

**ADVANCED REVIEW**

# The overlooked role of discourse in breaking carbon lock-in: The case of the German energy transition

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Over the last 15 years, research on carbon lock-in has investigated why decarbonization evolves so slowly in Western industrialized countries. In this paper, we argue that the role of discourses has been overlooked in the literature on carbon lock-in. We argue that discourses are both part of lock-in mechanisms and, using the concept of discursive turning points, important factors in explaining change. This implies that we need to carefully investigate the dominant discourses that constitute and justify the very technologies, institutions and behaviors of the status quo. For the case of the German energy transition, we demonstrate the importance of discursive turning points for overcoming carbon lock-in, based on a literature review. Germany's long-standing lock-in of fossil fuels and nuclear power was undermined by the rise of the energy transition discourse. This discourse transitioned from a very marginal position to dominance through a number of factors, winning against the energy mix discourse. Over time the energy transition discourse became de-radicalized. Coal has been able to defend its role in the German energy mix in the name of affordability and energy security. While renewables continue to grow, this happens alongside a remaining carbon lock-in. We conclude that discursive lock-in and discursive turning points are useful analytical tools that help to explain how the transition to renewable energies unfolds. In future research, the interaction between discursive lock-ins and other types of lock-in should be investigated.

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**1 | INTRODUCTION**

The German energy transition counts as one of the leading examples of successful decarbonization in the struggle against dangerous climate change. However, while renewable energies have been added to a complex mix of incumbent energy technologies, they have not yet replaced it. Why is the low-carbon transition so difficult? According to Unruh, there are “macro-level forces that can create systematic barriers” (2000, p. 819) to a transition away from fossil fuel-based technological and

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institutional systems. Unruh called these systematic barriers a “carbon lock-in” (2002, p. 318). He distinguished between technological, organizational, industrial, societal and institutional sources of this carbon “lock-in” (Unruh, 2002, p. 318). Over the last 15 years, carbon lock-ins have become a popular field of research (Unruh & Carrillo-Hermosilla, 2006). In their seminal review of the literature on carbon lock-in, Seto et al. (2016) discuss insights on infrastructural/technological lock-in, institutional lock-in and behavioral lock-in. In this article, we argue that discursive carbon lock-ins, their interaction with other types of lock-in, and their essential role in explaining stability and change have been overlooked in the current literature on carbon lock-in.

We consider discourse as a crucial dimension of lock-in. French historian Michel Foucault (1980) has argued that language is not descriptive of reality, but constitutive of it. A discourse assigns meaning, defines power relations and creates subjects and objects through practices. A discourse is always in competition with other discourses and is struggling for its reproduction (by practices) and for dominance in a field. For the topic of lock-ins, this implies that we should also carefully investigate the dominant discourses that constitute and justify the very technologies, institutions and behaviors of the status quo.

For the case of the German energy transition, we demonstrate the importance of discourses in sustaining and overcoming carbon lock-in based on a literature review. In this article, we review four decisive change points in the unfolding of the German energy transition and study the role of discourses in each of them. Firstly, we investigate how a newly-elected Red-Green government set up the Renewable Energy Act in the year 2000 and successfully negotiated the phase-out of nuclear energy, thereby promoting a radical regime change towards renewables. Secondly, we investigate how a newly elected Conservative-Liberal government reversed Red-Green nuclear phase-out policy and extended the operating times for nuclear power in 2010. Third, we study how the same Conservative-Liberal government performed a U-turn towards shorter operating times for nuclear power in the light of the accident in Fukushima in March 2011, thereby reinforcing the (discursive) lock-in of coal. Finally, we study the reforms of the Renewable Energy Act in 2014 and 2016 by a Conservative-Social Democrat government, and the continuing struggle about when and how to end the mining and burning of lignite coal. What was the role of discourses in bringing about these policy changes?

The next section gives a short introduction to the literature on path dependency and lock-in. We highlight the importance of ideas and discourses in this literature and develop the concepts of discursive lock-in and discursive turning point. In addition, we quickly review the literature on path dependency and carbon lock-in: We highlight that discursive lock-ins and the role of discourses in overcoming them has been overlooked and develop the concept of discursive carbon lock-in. Section 3 explains the sampling strategy of this review paper. Section 4 introduces the German energy transition. Based on a literature review, we argue that the history of the German energy transition is best understood as a struggle between two competing discourse coalitions, namely the energy transition discourse and the energy mix discourse. We investigate how the discourse coalitions sustained their respective discourse and how hegemony became disrupted, for example, through an external event like the nuclear accident in Fukushima. We show that the energy transition discourse has established a space for renewable energies alongside a continuing discursive carbon lock-in.

In the discussion, Section 5, we suggest that a suitable approach to the study of carbon lock-in should address discourse as underlying all other three types of lock-in (technological, institutional, behavioral) and study them in an integrated approach. The interaction between all four types of lock-in needs to be better explored in future research. We conclude in Section 6 that the inclusion of discourses in the study of carbon lock-in fills an important explanatory gap.

## 2 | THEORIZING DISCURSIVE CARBON LOCK-IN

### 2.1 | Theorizing path dependency

This section develops an understanding of the concept of path dependency and its underlying mechanisms of reproduction based on the political science literature on this topic. Krasner has claimed that “path dependent patterns are characterized by *self-reinforcing positive feedback*” (1988, p. 83). Pierson (2000) has defined path dependency in line with the concept of increasing returns: “Each step along a particular path produces consequences which make that path more attractive for the next round. As such effects begin to accumulate, they generate a powerful virtuous (or vicious) cycle of self-reinforcing activity” (Pierson, 2000, p. 253). According to Pierson (2000, p. 254), four mechanisms developed for economic applications by Arthur (1994, pp. 112–114) contribute to explaining path dependency in the realm of political science. These are (a) high exit costs, (b) learning effects, (c) coordination effects and (d) self-fulfilling expectations. High set-up costs imply high exit costs making a later turn-around cost-intensive. Learning-by-doing leads to learning effects among users, making the use of the learned option more efficient over time. Third, coordination effects occur when “the benefits an individual receives from a particular activity increase as others adopt the same option” (Pierson, 2000, p. 254). Pierson calls these benefits “network externalities”

(2000, p. 254). Finally, as users seek to avoid drawbacks later on, their (self-fulfilling) expectations about what others will do influences which choice they make now.

