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Socio-cultural framing during the emergence of a technological field: Creating cultural resonance for solar technology

Tea Lempiälä^{a,*}, Eeva-Lotta Apajalahti^b, Teresa Haukkala^c, Raimo Lovio^d^a University of California, Merced School of Engineering, Department of Management of Complex Systems, 5200 Lake Rd, Merced, CA, 95343, United States^b University of Helsinki, Centre for Consumer Society Research, P.O. Box 24, FI-00014, University of Helsinki, Finland^c Tampere University, Faculty of Management and Business, 33014, Tampere University, Finland^d Aalto University, School of Business, Department of Management Studies, P.O. Box 21230, FI-00076, Aalto, Helsinki, Finland

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ABSTRACT

This paper depicts how cultural resonance for novel technologies is constructed as a gradual, interactive process. We adopt a cultural framing perspective and strive to understand how actors assign meaning to the novel technology and determine its appropriateness for the local context. Existing research has largely focused on the strategic and political aspects of field framing processes through depicting conscious framing struggles between protagonist and antagonist actors. In addition to such strategic framing activities, we examine how other socio-cultural factors, such as changes in actor positions, interaction between framing activities, and the cultural “repertoire” of frames interact in producing cultural resonance. For our empirical case study, we followed the emerging technological field of solar energy during an intensive period of change. Our study contributes to the growing number of studies that draw attention to the creation of cultural resonance as an interactive multi-actor process by offering in-depth understanding of the multifaceted interactions that constitute the meaning-making process for an emerging field.

1. Introduction

Technologies come into being through human agency and the formation of shared social meanings about the novel technology embedded in the local culture (Geels, 2002). In the emergence of technological fields, it is essential that the novel technology gains meanings that make it feel appropriate and relevant for the local context in order to gain momentum and induce action from the relevant parties. The positioning of a novel technology with respect to existing institutions, structures and meanings is always a question of evolving social frames, rather than a natural quality of the technology (Markard et al., 2016). It is thus a question of framing whether a solution is considered as environmentally friendly, modern, or job-creating (Rosenbloom et al., 2016; Geels and Verhees, 2011). To date, this socio-cultural nature of field emergence has not received full attention in innovation studies. The attention has been predominantly directed toward political decision-making, resource distribution and societal structures, which, though crucial, leave out important socio-cultural facets of technological change (Geels and Verhees, 2011). This paper aims to better understand the meaning-making process that contributes to whether a novel technology is viewed as relevant in the local context, and shed

more light on the “deep cultural dynamics” that are at play in the emergence of technological fields (called for by Geels and Verhees, 2011; Markard et al., 2016; also Diehl and McFarland, 2010). By emerging technological field, we mean a pattern of relationships and a set of shared meanings between actors in a novel product-market domain still in formation (Garud et al., 2002).

The cultural resonance of a novel technology is central in determining whether it is perceived as relevant and appropriate for the local context. We define cultural resonance as coherence and alignment between the meanings associated with a technology and the “cultural repertoire” of frames in the surrounding society (Williams, 2004, 106; Van Gorp, 2006; Kubal, 1998). Its importance has been emphasized in social movement research (see Benford and Snow, 2000; Snow and Benford, 1988) and, more recently, within socio-technical transition studies (under the term cultural legitimacy) (Geels and Verhees, 2011; Markard et al., 2016), especially in the context of strategic multi-level interaction (Bosman et al., 2014; Roberts, 2017; Rosenbloom et al., 2016; Rosenbloom, 2018; Smith et al., 2014). Cultural resonance has been shown to yield increased resource mobilization, political and public support, investments, and overall integration of the novel innovations to the society (e.g. Benford and Snow, 2000; Geels and

* Corresponding author.

E-mail address: tlempiala@ucmerced.edu (T. Lempiälä).<https://doi.org/10.1016/j.respol.2019.103830>

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Verhees, 2011; Markard et al., 2016).

