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PNAS RESEARCH ARTICLE | SOCIAL SCIENCES OPEN ACCESS

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Edited by Florian Kern, Institut fur okologische Wirtschaftsforschung, Berlin, Germany; received May 16, 2022; accepted December 21, 2022 by Editorial Board Member William C. Clark

Addressing sustainability challenges requires fundamental transformations in electricity, heat, mobility, and agri-food systems. To do so, research and policy efforts tend to emphasise the importance of fostering new, more sustainable systems through innovation. Instead, this paper focuses explicitly on the "flipside" of innovation: The fate of established systems faced with their potential destabilisation and decline. It is argued that any transition in consumption-production systems involves a combination of innovation (something new emerges) and destabilisation (something old is being challenged). To examine the role of destabilisation, decline, and phase-out for policy and practice efforts, this paper advances conceptual and empirical contributions. Conceptually, it elaborates a framework based on three interacting destabilisation mechanisms: The build-up of pressures, strategic responses by central system actors, and changing commitments to reproductive activities. Empirically, it draws on the historic dismantling of electric tramways in France. The decline of the tramway in France followed a gradual erosion pattern resulting from the long-term degradation of technical, political, and economic conditions, which was accelerated by a relatively rapid phase-out programme. A discussion section offers insights on the temporality of destabilisation, the context of phase-out decisions, and the interaction of destabilisation and innovation processes.

socio-technical transitions | system destabilisation | system decline | system phase-out

Significance

System destabilisation and decline are essential processes to understanding sustainability transitions. Phasing out undesirable systems generates increased attention as an important focus for sustainability governance. This paper provides key handles on these research and governance objects, illustrations from an empirical case (electric tramways in France), and a discussion of key aspects of destabilisation (temporality, decision-making, link with innovation).

Why, knowing what we know about the pervasive environmental and social impacts of fossil fuels, or high-input agriculture, are we finding it so difficult to leave underlying systems and associated practices behind? This question, which has animated the sustainability community for decades, has triggered a large spectrum of constructive responses from policy and practice, including the pricing of externalities (e.g., carbon tax or trading), regulation (e.g., restrictions on the use of pesticides), and support for alternatives (e.g., electric cars, renewable energy, organic agriculture). What these responses have in common is a focus on creating the conditions for the emergence and generalisation of alternative solutions. Implicitly, a dependence problem has been translated into a substitution problem, which risks taking attention away from the root causes—i.e., the lock-in of unsustainable established systems—and how to deal with them. Because structural lock-in and the active resistance of incumbent actors prevent and slow down transitions efforts (1), focusing on destabilisation and its governance is critical to accelerating transitions (2, 3).

The key argument of this article is that, while it is essential to continue developing more sustainable (or less harmful) technologies, practices, and systems, it is equally important to focus on the destabilisation, decline, and phase-out of established systems (see Table 1 for a disambiguation of these terms). Indeed, unsustainable consumption-production systems will not simply fade away on their own. They require active phasing out. What are the key mechanisms contributing to the destabilisation of consumption-production systems and how may these be actively governed? Explicitly focusing attention on this "flipside" of transitions holds a double promise: 1) an improved understanding of the conditions under which established systems may decline or persist in the face of destabilisation pressures and 2) lessons about how the phase-out of undesirable systems may be governed.

Within the Multi-Level Perspective on transitions (MLP), the destabilisation of existing socio-technical systems (e.g., due to persistent challenges) is understood as an important precondition for the breakthrough of radical alternatives (4), although most studies treat this as a contextual backdrop rather than the focal object of study. This paper draws from over a decade of research on destabilisation in transitions studies. Theoretically, there is a need for generic explanations and propositions about the relevant causal mechanisms of destabilisation. Empirically, there is a need to move further towards the mobilisation of cases in different sectors and contexts, as different patterns are likely to point to the combination of different mechanisms (3). Analytically and

Author affiliations: [a]Laboratoire Interdisciplinaire Sciences Innovations Sociétés, Institut National de Recherche pour l'Agriculture, l'alimentation et l'Environnement, Université Gustave Eiffel, Cité Descartes, 5 bld Descartes, F-77545 Marne-la-vallée cedex 02, France; and [b]Manchester Institute of Innovation Research, University of Manchester, Booth Street West, M15 6PB, Manchester, UK

This paper is part of a Special Feature on Sustainability Transitions in Consumption-Production Systems. The collection of all PNAS Special Features in the Sustainability Science portal is available here: https://www.pnas.org/sustainability-science.