Ikenberry (1994) argued that institutions also have distributional effects. Institutions create their own constituencies of beneficiaries who defend institutional reproduction. Institutional sociologists have observed that new institutions tend to be mirrored on existing ones, resulting in institutional isomorphism. The mechanism behind isomorphism is supposedly cognitive (Thelen, 1999, pp. 386–387). Pierson has observed that actors who want to redistribute political authority in their favor also often draw on seemingly small institutional changes that enhance their competitive advantage dramatically over time through mechanisms of increasing returns (Pierson, 2000, p. 259).

However, historical institutionalists challenge too deterministic readings of the concept of path dependency. They highlight that adoption by an early mover is not the end of the story—“further choice points exist” (Thelen, 1999, p. 386). Historical analyses show that many institutions with early-comer advantages did not last long in the absence of mechanisms that reproduce them (Thelen, 1999, p. 391). Thelen (1999) has famously argued that institutional stability over time actually requires explanation: “The language of ‘lock-in’ frequently obscures the fact that, because institutions are embedded in a context that is constantly changing, stability—far from being automatic—may have to be sustained politically” (p. 396). Moreover, many concepts of path dependency overlook the role of conflict and power in the constitution and lock-in of institutions. For historical institutionalists, institutions are always “enduring legacies of political struggles” (Thelen, 1999, p. 388) so there is no determinism or automaticity to path dependency.

Historical institutionalists are good at explaining stability through such mechanisms of path dependency. But how can change be explained? According to Kingdon (2003) so-called windows of opportunity open in response to external shocks and are then exploited by policy entrepreneurs to promote a policy change (Erickson, Kartha, Michael, & Tempest, 2015). However, which direction a policy response to a shock takes, depends not only on policy entrepreneurship but also on the pre-existing political, social, and economic context (e.g., Stenzel & Frenzel, 2008). Process-sequencing models of policy-making over time (Howlett & Rayner, 2006) have emphasized that the outcomes at historical switch points are “firmly based or rooted in previous events and thinking as related structural processes of both negative and positive feedback [which] affect actor behaviour” (Howlett, 2009, p. 250). Historical institutionalists argue that path dependency can be disrupted across policy fields, across policy levels and across time. Weir (1992) suggests that the “unexpected ‘collision’ of two (previously) unconnected policy streams” (Thelen, 1999, p. 396) can derail prior path dependencies, leading to unforeseen outcomes. Pierson (1996) highlights “gaps” between levels of action and time “lags” between short and long-term events both of which create space for new actors to influence institutional development in surprising ways. Thelen distinguishes “ideational and material foundations” of institutions which “if shaken, open possibilities for change” (1999, p. 397). In line with this, the same external trend affects the reproduction of different institutions differently: depending on the mechanisms of reproduction in question.

On the basis of the above review of literature on path dependency, we define lock-in as “temporary stabilization of paths-in-the-making” (Garud, Gehman, & Karnoe, 2010, p. 760) and allow for the option that self-reinforcing mechanisms could be “strategically manipulated” for the purpose of “path creation.” Following Becker et al. (2016, p. 27), we define path creation as moments where “agency determines the outcome of events and the direction of institutional change.” If a change will really lead to a new path or be short-lived depends on whether any mechanisms of increasing returns have been established (Becker et al., 2016, p. 37). Any empirical analysis must therefore look for these mechanisms.

## 2.2 | Theorizing discursive lock-in

Of particular interest for our idea of discursive lock-in is Pierson's observation that

“understandings of the political world should themselves be seen as susceptible to path dependence [...] The development of basic social understandings involves high start-up costs and learning effects; they are frequently shared with other social actors in ways that create network effects and adaptive expectations. The need to employ mental maps induces increasing returns.” (Pierson, 2000, p. 260)

Pierson goes on to insist that once established, such mental maps or understandings are path dependent, both at the individual level and at the level of social groups. Other theoretical traditions have conceptualized the ideational foundations which stabilize institutions and actor roles as “frames” (Schön & Rein, 1994) or as “discourses” (Hajer, 1995; Schmidt, 2008).

Schön and Rein (1994) define frames as “underlying structures of belief, perception, and appreciation” (p. 23). A frame offers a lens through which observations of reality can be made sense of. A frame works a bit like a filter—it is always selective (Schön & Rein, 1994, p. 30). The frame structures perception in such a way that in the observation of (social) reality and its articulation in words the frame itself is reproduced. For those who perceive social reality through the lens of one particular frame, alternative frames don't make sense. They see different facts and are persuaded by other causalities: “Such disputes are

resistant to resolution by appeal to facts or reasoned argumentation because the parties' conflicting frames determine what counts as a fact and what arguments are taken to be relevant and compelling." (Schön & Rein, 1994, p. 23). This explains the key mechanism of frame stability: frames are self-reinforcing. This implies that a change in frame cannot be achieved through the means of rational argumentation as each frame has its own idea of rationality.

A second and more widespread conceptualization of the role of ideas in bringing about institutional change (and to a lesser extent path dependence) is found in discourse analysis (Hajer, 1995) or discursive institutionalism (Schmidt, 2008). A discourse perspective starts from the assumption that language is not a neutral medium capable of describing an objective reality (Hajer, 1995). Instead, language is reconceptualized as discourse. A discourse is defined as a system of shared meanings, which is reproduced in social practices (Hajer, 1995). Hence, discourses are not just descriptive of the world, they are in fact productive of it (Foucault, 1998). A central feature of discursive institutionalism is the idea that actors engage in deliberation about competing world views that would justify one set of institutions as opposed to another (Schmidt, 2008, p. 314).

Environmental politics fundamentally involves a "struggle for 'discursive hegemony' in which actors seek to achieve 'discursive closure' by securing support for their definition of reality" (Scrase & Ockwell, 2010, p. 2228; see also Bosman, Loorbach, Frantzeskaki, & Pistorius, 2014, p. 47). Behind each discourse are loosely organized discourse coalitions that draw on and advocate a particular discourse (Hajer, 1995). Discourse structuration is reached when one discourse dominates the process of sense-making in a given policy domain or social unit (Hajer, 2006, p. 70). Discourse institutionalization means that a discourse has become institutionalized in a set of institutional arrangements (Hajer, 2006, p. 70). Only when these two conditions are met, can a discourse be said to have reached discursive hegemony (Hajer, 2006, p. 71).

