; Rommetveit and Wynne, 2017; Ryghaug and Skjølsvold, 2021). The practice of reordering the present to bring about the future clearly resonates with the concept of prefiguration. However, for prefiguration to be a workable concept, it is necessary to address the paradox at its core: the seemingly contradictory practices of working to bring a specific order into being while also acting as if it has already been achieved. This contradiction can be elucidated through the concepts of ends-guided and ends-effacing prefiguration (Swain, 2019).

In *ends-guided prefiguration*, present-day means are defined with reference to established ends. By working backwards from the ends, the appropriate means can be specified (Swain, 2019: 52–54). Whereas this is also a feature of traditional strategic politics (Christensen, 1985), ends-guided prefiguration differs in one important respect: rather than employing any available means, means should have an immediate relationship to ends (Swain, 2019: 52). Using a decarbonised society as an example, an ends-guided approach would outline the characteristics of such a society (e.g. in terms of energy generation, transport systems, political organisation, distributional aspects) and then specify the appropriate means for realising these ends. In this context, continued fossil fuel extraction would be an inappropriate means even if this could help fund decarbonisation, because the means would be inimical to the ends.[1] This points to a challenge regarding ends-guided prefiguration: it requires substantial agreement regarding ends and the appropriate means for reaching them, which is often scarce in politics (Jørgensen, 2012; Torrens et al., 2019).

Ends-effacing prefiguration seeks to enact a future ideal in the present (Swain, 2019: 54–57). The point is to blur the means-ends distinction by recognising means *as* ends (Maeckelbergh, 2011): rather than being steppingstones towards a future goal, present-day actions can be significant in their own right. This promotes an open-ended and iterative approach where experimental practices can be tried out and built upon (Van de Sande, 2013). For example, if closing coal plants is a means for decarbonisation, the closing of coal plants might itself become an end. The formulation of this new end might then generate new means for closing further plants, for example, removing fossil fuel subsidies. These means might themselves become ends, and so the cycle continues. By turning attention to the present, ends-effacing prefiguration forces one to judge actions according to themselves, rather than a future goal. However, organisations tend to have goals, even end-goals (e.g. societal decarbonisation), which raises the question of how the merits of ends-effacing prefiguration can be retained without reverting to ends-guidance.

To this end, Dan Swain (2019: 58) suggests thinking of ends-effacing prefiguration in terms of prolepsis. Prolepsis refers to actions and contexts where subjects act out later stages of development, for example, a child acting as an adult. Acting out a later developmental stage serves as a learning process: one '[assumes] that something is possible before it is, in order to help make it so' (Swain, 2019: 58). For proleptic practices to work, the stage to which one projects oneself must be distinct from the current stage of development, but sufficiently close that it can still be approximated. The relative proximity allows for the possibility of getting something right, thus establishing results of lasting significance. Hence, successful proleptic practices are formative and educational, as they establish a context from which new (proximate) ends can be formulated and attempted. In this way, proleptic practices can be considered reality-making (cf. Voß and Simons, 2018): they demonstrate that something is possible while also generating further possibilities (cf. Grandin & Sareen, 2020). By thinking of ends-effacing prefiguration in terms of prolepsis, one can retain its experimental and open-ended characteristics *and* make a means-ends distinction without lapsing back into ends-guidance. This allows for maintaining the central feature of bringing the future into the present, while also acknowledging means as having value in themselves – they are not *mere* means – and recognising 'ends and means as distinct but still *of a kind*' (Swain, 2019: 59, emphasis in original).

To summarise: the temporal aspects of sustainability transitions are under-theorised. The same can be said for scholarship on policy and technology experimentation, where temporality tends to be discussed in terms of the temporary-permanent dichotomy. Ends-guided and ends-effacing prefiguration offer a way to understand the distinction and relationship between present and future and may thus help address these shortcomings.

[1] Also consider the paradox of establishing a large state apparatus to, eventually, abolish the state (cf. Boggs, 1977).

4. Methods

The article builds upon semi-structured interviews and observations made in relation to two transport-related case studies, Forus Shuttle and Car-free City Life. The case studies are discussed in detail in Section 5. The Forus Shuttle interviews were conducted by a colleague and me between November and December 2018 (Table 1). These interviews were supplemented by observations, which were made when we rode the automated bus along its route while interviewing the operator. I conducted the Car-free City Life interviews between June and November 2020 (Table 2). Due to COVID-19, these interviews were conducted using video conferencing software. In both cases, the interviewees were chosen because they had an important role in the project in question or because they could contribute an alternate viewpoint on the case. The overall motivation was to understand the two projects in their immediate context and the future they were thought to enable. To this end, interviewees were asked about the inspirations and goals of their respective projects, and how they expected their project to evolve moving forward.

The interviews were recorded, transcribed, and subsequently coded using an approach inspired by grounded theory (Charmaz, 2006). Each sentence was given a descriptive code (e.g. 'assumes that automated buses will follow the successful trajectory of the internet'). Afterwards, I considered how the initial codes might be aggregated into more overarching codes (e.g. 'expected developments', 'experience and attitude'). Finally, I focused on the interrelation between the overarching codes, and how the interrelation differed between the two cases. This approach allowed me to abstract 'upwards' from the descriptive level, and thus also to avoid applying a preestablished theoretical framework prematurely. My findings suggested that the temporal orientation was a crucial aspect of both experiments. However, this aspect was seldom discussed in transitions literature; the literature on prefiguration, on the other hand, echoed my findings. Hence, my choice of overarching conceptual framework and my initial theorisation regarding temporal aspects emerged from my findings and the subsequent literature review, rather than vice versa.

5. Analysis

5.1. Forus Shuttle: Preparing the future

The Forus Shuttle project was the first project to test an automated vehicle on Norwegian public roads. The project was carried out at Forus outside of Stavanger on Norway's South-Western coast and was initiated by a three-company partnership consisting of Kolumbus (Rogaland County's public transport provider), Forus PRT (a private mobility company) and Forus næringspark (Norway's largest business park). The partnership carried out a project consisting of two phases. In the first phase, they tested an automated bus at a test track; in the second phase, they trialled the same bus on a public road. At the project's core was the idea of trialling an emerging technology in a societal setting to facilitate social learning (Haugland and Skjølsvold, 2020), which also makes the project a typical example of technology experimentation (Weiland et al., 2017). Simultaneously, the partnership's overall approach to experimentation can be described in terms of ends-guided prefiguration (Swain, 2019).