Author contributions: B.T. designed research; performed research; contributed new reagents/analytic tools; analyzed data; and wrote the paper.

Competing interest statement: F.K. and B.T. are coauthors on a Viewpoint article and a project report, both published in 2019.

This article is a PNAS Direct Submission. F.K. is a guest editor invited by the Editorial Board.

[1]Email: Bruno.turnheim@inrae.fr.

Published November 13, 2023.

Table 1. Terminological clarifications

Destabilisation	A process through which system stability becomes challenged
Decline	A reduction in system resources, performance, or influence
Phase-out	The intentional governance and management of system downsizing or input reduction

methodologically, there is a need for sharper descriptors to evaluate and explain destabilisation processes.

Further, the destabilisation and phase-out of established systems is being recognised as a governance objective in its own right, particularly for systems that are significantly resistant to pressures for change. In the context of climate change mitigation, for instance, the Intergovernmental Panel on Climate Change is explicitly recognising the phase-out of coal and carbon-intensive industries as a key policy objective for climate mitigation (5) and the need to envision new development models for coal-dependent regions or carbon-intensive industries (6, 7). In the context of agriculture and food systems, systemic dependences on pesticides and other external inputs are significant challenges (8) calling for dedicated phase-out strategies. Similar contexts can be observed in other sectors, such as with calls to shift away from cars in urban settings, phase-out consumer plastics, or move towards zero-waste manufacturing. These situations, besides requiring new means to ensuring associated societal functions (heat, power, light, mobility, food), call for an explicit focus on how to reduce, phase out, and deal with the aftermath of unsustainable systems potentially left behind. While long-term phase-out objectives have multiplied in recent years, there remain significant uncertainties about the effective means to implement such reduction objectives.

The next section puts forward a conceptual framework to make sense of and trace destabilisation processes. The empirical section provides illustrations from the history of tramway decline, with a particular focus on France and Paris. The dismantling of electric tramways in France was selected because it is an historical case of destabilisation followed by total system decline. It is particularly interesting because it combines slow dynamics (the gradual build-up of pressures, the gradual erosion of infrastructure, and maintenance commitments) with an accelerated final sequence of active phase-out. It provides keys to understanding the chain of events leading to phase-out programmes. The paper ends with a discussion of tranversal issues and a conclusion.

Conceptual Framework

This section focuses explicitly on the destabilisation of established systems in the context of socio-technical transitions in order to propose a conceptual framework compatible with the MLP. It argues for the importance of a *socio-technical* perspective on transitions and specifically on destabilisation processes.

The MLP provides a useful heuristic for understanding socio-technical transitions (4, 9) and making sense of a variety of possible transitions pathways (10, 11). Its most significant conceptual move is to articulate a multi-dimensional understanding of systems (conferred by socio-technical configurations) with a multi-level logic to explain how such systems change or remain dynamically stable, notably by distinguishing mechanisms operating at three levels of socio-technical structuration (niches, regimes, landscapes). The long-term stability observed in established socio-technical configurations is understood as resulting from the co-evolution of entities in different dimensions that can be traced over time: techno-economic (material artefacts, infrastructures, markets), institutional (rules, institutions), and relational (actors and their relationships) (12). As a result of such strong interdependences, socio-technical configurations have a tendency to resist or adapt to change, except when confronted to exceptional circumstances. At its core, the MLP involves two fundamental processes of change: 1) the emergence and stabilisation of radical innovations and 2) the reconfiguration of existing socio-technical systems.

Most work within transitions studies remains focused on the analysis of emergence and stabilisation of radical innovation, in particular alternatives offering significant advantages related to their improved technical performance and/or sustainability attributes. Such work hence naturally foregrounds the importance of niches as protective spaces for the development of radical innovations (13), as well as the fruitful conditions for radical innovations to break out of their niches to replace or reconfigure existing regimes (14). Other work still focuses on whole system reconfigurations to explore a variety of transitions pathways (10, 15). In both contexts, problems faced by established systems are essential for the development and successful deployment of alternatives: in early stages of transitions, they may motivate the search for alternatives while, in later stages, they can open up windows of opportunity for the deployment of alternatives. However, the particular dynamics of destabilisation are rarely foregrounded in such studies.

