Please cite the Published Version

Additional Information: This is an Author Accepted Manuscript of an article published in Energy Research and Social Science.

Rethinking the meaning of "landscape shocks" in energy transitions: German social representations of the Fukushima nuclear accident

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ARTICLE INFO

ABSTRACT

Sociotechnical sustainability transitions are understood to involve changes in cultural meaning, alongside a wide variety of other changes. One of the most popular conceptual models of such change, the multi-level perspective, exogenously locates slow-changing cultural factors in the 'sociotechnical landscape', viewing this landscape as periodically subject to 'shocks' that may support the break-through of niche innovations. Here we emphasise that shock to a sociotechnical system has social psychological dimensions, including meaning-related correlates. Accordingly, we apply social representations theory, as a theory of meaning, to provide a social psychological account of energy landscape shock and associated policy change. For illustration we take newspaper representations of the 2011 German social and policy response to the nuclear accident at the Fukushima Daiichi power plant in Japan. The study illustrates the inter-related role of affect, identity and symbolic meaning-making in the public response to a sociotechnical landscape shock.

1. Introduction

Geels' multi-level perspective (MLP) [1] is a popular and influential framework for the analysis of socio-technical transitions, in which the latter refers to the co-evolution of society and technology. The framework views this evolution as the interplay of three levels of increasing structuration, referred to – in order of increasing structuration – as the 'niche', the 'regime' and the 'landscape'. The niche is conceptually defined as the location of novel technologies and practices, while the landscape is the background of slow-changing factors such as long-term trends and cultural, taken-for-granted values. Arguably meriting further theorisation as a concept, the landscape:

> refers to broader contextual developments that influence the sociotechnical regime and over which regime actors have little or no influence. Landscape developments comprise both slow-changing trends (e.g. demographics, ideology, spatial structures, geopolitics) and exogenous shocks (e.g. wars, economic crises, major accidents, political upheavals) [2] p. 225.

By contrast, the regime refers to the rules and institutions that underpin the status quo and by definition enjoys relatively stable networks of vested interests, institutionalised regulation and infrastructure, as well as established norms, practices and beliefs [3]. Regimes by nature resist change counter to their core architecture. Yet regime change does happen and 'landscape shocks' in the form of unexpected events are conceived of as playing a key role in this [4].

Our purpose here is to provide and discuss an illustration of the social psychology of a particular landscape shock that had repercussions for German energy policy. As Hermwille observes with respect to the same case of the Fukushima nuclear accident[1] [5], landscape shocks do not have inherent meanings: such meanings are constructed by those who experience them. Moreover while individuals ascribe meaning, they usually do so in terms of ideas that are socially acquired. Hence meaning is to a significant extent a social construction, shaped by cultural contexts. That said, by drawing on social representations theory (SRT) for our characterisation of landscape shock, we deliberately choose a concept that is theoretically positioned as spanning the individual and the social, avoiding the methodological and epistemological issues raised by strongly individualistic approaches to understanding agency in transitions [6,7]. We also continue the view of sociotechnical transitions as interpretive in the SCOT (social construction of technology) tradition [6].

To this end, we document the symbolic meanings of nuclear power in German public discussion, specifically following the 2011 nuclear accident in Fukushima, Japan. In so doing, we discuss but stop short of making strong, causality-related claims with respect to the empirics. Rather, we focus on research questions relevant to further work on the social psychology of different types of landscape shock [1,4,8]. Our focus is also wider than risk perception. For a more specifically risk-focused study, one could look to, for example, the social amplification of risk framework (SARF) [9]. While SARF aims to show the causality and structure of relationships among the factors specified as involved in

risk perceptions [10], here we focus in detail on the meanings ascribed to nuclear power and the Fukushima accident, in the context of landscape shock.

We echo a hypothesis previously expressed, namely that social representations of technology and related practices, changing and otherwise, play a role in sociotechnical change [11]. Here, though, our purpose is to provide an in depth account of nuclear energy representations specifically at a time of landscape shock, not to undertake a more extended, longitudinal study that might show further causality or association over time between changing representations and changing energy policy. In short, we analyse representations of the Fukushima nuclear accident to further explore the role of social psychological processes in the co-evolutionary interactions between technology, institutions and agents of which sociotechnical transitions are comprised [12].

The main research questions explored here are thus: does landscape shock have social psychological dimensions and how might we characterise these? Our wider purpose is to extend the small but developing literature that explicitly applies social psychology within sociotechnical transitions frames, to connect the different 'levels' of processes – macro, meso and micro [13] – that are relevant to energy transitions. Hence the aim is to present a social psychological account of the landscape shock that is posited in the sociotechnical transitions literature as one of several possible factors in inducing and/or or supporting sociotechnical system change at 'niche' and 'regime' levels [4]. Social psychological processes are referred to in established sociotechnical transitions frameworks and typologies, in terms such as cognitive rules and schemas [4], norms, beliefs and meaning. Yet such references in the sociotechnical transitions literature have been little explored in terms of detailed connection to sociotechnical theory. Exceptions include [14] norms and a small literature using SRT that is described below[2].

The challenge for those interested in conceptually or theoretically connecting social psychological and sociotechnical transitions concepts closely lies in identifying and applying concepts that can bridge the epistemological differences between the disciplines, bringing richer accounts of agency-related processes to sociotechnical thinking and an understanding of sociotechnical processes to social psychological thinking [7]. In the same way that others have posited the value of such integrated accounts for designing interventions for individual and societal behaviour change for sustainability [15], so do such accounts deepen understanding of sociotechnical change processes. Moreover, while here we examine a single case in a single country, this nonetheless allows the inference of potential 'generative mechanisms', the term given by critical realists to social processes that underlie observable phenomena[3] [16], for further study in cross-case and also longitudinal research designs. In the discussion section we thus go a little beyond the data to consider potential research directions.

The social and policy response of Germany to the Fukushima catastrophe has also been described elsewhere as a landscape shock [5,17]; as underlying an energy regime shift [5,18,19]; an energy policy U-turn [20]; and as a key part of a policy window for change [21].

In terms of German energy policy, the event is embedded in a multi-layered and complex interplay of factors ultimately leading to the political decision for a nuclear phase-out. Although there are several studies of the case from policy-related perspectives, surprisingly, the case has – to our knowledge – not yet been analysed from a social psychological perspective. This is despite most of such studies directly or indirectly pointing to the critical role of public opinion (e.g. [5,22,19,18,23]).

With the above in mind, the paper is structured as follows: section 2 outlines the theoretical context, describing how SRT has been connected to sociotechnical transitions frames to date; how social identity and social representations are interconnected; and how SRT understands risk perception. These elements are then brought together in a social psychological depiction of landscape shock. Section 3 describes and justifies the research design. Section 4 sets out the empirical results, describing social representations of the nuclear accident in the German newsprint media, in terms of four related representational themes: nuclear energy in general; nuclear-related risks post-Fukushima; German nuclear energy policy; and a number of further sense-making patterns. Section 5 discusses these further, highlighting the role of social meaning making in transitions and directions for further research.

2. Theoretical perspectives

We draw primarily on one main theoretical perspective – Moscovici's SRT [24] – and connect this to the idea of landscape shock as potentially involved in supporting niche innovations, pressuring regimes (the prevailing sociotechnical rules that manifest as the status quo) and opening policy windows for change [4]. The following sections both outline relevant aspects of SRT and summarise how it has been used to date in relation to sociotechnical transitions theory.