The most significant mechanism of discourse stabilization is the continuous practice of boundary formation between what is considered to be part of the discourse and what is not (Van Assche, Beunen, & Duineveld, 2014, p. 82). Poststructuralist thinking on path dependency and lock-in highlights that discourses can be stabilized through at least three different factors (Van Assche et al., 2014, pp. 80–82): The first is path dependence, referring to "legacies from the past that influence the current reproduction" (Van Assche et al., 2014, p. 81). Secondly, they describe interdependence, that is, the web of institutional and personal relations that limits choice options. Third, goal dependence matters in constraining options, most powerfully expressed in "constructed futures" (Van Assche et al., 2014, p. 81). The interaction between these three factors is said to create rigidities that stabilize discourses as well as create contingencies and new openings.

According to theories of deliberative democracy, deliberative processes need to encourage understanding and learning across discourses. When agents seek to actively transform, three discursive strategies seem promising: the use of metaphors to offer a new perspective on an old topic, the use of open (undefined) concepts to bridge gaps between competing discourses, and the use of master signifiers that create coherence in a discourse (Van Assche et al., 2014, p. 82). In the best case, "[s]ystems of meaning or frames of reference shift and evolve in response to such encounters" (Healey, 1993, p. 239). However, such learning through deliberation is usually only incremental (Schön & Rein, 1994).

To allow for more substantive change, the reproduction of power relations in dominant discourses (or dominant "frames") needs to be disrupted. A key mechanism of transformation is boundary crossing that seeks to renegotiate where the line is drawn (Van Assche et al., 2014, p. 82). Kulynych defines a performative act as "one which brings into being that to which it ostensibly refers" (1997, p. 330). Performative strategies enact an alternative reality instead of discussing it. Finally, external shocks can disrupt the reproduction of the dominant discourse. However, if a shock translates into discursive change depends on if and how the external shock is given meaning as a "discursive event" (Hajer, 1995).

Based on the above review of discursive institutionalism and poststructuralist approaches, we conclude this section by suggesting a definition of discursive lock-in and discursive turning points. First of all, we don't limit the idea of lock-in to the past, that is, path dependency, but following Van Assche et al. (2014), we add to this goal dependence and interdependence. Hajer (1995) has argued that "discursive hegemony" is reached when the reproduction of a discourse has been institutionalized, allowing us to identify institutional mechanisms of its reproduction. In analogy to Pierson's (2000) concept of path dependence, we suggest here that discursive lock-in is reached when such institutionalized mechanisms of discursive reproduction include mechanisms of reproduction related to a mental map (or discourse) based on increasing returns. In order to reach a discursive turning point, the mechanisms of reproduction of the hegemonic discourse must be disrupted effectively. This can be achieved through deliberation, through performative action and through external shocks that work as discursive events. The following section will now return to the topic of carbon lock-in.

### 2.3 | Carbon lock-in: A vibrant research field

What is a carbon lock-in and which different sources of lock-in have been identified in the literature? According to Unruh, the term carbon lock-in refers to "industrial economies [that] have become locked into fossil fuel-based technological systems through a path-dependent process driven by technological and institutional increasing returns to scale" (2000, p. 817). Even though economically viable and environmentally friendly technological alternatives are available, they are not picked up

(Unruh, 2000, p. 817). Unruh introduces the concept of a “Techno-Institutional Complex” (2000, p. 818) to highlight that technologies and institutions co-evolve in a path-dependent manner. Unruh distinguishes between five sources of carbon lock-in: technological, organizational, industrial, societal and institutional (Unruh, 2002, p. 318).

Over the last 15 years, carbon lock-in has developed into a vibrant research field (see for example Driscoll, 2014; Klitkou, Bolwig, Hansen, & Wessberg, 2015; Unruh & Carrillo-Hermosilla, 2006). In a recent review paper on carbon lock-in, Karen Seto et al. (2016) summarize and discuss research on infrastructural/ technological, institutional and behavioral sources of carbon lock-in. Firstly, a large amount of greenhouse gas emissions is emitted by and built into the very infrastructure within which we live and work. Carbon lock-in is caused by infrastructure that directly emits greenhouse gases, for example coal-fired and gas-fired power plants (Seto et al., 2016, pp. 429–431). Such installments usually have very high original investment costs and profit can only be made if they are allowed to operate for a lifetime of 20–50 years (Seto et al., 2016, p. 428, Figure 1). A second element of infrastructural lock-in is created by the supporting infrastructure which facilitates the operation of power plants such as refineries and pipelines. Finally, there is also a significant carbon lock-in within built infrastructure of human societies (Banister, Watson, & Wood, 1997; Makido, Dhakal, & Yamagata, 2012).

Carbon lock-in is also perpetuated by institutions. Institutions are products of fierce political battles in which one fraction of actors seeks to institutionalize (and thereby perpetuate) their favored policy at the cost of possible alternatives. Once institutions are in place, they create strong incentives and barriers against change, they are defended by their beneficiaries which often form a powerful network (Mahoney & Thelen, 2009; Seto et al., 2016, pp. 433–434). Most interestingly, Seto et al. (2016, p. 437) suggest that the most promising way to overcome carbon lock-in is “fostering institutional lock-in of a new, decarbonizing trajectory.” They suggest that “whether institutional lock-in is positive or negative depends on one's perspective and the range of stakeholder interests being considered” (2016, p. 437). In this sense, the remainder of our article is also a study of increasing indications of institutional lock-in of renewables. Seto et al. (2016) stress that every transition begins with planting “seeds of transition” (p. 435) which then develop momentum of their own, possibly towards a “virtuous cycle of decarbonisation” (p. 436).

Finally, individual decisions influence the carbon intensity of individual lifestyles. Such decisions are embedded in social norms and cultural values. A behavioral carbon lock-in is explained by Seto et al. (2016, p. 438) as involving both individual habits and social structure, which also interact.

Seto et al. (2016, p. 443) emphasize that technological, institutional and behavioral lock-ins are “interdependent and mutually reinforcing.” Breaking out of a carbon lock-in in one of these areas often requires the other dimensions of lock-in to change as well. Apparently, Seto et al. (2016) did not include discursive lock-ins (and the constructivist and poststructuralist literature around it) in their review and classification of carbon lock-in. Yet a discourse perspective is also needed to explore the role of discourse in perpetuating and undermining carbon lock-in. As we will show in the remainder of this article, discourse underlies all other three forms of (carbon) lock-in.