The proposition put forward here is, within the broad frame of the MLP, to focus specifically on what happens to established socio-technical systems when they face challenging conditions that question their deep-seated stability, i.e., their destabilisation and potential decline. This has become a research focus in its own right in transitions studies (3, 16).

The destabilisation of socio-technical systems can be defined as a "longitudinal process by which otherwise relatively stable systems become exposed to pressures significant enough to threaten their continued existence and "normal" functioning, triggering the deployment of strategies for system preservation (continuity) or transformation (change)" (3). How, then, to observe, make sense of, explain, and comparatively analyse system destabilisation from a *socio-technical* perspective?

The destabilisation of socio-technical systems involves the interaction of three core mechanisms, themselves folded into three dimensions (techno-economic, institutional, relational):

External pressures for change exerted on systems. These include techno-economic challenges (e.g., technological competition, shrinking demand, supply-chain problems, technical accidents), institutional challenges (e.g., legitimation and reputation problems, regulatory constraints), and relational challenges (e.g., changing ecologies of actors). Individual pressures can be perceived as episodic (shocks) or more enduring (stresses) (17) and vary in intensity. Pressures can build up (or recede) over time, and the interaction of multiple pressures influences the type of pressure fronts observed (18), which may be more or less challenging.

Strategic responses to such pressures by actors within systems. Incumbent actors are particularly resourceful and powerful actors assuming a position of centrality within established socio-technical systems (1, 19). They hence have much to lose from destabilisation. They tend to be driven by preservation imperatives and guided by incremental change logics, unless destabilisation contexts intensify so as to rule out continued existence without the enactment of transformative change. Nonetheless, strategic responses to external

challenges may differ significantly according to individuals within groups (20) and, over time, along a gradient from denial of problems, active resistance, and delay, to diversification attempts and the search for alternative paths (21, 22). Strategic responses can be observed along techno-economic (e.g., technical innovation, market positioning), institutional (e.g., reputation management, lobbying, institutional work), and relational dimensions (e.g., defensive alliance formation).

Changing commitments to reproductive activities within systems. The stability and inertia of established systems result from a combination of structural and enacted processes. While system stability can be actively defended and protected through strategic action (see above), it is also a latent outcome of reproductive engagements towards different dimensions of structure. Socio-technical systems are continuously being reproduced, maintained, and repaired (23), and such processes are essential to the *normal* and *stable* functioning of said systems. This concerns techno-economic dimensions (e.g., maintenance of infrastructures, repairs of defective or worn-out parts, resuming operations after technical incidents), institutional dimensions (e.g., legitimation, reproduction, and enforcement of rules), relational dimensions (e.g., maintenance and activation of social ties and networks), as well as practice dimensions (e.g., repeated and routine performance of practices). Conversely, interruptions or reduced commitments to reproductive activities, such as underinvestment in infrastructure maintenance, the abandonment of certain practices, decreasing commitments to formal and informal rules, or disengagement from support coalitions, can all contribute to the fragmentation of socio-technical systems (20).

In practice, these mechanisms can guide the analysis of destabilisation in historical or contemporary cases within which they can be traced. The specific way in which pressures, strategic responses, and changing commitments become articulated and combine over time is likely to produce a variety of destabilisation patterns, which may be analysed comparatively with reference to typologies of destabilisation pathways.

Results: The Dismantling of Tramways

The Decline of Electric Tramways. Tramways, once a central feature of most Western cities and the backbone of peri-urban passenger transport, have receded significantly in most European countries during the twentieth century. While this was a generalised process, it happened at different rates, speeds, and times. The number of towns with active electric tram systems has declined by over 90% of maximum capacity in France, England, and Italy, while countries like Sweden, Germany, and Austria maintained between 25% and 50% of systems active, and Russia continued tram expansion into the late twentieth century (Fig. 1). According to that same indicator, there are significant variations between peak dates, the duration of various rates of decline from peak, and the overall sharpness of decline. Among countries having almost fully phased out trams, England's appears as a particularly steep decline (which is due to a particularly aggressive phase-out campaign), while France and Italy have followed more gradual patterns. Similarly, Paris stands out as having experienced a radical tramway phase-out, with a steep decline from a peak 126 active lines in 1925 to only 1 by 1938 (Fig. 3).

Explaining Decline and Rapid Phase-Out as Outcomes of Gradual Destabilisation. A closer examination reveals that these dramatic decline figures were preceded by signs of multiple active destabilisation mechanisms. In the French case, for instance, following a staggering expansion of activity and investment, problems can be traced back to the turn of the century.