The Forus Shuttle was based in a specific vision: in the future, automated buses might complement traditional public transport and allow people to 'live where they currently live and continue to have the opportunity to live where they currently do, while also having access to as good mobility services as possible' (Jenny, Kolumbus). From this end, the partnership worked backwards: whereas the vision could not be realised immediately, an automated public transport system could still be approximated through currently available technology. Indeed, as succinctly summarised by Daniel (Kolumbus), the partnership believed that 'someone actually has to conduct the trials we have conducted, both at the test track and on the road, in order for us to get where we want to be some day in the future'. That is, the partnership believed that the envisioned ends could only be realised by means of trialling similar technology in the present: the automated bus was thought of as a precursor to the envisioned system, as well as a means for bringing the system into being. In practice, the automated bus was mobilised to establish two essential components of a future system: a user-base and a functioning technology.

In Phase One, the partnership tested the bus's capabilities and limitations at a test track. Additionally, specific groups were invited to the test track, including 'kindergartens, schools, senior citizens [and] the Norwegian Association of Disabled' (Olivia, Forus PRT). There, the groups learnt about the bus and could ride it in a controlled environment. According to the partnership, this strategy was successful in persuading the targeted groups: even senior citizens, who sometimes hesitated to enter the bus, eventually found the

Table 1
Interviews, Forus Shuttle.

Institution/company	Function	Interviews
Kolumbus	Regional public transport company/ 'mobility provider' for Rogaland County	5
Forus PRT	Project leader for the project; interviewee also had experience in operating the automated shuttle bus	1
Forus business park	Manager of the properties in the business park; provided a stretch of road for testing	1
Department of Transport, Rogaland County	Authority over Kolumbus; shared their responsibilities with the Norwegian Public Roads Administration	1
Smart City Office, Stavanger Municipality	Produced Stavanger's smart city strategy, including elements for energy, climate, and environment	1 (2 interviewees)
Norgesbuss	Provided the bus drivers for Kolumbus in the Stavanger region; interviewee operated the automated bus	2 (1 interviewee)

Table 2
Interviews, Car-free City Life

Institution/company	Function	Interviews
City Development Committee	Organ at the uppermost level of Oslo City Government; responsible for approving changes to area zoning plans	1
Department of Urban Development	Oslo Municipality's overarching organisation for urban development	2
Agency for Planning and Building Services	Developed the new area zoning plan for the Car-free City Life project area	4
Agency for Real Estate and Urban Renewal	Responsible for Oslo Municipality's properties; involved in urban development initiatives	1
Agency for Urban Environment	Responsible for implementing physical and regulatory changes in the project area	1
Oslo Trade Association	Member organisation for businesses in the Oslo region, represented business interests within the project area	1

automated buses to be an attractive prospect. The openness toward the public was motivated in a belief that it was important to let the public gain ownership and understand that this is down to earth, this is not dangerous. (…) Because you have these moral questions, and you have this unnatural feeling of entering a vehicle without a steering wheel or pedals, feeling as if you are handing your life over to the technology. (Olivia)

Similarly, Jenny argued that 'there will always be some fear of the unknown, there will always be uncertainty in relation to the unknown'. Notably, these statements focus on unnatural feelings, uncertainty, and fear. The partnership interpreted scepticism and/or opposition in terms of irrationality, as is often the case with new technologies (Stilgoe and Cohen, 2021). Exhibiting a profoundly modernistic mindset, the partnership considered unnatural feelings a barrier to be overcome. The bus elicited these feelings but could simultaneously be used to override them: with the future materialised as a bus without steering wheel or pedals, the unknown became knowable, allowing for the unnatural to be naturalised.

Communication was also a key part of the partnership's strategy. By explaining how the bus functioned and how such buses could be used in the future, people were expected to let their guard down. For example, when talking to passengers, the bus operator emphasised how precisely the bus followed its pre-programmed route and how the bus could react faster than him. Such communication was intended to make passengers feel and understand that they were safe during their ride. As such, Phase One focused on establishing automated buses as an exciting – but safe (cf. Hildebrand, 2019) – prospect, especially for groups with unfulfilled transport needs. As a present-day embodiment of the future system, the automated bus allowed the partnership to use both communication and hands-on experience to cultivate a user-base. In the project's next phase, the partnership focused on establishing a functioning technology.

In Phase Two, the automated bus serviced two bus stops along a 1.2-kilometre stretch of public road (Fig. 1). To ensure safety, a bus operator was always present. The road test was justified in terms of learning: to understand the technology and its prospects, it was also considered necessary to understand how motorists would interact with the bus. As Norwegian legislation requires testing to proceed with caution, the road itself had to be modified for the trial. The speed limit was lowered from 50 to 30 kilometres per hour, speed bumps were installed, and the traffic pattern was adapted to consistently give the bus right of way. These adaptations helped ensure safe operations while also creating a setting where automated buses and regular vehicles could interact within the same infrastructures and at similar speeds.