There are a number of studies that explicitly investigate the contribution of discourses in sustaining and undermining carbon lock-in. According to Scrase and Ockwell (2010) discourses of the energy transition will only be successful in the United Kingdom if they are framed in a way that is in line with the prevailing core government imperatives such as economic growth and national security. Alternatively, environmental protection must also become a core government imperative. Bosman et al. (2014) have studied how Dutch energy utilities discursively frame the energy transition. They show that the Dutch energy utilities are not against decarbonisation as such, but that they want energy security and energy affordability reprioritised (p. 51). This dominant storyline is contested by “storylines in the making” (Garud et al., 2010) like the idea that natural gas could be a transition fuel (Bosman et al., 2014, p. 48). These “storylines in the making” could “delegitimize the dominant storyline” of decarbonisation and lead to “discursive regime destabilisation” (p. 57) if the trend continues. In this case, the outcome could be the “renewed lock-in ... into natural gas” (p. 56). From a similar theoretical perspective, Essletzbichler (2012) and Simmie, Sternberg, and Carpenter (2014) investigate path creation towards renewable energies in the United Kingdom (and Germany in the second case).

The goal for the remainder of this article is to demonstrate the importance of the concept of discursive lock-in drawing on the case of the German energy transition. We will return to the question how the discursive dimension can be integrated with the other types of carbon lock-in in the discussion section.

### 3 | METHODOLOGY

We conducted a keyword search in the journal databases Web of Science and Scopus to identify relevant articles for our literature review (see Table 1). Three keyword search groups were used in combination to identify relevant articles for the literature review: The first group contained concepts related to discursive approaches (e.g., discourse, narrative, story-line, framing), and the second group set the context of the German energy transition. The third set of search terms looked for papers using discourse and lock-in in the context of the German energy transition. Only the paper by Hake, Fischer, Venghaus, and

TABLE 1 Date of last database inquiry: 24th November 2017; 15th December 2017

Sampling steps	# Results
<b>Search in Web of Science</b>	29
<i>Keyword groups:</i>	
1. Discourse, discursive, narrative, story-line, framing, governmentality, dispositive	
2. Energiewende, German energy transition	
3. Lock-in, path dependence	
<b>Search in Scopus</b>	30
<i>Keyword groups:</i>	
1. Discourse, discursive, narrative, story-line, framing, governmentality, dispositive	
2. Energiewende, German energy transition	
3. Lock-in, path dependence	
<b>Searches combined without duplications</b>	42
<b>Application of selection criteria left a relevant sample of</b>	11
<b>Snowballing added to this</b>	10
<b>Final no. of reviewed papers (database sample and snowballing results combined)</b>	21

*Note.* **Web of Science** results “from ALL Databases”; timespan covered: “All years”; language: English, keywords were searched based on TS = topic search (example: TS = (discourse AND Energiewende) including use of asterisks where necessary. **Scopus** results included the following disciplines: Social sciences, environmental science, energy, earth and planetary sciences; language: English, keywords were searched as in this example: TITLE-ABS-KEY (discourse AND Energiewende) including use of asterisks where necessary. We combined the search term groups 1 (with and without the search term group 2) and 3 using the Boolean operator AND.

Weckenbrock (2015) explicitly studies path dependencies in the German energy transition, however, discourses are only one factor among others in their analysis. As a result, we created the argument that discourses matter for creating and overcoming lock-ins in the German energy transition ex-post and used the available discourse studies to back up this idea. The identified papers used different theoretical frameworks: discourse (e.g., Leipprand, Flachsland, & Pahle, 2016; Möldner, 2015), narratives (e.g., Hermwille, 2016; Lauber & Jacobsson, 2016), discourse coalitions (e.g., Stefes, 2010; Strunz, 2014) or considered discourses as one analytical factor among others (e.g., Hake et al., 2015). Out of the identified sample, we included papers in our review which focus on the policy discourse (parliament, parties, NGOs, industries, etc.). We excluded papers from our review, (a) that focus on the local level, (b) that study discourses of science, media or public opinion, (c) that focus only on one specific technology (e.g., biogas or fracking), (d) that apply a different disciplinary perspective (economics or engineering), and, lastly, (e) that are off topic. Aside from the database search, we followed up the reference lists of our sample and pursued hints by colleagues to identify more relevant papers.

#### 4 | DISCURSIVE LOCK-INS AND TURNING POINTS IN THE GERMAN ENERGY TRANSITION

In this section, we explore discursive explanations for continuity and change in the German energy transition over time. The case of Germany is particularly suitable as it has been thoroughly studied from a wide variety of theoretical perspectives, including many discourse studies, on which we will focus. The German energy transition is presented in the literature as a case where a carbon lock-in has been successfully undermined (Seto et al., 2016, p. 434). Some scholars refer to the current state of renewables in Germany as “RES-regime” (RES, renewable energy sources) that consolidates itself progressively at the expense of a crumbling support for the incumbent “fossil-regime” (Strunz, 2014, p. 153, Table 2). However, we question this linear story of progress on the basis of the reviewed discourse literature. In fact, our analysis will show the continuity of the German carbon lock-in alongside the growth of renewables.

In the following analysis, we draw on the case of the German energy transition to demonstrate the importance of discourses for maintaining and overcoming carbon lock-in. Our guiding questions are:

1. Which discourses helped sustaining the carbon lock-in?
2. Which discourses contributed to undermining or overcoming the carbon lock-in?
3. In which periods do discursive explanations offer most added value?

The history of the German energy transition now spans more than three decades (for a full historical overview see Hake et al., 2015, Renn & Marshall, 2016). In this analysis, we focus on four historical change points over the course of the German energy transition.

1. Renewable Energy Act 2000 and nuclear phase-out 2002
2. Lifetime extension for nuclear power plants in 2010

3. Return to shorter lifetimes for nuclear power plants in 2011
4. Reforms to the Renewable Energy Act in 2014 and 2016

For all four change points we ask: What was the role of discourses in enabling them? Can we still speak of carbon lock-in in Germany or has the carbon lock-in been overcome? For the German case, the lifetime extensions and the return to shorter lifetimes for nuclear matters, as the continuity of the carbon lock-in is also a result of the early nuclear phase-out.

#### 4.1 | Renewable Energy Act and nuclear phase-out

The energy transition in Germany was up against a long-standing lock-in of fossil fuels and nuclear power (Hake et al., 2015; Renn & Marshall, 2016). The Renewable Energy Act (REA) from 2000 marks a “turning point” in German energy policy (Hake et al., 2015, p. 539), “changing the rules of the game” towards what transition studies call a regime change (Lauber & Jacobsson, 2016, p. 150). Which factors paved the way for this game changing decision and what was the role of discourses in this process of undermining long-standing carbon lock-in?