Despite their apparent success, tramways suffered from the *conflation of multiple pressures* (economic, technical, legitimacy, institutional), *poorly adapted response strategies,* and a general tendency towards *reduced commitments* that considerably weakened the system and its ability to adapt to rapidly changing circumstances.

Pressures. Economically, 1902 marks the beginning of a sectoral crisis for French tramways (24). The market for new electric tramway lines became saturated following a tremendous expansion, as it was adopted even in towns below the 30,000 inhabitants. The reduced market for the construction of new lines led to a gradual retreat of carriage manufacturers and their diversification to new activities, such as hydroelectric dams. The

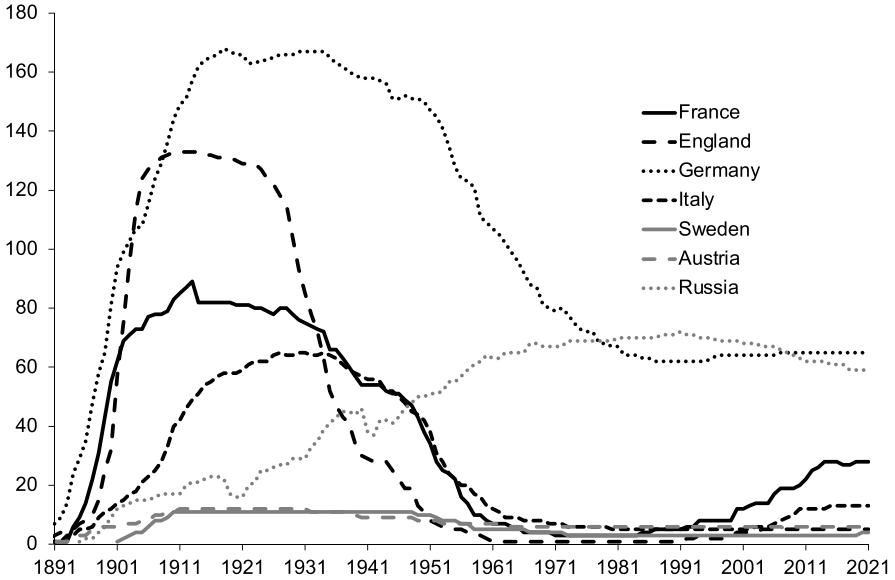

Fig. 1. Number of cities with active electric tramway networks, selected European countries (Note: the staggering expansions of the 1890s to 1900s include new networks and conversion of existing networks to electric traction).

tramway market slowdown, despite continuous ridership growth until 1925 (see Fig. 2 for Paris), also exposed financial viability problems for operators and their investors given that many lines were barely profitable (25, 26), particularly in smaller towns.

Technically, tramways were exposed to two major problems. First, the infrastructure was generally poorly maintained, which has been attributed to the low technical standard of tramways, line expansions leading to excessive wear and tear, low operating profitability discouraging maintenance or modernisation investments (27), and poor rates of rolling stock renewal. The general cultural hostility to overhead electrification, seen as an eyesore to French urban aesthetics, further delayed the generalisation of a much safer and less costly technical option (24). Paris networks rapidly converted to electric traction with overhead or ground lines between 1912 and 1914 following the network restructuration of 1910, but World War I discontinued the modernisation. Secondly, by contrast, motorbuses benefited from a positive modern image, as well as improved profitability as they grew in capacity and flexibility. The substitution of motorbuses and trolleybuses for tramways—first demonstrated in 1926 and applied more systematically from 1930 (28)—became a self-fulling prophecy (29). The generalised deployment of motorbuses both enabled and required the dismantling of tramway lines. Motorbuses eventually replaced tramways as the main overground mode of public transport in Paris (Fig. 2).

Legitimacy problems also plagued French tramways, namely concerning democratisation and congestion. In Paris, the tramway had, since its inception, been objected to by the bourgeois class on aesthetic grounds as well as on social grounds because it effectively connected poor peripheral zones to affluent central neighbourhoods (29). Tramways became increasingly associated with poorer users as it expanded into peri-urban areas and price reductions allowed its democratisation. The retreat of first-class zoning signalled the end of leisurely tramway travel—an indication of reduced desirability for affluent social groups. Furthermore, electric tramways did not benefit from dedicated infrastructure adjustments. Line routes, often inherited from previous generations of horse or steam traction tramways, shared road space with other forms of locomotion. They did not benefit from any particular kind of protection or traffic priority (29). Tramway lines were not redesigned in accordance with the new travel speeds made possible by electric traction and the rapid urbanisation rates calling for greater commuting distances. This resulted in important congestion problems that both reduced the convenience of trams and later became seen as a major obstacle to the deployment of automobiles.