2.1. Social representations theory

Moscovici's theory of social representations itself is primarily centered on the production and function of cultural meaning systems [25,26]. By focusing on everyday thinking, communication and action, the theory aims to determine the link between human psychology and modern social and cultural trends. Moscovici argues that social psychological phenomena and processes of meaning making can only be properly understood by acknowledging their historical, cultural and macro social embeddedness [27]. The theory is premised on socially constituted individuals, aiming to overcome dichotomies between the individual and the social, as well as between subjective and objective [27] (p. 101). As a constructivist approach, SRT blurs the line between subject and object: an object can only be an object for a group (the subject) if it is socially represented [27], and the group that represents it, at the same time represents itself in and by the representation [25]. Hence, SRT "seeks to provide theoretical and empirical insight into the thoughts and behaviours of people in relation to others" [28] (p. 3–4).

The term *social representation* refers to the collective elaboration: "of a social object by the community for the purpose of behaving and communicating" [29] (p. 251). The main function of social representations is to make the unfamiliar familiar by anchoring strange ideas and reducing them to "ordinary categories and images, to set them in a familiar context" [24] (p. 29). Thus, social representations are collective phenomena constructed in everyday thinking, communication and social practice and reflect their historical, cultural and group-specific contexts [27]. The concept refers both to the process of social representation, through which representations are elaborated, as well as the form of a social representation, meaning the structure of thought and action produced through the process [30]. Hence SRT refers both to the process and practice of the social construction of meaning; and social representations simultaneously influence and constitute social thought and practice [31]. Here, representations of the Fukushima incident in German newspapers are taken as indicative of the then-circulating representations in wider society and thence as further indicative of the so-

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[1] We describe the incident as an accident, but later in the paper we do refer to the warnings and recommendations that suggest preventability.

[2] At this point it may be useful to acknowledge in a little more depth the debates arising from the very different epistemologies of individual-level psychological and sociological approaches to understanding human behaviour or practice. Our view is that each has a different, complementary value (echoing [68]) and that social representations theory can bridge the divide in a way that is supportive of understanding the social psychological aspects of sociotechnical transitions processes, specifically because such representations are conceived of as simultaneously individual and social. This in turn renders the theory useful for connecting levels of analysis [7,69].

[3] Indeed, although the MLP is based in a structuration ontology [1], others have rightly observed that critical realism has much to offer as an approach to framing the analysis of related, underlying and contributory processes [70,71].

cial-psychological dimensions of the landscape shock triggered by the incident.

There are three mechanisms of interest here. Anchoring strives to anchor new or unfamiliar ideas in a familiar context mainly through categorization and naming. Anchoring involves the naming and classifying of novel encounters, ideas and things in order to furnish social groups with a basic understanding of a novel concept [32]. Anchoring may include cultural, metaphoric, thematic and emotional dimensions.

Objectification shapes the abstract and unknown into a concrete mental image by assigning tangible qualities [24]. Moscovici argues that both mechanisms "make the un-familiar familiar, the first by transferring it to our own particular sphere where we are able to compare and interpret it, the second by reproducing it among the things we can see and touch and thus, control." [24] (p. 29). The third mechanism of interest is thematization. According to the theory, themata are "the antimonies or dyadic oppositions that lie at the root of common sense and shape how we make sense of issues in the social world" [28] (1.1). The concept of themata refers to underlying collective and general patterns of thinking that generate social representations [33]. Themata are typically antithetical, temporally stable dyads such as self/other, good/bad or fear/hope are deep-rooted, historically embedded and taken-for-granted cultural categories, yet occasionally apolar triads such as constancy/evolution/catastrophic change can be found [34]. Whereas we make limited use of the objectification concept here, we do make use of the concept of themata in relation to the representation of risk[4].

2.2. Social representations of sociotechnical phenomena

Social representations of particular sociotechnical systems (fracking for shale gas and gasification of municipal waste) have been shown to involve differing forms of 'anchoring' (association) [25] reflective of differing cultural contexts and interests. In the case of fracking for shale gas, newspaper discourse in the UK, Germany and Poland differed across countries. In the case of gasification of municipal waste, advocates and opponents of the technology respectively associated it with positive and negative representations of – and expectations for – incineration. The authors argue in both cases that these representational processes are examples of the types of psychological processes that are sometimes acknowledged as relevant for sociotechnical transitions (e.g. [13]), but which are rarely connected in depth with sociotechnical theory [35,36].

Here we analyse representations of the Fukushima nuclear accident to further explore the role of social psychological processes in the co-evolutionary interactions between technology, institutions and agents of which sociotechnical transitions are comprised [12]. More specifically, the aim is to present a social psychological account of the landscape shock that is posited in the sociotechnical transitions literature as one of several possible factors in inducing or supporting sociotechnical system change. This notion is found in the multilevel perspective of such change [1], as well as in idealised change typologies ('transition pathways') [4]. In both, an ontology of three levels is posited, reflecting differing degrees of structuration: the niche level, in which innovations emerge; the socio-technical regime level, which is the level of established rules and practices that stabilize predominant systems; and the exogenous landscape level of mostly slow-changing, taken-for-granted factors, but where landscape shocks are also conceptually located [4]. Each level is characterized by heterogeneous configurations of factors. The interplay between levels takes place in multiple dimensions, such as markets, regulations, cultural meanings and infrastructure [3,12]. Within the MLP, transitions are characterized through circular causality, meaning that various processes take place simultaneously on different levels, linking up and reinforcing each other [12].

Within the above frame, landscape shock figures more specifically in a posited technological substitution pathway, opening up a window of opportunity[5]. Significantly, this is conceived of as including cognitive and/or normative change, alongside change in other features of the incumbent regime [4]. Moreover, the MLP is inherently social in the sense of involving processes that relate to groups of people, however organised or conceived of. Hence the framework includes dimensions of cultural meaning [3], the symbolic meaning of technology [1], sense making processes and changes in perception [4]. Arguably these processes involve individual-level and hence psychological as well as social processes [37], but in any case there has to date been very limited theorisation of the social processes involved at the landscape level, particularly as regards landscape-regime interactions. In part this reflects a general focus in the literature on delineating broad transition processes, rather than connections between levels or qualitatively different types of process [13].

2.3. Social representations, social identity and risk

There are two further applications of SRT that are directly relevant to the present context: social identity construction and risk perception. Beginning with identity, as explained above, SRT does not disconnect the object from the subject, but rather conceives of both as co-constituted [27] (p. 104). This in turn means that social representations are conceived of as intertwined with social processes of identity construction: "Social representations both arise out of and work to consolidate collective identifications" [28] (p.5). The process of social representation thus contributes to the formation of group identities. By sharing social representations, a common identity is shaped that is based on the worldviews that a group has in common [30]. Hence, the process of representation and the process of identity are intertwined: the social categories that shape identity are social representations themselves [38]. Conversely, identities shape representations: "Social representation (as a psychological process that is at once cognitive and cultural) is only possible through the communication of emergent and relational identities, shifting claims to difference and claims to commonalities" [39] (p. 156). In short, within SRT, identity has a transformative nature (Howarth 2011) and is conceptualized as dynamic and context-specific: "Identities are contextual — they change as we move from context to context" [40](p. 361).