The energy transition was enabled and promoted by a discourse that advocated an alternative energy future for Germany starting in the 1980s (Hake et al., 2015, p. 544). The classic energy transition discourse (Leipprand et al., 2016, p. 8) strongly favors renewables over all other sources of energy, sees no place for nuclear and supports the quick phasing-out of coal and gas. Moreover, its supporters promote a decentralized system of energy supply, where consumers become producers of their own energy (Schmid et al. 2017). Initially, this discourse was only of marginal influence.

The energy transition discourse slowly but continuously grew a discourse coalition (Hajer, 1995). In West Germany, the energy transition was developed and promoted among others by the newly founded Öko-Institut (Krause, Bossel, & Müller-Reißmann, 1980). The energy transition discourse was later picked up by the newly founded German Green Party (Lauber & Jacobsson, 2016, p. 150) which was elected into the German Federal Parliament in 1983 (Hake et al., 2015, p. 536), thereby giving the discourse an institutional base.

The Chernobyl nuclear accident in 1986 led to a swing in public opinion and underlying discourses. Hajer has classified Chernobyl as “discursive event” that led to a discursive turning point (1995), though of course the outcome was dependent upon pre-existing discourses in each country. In the weeks after Chernobyl “86 percent of Germans were in favour of a nuclear phase-out”, including for the first time, the German Social Democrats (Hake et al., 2015, p. 536). As a result, the energy transition discourse began to gain momentum (Stefes, 2010, p. 154).

The first path creation (Becker et al., 2016) for the German energy transition discourse occurred in 1990. The Act on the Supply of Electricity from RES into the Grid (short: Feed-in Act) made sure that those who invest in renewables receive subsidies and access to the grid. The Feed-in Act came about more or less accidentally upon initiative from a few Conservative and Green MPs (Hake et al., 2015, p. 539; Jacobsson & Lauber, 2006, p. 149). According to Stefes (2010), the Feed-in Act can be explained as a case of policy entrepreneurship (Stefes, 2010, p. 155). Meanwhile, the incumbent large energy utilities were exploring the East German energy market and underestimated the Feed-in Act (Stefes, 2010, p. 155). The overwhelming success of the Feed-in Act has been to some degree unforeseeable (Stefes, 2010, p. 160; Lauber & Jacobsson, 2016, p. 149). According to Stefes (2010, p. 158) the Feed-in Act from 1990 created path dependency. It paved the way and removed possible resistance for the Renewable Energy Act of 2000, which by that time seemed far less radical than its predecessor (Grasselt, 2016). The concept of feed-in tariffs (in a revised version) was reproduced in the later law, showing a case of institutional isomorphism (Thelen, 1999, p. 386).

The Feed-in Act had distributive effects which created path dependency (Ikenberry, 1994). As renewable energy technologies advanced and matured under the financial incentive structure set by the law, a wide range of beneficiaries created a constituency which reinforced the energy transition discourse (Strunz, 2014, p. 152). The resulting growth of wind power generation (by a factor of 78) and solar power (by a factor of 42) between 1990 and 1999 far surpassed expectations and generated a lobby for renewables based in “environmental and RE associations as well as from metalworkers, farmers, church groups and the influential investment goods association VDMA” (Lauber & Jacobsson, 2016, p. 150). This discourse coalition around the Feed-in Act later became institutionalized as a powerful lobby in the form of the Federal Association for Renewable Energies (Stefes, 2010, p. 156).

From 1990 onwards, the climate change discourse rose to the top of German and international political agendas (Hake et al., 2015, p. 538), thereby creating further momentum for the energy transition discourse (Stefes, 2010, p. 154). A Bundestag selected committee on “Preventive Measures to Protect the Earth's Atmosphere” concluded its 1990 report with strong goals for the reduction of energy-related CO<sub>2</sub>-emissions (Hake et al., 2015, p. 538). While all political parties supported these climate goals they were divided over the question of whether nuclear should remain part of the climate-friendly energy-mix or not (Hake et al., 2015, p. 538). The energy transition discourse was extended to include this new discursive element of climate change (Leipprand et al., 2016), thereby attracting new supporters.

We argue that the rise of the energy transition discourse in combination with elements of path dependency and a change in government explain how it became possible that a newly elected Red-Green government was in a position to replace the 1990 Feed-in Law with the Act on Granting Priority to Renewable Energy (REA) in 2000. According to Stefes (2010, p. 158), the drafting and final breakthrough of the EEG is also due to the effort of two policy entrepreneurs. The REA's goal created goal dependency (Van Assche et al., 2014) by stating that renewables should in the long run replace both nuclear and fossil fuels (Lauber & Jacobsson, 2016, p. 150). The Red-Green coalition government also negotiated the phase-out of nuclear energy with the four large energy corporations in a so-called “nuclear consensus” from 2000 which was turned into law in 2002 (Hake et al., 2015, p. 539). This implied the end of nuclear power in Germany between 2015 and 2020 (Hake et al., 2015, p. 539), thereby institutionalizing another core tenet of the energy transition discourse.

The German Renewable Energy Act (2000) facilitated the rapid growth of renewable energies in Germany from 29 TWh in 1999 to 161 TWh in 2014 (AGEB, 2015). The law fostered “distributed ownership,” thereby broadening the number of those benefitting from the energy transition, creating further distributive effects (Geels et al., 2016, p. 910; Lauber & Jacobsson, 2016, p. 150). Even though the Red-Green government coalition lost power in 2005, the REA continued to enjoy broad support, including the support of six out of nine Conservative-ruled Federal States (Lauber & Jacobsson, 2016, p. 151). When the Conservatives and Social Democrats took over power in 2005, it was certain that the policies of the EEG and the nuclear phase-out would be continued.

To sum up: The energy transition discourse rose from a marginal position in the 1980s to a dominant position in the policy discourse in the year 2000. It has been significantly strengthened by the anti-nuclear discourse after Chernobyl in 1986 and the rise of the climate change discourse in the early 1990s. There was a moment of path creation for the energy transition discourse with the Feed-In Law from 1990, leading to a significant institutionalization in the Renewable Energy Act in 2000 and in the nuclear phase-out in 2002. The long-term goal was the replacement of the nuclear-fossil regime by renewables (Strunz, 2014, pp. 152–154).