Institutionally, the rules and regulatory framework guiding tramway concessions and operations was poorly adapted to the technological and urban transformation promise of tramway systems. Indeed, disengaged public administrations failed to envision the potential for peri-urban line extensions (as opposed to their German counterparts) or to adapt regulations to the specificities of electric traction, such as segregated lines that could have enabled faster speeds and prevented important congestion problems (29).

So, French tramways became exposed to a multiplicity of problems that together generated a destabilisation pressure front. This, however, is not enough to explain their decline. Indeed, this pressure front was exacerbated by *reduced commitments* (which led to a gradual erosion of infrastructure and services), as well as the incoherence of *strategic responses*.

Reduced Commitments and Incoherent Response Strategies. Confronted with structural financial problems, tramways suffered from a chronic lack of investment in infrastructure and maintenance. Rolling stock renewal did not follow the growth of tramway passengers—electric tramway engine orders decreased steadily between 1900 and 1925 (24)—hence contributing to overall service degradation. The failed modernisation of tramways, which restructuring only partly rectified, also contributed to its loss of desirability among users and operators, notably relative to the advent of the motorbus. While motorised transport had many advocates and symbolised modernity, tramways did not benefit from significant advocacy.

Actors engaged with tramway construction and operations did not offer significant resistance to the various pressures. A heterogenous and distributed industry led the way to concentration and coordination of public transport operations, but these new actors had no real commitment to tramways and offered no particular resistance to the advent of the motorbus, to which they largely contributed. Similarly, the lack of a nationally structured electrical industry meant that tramway construction interests were thin (24).

The Compagnie Française pour l'exploitation des procédés Thomson-Houston—a French subsidiary of General

Fig. 2. Public transport passengers in Paris, 1910 to 1938.

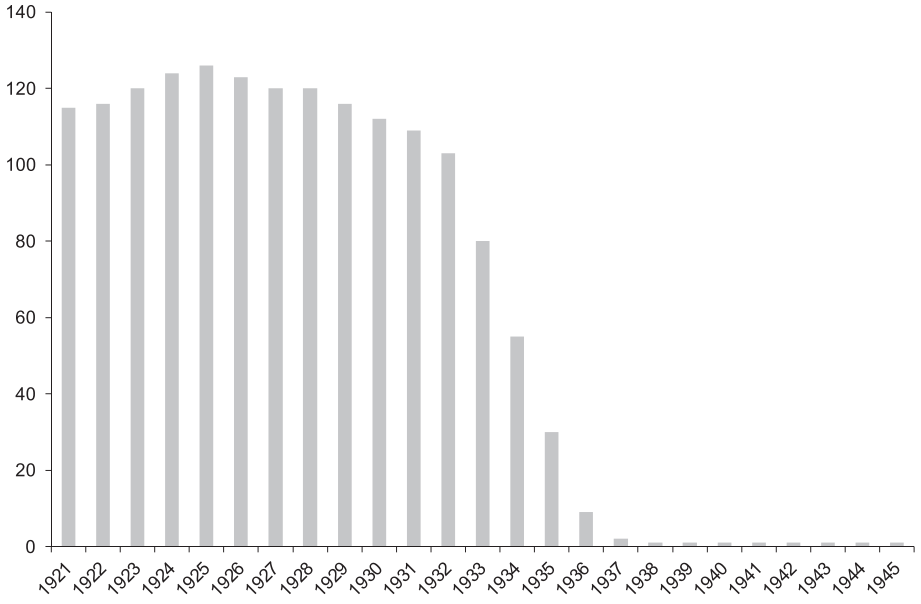

Fig. 3. Number of active tram lines in and around Paris, 1921 to 1945.

Electric—became a dominant actor of tramway development and operations, notably through financial acquisition of tramway and electric companies. It held 50 tramway companies by 1902, but disengaged from tramway production soon thereafter by diversifying into hydroelectric dams, long-range electric transmission, and telephone infrastructure (26).