Framing is an essential part of building cultural resonance, as frames are integral in determining which meanings become associated with the novel technology. Cultural frames refer to socially shared assumptions of the meaning of particular events and actions (Goffman, 1974) through which individuals come to understand what is relevant for a particular time, place, and community (Diehl and McFarland, 2010). These deep cultural frames act as a backdrop to the more explicit and strategic framing activities with which actors engage in intentional efforts to influence the dominant meanings on a particular field (Benford and Snow, 2000; Cornelissen and Werner, 2014). Much of the extant research on framing novel technologies has focused on strategic framing activities, while the social complexity of the framing process, i.e. how multiple intertwined frames and socio-cultural factors produce shared meanings (Goffman, 1974; Diehl and McFarland, 2010), has been rarely depicted. Although several studies have recognized the fact that protagonist and antagonist actors adjust their framing activity as a response to each other and to cultural meanings (e.g. Geels and Verhees, 2011; Rosenbloom et al., 2016; Granqvist and Laurila, 2011), their focus has not been in the detailed examination of the socio-cultural aspects of the meaning-making process.

The research question of the paper is: How is cultural resonance for a novel technology created (or lost) in a socio-cultural framing process during field formation? The empirical context of the study is the emerging field of solar energy in Finland, which represents a particularly challenging context to solar due to its northern location and deeply rooted cultural beliefs of the lack of sunlight. We have followed the emerging field in real time by observing the main “field configuring events” (Garud, 2008), interviewing key actors, and conducting extensive document and media analysis. With this research, we contribute to the growing number of studies that draw attention to the creation of cultural resonance as an interactive multi-actor process (Geels and Verhees, 2011; Markard et al., 2016; Rosenbloom et al., 2016; Rosenbloom, 2018). Our study offers in-depth understanding of the complexity and unpredictability of the meaning-making process for novel technologies. Our findings draw attention to the fact that cultural resonance is created or lost as an interplay between various socio-cultural factors that interact with strategic framing activities in producing shared meanings on the emerging field. We particularly draw attention to how the profiles of actor coalitions, the interactions (or lack thereof) between these coalitions and the cultural repertoire of frames influence the way the protagonist and antagonist frames are interpreted on the emerging field. We show that this necessitates the protagonists to flexibly adjust their framing activities in order to avoid undesired meanings on the field. Concretely, we demonstrate how the movement from inertia towards field mobilization happens as a movement from an abstract sense of distance to closeness under three master frames: Temporal, Geographical, and Societal proximity. Our study particularly highlights the challenging nature of Temporal Proximity and demonstrates how protagonists need to navigate competing and even paradoxical temporalities in order to achieve momentum for the novel technology.

Our paper is structured as follows. In section 2, we discuss our theoretical grounding in socio-technical transitions and socio-cultural frames, and present our theoretical framework. In section 3, we introduce our research design and data sources. In section 4, we present our findings and section 5 discusses their contribution to the existing literature and offers policy implications.

2. Theoretical framework

2.1. The social nature of socio-technical transitions

Socio-technical transitions refer to “major technological transformations in the way societal functions ... are fulfilled” (Geels, 2002, 1257). Transitions, as societal changes, take place in a complex web of

social and economic institutions, political systems, cultural meanings, structural arrangements, and human action (Markard et al., 2012). Traditionally, transition literature has taken a large-scale view to the changing socio-technical configurations, often through long-term historical case studies spanning several decades (Geels and Schot 2007; Geels, 2002). Consequently, more detailed facets of field formation, such as agency, social processes, and political struggles have received lesser attention (Markard et al., 2012). Although human agency and the “cultural meaning of technology” (see e.g. Rip and Kemp, 1998) have been inherent parts of technological transition studies since its formation, they have only recently gained more explicit attention in both empirical studies and theoretical discussion.