The physical and regulatory modifications must be understood in relation to the partnership's expectations for automated buses:

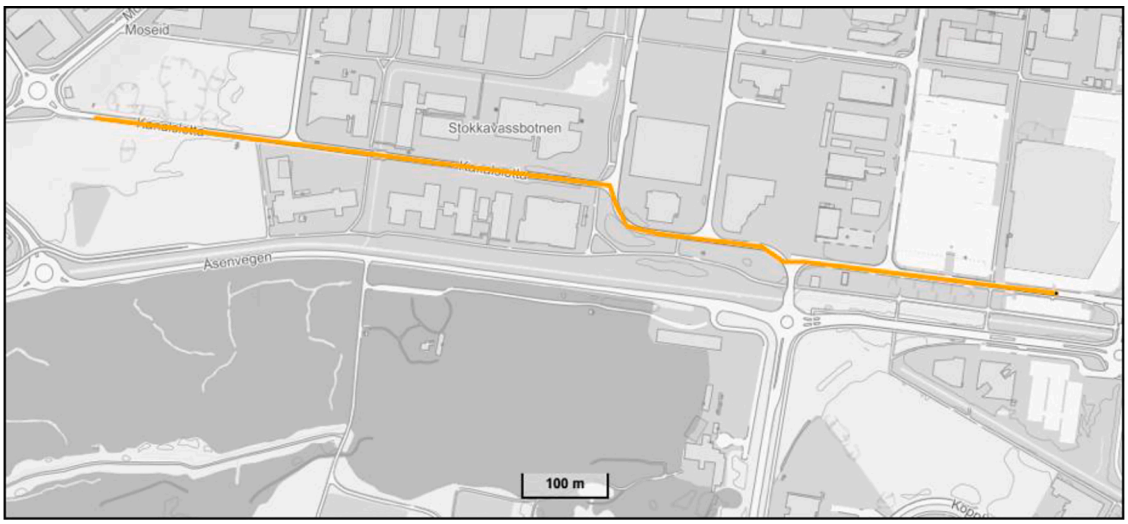

Fig. 1. The bus's route during phase two. (© Kartverket under a CC BY 4.0 license, modified by the author).

the partnership expected that automated buses would soon operate at the speed of regular traffic. Hence, the modifications can be seen as tools for narrowing the gap between the present and the future to facilitate more realistic conditions for learning about motorist-machine interactions. However, motorists were frequently frustrated by the slow-moving bus, as communicated through negative posts on social media, extended middle fingers, and hazardous overtaking. The partnership ascribed these reactions to the bus's low speed (12–15 km/h) and defensive driving style. To avoid interrupting the flow of traffic, the partnership ultimately removed most of the modifications, thus also reducing the potential for learning about machine-motorist interaction in a setting reflecting the future.

The bus operators also played an important role in keeping up appearances towards motorists. The bus operator frequently intervened with the bus's programming, interventions which were justified with reference to the negative reactions and hazardous manoeuvres the bus prompted in motorists. Despite having the right of way, the bus operator would actively defer the bus from driving onto the road, as to avoid other motorists being stuck behind the slow-moving bus. Matthew (Norgesbuss) contended that bus operators would make such considerations in general, to avoid leaving motorists with a negative impression. Rather than simply overseeing the bus's operations, the operators clearly managed how passengers and motorists perceived the bus. The bus still depended on human judgment and an awareness of human emotion and reaction that far exceeded the technology's capabilities. This also means that the operators managed the motorists' expectations to automated buses. Through their actions, the operators made a future with automated vehicles seem acceptable also to those outside the bus – motorists in particular.

After the first months of testing, the partnership 'could wholeheartedly agree that the interactions between motorists and the bus had improved' (Olivia). This might imply that the road-based social learning of the second test phase was a reciprocal process in which the partnership learnt about the motorists' interactions and motorists learnt to interact with the automated bus. However, the above examples suggest that the improvements identified by the partnership might, at least in part, have been due to operators adapting or yielding to other road-users. Rather than imitating future operational conditions, the testing yielded to the existing mobility culture. The pilot project gradually shifted away from a modified setting conducive to second-order learning and toward a setting where the bus was merely tested on a public road. Rather than allowing tensions to arise, which might give insights into future road interaction, the partnership sought to minimise tensions.

The activities in Forus Shuttle relied upon an automated bus being employed in the present while also standing in for an envisioned future system. The bus was used to establish a user-base and to assess what it would take for the technology to work properly, activities that were considered key for realising the envisioned system. Notably, these practices sought to make automated transport appear attractive to both users and non-users. This points towards a limitation of ends-guided prefiguration in technology experimentation. The temporal distance between experiment and implementation allows proponents to make spectacular claims regarding the technology's future capabilities, regardless of its current ones. Paradoxically, such claims can only be made *because* the technology is considered under development (cf. Suboticki and Sørensen, 2021). The on-going development suggests that the *final* technical capabilities of automated buses have yet to be ascertained. The technology's liminality allows proponents to make exaggerated claims, which makes it conducive to shared expectations. However, even projects built upon shared expectations give rise to issues upon implementation (Eames et al., 2006; Marres, 2007; Torrens et al., 2019). The shared expectations prescribed in technology experimentation defer politics by pushing possible tensions and contestations into the future.

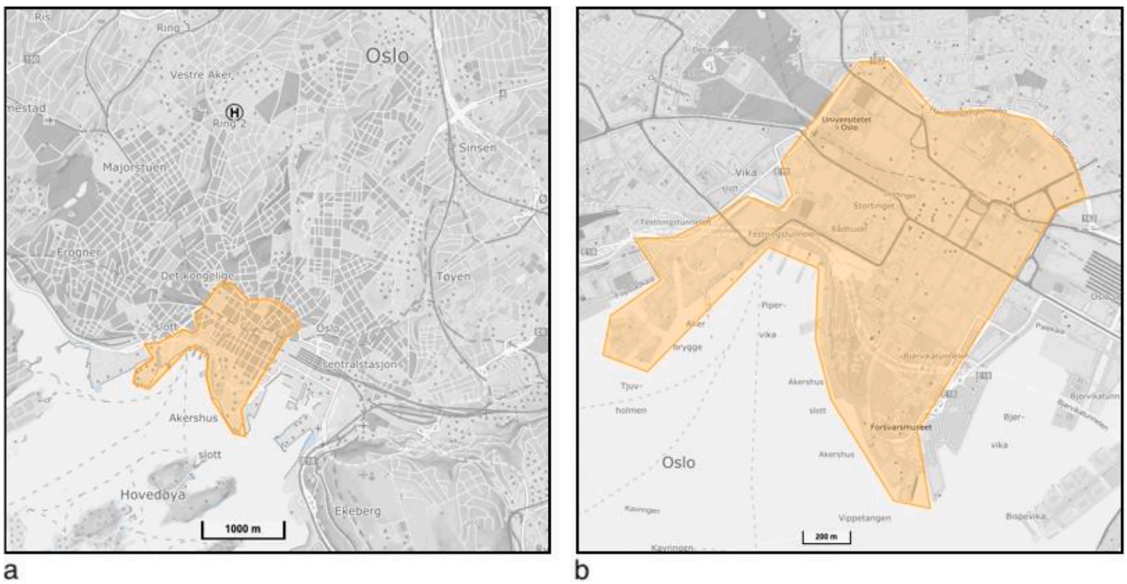

Fig. 2. The location of the car-free city life project. (a) The project area's placement within the larger Oslo area. (b) Detail view of the designated project area (© Kartverket under a CC BY 4.0 license, modified by the author).