The organisation and administration of public passenger transport were chaotic, with as many as 12 operators in Paris and multiple conflicting public policy frameworks (28). The restructuration of 1910 allowed the amalgamation of lines and partial modernisation, but it was interrupted by the war. 1921 marked a more significant restructuring, as tramway and omnibus operations were licensed to a single organisation, the Société des Transports en Commun de la Région Parisienne (STCRP), hence bundling the operation of 112 electric tramway lines (over 960 km and 2,500 tramways), 41 bus lines (over 250 km and 734 buses) (30, 31), and bringing them under the exclusive public ownership of the Department of the Seine. Despite its explicit mission to harmonise access to public transport throughout the city (i.e., maintaining unprofitable lines where necessary), the STRCP routinely entered into conflict with local authorities over the lack of investment in peripheral lines (28). Public actors did not show much stamina in upholding the principles of accessible public transport and urban planning that could have maintained an interest in tramways as a viable technological option (24)—for instance, ambitious but costly plans for "express" tramway lines linking Paris to its rapidly (but chaotically) growing suburbs never materialised (31). The STCRP initiated a rationalisation programme: tramway line closures, extensions, new connections between disjoined networks, and replacement by motorbuses on demonstration lines from 1926 (28). An unevenly distributed modernisation programme nonetheless did not succeed in ensuring the newly-embraced need for 'profitability' of tramways.

The disengagement of market and policy actors and decreasing commitments to reproductive activities (infrastructure maintenance, modernisation, fleet renewal, adaptation of rules) thus led to a gradual and lasting erosion of service: Tramways had been effectively hollowed out. Following initial municipal proposals in 1924 (32), and the conclusive closure of a few redundant lines between 1926 and 1928, the 1929 decision to dismantle all inner-city tramways in Paris within 5 years, in the middle of a general economic recession, officially sanctioned this systematic abandonment. The decision was followed by an impressive phase-out throughout Paris. The dismantling programme, though initially planned for Paris only with the expectation that suburban networks would stabilise the changes, was extended in 1932 to its outskirts (31). In less than 10 years, virtually all tramway lines had been dismantled at an impressive pace (Fig. 3), with an accelerated closure rate of over 20 annual lines closing between 1933 and 1936. While only a small fraction of the rolling stock was sold to provincial towns, most of it was scrapped (31). The phase-out of tramways spread throughout the country, first to smaller cities, and then to larger ones, well before the mass generalisation of automobility (33), and at a time when many international capitals were modernising their tramway networks. The few tramway lines still operating in France after 1960 were perceived as remnants of a now outdated past (29).

To sum up, the French tramway phase-out, as drastic as its realisation may seem, given the acceleration of line closures, was preceded by nearly three decades of destabilisation marked by chronic problems and gradual retreat technically, politically, and economically. There was no particularly eventful triggering event in the destabilisation process, which rather followed a *gradual erosion* pattern. The decision to systematically dismantle tramways, enacting the phase-out, was the last nail in the coffin.

Discussion: Making Sense of Destabilisation Patterns

Destabilisation can follow a variety of patterns which can be empirically explored in cases. Typologies provide a useful way to make sense of such empirical variety, notably since they allow the specification of possible variants. Here, I discuss relevant dimensions of variation across cases, including:

* The duration and speed of destabilisation, and the timing of interactions between relevant mechanisms
* The timing of phase-out decisions along destabilisation sequences
* Interaction with innovation processes.

Temporal Issues. Destabilisation, decline, and phase-out raise temporal issues about their duration, speed, and timing. "How long does it take?" is an important question for transitions (34–36) that has been applied to the formative and diffusion phases of innovation (37, 38) and more recently to relative decline rates in fossil fuels (39). The duration of system decline varies significantly across cases, whether these concern different sectors, systems, and/or geographical contexts, as illustrated with the different rates of tramway decline observed in various European countries (Fig. 1). Further, the French tramway case illustrates that, just as the diffusion of innovations is a cumulative process, the tramway phase-out also spread from city to city, first in Paris, rapidly followed by smaller cities, and only two decades later by larger cities. However, it is also important to note that the phase-out of electric tramways in Paris stands out as a particularly rapid phase-out of infrastructural systems, owing in particular to 1) the accumulation of technical, organisational, and institutional problems, 2) the wartime interruption of a modernisation programme, 3) a general state of underinvestment, 4) the availability of a substitute (motorbuses) bestowed with additional benefits (e.g., flexibility), and 5) the lack of organised supporters (e.g., users or operators) in a position to defend the tramway.