Regarding the last of the SRT applications required for understanding the Fukushima case as a social psychological landscape shock, we turn to SRT as a way of characterising meaning-making of the new form of the Fukushima power plant [41]. Novelty is by definition unfamiliar and may be experienced as threatening to a social group [27]. SRT proposes an intersubjective theory of risk, in which human thought is seen as relational, guided by emotions and highly dependent on intuitive and experiential thinking: "The response to risk is a highly social, emotive and symbolic entity" [41] (p. 55). While the role of emotions was long neglected in approaches to risk research that (nonetheless usefully) highlights cognitive biases, other research traditions have highlighted the central role of emotions in the construction of risks [42]. While cognitive research on risk perception has focused on the biases and limited cognitive capabilities of humans, the concept of bounded rationality notwithstanding [43], the SRT approach focuses on social knowledge, symbols and emotions [41].

The relationship between identity and social representations is described above and as social representation is interwoven with identity processes, identity also plays into the representation of risks. The re-

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sponse to risks requires material and symbolic coping and the latter is at the heart of SRT. Within the process of symbolic coping, a central motivation is to identity protection: social representations "emerge precisely in response to danger to the collective identity of the group, and consequently, a central purpose of representation is to defend against feeling threatened" [41] (p. 66). Furthermore, how a risk is constructed is shaped by the identity of a group. The underlying values of a group shape the images, symbols and metaphors used to represent the risk [41]. In short, the social representation of risks plays a crucial role in processes of social change and is embedded in identity construction.

3. Research design

The main research questions of the study relate to the nature of the social psychological aspects of landscape shock in a particular case and more generally, landscape shock being a key concept in sociotechnical transitions theory. Our proposition is that SRT can provide the terms for an account that helps to characterise the social psychology of landscape shock in question, particularly because the theory explicitly bridges social and individual experience. We then illustrate this with a case study. Overall, the research design seeks to meet the criteria of plausibility and convincingness that are common to qualitative work [44], offering a theoretically-informed account as well as new empirics. The particular case study is chosen on the basis of supporting a social psychological characterisation of landscape shock, which is posited in the sociotechnical transitions literature as central to one of several pathways by which regime change may occur [4]. Given this, the case needs to be capable of illustrating interactions and processes relevant to both the landscape and the regime[6].

As the research design involves a single country case, we should also comment on issues of generalisability[7]. As is usual in case study research, we are not claiming generalisability to other cases in terms of the empirical specifics, here the specific themes in the data: these are context-dependent and may or may not be found elsewhere. Rather, our purpose is conceptual development [45] in terms that arguably span cases, with the latter claim being based on the knowledge that the terms themselves (social representations theory [46] and sociotechnical landscape shock [1]) have been applied across multiple cases and contexts [47,48]. Hence our aim is to offer a generally applicable way of understanding situations of which there are multiple instances. The empirical case is offered as an illustration of the proposition, and the theoretical proposition is made abductively, as theoretically fitting the questions posed.

In the next section we describe the background to the case material. The case is pivotal not only within the German energy transition, but is also more widely relevant empirically and theoretically, given the global importance of nuclear power and the inevitability of landscape shocks.

3.1. Case Study: German reaction to the Fukushima nuclear accident

On March 11th in 2011, the combination of inadequate sea defence walls, an earthquake and a subsequent tsunami triggered a sequence of events that ultimately led to three nuclear reactor meltdowns, associated hydrogen explosions and the uncontrolled release of radioactive emissions at the Fukushima Daiichi power plant in Japan. This case study centres on Germany's public and policy reaction to the accident, as characterised in terms of SRT and as indicated via representations

in the German print news media of the time[8]. Below we firstly describe the German energy system context, drawing on terms from sociotechnical sustainability transitions, and thereafter the psychosocial sense making processes and dominant patterns of meaning making in the case.

The nuclear accident at Fukushima was arguably experienced by energy regimes internationally as a landscape shock. Although the Fukushima powerplant operators (Tokyo Electric Power – Tepco) had ignored repeated warnings about the risk over an earthquake-induced Tsunami overtopping the sea defence wall of the powerplant [49], the immediate events in Japan were nonetheless perceived and experienced as unforeseen and uncontrollable by the incumbent actors involved [5] (p. 241). Yet while most of the largest nuclear power–producing nations committed to only modest safety reforms of their nuclear power plants in response [18] (p.379), the shock had a profound effect on the German energy sector. In less than four months, the German Parliament had passed the '13th Act amending the Atomic Energy Act' on June 30th, 2011 and had committed to a rapid nuclear phase-out. As part of the Act, eight nuclear power plants immediately lost the right to operate and the remaining nuclear power plants would be closed down by 2022 [50]. The nuclear accident thus triggered a crisis within the German energy regime and opened a window of opportunity for change [21] that ultimately led to the phase-out. Given the contrast in German reaction and the reaction of other nations, it is clear that an external or landscape shock itself has no inherent or context-independent meaning: such meaning is socially constructed [5] and context-specific and it is to this context that we turn next.

Germany has a strong anti-nuclear movement that was established in the 1970 s and 80 s. This, in combination with citizen groups working on environmental issues and opposing NATO, gave rise to the Green Party in 1980 in West Germany, which in turn gave rise to Die Grüne (Bündnis 90/Die Grünen) in 1993, via a merger of West and East German Greens and Alliance (Bündnis) 90 after the fall of the Berlin Wall. In 2001, an SPD[9]-Green Party agreement was established on a gradual nuclear phase-out by 2022; this also further strengthened policies for energy demand reduction, energy efficiency and renewable energy support [51]. However, in 2010 – just months before the nuclear accident in Fukushima – the then German government coalition, which consisted of the traditionally pro-nuclear power parties, the CDU and FDP[10], decided on a lifetime extension for nuclear power plants. The coalition argued that the extended use of nuclear energy was required for meeting climate targets and also required to support the development of renewable energy [51]. Hence, at the time of the Fukushima accident of March 2011, there was no indication that the government coalition would support, let alone instigate, a rapid nuclear phase-out plan [18].

Post-Fukushima in 201 l, mass anti-nuclear protests were held across Germany. In the wake of the unfolding nuclear crisis and just three days after the earthquake and tsunami, the German government announced a three-month moratorium which included the immediate shutdown of the eight oldest nuclear power plants and the establishment of the Reactor Security Commission (RSK), which was instructed to carry out safety checks on all German nuclear power plants [18]. Furthermore, an ethics commission was convened to evaluate the use of nuclear power. The ethics commission recommended a rapid nuclear phase-out plan in its final report [52]. This phase-out plan was imple-

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[6] Nuclear power is treated as part of the 'regime' because it receives substantial, formally instituted support globally.

[7] For studies examining the impact of Fukushima incident on public opinion across countries, see e.g. [73,74]. It might also be noted that whether generalisation is a concern depends on one's purpose: a single case may be viewed as having intrinsic value, regardless of the implications of this for understanding other cases [45].

[8] We use this phrasing to acknowledge that, when using news media as sources, the representations chosen to reflect and discuss public and policy reaction are those of journalists. This would not be the case if the representations studied were letters to the editor, or the lightly moderated comments by publics that may follow online news articles.