5.2. Car-free City Life: Experiencing the future

Car-free City Life began development in 2015, when the newly elected City Government of Oslo declared that a 1.5 square kilometre area in Oslo's city core would be made car-free (see Fig. 2). Since 2016, the City Government and associated public agencies have implemented a variety of measures, relating to both transport (removing 700 parking spaces, changing traffic patterns to pedestrianise streets, improving bike paths) and urban environment (upgrading specific streets, adding benches and playgrounds, improving lighting). However, the area is not entirely devoid of cars, and might be better described as car-less. It is an area where non-essential and especially private car use is restricted. The area is still accessible for public transport (including taxis), commercial/freight transport, residents within the designated area, and vehicles for people with disabilities. It is also still possible, though more complicated, to drive through the area with a private vehicle.

To make *permanent* changes to the urban fabric, it was necessary to alter the area zoning plan. Altering the plan is a thorough and protracted bureaucratic process, a process that the project organisers initiated in 2016. However, the organisers sought to reduce car-use even before the plan was finalised. To compensate for the slow bureaucratic process, they used temporary measures to prefigure some of the changes suggested in the new zoning plan. The temporary measures also played another role, independent from the zoning plan: they were used to test and identify tenable approaches to altering the urban fabric. Thus, the temporary measures became a key component of an open-ended and experimental process that could be – and has since been – repeated elsewhere in the city. This makes the project a clear example of policy experimentation (Kivimaa et al., 2017: 25).

The measures implemented to prefigure the car-less future can be divided into two complementary categories: measures meant to decrease traffic and measures meant to promote urban life. The use of temporary measures carried a dual function. On the one hand, they could be used to demonstrate the possibilities associated with car-less environments. This function was also reflected in an emphasis on quality in the built environment, where temporary measures were required to be of high quality regardless of being temporary. On the other hand, the use of temporary measures also allowed the organisers to gain an initial understanding of which measures might function and not. Hence, the project exhibited both demonstrative and exploratory functions.

The strategy in Car-free City Life was based in a simple principle: measures meant to curb car use make private car use less attractive. As such, the measures implemented in Car-free City Life were geared toward changing how motorists experienced the city centre. For example, Mariah (Agency for Planning and Building Services) emphasised, 'it is still possible to drive a car through the city centre. It's just more complicated'. This suggest that even if car-reduction was considered a means for facilitating urban life, the associated re-prioritisation of infrastructures might also influence transport choice. As exemplified by George (City Development Committee), 'It is obviously illogical to assume that no one will change their travel behaviour if car use becomes more complicated, when all experience shows that people do. (…) If you make it less attractive, fewer people choose the car'.

The central strategy of Car-free City Life lay in reconfiguring infrastructures and reorganising the built environment to foster a new urban environment. The strategy was motivated by the prospect of improving urban life for all of Oslo's inhabitants. For example, George argued that 'when we are upgrading the city centre, we are really upgrading the city for the whole of the city's population'. This framing allowed the project organisers to consider motorists a special interest rather than the primary interest group they are often conceived as in a transport context. Because their interests were considered to run counter to the overall project, impacting them was deemed acceptable. The removal of street parking, for example, might 'be an actual problem and a challenge to some, but to most people, it is not' (Andrew, Agency for Real Estate and Urban Renewal). Because motorists were generally considered able to use other modes of transport, curbing car use was not considered an untenable intervention.

Business owners in the Car-free City Life area expressed concerns about the project. They were concerned that reduced vehicular access would have a negative effect on the businesses within the project area. Both business representatives and opposition politicians argued that temporary measures could be implemented but should be removed if they had a demonstrably negative effect on revenue. Most interviewees expressed a clear ambivalence toward this view, both with regard to the prioritisation of business interests and the problem of establishing causality between temporary measures and business turnover.

In terms of business interests, the needs of a particular subset of motorists were brushed aside. Motorists make up approximately 10% of commerce in the city centre. In terms of revenue the percentage is somewhat higher, sufficiently so that, according to business owners, this revenue is what keeps businesses afloat. The interviewees tended to describe these shopper-motorists in terms that indicated high socio-economic status: they were busy people who would drive, or even be chauffeured to storefronts to buy expensive clothes and watches. However, Andrew argued, 'the people who bike, walk, and use public transport have more time to spare and run multiple errands. They spend a massive amount more than motorists and contribute in a whole other manner to urban life'. The mobility needs of shopper-motorists and, by extension, the revenue of businesses was not prioritised: rather than facilitate the needs of one-tenth of the customer base, the city should meet the needs of the nine-tenths who contribute to a bustling urban life. Hence, the project was political from the outset: the interests of motorists and businesses were considered subordinate.

Whereas the Car-free City Life organisers made explicit prioritisations when developing the project, the project was also characterised by a tentativeness. For example, the removal of street parking had an unintended effect. The issue was raised by the Norwegian Association of the Disabled: whereas its members had *access to* reserved parking, they would also use regular parking spaces. Hence, the reduction of parking spaces in the city centre complicated the everyday life of its members.

A similar issue arose when the parking spaces around the piazza in front of Oslo City Hall came were removed. Whereas the project organisers considered this an important symbolic gesture, the buildings surrounding the piazza also housed a variety of specialist doctors. Hence, the removal of parking spaces had the unintended effect of complicating access both to specialist doctors and the City Hall. The organisers found it important to address these issues: as one interviewee emphasised, people with disabilities 'are not the opponents you want; these are the people you want to attend to in every step' (Odessa, Department of Urban Development). After

having been notified about this issue, the project organisers worked with the Norwegian Association of the Disabled to address it. As opposed to motorists in general, people with disabilities were considered to have a legitimate need for using private vehicles in the city centre.

