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The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014)

Frank W. Geels[a,*], Florian Kern[b], Gerhard Fuchs[c], Nele Hinderer[c], Gregor Kungl[c], Josephine Mylan[a], Mario Neukirch[c], Sandra Wassermann[d]

[a] Sustainable Consumption Institute, Manchester Institute of Innovation Research, University of Manchester, Manchester, UK
[b] SPRU, University of Sussex, Brighton, UK
[c] Institute for Social Sciences, University of Stuttgart, Stuttgart, Germany
[d] Center for Interdisciplinary Risk and Innovation Studies, University of Stuttgart, Stuttgart, Germany

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ABSTRACT

This paper aims to make two contributions to the sustainability transitions literature, in particular the Geels and Schot (2007. Res. Policy 36(3), 399) transition pathways typology. First, it reformulates and differentiates the typology through the lens of endogenous enactment, identifying the main patterns for actors, formal institutions, and technologies. Second, it suggests that transitions may shift between pathways, depending on struggles over technology deployment and institutions. Both contributions are demonstrated with a comparative analysis of unfolding low-carbon electricity transitions in Germany and the UK between 1990–2014. The analysis shows that Germany is on a substitution pathway, enacted by new entrants deploying small-scale renewable electricity technologies (RETs), while the UK is on a transformation pathway, enacted by incumbent actors deploying large-scale RETs. Further analysis shows that the German transition has recently shifted from a 'stretch-and-transform' substitution pathway to a 'fit-and-conform' pathway, because of a fightback from utilities and altered institutions. It also shows that the UK transition moved from moderate to substantial incumbent reorientation, as government policies became stronger. Recent policy changes, however, substantially downscaled UK renewables support, which is likely to shift the transition back to weaker reorientation.

1. Introduction

Early work on socio-technical transitions (Rip and Kemp, 1998; Geels, 2004) emphasized the importance of alignments between developments at multiple levels, characterized in the multi-level perspective (MLP) as niche-innovations, existing regimes and exogenous landscape. Geels and Schot (2007) subsequently suggested that different *kinds* of alignments lead to different transition pathways. They constructed a typology based on combinations between two dimensions: the *timing* and *nature* of multi-level interactions. This led them to distinguish four transition pathways: (1) *technological substitution*, based on disruptive niche-innovations which are sufficiently developed when landscape pressure occurs, (2) *transformation*, in which landscape pressures stimulate incumbent actors to gradually adjust the regime, when niche-innovations are not sufficiently developed, (3) *reconfiguration*, based on symbiotic niche-innovations that are incorporated into the regime and trigger further (architectural) adjustments under landscape pressure, (4) *de-alignment and re-alignment*, in which major landscape pressures destabilize the regime when niche-innovations are insufficiently developed; the prolonged co-existence of niche-innovations is followed by re-creation of a new regime around one of them. Geels and Schot (2007) further proposed that a transition may shift between pathways: "If landscape pressure takes the form of 'disruptive change', a sequence of transition pathways is likely, beginning with transformation, then leading to reconfiguration, and possibly followed by substitution or de-alignment and re-alignment" (p. 413).

While this pathways typology has been useful, it is mainly formulated in processual and phenomenological terms. The typology pays limited explicit attention to agency and institutions. The influence of landscape developments arguably depends not only on timing (compared to niche and regime developments), but also on interpretation and mobilization by actors. Furthermore, whether

* Corresponding author. Tel.: +44 1612757374.
E-mail address: frank.geels@manchester.ac.uk (F.W. Geels).

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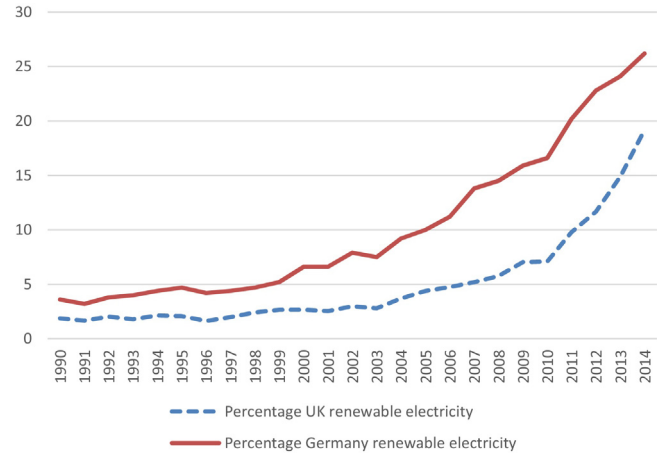

Fig. 1. Percentage of UK and German renewable electricity, 1990–2014 (data from DUKES and AG Energiebilanzen (http://www.ag-energiebilanzen.de/, last accessed June 30, 2015).