[9] The SPD is the politically left-leaning Social Democratic Party (Sozialdemokratische Partei Deutschlands).

[10] The FDP is a relatively small, centrist/centre-right Free Democratic Party (Freie Demokratische Partei). The CDU is the major centre-right party of German politics, the Christian Democratic Union (Christlich Demokratische Union Deutschlands).

mented by the German government three months after the catastrophe in Japan. With a major policy reversal, the government coalition abandoned their support for nuclear energy and decided on an even faster nuclear phase-out than the one they had agreed a few months before [18]. Eight reactors were shut down immediately; until March 2011, Germany obtained 25% of its electricity from nuclear energy, using 17 reactors. The latter figure is now about 12% from seven reactors [53].

In order to understand the policy shift, the historical, political, technological as well as cultural context also need to be acknowledged. As already pointed out, the strong anti-nuclear movement, which was backed by a highly mobilized opposition and a well-positioned renewable power sector, are key contextual factors in the post-Fukushima energy policy shift. Anti-nuclear mainstream media coverage added to the political pressure [18] and overall the case illustrates the crucial role of timing in transition processes in general [4] and particularly in this case [21]. Furthermore, the 25th anniversary of the Chernobyl nuclear accident was six weeks after the earthquake and added further symbolism to the crisis.

Finally, in terms of further context, one must also understand the cultural environment. For this, Hofstede's research on national cultures is useful [54,55].[11] In Hofstede's terms (please see footnote 8 too), German culture displays high levels of *uncertainty avoidance*, or risk adversity, as well as a *long-term orientation.* From this perspective, German culture is characterised as including the trait of feeling threatened by the unknown and of creating beliefs and institutions to avoid dealing with – and/or to prepare for – uncertain situations. The culture is also characterised by a strong security-orientation and a forward action approach, to gain certainty and control. This goes hand in hand with relatively high levels of the *long-term orientation* dimension, referring to the way that a society approaches the future. Hence German society in the above terms is defined as relatively pragmatic, showing a high ability to adapt beliefs, traditions or behaviors to changed conditions or to achieve particular results. This uncertainty avoidant, pro-active approach is reflected in the reaction to the nuclear accident and helps in combination with the factors mentioned above to understand the drastic policy shift as well as the unique response by the German public to the nuclear accident.

3.2. Analytic method and data selection

The news media are assumed to play a role in shaping and transforming social representations generally and in relation to energy [27,33,41,56,57]. That is, particularly in the context of disaster, for most people, initial and often subsequent contact with the event is via news media, in which any specialist knowledge involved is translated into widely comprehensible terms and risks are framed not only probabilistically, but also emotionally [41]. That said, it should be noted that there is likely multi-directionality among the processes involved in opinion-shaping, of which the news media are a part.

Methodologically, qualitative content analysis [58] was applied to German newspaper articles on the Fukushima case, with the aim being to uncover themes that reflect dominant patterns of meaning making of the accident and the effect of that accident on risk representations of nuclear energy. The focus is on lay public representations, not on specialist, trade or commercial representations.

Coding was by one of the authors only and reflects the themes in the data, while bearing in mind the analytic concepts of SRT. The coding scheme is thus primarily inductive in practice, though hybrid in the sense that the three core concepts of SRT – anchoring, objectification and thematisation –are selectively used in the interpretation where applicable. The sample articles are coded throughout, such that a particular article may have multiple codes allocated to it and the codes are applied at any point in the article. The coding scheme, their hierarchical arrangement, their corresponding numerical incidence and the sources of the illustrative quotations are appended. In terms of process, first, a comprehensive coding consisting of several rounds was carried out to gain an overview of the post-Fukushima discussion; second, the codes were grouped into overarching themes and dominant patterns were identified. A coding scheme consisting of the most dominant codes was established and used for a final round of coding.

In terms of data selection for the media analysis, newspaper articles were accessed via the search engine NexisLexis. The latter covers a wide range of newspaper and other media sources for more than 100 countries. To allow for a variety of risk representations in the German press, no selection filter was used, such that the local, regional and national press of all types are represented in the main sample. Similarly, all parts of the articles were used, as all representations are of interest for our purpose. The period for the analysis includes media coverage between the accident and the formal political decision in Germany to phase-out nuclear energy. The starting point for the data selection is thus the 11th of March 2011, the beginning of the nuclear accident in Fukushima, and the end point is the 30th of June 2011, which marks the majority vote for the nuclear phase-out by the German Parliament.

The search was based on the terms "Fukushima" and "nuclear energy" together. To exclude articles that mention these terms only once, the search function "ATLEAST2" is used to exclude articles that do not specifically focus on the nuclear accident and nuclear energy. The search produced 705 items in total. Of these, 568 newspaper articles and 50 magazine articles were chosen as the sample (618 items), excluding web-based publications and publications by science, industry and trade, given that our focus here is on social representations in general public discourse. While scientific, industrial and commercial discourse is certainly of interest and indeed legitimately constitutes a strand, or strands, of societal thought, to include these publications would have deviated from our focus on lay public representations. To render the analysis more manageable, every third article was selected for the analysis (n = 618/3), resulting in 206 items. As this selection process reflected no other form of systematisation, such as day of the week, there was no evident form of systematic bias. After then deleting duplicate items, the final sample consisted of 185 newspaper items in total.

4. Results

The results of the newspaper analysis are clustered below into three sections. The first section focuses on general representations of the nuclear accident. The second part discusses the representation of nuclear power in general and representations of the risks of this for Germany in particular. The final section addresses overarching sense-making patterns that connect the first and the second part. In each section we first give a general overview of the representations and then a table of notable examples. Italics are used in the main text to indicate themes coded. More detail is appended.

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[11] It is not our purpose here to defend the perceived similarities between Germany and Japan found in the newspaper articles. Nonetheless there are other relevant cultural surveys and scales that also support this, such as the World Values Survey, which uses a broad range of questions that include additional scales by Schwartz [75]. Using the World Values Survey, Ingelhart and Welzel find that Japan and Germany both score highly in terms of secular-rational and self-expression values [76]. Secular-rational values tend to be strong in countries with a long history of social democratic policies, while self-expression values are strongest in Western countries. The combination of the two values sets is geographically most prevalent in Protestant northern Europe [76].

4.1. Representations of the Fukushima accident

4.1.1. Representations of the incident itself

German newspaper representations of the Fukushima accident repeatedly describe the incident as a *turning point*[12] and as a *warning or lesson* to be learned from. The accident is referred to as the end of the nuclear age and the term "Fukushima generation" is repeatedly used to describe the impact of the catastrophe, underlining also a temporal dimension. It is argued that Fukushima changed everything. Furthermore, Fukushima is represented as a synonym for the risks of nuclear power in general (*Fukushima = NE [nuclear energy] risks*). This representation is not focussed on specific risk factors, but is rather based on a generalisation and an abstraction of risks as unspecified dangers.