#### **4.2 | Lifetime extension for nuclear power plants: The nuclear bridge**

In this section, we briefly look at the newly-elected conservative-liberal government's decision to extend the lifetimes of the German nuclear power plants in 2010. What was the role of discourses in enabling this policy roll-back?

The development of the Renewable Energy Act and especially the phase-out of nuclear power was strongly contested by the energy utilities as well as the Conservative Party and the Liberal Democrats (Hake et al., 2015, p. 540; Lauber & Jacobsson, 2016, p. 151). In their discourse analysis looking at speeches in Federal German Parliament, Leipprand et al. (2016, pp. 8–9) identify an energy mix discourse in defense of nuclear and carbon which challenged the energy transition discourse from its early days on. It problematizes the unreliability of renewables (Leipprand et al., 2016, pp. 8–9) and is concerned about rising consumer electricity prices as a result of the rapid expansion of renewables, fostered by guaranteed feed-in prices (Gawel & Lehmann, 2014). It recognizes climate change but warns of the costs of overly ambitious mitigation measures (Leipprand et al., 2016, p. 9).

When the Conservative-Liberal coalition came into power in 2009, the energy mix discourse informed decision-making. One of the new government's first projects was to challenge the nuclear phase-out's agreed timeline. The coalition parties drew on the energy-mix discourse, to argue that keeping the nuclear power plants running longer would be more cost-effective. Chancellor Merkel and the nuclear-lobby promoted nuclear power as a safe and climate-friendly bridging technology to the solar age (Grasselt, 2016, p. 458; Strunz, 2014, p. 153, 2010). The Liberals saw it as their mission to make energy affordable again and promoted a costs discourse. They claimed that the high price of the energy transition was creating problems for the competitiveness of German industry (Gawel & Lehmann, 2014; Grasselt, 2016, pp. 454, 456; Leipprand et al., 2016, see also Borshchevska, 2016).

In 2010, Chancellor Merkel's government released the energy concept. The concept confirmed the ambitious expansion of renewable energies in the long run (Strunz, 2014, p. 153) and foresaw nuclear energy as a bridging technology in conjunction with a flexible coal and gas power park (BMW & BMU, 2010, p. 14). This can be seen as an indication that the core tenets of a de-radicalized energy transition discourse enjoyed cross-party support and were now extensively institutionalized. This de-radicalized variant of the energy transition discourse was in line with the discourse of ecological modernization (Leipprand et al., 2016, p. 17).

On the basis of the energy mix discourse, the Conservative-Liberal coalition extended the allowed operating time for nuclear power plants by eight (for those built before 1980) or 14 years (for those built after 1980), respectively. The longer operating times for nuclear power plants were strongly contested at the time by the Green Party, the Social Democrats, the Left, and the anti-nuclear movement, who staged protests (Hake et al., 2015, p. 542).



### 4.3 | Return to shorter lifetimes for nuclear power plants: Reinstating coal as a bridge

This section investigates the governmental U-turn in the year 2011 when the extension of the lifetime for nuclear power plants was taken back. What was the role of discourses in enabling this change?

In March 2011, there was a nuclear core melt-down in Fukushima, Japan. The return to shorter operating times for nuclear power plants in Germany can best be explained by discourse and framing approaches that study Fukushima as a decisive event (Haunss, Dietz, & Nullmeier, 2013; Hermwille, 2016; Renn, 2012; Shim et al., 2015). In Germany, Fukushima led to a discursive turning point regarding nuclear power, which Hermwille termed a “landscape shock” (Hermwille, 2016, p. 238). In Germany and Switzerland, the media constructed Fukushima as an accident that exposed the high-security risks of nuclear power (Kepplinger & Lemke, 2016, p. 355). In other countries, in Britain and France for example, the tsunami leading to the Fukushima core melt-down was considered by the media as a natural disaster that could not have been prevented (Kepplinger & Lemke, 2016, p. 355).

At the time, two narratives struggled for hegemony in Germany (Hermwille, 2016, p. 241). The dominant energy mix discourse presented nuclear energy as a safe bridging technology to the solar age, which guarantees supply security and is environmentally friendly (Möldner, 2015, p. 126). On the other hand, the anti-nuclear discourse (which has always been part of the energy transition discourse) emphasized the security risks of nuclear power and highlighted the unresolved problem of nuclear waste disposal (Hermwille, 2016, p. 441). Also, the centralized nature of nuclear power was considered to be incompatible with a renewable energy system (Möldner, 2015; Schmid et al., 2017).

In the days after Fukushima, the German anti-nuclear movement took to the streets in thousands (Hake et al., 2015, p. 542). The energy mix discourse, which had conceptualized nuclear power as safe, lost its credibility and the nuclear lobby failed to come up with an alternative storyline (Hermwille, 2016, p. 242). The energy mix discourse's argument that the energy transition endangered German competitiveness faded away (Grasselt, 2016, p. 456). Instead, the discursive element that highlights the uncontrollable risks of nuclear power became dominant and linked to the energy transition discourse (Grasselt, 2016, p. 457; Hermwille, 2016, p. 242; Möldner, 2015, p. 128). The energy transition discourse promised to solve the problems of nuclear risk, climate change and energy shortage at the same time (Hermwille, 2016, p. 242). The articles studying the discursive and political dynamics around Fukushima agree that the event triggered a discursive turning point regarding nuclear power in Germany (Hake et al., 2015; Mez, 2012; Shim et al. 2015; Schreurs, 2015, p. 36). After the disaster, the balance of power had shifted away from the nuclear-bridge narrative to the nuclear-risk narrative (Shim et al., 2015, p. 67; Strunz, 2014, p. 154).

Given the lack of public support for nuclear energy, German Chancellor Merkel made a U-turn in the Conservative-Liberal coalition government's nuclear policy 4 days after Fukushima. She took back the added operating times (initially only for 3 months) and ordered all remaining power plants to close by the end of 2021 (Hake et al., 2015, p. 542). It can be argued that the reversal of this nuclear phase-out decision was enabled by path dependency, since it marked a return to the former nuclear phase-out agreement (Grasselt, 2016, p. 448). Some authors classify the return to short operating times for nuclear power plants as a “regime shift” from a nuclear-fossil-regime towards a renewable energy-regime (e.g. Strunz, 2014).