niche-innovations are 'symbiotic' or 'disruptive' depends not only on technical characteristics, but also on how such innovations are configured and institutionally embedded. The current pathways typology represents a 'global' (or 'outside-in') conceptual logic, which Poole and Van de Ven (1989: 643) characterize as depicting "the overall course of development of an innovation" which "takes as its unit of analysis the overall trajectories, paths, phases, or stages in the development of an innovation". They contrast this with a 'local' (or 'inside-out') conceptual logic which depicts "the immediate action processes that create short-run developmental patterns" and focuses on "the micro ideas, decisions, actions or events of particular developmental episodes". Building on their suggestion that process theories should ideally have both logics, the paper's first aim is to develop the 'local' logic of the transition pathways typology. So, we aim to reformulate and differentiate the existing transition pathways in terms of endogenous enactment, using the conceptual categories from Geels (2004), who distinguished between: (1) actors and social groups, (2) rules and institutions, and (3) technologies and wider socio-technical system. Our reformulation strategy, first, brings together and systematizes insights from other transition papers and, second, imports some ideas from other literatures. The second aim is to develop alternative understandings of shifts between transition pathways, which depend less on external landscape pressure and more on shifting actor coalitions, struggles, and adjustments in formal rules and institutions.

To demonstrate our contributions, we present a comparative analysis of the unfolding low-carbon electricity transitions in the UK and Germany. Both countries have developed ambitious electricity transition plans. Following the 2011 Fukushima nuclear accident, the German government adopted an official energy transition strategy, the *Energiewende*, which included a nuclear phase-out by 2022 and renewable electricity goals of 35% by 2020, 40–45% by 2025, 55–60% by 2035 and 80% by 2050. The 2008 UK Climate Change Act committed to 80% reduction of greenhouse gas (GHG) emissions by 2050. The UK Low Carbon Transition Plan (2009) articulated a target of 30% renewable electricity by 2020 and almost complete decarbonisation of electricity by 2030. Both countries have made some progress, with the contribution of renewables to power generation increasing between 1990 and 2014 from 3.6% to 26.2% in Germany and from 1.9% to 19.1% in the UK (Fig. 1).

We will show that both countries followed very different transition pathways, with Germany enacting a technological substitution pathway (which we characterize as 'unleashing new entrants') and the UK a transformation pathway (which we characterize as 'working with incumbents'). Analysing actors, institutions, and deployed technologies, we also show how struggles and conflicts led to shifts between transition pathways in both countries.

Section 2 describes our conceptual reformulations and differentiations of the transition pathways typology. Section 3 discusses case-selection and data sources. Sections 4 and 5 present analyses of the UK and German electricity transitions. Section 6 discusses findings. Section 7 offers conclusions.

2. Conceptual perspective

2.1. Background assumptions

Before reformulating the transition pathways typology (Section 2.2), we briefly explicate our assumptions about agency and indicate how a 'local' (enactment) logic can be related to the 'global' MLP logic (of trajectories and alignments). This is also important because some scholars have (incorrectly in our view) claimed that the MLP does not accommodate agency, conflict and struggle. Drawing on insights from science and technology studies (STS), evolutionary economics and neo-institutional theory, Geels (2004) distinguished between: (1) actors and social groups, (2) rules and institutions, (3) technologies and socio-technical system, and articulated dynamic interactions. He used the metaphor of socially embedded 'game playing' to emphasize the moves and countermoves of actors and social groups, which are constrained by 'rules of the game' and oriented towards reproducing or modifying elements of socio-technical systems. "In each round actors make 'moves', i.e. they do something, e.g. make investment decisions about R&D directions, introduce new technologies in the market, develop new regulations, propose new scientific hypotheses. These actions maintain or change aspects of ST-systems. The dynamic is game-like because actors react to each other's moves" (Geels, 2004: 909). These games include interpretations and power: "Different actors do not have equal power or strength. They have unequal resources (e.g. money, knowledge, tools) and opportunities to realize their purposes and interest, and influence social rules. The framework leaves room for conflict and power struggles. After all, there is something at stake in the games" (p. 909).

Geels and Schot (2010) further elaborated these notions and articulated the link between agency and field-level trajectories. They suggested that a trajectory can be conceptualized as a sequence of events (or 'event chain') and that each event can be analysed in terms of more specific 'morphogenetic cycles' (Archer, 1982), constituted by four successive mechanisms (Fig. 2): (1) structural conditioning of actors by existing rules and institutions, (2) social interaction between actors (search, learning, collaboration, sense-making, conflict, moves, countermoves), (3) structural elaboration (reproduction of rules and institutions or efforts to modify them via institutional entrepreneurship), and (4) externalization and institutionalization (acceptance and retention of rule changes). This conceptualization means that trajectories in the MLP are always enacted and that even stable trajectories require continuous effort by actors (via reproduction).

This basic conceptualisation of the enactment of trajectories informs our reformulation of transition pathways below, which vary in terms of who the dominant actors are and how they shape the reproduction or change of rules and institutions. This

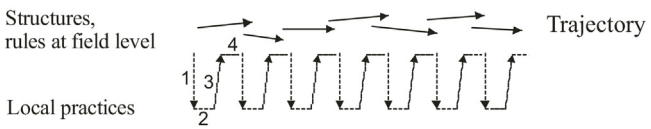

Fig. 2. Trajectory as field-level event chain, resulting from successive morphogenetic cycles (Geels and Schot, 2010: 52).