The strategy pursued in Car-free City Life can be described as ends-effacing prefiguration. The goal was to realise 'an actual, physical change in the city' (Michael, Agency for Planning and Building Services). In terms of prolepsis, the project chose an approach where means and ends would be 'of a kind' (Swain, 2019: 59). Whereas private cars were not removed entirely, the implemented measures still made car use more complicated and less attractive. This points to the organisers' willingness to prioritise urban life over car-based transport and thus also embed specific ideas in both the project and, subsequently, into the built environment.

Beside the willingness to prioritise, Car-free City Life was also characterised by a certain tentativeness. The tentativeness can be traced to the fundamental challenge – and purpose – of the project. As succinctly summarised by one interviewee, 'no one has seen a low emission society, nobody has seen a car-free city centre before. Hence it is necessary that we display it' (Odessa). Rather than starting out with a detailed vision of a low emission society, the exact configuration is open and subject to change, thus exemplifying how the actualisation of a future ideal in the present will necessarily exhibit experimental characteristics (Van de Sande, 2013: 230). However, the overall shift away from prioritising motorists can be understood in terms of reality making (Voß and Simons, 2018) or catalysation (Grandin and Sareen, 2020): the primary goal of Car-free City Life was to demonstrate another kind of city.

6. Discussion: The politics of prefiguration

The German historian Reinhart Koselleck has described experience as present past, the past 'whose events have been incorporated and can be remembered' (Koselleck, 2004: 259). Expectation, on the other hand, is 'the future made present' and thus refers to 'the not-yet, to the nonexperienced' (Koselleck, 2004: 259). Prefiguration can be said to seek the fusion of experience and expectations. Can such a concept help elucidate the temporal dynamics of transitions? Considering the two cases presented in the previous section, I argue that it can. Specifically, the concept helps sensitise us to the temporal orientation of technology and policy experiments. The case studies discussed above both sought to combine experience and expectations, but the underlying motivation and resulting approach to prefiguration differed.

Forus Shuttle exemplifies ends-guided prefiguration. The project, like most technology experiments, exhibited a clear pro-innovation bias. This aspect of experimentation is well-documented (e.g. Engels et al., 2019; Pel et al., 2016). However, technology experimentation also exhibits a pro-*future* bias: such experimentation is necessarily grounded in a positive view of the future, in the prospect of progress. Claims that a technology is under-developed may also make the technology seem promising: its cumbersome and/or expensive nature simply means that there is ample room for improvement (Haugland and Skjølsvold, 2020; Borup et al., 2006). Expectations regarding the future capabilities of technologies motivate current-day experiments, experiments that are expected to help realise the more mature form of the technology.

When the embodiment of the future in the present is directed towards a known end, one runs the risk of projecting present ideals into the future. The Forus Shuttle partnership expected automated buses to operate at 'regular' speed, which suggests that the ideal mode of implementation was dictated by current road rules and practices (Haugland and Skjølsvold, 2020; see also Hoogma et al., 2002: 197; Schot and Geels, 2008: 541). Furthermore, automated transport was envisioned as a means for establishing a greener mode of transport capable of serving – and preserving – current settlement and transport patterns. This points towards the promissory aspect of technology experiments, but also the associated politics: the prospect of using technology to improve but essentially retain established patterns is conducive to shared expectations, because it suggests that current problems may be ameliorated without negatively affecting anyone. Due to being ends-guided, technology experimentation may defer the politics associated with a technology and its future implementation. This is a crucial difference between ends-guided and ends-effacing practices.

Car-free City Life exemplifies ends-effacing prefiguration. The organisers' approach was straight-forward: to work towards a low carbon society, they implemented measures meant to reduce car use. Whereas the organisers recognised that a car-free city, or even a car-free city centre could not be established overnight, they still saw the opportunity to implement means embodying this end. In the resulting approach, ends and means are 'distinct but still *of a kind*' (Swain, 2019: 59, emphasis in original).

Car-free City Life suggests that policy experiments focussed on the present may be conducive to transitions, because its uncertainties lie elsewhere than the uncertainties associated with automated buses (cf. Christensen, 1985). With a car-free city centre, there are uncertainties regarding practical matters, political viability, and its impact on greenhouse gas emissions (see also Swain, 2019: 56). With automated transport, the prime uncertainty relates to whether the technology is at all viable, but also whether its realisation might reproduce or even worsen the problems it is envisioned to solve. Put differently, claims regarding future technological capabilities are characterised by an unwarranted *certainty* that technology is the appropriate means for addressing a problem. This also causes a subtle shift in the project's ends: the initial goal of addressing mobility problems is replaced by the goal of facilitating and realising the technology. The shift turns the trial into 'mere' means for technology development, rather than a stand-in for the envisioned system (cf. Swain, 2019: 54). The various kinds of (un)certainty point toward widely different courses of action: one course addresses problems directly; the other merely purports to do so through technology development.

One might criticise ends-effacing prefiguration for being too pragmatic or too unconcerned with results. However, the effect of technologies in development is also uncertain. The technology might not come to fruition (Subotticki and Sørensen, 2021), and even if it does, its effects will depend on the form of the system the technology is claimed to enable. Hence, rather than continue to pursue the claimed capabilities of future technology, more resources should be directed towards actions and practices that are already possible to enact – what some have denoted as 'far less sexy policy- and regulatory measures' (Sengers et al., 2019: 161).

Ends-effacing prefiguration seeks to embody the future in the present, if not in fully then at least in kind (Swain, 2019: 59). Hence,

ends-effacing prefiguration requires less of an emphasis – or perhaps another kind of emphasis – on acceleration than does ends-guided prefiguration. Shifting attention towards the present might leave more time and room for engaging with distributional aspects, with tensions, contestations, and prioritisations (Skjølsvold and Coenen, 2021), because there is no distinct, pre-established goal to accelerate towards. For example, Car-free City Life actively gave lower priority to motorists and business interests. Without implementing measures for reducing car use, the project would 'risk being reduced to putting up some greenery and benches' (George). To embody the desirable future in the present, priorities were necessary.