The event is very often linked to the nuclear accident in *Chernobyl*, with anchoring separable into categories of similarity and difference. On the one hand, Fukushima is represented as a second Chernobyl and parallels are drawn. Fukushima is seen as the result of the ignorance in respect of Chernobyl. However, Fukushima is presented as an opportunity to learn the lesson now and draw the necessary inferences. The dominant narrative regarding the differences between Fukushima and Chernobyl is that Fukushima occurred in a highly developed, security-oriented democracy. It is argued that in the case of Fukushima it is not possible to shift the focus and place the blame on the lack of some form(s) of appropriate capacity, as might be applied in the case of Chernobyl. The overall conclusion drawn is that Fukushima demonstrates that nuclear accidents can happen anywhere and to anyone.

Despite Chernobyl, Fukushima is repeatedly anchored in the nuclear bombing of *Hiroshima and Nagasaki*. *Links between nuclear energy and nuclear weapons* are drawn and often, and both are represented as similar or even identical in their consequences. For example, the question is asked several times: how Japan – as the only country in the world that has experienced atomic bombing – can use nuclear energy? Furthermore, Fukushima is represented as a trigger of the deep Japanese trauma that is rooted in the nuclear bombing of Hiroshima and Nagasaki and links between the aftermath of the bombing and the nuclear accident are drawn.

Fukushima is also anchored in the *German anti-nuclear movement* and the nuclear accident is represented as the prophecy come true, with the opponents of nuclear power seen as right (factually and ethically) all along. In general, the anti-nuclear movement and its actors are represented in a very positive light. The foregoing are illustrated in Table 1.

Overall the response to the Fukushima incident needs to be understood within the context of a German society that has been highly sensitised in its perception of NE, with a strong anti-nuclear movement in the 1970s and 1980s (Section 3.1). As theorised in the MLP [1], the shock takes place in a landscape with particular historical but also generationally-specific dimensions. Fukushima is anchored in three salient, negative experiences of nuclear energy, each with resonance for German society, through proximity or war-time associations: Chernobyl, Hiroshima and Nagasaki. This cultural assimilation maps the new social representation of Fukushima to corresponding, familiar phenomena [33]. The result is that the adverse possibilities of nuclear energy, even if of low probability, are reinforced. The technology is portrayed as uncontrollable, unresolved, beyond human capabilities, despite it being embedded in a high technology, high security-oriented democ-

racy. Similarly it is anchored in the negative emotion of fear [59] and the language of nightmares (see Table 2).

4.1.2. Representations of nuclear energy

The debate around Fukushima is also embedded in a more general discussion of the benefits and disbenefits of NE. In the post-Fukushima debate NE is repeatedly described as *unsafe, dangerous* or *harmful* to humans as well as the environment and as an *outdated* and *uncontrollable* technology. It is labelled as a *risk technology*. Bipolar themata emerge: where nuclear energy is referred to as a *threat* and as *evil*, the opposites are implicit. Nuclear energy is also personalised as an enemy. Despite these strongly negative representations, NE is also represented as *climate-friendly* and the trade-off between the risks of NE and its usefulness in achieving climate targets is discussed (*the risks of NE vs. the cli-*

Table 1
Representations of the Fukushima incident.

Code	Example
Turning point	"After the nuclear catastrophe in Fukushima and pressured by the frightened public, the government decided on a final plan to phase out NE." (B.Z. June 5th, 2011)
Warning or lesson	"The decisive lesson from this tragedy is: NE is uncontrollable, neither by humans nor by machines." (Berliner Kurier March 13th, 2011)
Fukushima = NE risks	"Fukushima is proof that managing NE is beyond human capabilities." (Stern March 17th, 2011)
Chernobyl	"Chernobyl was dismissed as a failure of a bankrupt communist system. In contrast, the latest nuclear accident occurred in a highly industrialized civilization with a distinct security culture." (Die Welt March 18th , 2011)
Hiroshima and Nagasaki	"The country relied upon the development of nuclear energy despite Hiroshima, which is one of the nightmares of the Japanese national consciousness." (taz April 11th, 2011)
Links between nuclear energy and nuclear weapons	"A nuclear power plant contains the energy and radiation potential of several atomic bombs – the risks are extensive." (Der Spiegel March 21th, 2011)
German anti-nuclear movement	"The anti-nuclear movement warned for decades against the dangers and the unsolved problem of the final storage of NE. Now at the latest it should be stated: they were right all along." (Die Zeit March 24th, 2011)

Table 2
Representations of nuclear energy (NE).

Code	Example
Unsafe, dangerous or harmful	"NE is the most dangerous technology used in this country." (Die Zeit March 17th, 2011)
Outdated	"The German power plants are much older and much less safe." (Die Zeit March 24th, 2011)
Uncontrollable	"The fact is that NE is uncontrollable." (Rheinische Post March 24th, 2011)
Risk technology	"The nuclear horror scenario is known: it has accompanied this high-risk technology since its emergence." (Berliner Zeitung March 14th, 2011)
Threat / evil	"This is about the fight between good and evil. In the climate context, the evil is hard to identify. It is not as easily captured as the nuclear power plant with its cupola and cooling tower." (Die Zeit March 24th, 2011)
Climate-friendly	"Climate protectors are starting again the old debate: Is NE needed, to save the climate?" (taz April 4th, 2011)
The risks of NE vs. the climate catastrophe	"The disadvantage of the political turn: The fulfilment of the climate targets will become a lot more difficult." (Die Welt March 30th, 2011)

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[12] Italicised phrases here are codes that can also be found in the associated tables, alongside examples from the newspaper articles, all of which have been translated from the original German. The terms nuclear energy (NE) and nuclear power in the sense of electricity are used interchangeably, as discussion of nuclear waste heat is absent from public representations.

mate catastrophe).[13] This suggests multiple, often competing representations of nuclear power, as would be expected of the technology.

4.1.3. Risk representations

Regarding risk representations, rather than relating to factors inherent to the technology, nuclear power is anchored to connotations of uncontrollability and hence the risk factors of *natural disasters*, *plane crashes* and *terrorist attacks*. Plane crashes and terrorist attacks are viewed as context-independent and hence beyond the management capabilities of German safety standards. Although the specific nature of the Fukushima nuclear accident is acknowledged, the risks of and to nuclear power are generalized, as well as there being references to floods and other natural catastrophes that are context-specific for Germany as well.

In addition to the risks of nuclear power being described as *unknown*, *uncontrollable*, *unforeseeable*, they are also viewed as *unprecedented*. Hence, the risks are represented in a rather unspecific, difficult to predict, uncertain way. Also of note here is the frequent use of the personal pronoun 'we' in the articles, denoting a collective dimension that echoes the collective identity proposition inherent in social representations theory [26]. Examples of such representations are illustrated in Table 3.

4.1.4. Policy and policy actor representations

A large part of the post-Fukushima debate in the newspapers is focused on German policy actors'- approaches to nuclear energy. The government coalition was strongly criticized for its pre-Fukushima decision to prolong the use of NE (*criticism of life-time extension*). The main critique is that the government acted in a manner that is *irresponsible, careless and ignorant* prior to the accident, by promoting the use of NE. Furthermore, it is argued that the *risks of NE were known* by the government and that the *risks were deliberately ignored*. A dominant narrative is that the government valued *profit over public safety* by promoting NE. Additionally, the political U-turn post-Fukushima is labelled as insincere and as solely based on *political calculation*. The chancellor Merkel herself is several times referred to as *Merkel, the physicist*, as she has a background in physics. It is described as ironic or insincere that Merkel, who is seen as an expert on NE based on her background and has been a strong advocate of NE pre-Fukushima, is now promoting a rapid nuclear phase-out. In fact, this questions Merkel's values and her moral stance vis-à-vis NE.[14] Overall we find strong representations with associations to character traits such as irresponsibility, insincerity, carelessness and ignorance, accompanied by political calculation and profit orientation. This creates a context in which both politicians and policymaking, as well as economics and business are associated with questionable values and virtues. A profit-seeking versus safety-seeking themata is thus established. The critique also goes further, by attacking nuclear lobbyists who are represented as having lied to the collective for decades. This takes place in the context of where the dominant narrative regarding the role of NE *is that the technology not needed for energy security* and that the moratorium demonstrates that a nuclear phase-out is manageable. Table 4 provides illustrative quotations, without seeking to be comprehensive as to the range of policy actors represented.