At the same time, a new variant of the “energy mix” discourse was on the rise (Grasselt, 2016, p. 456; Leipprand et al., 2016). With the near-end of nuclear power, there were renewed concerns about energy supply security. “[B]efore Fukushima, the role of nuclear energy as a ‘bridge’ towards the solar age was highlighted; after March 2011 new, efficient fossil power plants are called for to ensure supply security.” (Leipprand et al., 2016, p. 12). With nuclear power being discontinued, coal and lignite gained structural importance to cover the base load (Smyrgala, 2017, p. 335). In the aftermath of the Fukushima disaster, the de-radicalized energy transition discourse continued to enjoy cross-party support.

In sum, the Fukushima core melt-down led to a discursive turning point. The energy mix discourse's claim of nuclear as a safe bridge lost credibility and was replaced by a nuclear risk narrative, leading to shorter lifetimes for nuclear plants. However, this also indirectly strengthened the role of coal, stabilizing carbon lock-in, in order to ensure supply security.

### 4.4 | Reforms of the Renewable Energy Act 2014 and 2016: Capping the growth of renewables and clinging to coal

In this section, we investigate the role of discursive explanations in bringing about major reforms of the Renewable Energy Act in 2014 and 2016. These reforms have changed the subsidy regime of the energy transition, now favoring large utilities. Which role have discourses played in enabling these reforms?

By 2014, electricity from RES had grown to almost 25% (161 TWh) while the supply from nuclear power had dropped by almost half (from 170 TWh in 2000 to 97 TWh) (AGEB, 2015). However, 40% of German electricity was still produced using coal (265 TWh) (AGEB, 2015). Given the speed in the growth of renewables, “a two-thirds share [of renewables] by 2030 was within reach” (Lauber & Jacobsson, 2016, p. 159).

The energy transition discourse was dominant, and all actors were forced to debate using its terms. However, the energy transition had grown a number of critics demanding course corrections. The four large utilities (RWE, Vattenfall, EnBW, and Eon), realized that the energy transition was happening without them and that their market shares in the electricity market were declining (Lauber & Jacobsson, 2016, p. 159). Most of the renewable energy installations in Germany were at that time owned by banks, farmers and private investors (Dallos, 2014). As a result, the utilities became interested in establishing their own share of renewable energies, and to change the subsidy structure towards their needs.

The implementation of the energy transition was also blocked by local citizens in many places. Citizen protests formed in opposition to local renewable energy projects, delaying and even stopping many installations (Reusswig et al., 2016). Grid extensions needed to distribute overcapacity of wind energy from the North Sea to Southern Germany where nuclear power plants were closed down, faced similar problems (Neukirch, 2016; Weber & Kühne, 2016).

In 2012–2014, the “costs discourse” became salient in Germany, as a way of problematizing the costs of the energy transition, supported by a discourse coalition of Liberals, Conservatives, the large utilities and the European Commission (Lauber & Jacobsson, 2016, p. 159). While the core tenet of the energy transition discourse—namely the expansion of renewables—was not challenged, the mode of distributing subsidies was. The supporters of this discourse claimed that renewables were growing too fast, that this was making electricity too expensive and that the incentives for renewables needed to be cut back and/or changed (Lauber & Jacobsson, 2016, p. 153; Geels et al., 2016, p. 906). Some supporters of this discourse blamed the rising consumer electricity prices in Germany entirely on the Renewable Energy Act (Gawel et al., 2015; Geels et al., 2016, p. 906; Lauber & Jacobsson, 2016, p. 154). These arguments were widely reported in the media under labels like “cost tsunami” that would cause “deindustrialisation” in Germany (Gawel & Lehmann, 2014, p. 651, see also Borshevskva, 2016). While these are exaggerations, experts agree that there were some real cost issues that needed to be addressed.

The newly elected coalition government of Conservatives and Social Democrats responded to these cost problematizations by issuing reforms of the Renewable Energy Act in 2014 and 2016. The government decided to subsidize only a certain number of installations of each type of renewables per time period, defining “development corridors” for renewable energy's expansion, thereby setting a cap to subsidies. Secondly, in the name of cost efficiency, a shift from fixed feed-in tariffs to obligatory market premiums performed by auction procedures was introduced. These reforms “due to their legal and financial hurdles, tend[ed] to favour incumbents and other large-scale corporate operators (...)” (Lauber & Jacobsson, 2016, p. 154, see also Schmid et al., 2017, p. 54). The component of decentralization has certainly been hollowed out of the energy transition discourse, though it does leave a space for “citizen energy” (Gawel & Purkus, 2016). Since these reforms, the energy transition discourse enjoys wide cross-party support. The core goal of expanding renewable energies has remained on track. Electricity generation from renewables has gone up from 26% in 2014 (161 TWh) to 33% in 2017 (217 TWh), with large scale onshore and offshore wind accounting for the increase (AGEB, 2017). In January 2018, the new (old) coalition government of Conservatives and Social Democrats has confirmed the goal of generating 65% of electricity using renewable energy by 2030 (CDU and SPD, 2018, p. 25).

Nevertheless, the energy transition is happening alongside an on-going carbon lock-in (Leipprand & Flachslund, 2018, pp. 190–191, Nordensvärd & Urban, 2015, p. 164). In the year 2017, coal was still used to produce 37% of all electricity in Germany (AGEB, 2017). Despite the fact that the inevitability of a phase-out of coal has been accepted by all actors, the fight about the when and how has just begun (Leipprand & Flachslund, 2018, p. 199). On the one hand, environmentalists lobby for a quick phase-out of coal (Green Party, environmental NGOs); on the other hand, the coal companies, powerful business associations and the mining unions are united in their defense of the status quo (Leipprand & Flachslund, 2018, p. 198). This actor constellation was reconfirmed in fall 2018 in the escalating conflict about the clearing of Hambach forest in North-Rhine Westphalia for open lignite mining, where the Conservative-liberal state government sided with coal-interests. For the first time, there is a strong anti-coal movement in Germany on the rise with 50,000 protestors on October 6, 2018. As a result, there are indicators of a “beginning destabilization of the traditional actor coalition associated with the defence of the existing regime” (Leipprand & Flachslund, 2018, p. 198). In 2018, the Conservative-Social Democrat government has delegated the contested decision about the timeline for the phase-out of coal to a 31-member commission (Special Commission on Growth, Structural Economic Change and Employment).

In sum, the increased salience of the costs discourse within the energy transition discourse enabled the 2014 and 2016 reforms of the Renewable Energy Act. Coal has been able to defend its role in the German energy mix in the name of discursive elements of affordability and energy security. While renewables continue to grow, ownership is concentrating in the hands of large utilities.