The main attraction of ends-effacing prefiguration is its capacity to challenge the status quo through targeted interventions in the present (Grandin and Sareen, 2020: 76). Forus Shuttle and Car-free City Life both '[assembled] and [mobilised] collective subjects for specific attempts at shaping collective orders' (Voß and Simons, 2018: 217). Forus Shuttle sought to mobilise various parties in support of a preservative, consensus-based vision. Car-free City Life made specific prioritisations to challenge the long-standing order of automobility (Urry, 2004), and thus to introduce the possibility of another kind of city.

7. Conclusions

The preceding analysis and discussion suggest that prefiguration is a useful analytical tool for understanding the temporal aspect of transition-related experiments. Further work will be necessary to fully understand the relationship between the two binaries technology experiment/policy experiment and ends-guided/ends-effacing prefiguration. For example, the Forus Shuttle case suggests that technology experimentation is linked to ends-guided prefiguration. While I believe this applies to most experiments with emerging technologies, it does not apply to all technology experiments: for example, mature technologies may be employed in an ends-effacing fashion. Conversely, policy experimentation may also be ends-guided: for example, policies meant to promote the development of technologies that currently do not exist. However, one crucial distinction between ends-effacing and ends-guided prefiguration in transition experiments can already be identified: the former directly addresses a problem while the latter merely gives the impression of doing so – for example, by promoting technology development.

If experiments 'influence the world but do not bring particular futures about' (Hoogma et al., 2002: 196), an important question is how their influence is felt. I suggest that their influence depends upon whether they practice ends-guided or ends-effacing prefiguration. Ends-guided prefiguration is conducive to shared expectations. Because the realisation of an ends-guided experiment lies in the future, the future realisation can be claimed to benefit everyone, thus also deferring the politics that inevitably will become part of its realisation (e.g. Eames et al., 2006). Ends-effacing prefiguration, on the other hand, is conducive to politics, because ends-effacing experiments seek to implement means that are akin to ends (Swain, 2019). Hence, if successfully configured, the experiment in question will, to some degree or other, embody the politics of a future ideal. Simultaneously, because the means reflect the ends, the future ideal is also brought closer to realisation.

Some might read this article as a call to abandon technology development for *realpolitik* or pragmatism. In a sense, this might be correct. After all, the emphasis on the co-evolution of policy and technology in transitions research exhibits a pro-innovation bias, and thus tends to focus on 'neutral' policies concerning the best way to facilitate innovation rather than on, for example, distributional aspects.[2] Indeed, some claims in early transitions research read as slightly defeatist on behalf of 'traditional' political processes and institutions. For example, Kemp et al. (1998: 185) dismisses the capability of governments to plan for new technological regimes. However, the Car-free City Life organisers reached a similar conclusion but on a different basis: planning a low emission society is difficult because no one has seen it before. Hence, it is difficult to establish its exact configuration before its realisation, and it is difficult to get it right on first pass. This points toward the usefulness of ends-effacing prefiguration: the open-ended approach allows for adjusting the course when necessary (cf. Swain, 2019: 59).

The present-day actualisation of future ideals is necessarily an experimental process (Van de Sande, 2013). Ends-effacing prefiguration will encompass experiments whose politics cannot be fully anticipated beforehand (Bernstein and Hoffman, 2018). However, when the ideals of the future differ from today's ideals, prioritisations will be necessary. The willingness to set priorities and adhere to them allowed Car-free City Life to 'test' society in a meaningful way (Marres and Stark, 2020), as opposed to Forus Shuttle. If experiments are to challenge and overturn incumbent sociotechnical arrangements (Kivimaa et al., 2017; Sengers et al., 2019), or add meaningful variation to steadfast repetitions (Grandin and Sareen, 2020), they cannot rely upon a narrow range of future-oriented and consensus-based practices.

Both Forus Shuttle and Car-free City Life were in vivo experiments. Such experiments are necessarily prefigurative, in the sense that they work to realise a specific future, or some aspect of this future, in the present. The experiment may be structurally, relationally, and/or materially embedded, but such embedding is insufficient to challenge the status quo. In addition to being embedded, the experiment must also relate to the present rather than the future. Ironically, a stronger emphasis on present-day politics may generate new possibilities: by actively and continuously challenging incumbent social orders, arrangements that once seemed impossible may suddenly appear feasible, if not to fully realise then at least to attempt (cf. Swain, 2019: 59). Today and tomorrow might be distinct, but our actions decide whether they are of a kind.

[2] Although the co-evolution of policy and technology prescribed in transitions research may also encompass social policies, for example, subsidies for electric vehicles (Skjølsvold and Ryghaug, 2020)

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Data availability

Due to privacy agreements between the author and the interviewees, the interview data are not publicly available. Upon reasonable request, the author can share the data (anonymised and in Norwegian).