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[13] Here, we do not analyse the representations by voice, i.e. the extent to which representations are associated with a specific type of stakeholder or political position. Nonetheless where the same stakeholder holds contrasting or contradictory representations, this is known in social representations theory as cognitive polyphasia [26].

[14] Perhaps worth contrasting with representations of Merkel in times of Covid-19, where her scientific understanding is anchored to positive connotations: https://www.theguardian.com/world/2020/apr/16/angela-merkel-draws-on-science-background-in-covid-19-explainer-lockdown-exit.

Table 3
Risk representations of NE in Germany.

Code	Example
Natural disasters	"Until now, we based our risk scenarios on human error and technical failure. Now we are dealing with a natural phenomenon of an unprecedented scale." (Der Spiegel March 21th, 2011)
Plane crashes / terrorist attacks	"What has been an earthquake in Japan, can be a plane crash, terrorist attack or cargo ship accident in Europe." (Frankfurter Rundschau March 15th, 2011)
Unknown	"We will know which details those who are responsible did not have "on their radar", when the time comes, and when our country is heading towards a catastrophe." (Frankfurter Rundschau March 15th, 2011)
Uncontrollable	"The fact is, a nuclear catastrophe has no limits." (Rheinische Post March 25th, 2011)
Unforeseeable	"We are dealing with new types of threat, which are neither spatially nor temporally limited and whose probability of occurrence is extremely low, but they need to be prevented in any case." (taz April 1st, 2011)

Table 4
Policy and policy actor representations.

Code	Example
Criticism of life-time extension	"Can we trust the CDU-FDP government? Despite the fact, that they prolonged the lifetime of the oldest and most dangerous reactors without any specific need?" (Die Zeit March 17th, 2011)
Irresponsible, careless and ignorant	"The facts speak clearly against the use of NE: The nuclear meltdown in Chernobyl, the fourfold nuclear meltdown in Fukushima, Harrisburg, Sellafield, Forsmark, Asse and the unresolved problem the final storage of nuclear waste. Hence, political decisions should be based on responsibility." (Der Tagesspiegel April 10th, 2011)
Risks of NE were known	"What kind of new insights does the nuclear accident in Fukushima provide? Why establish an expert commission? Everyone who had been interested, could have known what experts have long been aware of: Such a nuclear catastrophe can occur at any time in any place, even in the allegedly safe power plants in Europe." (Stuttgarter Nachrichten March 24th, 2011)
Risks were deliberately ignored	"The pro nuclear parties and the nuclear lobbyists have simply lied to us for decades. Now they have to admit that they argued against better judgement." (Aachener Nachrichten March 19th, 2011)
Profit over public safety	"Their billions in profit were and are more important than the safety of billions of people. When safety can be too expensive, it has never been important in the first place." (Aachener Nachrichten March 19th, 2011)
Political calculation	"A clear majority of the German population perceive Merkel's policy change as an electoral maneuver." (Welt am Sonntag March 27th, 2011)
Merkel, the physicist	"Ironically, the physicist Merkel, the chairwomen of the popular party CDU, which until recently strongly supported NE, executes the partially immediate nuclear-phase-out." (Stern March 17th, 2011)
NE not needed for energy security	"It is reassuring for the public that eight nuclear power plants have been shut down and no shortage in energy supply is occurring." (Mitteldeutsche Zeitung April 19th, 2011)

4.2. Overarching sense-making patterns

Regarding overarching sense-making patterns, a self/other thema plays a crucial role in several ways that relate to identity. Firstly, identification processes between Germany and Japan are visible. The debate is dominated by *links, similarities* and differences *between Germany and Japan*, especially sociotechnically. Japan is represented as a *high-tech, security-oriented democracy and industrial state* and these traits are actively associated with Germany too. In other words, these aspects of Germany are anchored by German commentators to the same aspects of Japan. Accordingly, as a logical extension, the narrative *if this hap-*

pens to Japan, it could happen to us is explicitly referred to. These identification patterns take place both on an individual and collective level, indicating both cultural and social psychological dimensions and a like-us/not like us thema. The anchoring to Japan via a thema of high-tech competence/low tech and incompetence is disrupted by the Fukushima event: nuclear power is moved outside of its sphere of reference for both countries and is viewed as uncontrollable. That said, representations also change to include patterns of *cultural differentiation* between German and Japanese individual and collective traits. While the identification focuses on the pre-Fukushima timeframe,[15] the differentiation focuses on post-Fukushima and on the social handling of the crises in particular. The Japanese reaction is represented as passive, emotionally controlled, mainly noncritical and devoted to societal stability, often framed in contrast to the German culture (despite Hofstede's cultural characterisations referred to above [54]). Particularly referred to are the widespread German protests and the demand for a phase-out of nuclear power, compared to a perceived "Japanese reserve". Regarding this differentiation, Germany is positioned as a pioneer, putting Germany in a *special position* post-Fukushima. In this regard, there is a strong identification in terms of sociotechnical context and capabilities, but a differentiation in terms of German cultural traits and the implications of these for managing such a crisis. There is a refocusing of the intertwined identity and representation of German society and its collective identity on its own inherent strengths- 'the German citizen made their decisions'- through dissociation from a perceived Japanese trust in its technological capability. The departure in self-perception through comparison constitutes a degree of identity change for Germany, at this point in time, and is seen as a 'step into the future'. These points are illustrated in Table 5.

Despite the perceived similarities and differences between Japan and Germany, the debate is mainly centred on the domestic German context, using the Japanese accident as a point of access for discussion of nuclear power in Germany. The comparative anchoring with Japan, its socio-technical culture and rules and norms serves as a kind of cultural assimilation that allows the new social representations that have been triggered by the Fukushima incident to be 'mapped' to a well-known phenomenon or context [33]. The self/other thema is then also used to paint the two sides between the self, defined as the *anti-nuclear German public and political opposition* in contrast with the other, defined as the *German government and nuclear industry*. This also connects to the criticism towards NE policy detailed above and blame of the domestic government for exposing its people to the risks that are being represented through the Fukushima accident. This debate is not based on a technological analysis of the events in Japan, but rather is symbolic (Fukushima is described as Armageddon and the biblical battle between good and evil) and emotional (afraid, foolish). The use of nuclear power is represented as an *ethical issue* and the responsibility for *future generations* is often referred to. Hence Table 4 lists questionable character traits such as irresponsibility, insincerity, carelessness and ignorance, anchored to thinking around calculation and profit orientation. This ethical debate is interwoven with *religious references and metaphors*. The Church, as an important ethical and legitimising stakeholder, is consistently positioned as anti-nuclear, with the Fukushima accident described as the apocalypse and the use of nuclear power labelled as a sin. In this context, one of the most dominant patterns is the *hubris* narrative. Fukushima is represented as a symbol for the overconfidence of humanity in creating a technology beyond its control: Fukushima as nemesis through megalomania.