The French tramway case is also striking in terms of the scope of decline, with next to all tramway networks dismantled within 30 years, while countries like Germany, Austria, Sweden, or Russia did not follow this radical pattern (Fig. 1), maintaining and modernising a significant proportion of their tramway systems instead (27). A possible explanation for the near-total decline (also observed in England and Italy) is that tramways became framed as an "obstacle" to the advent of modern forms of passenger travel (e.g., motorbuses and cars). In other words, they got into the way of 'more desirable' (urban) development trajectories that called for the exclusive mobilisation of roads.

While shocks can be important for triggering, accelerating, or orienting destabilisation [Ref. Johnstone and Schot, this issue], they had a more indirect effect in this case. By delaying the restructuration and modernisation of the Parisian tramway system, World War I punctually interrupted its "normal" functioning and development. The delayed maintenance of the Parisian tramway system contributed to its further degradation and weakening on technical, economic, and political terms. So, while the 1921 restructuration marked the theoretical possibility of a post-shock return to normal functioning, conditions had changed significantly. The post-war modernisation of the tramway system favoured profitability-oriented rationalisation over the maintenance of universal public service and supporting infrastructure.

Phase-Out Decisions along Destabilisation Sequences. Phase-out decisions do not appear out of the blue; they require the combination of favourable conditions and are often preceded by significant delegitimation pressures, the weakening of reproductive engagements, and reduced capacity of incumbents to resist challenges. In this respect, decline and phase-out are very visible outcomes of long-winded and cumulative destabilisation processes. It appears important to avoid reifying phase-out decisions as major policy landmarks irrespective of the context within which they intervene. While indeed, they may have an important signalling effect or be inscribed in deliberate long-term planning, they are often mere symbolic announcements officially sanctioning a reality of decline already underway, as evidenced in the French tramway phase-out decisions. Decisions to phase-out systems, substances or practices often intervene "after the fact", once destabilisation and decline are already underway, rather than the beginning of a self-inflicted destabilisation trajectory. Recent national pledges to phase-out coal, for instance, are not as committing as they may seem given that most countries (besides Germany and the Netherlands) made them in circumstances "when potential stranded assets, employment losses, regional impacts, and other costs [were] low" (40) and should be critically examined in light of the conditions in which these have been announced (e.g., structural ageing of coal power capacity, low domestic coal production commitments).

Furthermore, phase-out policies can be introduced *before* destabilisation such as with the introduction of zero-pesticides or pesticide reduction objectives in agriculture (in which case, they may trigger a destabilisation sequence), *during* destabilisation, as with the second German nuclear phase-out following the Fukushima crisis (in which case they may modulate, orient, or accelerate destabilisation), or *after* destabilisation, as with the 2015 UK phase-out of unabated coal (in which case they can more accurately be seen as the "final nail in the coffin"). In certain cases, such as nuclear phase-outs, the shutdown of nuclear reactors is only the beginning of a long and uncertain road towards decommissioning (41), highlighting the importance of developing approaches for technological aftercare (42).

Destabilisation and Innovation: A Two-Way Interaction. Destabilisation and novelty creation are intertwined in transition processes (43), and their particular interaction determines the unfolding of transitions pathways.

The stability of established systems (through lock-ins or active resistance) tends to prevent the deployment of alternative systems and related innovations. This implies that transitions are rare phenomena because established systems and regimes will favour incremental innovation logics over deeper system transformations—keeping destabilisation pressures at bay. Concerning French tramways, for instance, the conversion to electric traction was an ineffective adaptive response, because it was not combined with deeper transformations of infrastructure (tracks), rules (e.g., speed regulations), or practices. The partial modernisation of French tramways temporarily prolonged system relevance, but failed to reinvent or consolidate their purpose, and so left them exposed to the pressure of alternative systems when they eventually emerged and became legitimated.

Indeed, the destabilisation of established systems is likely to open up opportunities for alternative systems. The destabilisation of French tramways developed and worsened as a result of neglected maintenance and a lack of organised resistance to problems (e.g., degraded performance, poor economic incentives, regulatory misalignment, user dissatisfaction, reduced legitimacy, and "outdatedness"). This generated a propitious context for the development of alternative urban transport innovations, which could position themselves in contradistinction to these negative framings: motorbuses were framed as flexible, safe, free from congestion, modern, and their higher cost decreased rapidly.