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References

Abbott, K.W., 2017. Orchestrating experimentation in non-state environmental commitments. Environ. Politics 26 (4), 738–763. https://doi.org/10.1080/09644016.2017.1319631.
Bernstein, S., Hoffmann, M., 2018. The politics of decarbonization and the catalytic impact of subnational climate experiments. Policy Sci. 51, 189–211. https://doi.org/10.1007/s11077-018-9314-8.
Boggs, C., 1977. Marxism prefigurative communism, and the problem of workers' control. Radic. Am. 11 (6)–12 (1), 99–122.
Borup, M., Brown, N., Konrad, K., van Lente, H., 2006. The sociology of expectations in science and technology studies. Technol. Anal. Strateg. Manag. 18 (3–4), 285–298. https://doi.org/10.1080/09537320600777002.
Callon, M., 1980. The state and technical innovation: a case study of the electrical vehicle in France. Res. Policy. 9 (4), 358–376. https://doi.org/10.1016/0048-7333(80)90032-3.
Charmaz, K., 2006. Constructing grounded theory: a practical guide through qualitative analysis. Sage.
Christensen, K.S., 1985. Coping with uncertainty in planning. J. Am. Plan. Assoc. 51 (1), 63–73. https://doi.org/10.1080/01944368508976801.
Cornell, A., 2016. Unruly Equality: U.S. Anarchism in the 20th Century. University of California Press.
Eames, M., Mcdowall, W., Hodson, M., Marvin, S., 2006. Negotiating contested visions and place-specific expectations of the hydrogen economy. Technol Anal. Strateg. Manag. 18 (3–4), 361–374. https://doi.org/10.1080/09537320600777127.
Engels, F., Wentland, A., Pfotenhauer, S.M., 2019. Testing future societies? Developing a framework for test beds and living labs as instruments of innovation governance. Res. Policy. 48, 103826 https://doi.org/10.1016/j.respol.2019.103826.
Fians, G., 2022. Prefigurative politics. In: Stein, F. (Ed.), The Open Encyclopedia of Anthropology. Open Knowledge Press. https://doi.org/10.29164/22prefigpolitics.
Garud, R., Gehman, J., 2012. Metatheoretical perspectives on sustainability journeys: evolutionary, relational and durational. Res. Policy 41 (6), 980–995. https://doi.org/10.1016/j.respol.2011.07.009.
Garud, R., Kumaraswamy, A., Karnøe, P., 2010. Path dependence or path creation? J. Manag. Stud. 47 (4), 760–774. https://doi.org/10.1111/j.1467-6486.2009.00914.x.
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.
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., Schwanen, T., Sorrell, S., Jenkins, K., Sovacool, B.K., 2018. Reducing energy demand through low carbon innovation: a sociotechnical transitions perspective and thirteen research debates. Energy Res. Soc. Sci. 40, 23–35. https://doi.org/10.1016/j.erss.2017.11.003.
Geels, F.W., Sovacool, B.K., 2016. Further reflections on the temporality of energy transitions: a response to critics. Energy Res. Soc. Sci. 22, 232–237. https://doi.org/10.1016/j.erss.2016.08.013.
Graeber, D., 2004. Fragments of an Anarchist Anthropology. Prickly Paradigm Press.
Grandin, J., Sareen, S., 2020. What sticks? Ephemerality, permanence and local transition pathways. Environ. Innov. Soc. Transit. 36, 72–82. https://doi.org/10.1016/j.eist.2020.04.008.
Haugland, B.T., Skjølsvold, T.M., 2020. Promise of the obsolete: expectations for and experiences with self-driving vehicles in Norway. Sustainability: Sci. Pract. Policy 16 (1), 37–47. https://doi.org/10.1080/15487733.2020.1765677.
Hildebrand, J.M., 2019. On self-driving cars as a technological sublime. Techné: Res. Philos. Technol. 23 (2), 153–173. https://doi.org/10.5840/techne2019722100.
Hommels, A., 2005. Unbuilding Cities: Obduracy in Urban Sociotechnical Change. The MIT Press.
Hoogma, R., Kemp, R., Schot, J., Truffer, B., 2002. Experimenting for Sustainable Transport: The Approach of Strategic Niche Management. Routledge.
Hughes, T.P., 1987. The evolution of large technological systems. In: Bijker, W.E., Hughes, T.P., Pinch, T. (Eds.), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology. The MIT Press, pp. 51–82.
Huitema, D., Jordan, A., Munaretto, S., Hildén, M., 2018. Policy experimentation: core concepts, political dynamics, governance and impacts. Policy Sci. 51, 143–159. https://doi.org/10.1007/s11077-018-9321-9.
Jasanoff, S., 2004. Ordering knowledge, ordering society. In: Jasanoff, S. (Ed.), States of Knowledge: The Co-Production of Science and Social Order. Routledge, pp. 13–45.
Jørgensen, U., 2012. Mapping and navigating transitions—The multi-level perspective compared with arenas of development. Res. Policy 41 (6), 996–1010. https://doi.org/10.1016/j.respol.2012.03.001.
Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technol. Anal. Strateg. Manag. 10 (2), 175–195. https://doi.org/10.1080/09537329808524310.
Kemp, R., Rotmans, J., 2005. The Management of the Co-Evolution of Technical, Environmental and Social Systems. In: Weber, M., Hemmelskamp, J. (Eds.), Towards Environmental Innovation Systems. Springer, pp. 33–55.
Kivimaa, P., Hildén, M., Huitema, D., Jordan, A., Newig, J., 2017. Experiments in climate governance – A systematic review of research on energy and built environment transitions. J. Clean. Prod. 169, 17–29. https://doi.org/10.1016/j.jclepro.2017.01.027.
Kivimaa, P., Rogge, K., 2022. Interplay of policy experimentation and institutional change in sustainability transitions: The case of mobility as a service in Finland. Res. Policy 51 (1), 104412. https://doi.org/10.1016/j.respol.2021.104412.