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[15] It should be noted in this respect that we are not empirically comparing pre- and post-Fukushima representations, but are referring to references in post-Fukushima representations. The Fukushima incident is represented as a bifurcation point that reflects German perceptions of particular differences between the cultures (Japanese 'reserve'), while particular similarities are perceived as remaining (advanced technological capability, nonetheless trumped by the ultimately 'uncontrollable' nature of the nuclear technology used).

Table 5
Identification and disidentification with Japan.

Code	Example
Links and similarities between Germany and Japan	"There are several boiling-water reactors operating in Germany, which are similar to those in Fukushima. And here, too, are dangers, which based on statistics should never occur: Terror attacks, floods, plane crashes." (Stern March 17th, 2011)
High-tech	"The maximum credible accident in the reactor in Fukushima demonstrates, that even in a high-tech country like Japan, which is prepared for all eventualities, NE is an uncontrollable highly dangerous risk technology." (taz March 14th, 2011)
Security-oriented	"Japan was considered a high-tech country with extreme security measures." (SonntagsZeitung March 20th, 2011)
Democracy and industrial state	"Fukushima is not Chernobyl, this is not about an outdated reactor in a dying dictatorship. This concerns a boiling-water reactor, just like the ones in Germany, and the accident happened in a democratic country, which is as highly technologically advanced as Germany or France." (Die Zeit March 17th, 2011)
If it happens to Japan, it could happen to us	"If the high-tech country Japan is unable to control NE, why should Germany be able to?" (Stern March 17th, 2011)
Cultural differentiation	"In Japan, being vulnerable is tantamount to shameful behaviour and regarded as harmful to society. At first glance, the high-tech Japanese society seems to be similar to western societies. However, the handling of the crisis reflects the differences." (Stern March 17th, 2011)
Special position of Germany	"Germany takes a step into the future. This involves risks and there are no guarantees. Nevertheless, the German citizens made their decision – despite the uncertainties regarding the ecological energy transition. *German angst*? Rather, let's call it *German cleverness*." (Die Zeit April 7th, 2011)

In this context, the self is formed on a *meta*-level by referring to humanity in general (*self = humans*), regarding both present and future dimensions (future generations). Fukushima is used to criticize generally the use of NE and to demonstrate the risks humans are willing to take. Relating to this, the *force of nature* represents a response to hubris: Nature struck back mercilessly against human wrongdoing. The narrative is that human mastery of nature is an illusion and that Fukushima demonstrates the dangers in believing otherwise ('this earth unleashes natural forces that exceed our imagination and are incalculable').

Nuclear power is thus overall represented as an uncontrollable technology within a world that is controlled by natural forces – not by humans. This leads to the final aspect: the discussion is subliminally shaped by *war references and metaphors*. For example, Fukushima is illustrated or described as a war zone, NE is framed as the enemy by referring to a war or fight against NE; the peaceful use of NE is negated and put on a level with nuclear weapons; and Fukushima is anchored in the war trauma of Hiroshima and Nagasaki. Table 6 illustrates the over-arching themes.

5. Discussion and implications for further research

We begin with implications specific to the case study and then move on to more generally applicable points, including implications for research directions. Nuclear debate in Germany immediately post-Fukushima involved social representations that were more emotional and symbolic than technologically detailed. Significant policy decisions were made while the nuclear crisis was just unfolding – without knowledge of the causes, the extent and the physical impact of the crisis. It was not of central interest in the newspaper representations as to *what* exactly had happened in Japan: the fact that an accident actually occurred in a highly developed country like Japan – like *us* – was the main concern and a driver for change in the debate. Hence, the identification with Japan is crucial in understanding the German reaction to this particular landscape shock.

Table 6
General sense-making patterns.

Code	Coding Example
Self = anti-nuclear German public and political opposition Vs. Other = German government and nuclear industry	"NE was established worldwide, because the nuclear industry is fully insured. All major accidents are paid by the people and they are ultimately paying with their lives. And the profits go to the companies. Germany's four biggest energy suppliers make 20 billion in profit each year." (Der Spiegel March 21st, 2011)
Ethical issue	"The termination of NE is less of an economic or political problem. Rather, it is an ideological issue. The most important work will be done by philosophers. A completely new system of argumentation and language is required. Because our world view is still based on the idea, that the world revolves around us humans." (Der Tagesspiegel April 18th, 2011)
Future generations	"For most people it is unthinkable to create problems on an unfathomable scale, which our descendants have to deal with for thousands of years." (Der Tagesspiegel April 10th, 2011)
Religious references and metaphors	"No wonder that people feel unsafe and afraid. The headline in a German newspaper over the weekend read "Armageddon". The catastrophe in Japan is framed as the biblical decisive battle between good and evil." (Stuttgarter Nachrichten April 18th, 2011)
Hubris	"Japan demonstrates the failure of a humanity who believes it is god-like. The vision to step into the role of the creator to dominate the elements failed already 25 years ago in Chernobyl." (Rheinische Post March 25th, 2011)
Self = humans	"We humans are prone to failure. We have to use a technology that can handle human mistakes." (Welt am Sonntag March 27th, 2011)
Force of nature	"Foolishness was paired with the fatal misbelief that we could master the forces of nature. But the catastrophe proves: This earth unleashes natural forces that exceed our imagination and are incalculable." (General-Anzeiger April 5th, 2011)
War references and metaphors	"A catastrophe like a war. "You know, a nuclear catastrophe is a state of war", says Ostrezov." (Die Presse March 20th, 2011)

Instead of an analysis of the specific causes of the events in Fukushima, discussion of the nuclear accident was anchored in discussion of domestic nuclear policy and Fukushima was used as a basis for a general discussion of nuclear power. Fukushima was framed as a symbol for the general dangers, risks and potential negative effects of nuclear energy. The far-off disaster in Japan was made symbolically proximate through the identification with Japan as a high-tech and security-oriented country; through generalization of the perceived risks and unpredictability of the technology; and through a generalised ethical framing of the debate, dominated by a religious hubris narrative. The debate was elevated to a *meta*-level that was focused on humankind (present and future) and its relationship with technology and behaviour towards nature. Instead of distancing the German self from the accident and blaming Japan, the blame was internalized, and the focus was put on the domestic actors who were regarded as responsible for the use of nuclear power.

The German discussion driven by the urge not only to prevent nuclear harm in the future, but also being responsible for this. This is arguably strongly related to the German cultural characteristics described in the first part of the case study: the fear of uncertainty and a fearful focus on the future. The narrative that future generations will pay for current use of nuclear energy and that the potential negative consequences of this are unpredictable was one of the driving arguments in the debate. By phasing out nuclear power, it was understood that Germany would not actually save itself from the potential consequences of nuclear accidents in the future, being surrounded by countries using nuclear technology. Nonetheless, Germany would not be the country *responsible* and this move was also considered as pioneering. Instead of physically distancing the German self from the potential danger, the decision to phase out nuclear power symbolically distanced the Ger-

man self from the potential future blame and guilt that would be connected to a nuclear accident.