## 5 | DISCUSSION

In the discussion of our findings, we return to Seto et al.'s (2016, p. 437) suggestion that the most promising way to overcome carbon lock-in is “fostering institutional lock-in of a new, decarbonizing trajectory.” We believe that the story of the German

energy transition should be told as one of increasing lock-in of renewables. We know that there are many who think the concept of lock-in should be reserved for negative developments only. However, we agree with Seto et al. (2016, p. 427) that lock-in as such should be defined as a neutral term. In the text above, we have applied many concepts from the realm of path dependency and lock-in to show how a new path dependency for renewable energies was created in Germany. For example, without the increasing returns effects of the 1990 Feed-in law, there might still be no energy transition in Germany at all. We think that the German energy transition is a clear case of the (discursive) institutionalization of a decarbonizing trajectory. However, this has happened alongside a continuing carbon lock-in that has not yet been successfully overcome.

Secondly, we return to our earlier claim that discourse actually underlies lock-in in the realms of infrastructures, institutions and behavior—it also connects and aligns them (Gailing, 2016; Lösch & Schneider, 2016; Moss, Becker, & Gailing, 2016; Van Assche et al., 2014). In our above analysis of the German energy transition, we have already shown this for the case of institutions. Institutions can be conceptualized as sedimented discourses. Once a discourse has secured its reproduction in one or several institutions, it has reached hegemony (Hajer, 1995). For the case of carbon lock-in, we paid special attention to institutions that create path dependency, interdependence or goal dependence, thereby stabilizing a certain governance path (Van Assche et al., 2014).

In our analysis of the German energy transition, we also paid attention to infrastructure. The value of the remaining coal and gas power plants directly depends on the way that dominant discourses suggest a calculation of costs. If prices are to speak the ecological truth, fossil fuels will no longer be profitable. So even something as material as infrastructure and economic cost calculations is directly dependent upon dominant discourses and corresponding policies. The discourse “gives materiality a social reality” (Moss et al., 2016, p. 48). Thereby, the object takes a certain material form by which it can be represented, and which may differ from alternative forms of investigating and knowing it—they can compete for attention (Mol, 2003).

Finally, our analysis of the German energy transition has also highlighted the role of actors as policy entrepreneurs. Nevertheless, the more common role for actors is that of reproducing dominant discourses in everyday behavior, thereby reinforcing existing lock-ins. In acts of self-governance and self-disciplining, actors reproduce dominant discourses and institutions in their habits (Foucault, 1998). This process also fails sometimes, so there are always a small number of resisting subjectivities whose behavior does not fit the norm (Kulynych, 1997). Under certain circumstances actors may be in a position to act performatively and to experiment with new forms of behavior and act as policy entrepreneurs (Kulynych, 1997). Depending on the context conditions, this can find followers and undermine a lock-in—or not. A carbon lock-in should therefore be investigated along all four dimensions (infrastructures, institutions, behavior, and discourse), while discourse should be seen as connecting the previous three.

## 6 | CONCLUSION

This article suggests that we should include the investigation of discourses in the study of carbon lock-ins. We have explored the relevance of discursive explanations for carbon lock-in for the case of the German energy transition. Our literature review has identified the discourses that help to explain continuity (lock-in) and change in the German energy transition over the last 30 years.

In our analysis, we have shown how Germany's long-standing lock-in of fossil fuels and nuclear power was undermined by the rise of the energy transition discourse. This discourse transformed from a marginal position to political hegemony through a number of factors. A moment of path creation was the institutionalization of the 1990 Electricity Feed-in Act. This created a discourse coalition for renewables that grew strong and fast, paving the way for the adoption of the Renewable Energy Act in the year 2000 and the nuclear phase-out decision that entered into law in 2002. Until 2009, Germany's renewable energy policy progressed despite ongoing contestations from opposition parties and utilities, based on the institutionalized energy transition discourse. However, when the Liberal Party came into government in 2009, the new Conservative-Liberal government extended the operating times of nuclear power plants in Germany. This was legitimized drawing on the energy mix discourse, which argued that nuclear power was a safe and affordable bridging technology to the solar age. At the same time, the energy concept 2010 assured the further expansion of renewables, promoted nuclear energy as a bridging technology, and gave coal and gas a stabilizing role to play. However, the Fukushima accident in March 2011 undermined the credibility of the safe nuclear bridge discourse, forcing the Conservative-Liberal government to perform a U-turn and to return to the shorter operating lifetimes for the nuclear power plants. Coal and gas remained as “necessary bridges” to the solar age. With the fast growth of renewable energies, the costs of the energy transition multiplied. This gave rise to discourses that problematized the subsidy scheme for renewables. The salience of costs discourses within the energy transition discourse allowed a Conservative-Social Democrat government to reform the Renewable Energy Act in 2014 and 2016, limiting the subsidized growth of renewables to fixed quotas. Currently, a decision about the date for phasing out coal has been delegated to a

commission. These observations have led us to the conclusion that the carbon lock-in has not yet been fully overcome in Germany, despite the fact that renewable energies have been able to win substantial ground.

Out of the four discursive turning points for which literature was reviewed in this article, the turning point after Fukushima stands out as the one with the strongest and purely discursive explanation. Comparative studies of discourses have shown that the policy response to the Fukushima nuclear core meltdown was fully dependent on pre-existing discourses in each country. Moreover, it was key as what kind of event Fukushima was discursively represented—an accident or a natural disaster. The other three change points demonstrate how change can be explained as a result of a combination of factors, involving discourse coalitions and discursive agency of policy entrepreneurs that crossed the boundary of existing discourses to leap into something new.

A key future research challenge is to study the nature of the interplay between discourses, infrastructures, institutions and behavior in maintaining or overcoming carbon lock-ins. Discourse is offering a compelling lens for integrating the three other types of carbon lock-in (i.e., infrastructural, institutional and behavioral). The discourse approach can help to explain change because it assumes that all elements require reproduction to sustain a lock-in. However, other theoretical approaches are also encouraged to combine the analysis of infrastructural, institutional, and behavioral carbon lock-ins with a discourse perspective. Although discourse is rarely the only explanatory factor, discourse matters greatly, as we have shown in this article. The rich literature using discourse perspectives should be more fully engaged with when it comes to studying carbon lock-ins and how they can be overcome.

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## CONFLICT OF INTEREST

The authors have declared no conflicts of interest for this article.

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