Kungl, G., Geels, F.W., 2018. Sequence and alignment of external pressures in industry destabilisation: Understanding the downfall of incumbent utilities in the German energy transition (1998–2015). Environ. Innov. Soc. Transit. 26, 78–100. https://doi.org/10.1016/j.eist.2017.05.003.
Latour, B., 1991. Technology is society made durable. In: Law, J. (Ed.), A Sociology of Monsters: Essays on Power, Technology and Domination. Routledge, pp. 103–131.
Maeckelbergh, M., 2011. Doing is Believing: Prefiguration as Strategic Practice in the Alterglobalization Movement. Soc. Mov. Stud. 10 (1), 1–20. https://doi.org/10.1080/14742837.2011.545223.
Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: An emerging field and its prospects. Res. Policy 41, 955–967. https://doi.org/10.1016/j.respol.2012.02.013.
Marres, N., 2007. The issues deserve more credit: pragmatist contributions to the study of public involvement in controversy. Soc. Stud. Sci. 37 (5), 759–780. https://doi.org/10.1177/0306312706077367.
Marres, N., Stark, D., 2020. Put to the test: for a new sociology of testing. Br. J. Sociol. 71, 423–443. https://doi.org/10.1111/1468-4446.12746.
Naber, R., Raven, R., Kouw, M., Dassen, T., 2017. Scaling up sustainable energy innovations. Energy Policy 110, 342–354. https://doi.org/10.1016/j.enpol.2017.07.056.
Pel, B., Avelino, F.R., Jhagroe, S.S., 2016. Critical approaches to transitions theory. In: Brauch, H.G., Spring, U.O., Grin, J., Scheffran, J. (Eds.), The Handbook of Sustainability Transition and Sustainable Peace. Springer, pp. 451–464.
Pestre, D., 2019. Environment and social innovation: why technology never was the solution. In: Lechevalier, S. (Ed.), Innovation Beyond Technology. Springer, pp. 175–194.
Raekstad, P., 2018. Revolutionary practice and prefigurative politics. A clarification and defense. Constellations 25 (3), 359–372. https://doi.org/10.1111/1467-8675.12319.
Roberts, J.C.D., 2017. Discursive destabilisation of socio-technical regimes: negative storylines and the discursive vulnerability of historical American railroads. Energy Res. Soc. Sci. 31, 86–99. https://doi.org/10.1016/j.erss.2017.05.031.
Rommetveit, K., Wynne, B., 2017. Technoscience, imagined publics and public imaginations. Pub. Underst. Sci. 26 (2), 133–147. https://doi.org/10.1177/0963662516663057.
Rotmans, J., Kemp, R., van Asselt, M., 2001. More evolution than revolution: transition management in public policy. Foresight 3 (1), 15–31. https://doi.org/10.1108/14636680110803003.
Rowbotham, S., 1979. Beyond the Fragments: Feminism and the Making of Socialism. Merlin Press.
Ryghaug, M., Skjølsvold, T.M., 2021. Pilot Society and the Energy Transition: The co-shaping of innovation, participation and politics. Palgrave McMillan.
Schippl, J., Truffer, B., Fleischer, T., 2022. Potential impacts of institutional dynamics on the development of automated vehicles: Towards sustainable mobility? Transp. Res. Interdiscip. Perspect. 14, 100587 https://doi.org/10.1016/j.trip.2022.100587.
Schot, J., Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. Technol. Anal. Strateg. Manag. 20 (5), 537–554. https://doi.org/10.1080/09537320802292651.
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.
Schot, J., Steinmueller, W.E., 2018. Three frames for innovation policy: R&D, systems of innovation and transformative change. Res. Policy 47, 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011.
Sengers, F., Wieczorek, A.J., Raven, R., 2019. Experimenting for sustainability transitions: A systematic literature review. Technol. Forecast. Soc. Chang. 145, 153–164. https://doi.org/10.1016/j.techfore.2016.08.031.
Skjølsvold, T.M., Coenen, L., 2021. Are rapid and inclusive energy and climate transitions oxymorons? Towards principles of responsible acceleration. Energy Res. Soc. Sci. 79, 102164 https://doi.org/10.1016/j.erss.2021.102164.
Skjølsvold, T.M., Ryghaug, M., 2020. Temporal echoes and cross-geography policy effects: Multiple levels of transition governance and the electric vehicle breakthrough. Environ. Innov. Soc. Transit. 35, 232–240. https://doi.org/10.1016/j.eist.2019.06.004.
Sovacool, B.K., 2016. How long will it take? Conceptualizing the temporal dynamics of energy transitions. Energy Res. Soc Sci. 13, 202–215. https://doi.org/10.1016/j.erss.2015.12.020.
Steen, M., 2016. Reconsidering path creation in economic geography: aspects of agency, temporality and methods. Eur. Plan. Stud. 24 (9), 1605–1622. https://doi.org/10.1080/09654313.2016.1204427.
Stilgoe, J., Cohen, T., 2021. Rejecting acceptance: learning from public dialogue on self-driving vehicles. Sci. Pub. Policy. 48, 849–859. https://doi.org/10.1093/scipol/scab060.
Suboticki, I., Sørensen, K.H., 2021. Liminal technologies: Exploring the temporalities and struggles in efforts to develop a Belgrade metro. Sociol. Rev. 69 (1), 156–173. https://doi.org/10.1177/0038026120918166.
Swain, D., 2019. Not not but not yet: present and future in prefigurative politics. Polit. Stud. 67 (1), 47–62. https://doi.org/10.1177/0032321717741233.
Torrens, J., Schot, J., Raven, R., Johnstone, P., 2019. Seedbeds, harbours, and battlegrounds: On the origins of favourable environments for urban experimentation with sustainability. Environ. Innov. Soc. Transit. 31, 211–232. https://doi.org/10.1016/j.eist.2018.11.003.
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., Geels, F.W., 2019. Incumbent actors, guided search paths, and landmark projects in infra-system transitions: re-thinking strategic niche management with a case study of French tramway diffusion (1971–2016). Res. Policy 48 (6), 1412–1428. https://doi.org/10.1016/j.respol.2019.02.002.
Törnberg, A., 2021. Prefigurative politics and social change: a typology drawing on transition studies. Distinktion J. Soc. Theor. 22 (1), 83–107. https://doi.org/10.1080/1600910X.2020.1856161.
Urry, J., 2004. The 'System' of Automobility. Theor. Cult. Soc. 21 (4–5), 25–39. https://doi.org/10.1177/0263276404046059.
Van de Sande, M., 2013. The prefigurative politics of Tahrir square – an alternative perspective on the 2011 revolutions. Res. Publica 19 (3), 223–239. https://doi.org/10.1007/s11158-013-9215-9.
Voß, J.P., Simons, A., 2018. A novel understanding of experimentation in governance: co-producing innovations between "lab" and "field. Policy Sci. 51, 213–229. https://doi.org/10.1007/s11077-018-9313-9.
Weiland, S., Bleicher, A., Polzin, C., Rauschmayer, F., Rode, J., 2017. The nature of experiments for sustainability transformations: a search for common ground. J. Clean. Prod. 169, 30–38. https://doi.org/10.1016/j.jclepro.2017.06.182.
Wetmore, J.M., 2003. Driving the dream—the history and motivations behind 60 years of automated highway systems in America. Automot. Hist. Rev. (40), 4–19.
Winner, L., 1980. Do artefacts have politics? Daedalus 109, 121–136.