In addition to the above emotional distancing, the cultural dissociation from particular, perceived Japanese cultural traits and values resonates with the premised nature of social representations as dynamic and dialogical in the sense of an interaction between new and old representations, leading to a new state[16] [60]. The case provides an illustration of how sociotechnical landscape shock is experienced in the broader social world, reflected in social representations of the technology at the heart of that shock, inferred from contemporaneous newspaper content. Landscape shock is here conceived of as a strongly social phenomenon with psychological dimensions. How widely these dimensions are experienced will depend on the nature of the shock. Each of Geels' examples – (wars, economic crises, major accidents, political upheavals) [2] – is likely to be experienced differently by different individuals and groups (demographic, cultural, national), in ways partly conditioned by the attributes of those groups (location, age, gender etc).[17] Hence while, as noted, the Fukushima incident appears to have suppressed the development of nuclear power internationally, the strength of the German response is associated with a particular socio-cultural history and hence culturally-specific meanings.

We stop short of identifying any specific causal mechanisms here: not because we doubt the existence of various, inter-related, mutually influencing processes, but because we cannot evidence these with the data gathered for present purposes. Nonetheless, we still note some evidence of change in social representations triggered by the Fukushima incident, in particular with view to a distancing from particular, perceived Japanese cultural traits and values and a refocussing on ways of thinking and doing deeply embedded in, and associated with German culture. In this we concur with others who have proposed that social representations of technologies and sociotechnical systems are likely to change over time, in parallel with sociotechnical change [61], and it is likely – even if not demonstrated here – that landscape shock events may be a trigger for social representational change and this merits further work.

We should also say a little more about risk representations, as risk perception is clearly important to this case, bordering on dread, a long-recognised form of risk perception [62]. The value of social representations in this context is not so much in terms of understanding the causal connections between the wide range of factors involved in risk perception, something that the social amplification of risk framework [9] does more comprehensively. Rather, SRT provides a theory of meaning, its stability and its change; while here we have approached meaning from a relatively interpretivist perspective that also emphasises affective dimensions [63], representations can in principle be used as indicators of such meaning, to track changes in meaning over time.

Moreover, being culturally embedded, such representations also have the potential to support cross-location and/or cross-cultural comparison of shared but also often competing views of technologies, sociotechnical systems and related policies. Operationalising this in studies that span before, during and after landscape shocks and other phe-

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[16] This dialogical view of social representations is not always emphasised, given that many social representations studies focus on the stability of familiarization in the process of anchoring and objectification.

[17] For example, at the time of writing in spring/early summer 2020, the spread of the coronavirus SARS-CoV-2 and the disease COVID-19 affects 213 countries, areas or territories; but the impacts on individuals and groups vary widely [77]. This form of landscape shock is of such severity that it has at least temporarily affected much regime-level functioning globally. The Fukushima nuclear incident deeply and rapidly affected the energy regime of Germany, arguably interacting with the cultural factors referred to above, but the coronavirus may affect behavioural norms relating to social distance internationally and on a sustained basis. This in turn may affect, for example, the load factors achievable in public transportation and hence increase the cost of mobility-related carbon emissions reduction. The first and multiple order consequences of the virus, across multiple, interacting regimes, remain to be seen.

nomena relevant to sociotechnical change is thus an evident direction for future research, as is comparison of representations held and issued by differing and competing interests [64], for whom a particular landscape shock may have different meanings and consequences. Building on this, there is also a need to better understand the functions and functioning of changing social representations in relation to sociotechnical change: more than simply correlative association, representations have persuasive power, not least through emotional anchoring. The latter also merits further investigation in future research. Social position can also be hypothesised as playing a role here: some actors' representations are more influential than others in terms of sociotechnical change, reflecting their salience with wider publics, their decision-making authority within an organisation, their capacity to mobilise resources [65] and so on.

6. Conclusion

Our aim here has been to develop and illustrate the value of a particular social psychological perspective for understanding the role of *meaning*, a construct located for different purposes at different levels of Geels' multi-level perspective (MLP) [1], the latter being a framework heavily applied in a wide variety of socio-technical transitions research. Here it is 'regime'-level meaning that we focus on, and in particular as a social psychological correlate of 'landscape shock', a process conceived of within the MLP framework as potentially triggering change in the regime, which itself consists of the prevailing social rules (in the structuration sense [66]) that manifest in the socio-material world around us.

In terms of limitations, we have acknowledged that the data that we present here do not allow observation of changed social representations of nuclear power in the news media studied, between pre- and post-Fukushima. That is, neither change in type nor frequency: observation of such change, even if in our view likely, requires a longer period of analysis. Similarly, as our data are a snapshot of social representations immediately post-Fukushima – and it might be noted that the latter phrase is an example of objectification – we have taken care not to implicitly attribute causality to the social representations observed, vis a vis policy change.

Nonetheless, we strongly suspect that anti-nuclear representations became 'hegemonic' in the sense of dominant, post-Fukushima. Rather, we focus on the representations that nuclear power experienced, during the few months after the Fukushima accident, and propose that this is a dimension of landscape shock that is salient and relevant to sociotechnical change. Moreover, we propose that the affective, ethical and risk associations of nuclear power at this time drew on and arose, in part because of the long-held values and cultural traits that the MLP locates conceptually and exogenously in the sociotechnical 'landscape' at a national level. Although – and in fact because – the German reaction to Fukushima is relatively unique[18] – the case illustrates forcefully the social embeddedness of (energy) technologies and also how sociotechnical regimes are underpinned by societal beliefs and legitimisation. Indeed the Fukushima incident helps to illustrate how norms, beliefs and meaning are as foundational to sociotechnical paradigms as the hardware in which they are manifested.

In terms of further work, we have argued that social representations theory has the potential to help inform an understanding of the social psychology of landscape shock in other contexts, where those contexts may comprise differing governance, cultural, technological, economic and other dimensions. The concepts that social representations theory brings – processes of anchoring, objectification and thematacisation –

are intended to help explain how and why some meanings of changing circumstances become accepted and salient in public consciousness, while others do not. These meanings and their change are amenable to study historically and contemporaneously and are thus capable of deepening an understanding of the 'critical junctures' [67] that landscape shocks consist of. The models of change embedded in socio-technical sustainability transitions frameworks vary, but in general, one of their key strengths is that change is not seen as simply one of political or entrepreneurial choice, but as an outcome of different types of interrelated process and structure that form a context in which political and other actors act. Landscape shocks potentially ease structural constraints, but the meanings ascribed to the different choice available, by and for different actors, are as important as the availability of options for change.

The Covid-19 pandemic is an obvious example of how landscape shocks may affect multiple regimes, revealing to the wider population both the interconnectedness and the fragility of economic systems. What is less obvious is how the socially shared and also contested understandings of such shocks, held by heterogeneous publics and stakeholders, will interact with changing material conditions, to open up or close down possibilities for different types of change. The study of contested and shared meanings in relation to sociotechnical transitions processes is not an alternative to political or institutional accounts, but a complementary route to understanding the complex set of processes involved. The time has perhaps never been more apt for more in depth and theoretically inclusive study of landscape shock.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2020.101710.

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