Furthermore, the successful deployment of alternative systems may *require* the phase-out of established systems, particularly in cases where they are perceived as mutually exclusive. Indeed, tramways were seen as a major obstacle to the development of urban motorised transport, because they monopolised and congested road space. As a result, the accelerated dismantling of tramway tracks was bolstered by the perception that urban congestion—largely attributed to tramways—was the main obstacle to motorised transport. In cases where operating space is not seen as mutually exclusive (like power generation, multi-modal transport, or crop choice), multiple systems may more readily co-exist side-by-side.

Innovation around alternative systems may threaten established systems, particularly if they promise superior performance against established criteria (e.g., faster, further, safer, cheaper) or entirely new performance criteria (e.g., congestion, flexible route planning). In the French tramways case, however, while the motorbus provided additional pressure to close tramway lines, it only precipitated a decline process that had prior origins: gradual system erosion through neglectful maintenance and dispersed agency.

Conclusion

Destabilisation is a crucial process in any transition: i) the destabilisation of established systems is necessary for novel systems to emerge and breakthrough, and ii) as alternative socio-technical propositions gain momentum, they generate challenges for established systems. Insights from destabilisation cases are essential for the development of collective intelligence about the means to reduce dependence to undesirable systems: destabilisation, decline, and phase-out offer a complementary outlook on potential solutions to address sustainability transitions.

This paper has contributed to working destabilisation into the MLP more explicitly. Indeed, examining destabilisation implies zooming in on the structure, functioning and fate of established systems. This paper has elaborated and analysed destabilisation mechanisms. External *pressures* arise from landscapes (shocks, stresses, and long-term conjectures), innovation niches, but also a number of orthogonal spaces with "niche-like" structures such as social movements whose innovative activity is oriented towards sociopolitical dimensions. Internal tensions arise from interruptions of reproductive activities within systems, whether this is through negligence (non-reproduction), through *weakening commitments* or through more active detachment from established logics. *Strategic action* by incumbent actors with vested interests in established systems is deployed to address external and internal challenges, usually towards preservation objectives but also towards transformation under certain conditions. Together these three mechanisms combine to generate a variety of possible destabilisation pathways.

There is a variety of possible destabilisation pathways, contexts, and enactment conditions. In terms of dynamics, destabilisation pathways may be gradual or accelerated. Accelerated destabilisation patterns—though possibly desirable from the perspective of the achievement of goals such as environmental sustainability—may also lead to more disruptive social and injustice outcomes if not combined with appropriate anticipation of losses and communities left behind. Patterns may also differ in terms of the main causal chains involved: crisis-induced paths are significantly different to gradual erosion paths or interrupted paths. Lastly, the orientations and outcomes of destabilisation processes also vary significantly: destabilisation cannot be assumed to be sustainable or just, or to be an inevitable and irreversible process.

Better understanding destabilisation pathways is crucial for navigating, anticipating, and governing sustainability transitions, notably in the context of their acceleration. There is a wide range of intervention strategies available, with very different implications on the speed and scope of transitions as well as their redistributive outcomes.

As society engages deeper with issues of system destabilisation and the legitimation of deliberate destabilisation towards sustainability goals, important questions no doubt arise: Which systems are most in need of deliberate destabilisation (e.g., those linked to the greatest sustainability impacts and/or deepest forms of incumbencies)? What are the main trade-offs involved with accelerating the phase-out of undesirable systems? How can these trade-offs be anticipated and minimised? How can we ensure that deliberate destabilisation efforts are targeting the most unsustainable systems and delivering lasting sustainability outcomes?

Materials and Methods

Data for the figures and tables were compiled from secondary sources, publicly accessible databases, and records. For Fig. 1, these included secondary sources for historical networks (44–52) and desk research for contemporary networks; for Fig. 2, data were drawn from a secondary source (31); for Fig. 3, data were compiled based on historical records maintained by the non-profit organisation FACS–Patrimoine Ferroviaire (retrieved from www.facs-patrimoine-ferroviaire.fr).

Data, Materials, and Software Availability. All study data are included in the main text.

ACKNOWLEDGMENTS. This work benefited from state assistance managed by the French National Research Agency under the "Programme d'Investissements d'Avenir" integrated to France 2030 attributed to the WAYS-OUT project under grant number ANR-19-MPGA-0010.

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