In an attempt to better unveil the social nature of socio-technical transitions, scholars have turned towards linguistic approaches and analyzed how discourses and narratives are used to attract attention to and material resources for novel technologies (e.g. Smith et al., 2014). Recent research has drawn attention to how actors promote their interests by using discursive strategies (e.g. Bosman et al. 2014) and how they create (competing) narrative storylines to frame novel technologies in a favorable manner (Rosenbloom et al., 2016; Rosenbloom, 2018). Rosenbloom et al. (2016) develop a model for ‘multi-dimensional discursive interactions’ to show how actors align the content of a novel technology (i.e. socio-technical features of an innovation) with the societal context wherein the technology diffuses. The authors explain that competing actor groups form their storylines based on content-context combinations, which they use as “strategic tools...to frame issues in a particular way and convince the public and decision-makers of their favored course of action” (Rosenbloom et al., 2016, 1278). Empirically, they demonstrate how solar protagonists and antagonists in Canada formed competing narrative storylines around four themes: economic development and innovation, operation of the electricity system, response to climate change mitigation, and a new paradigm for energy production. They find that, for instance with respect to economic development and innovation, protagonists framed solar PV as a contributor to the local economy through jobs, investments, and growing markets, while the antagonists framed it as a drain on the economy through increased energy prices and its foreign focus both in job creation and investments.

More widely, the extant literature has found that narratives supporting sustainable energy solutions often include themes such as sustainable future, technological progress, energy security, independence, job creation, and a better society (e.g. Barry et al., 2008; Curran, 2012; Eames et al., 2006; Laird, 2003; Nissilä et al., 2014). In addition to these themes (under which actors formulate competing storylines), both Rosenbloom et al. (2016) and Curran (2012) draw attention to silent framings of resistance, which refer to implicit meanings delivered as a sum of other framing activities or silent disregard. This means that antagonists do not acknowledge the storylines put forth by the protagonist in an attempt to avoid lending them credibility, and rather ignore them altogether or counter them with seemingly unrelated frames. Curran (2012) has noted that these silent framings are used to create an “uncertainty and knowledge gap” with respect to the use of renewable energy while not directly disputing its value altogether. Overall, Rosenbloom (2018) has found that the ‘discursive resonance’ of the narrative storylines is dependent on the strength of the content claim, topicality of the issue, its linkage to contextual developments, and the credibility and alignment of actors.

In addition to discursive approaches, transition scholars have aimed to deepen their insight into the social side of transitions through understanding how institutional and cultural structures interact with technological features and actors in producing legitimacy for novel technologies. For example, Markard et al. (2016) show how the institutional dynamics of biogas technology changed as the relationship between different contextual structures evolved. Biogas first gained legitimacy when it was displayed as a solution for enhancing waste recycling and sustainable agriculture. However, when it became

increasingly connected with the energy domain, biogas attracted criticism in the agricultural sector for increasing food prices and soil use for energy crop. This contextual change reframed biogas as a problem in the agricultural domain thus reducing its legitimacy. [Fuenfschilling and Truffer \(2014\)](#), on the other hand, demonstrate how actors are able to alter or maintain institutional structures by promoting some frames over another. They show how the Australian water sector broadened the scope of action and allowed new actors to enter the sector by expanding field frames. They conclude that the linkages between institutions, agency, and technology are integral and together produce the transformation ([Fuenfschilling and Truffer, 2016](#)).

Despite these recent advances, research on socio-cultural framing processes remains scarce — even though the importance of cultural meanings in legitimizing novel technologies has been widely recognized ([Geels and Verhees, 2011](#); [Markard et al., 2016](#)). And while the above scholars have drawn from the framing perspective in an attempt to understand how actors strategically mobilize language, and how they create “fit” between the technology and the surrounding societal context ([Geels and Verhees, 2011](#); [Rosenbloom et al., 2016](#)), predominantly these studies focus on depicting discursive framing struggles rather than socio-cultural framing processes. As an exception, [Geels and Verhees \(2011\)](#) explicitly examine cultural resonance (or in their terms, cultural legitimacy) in the context of a historical case study on anti-nuclear and pro-nuclear debates in the Netherlands. Drawing from [Benford and Snow \(2000\)](#), they evaluate how well certain frames produce cultural resonance and analyze how different strategic framing activities worked in a particular socio-historical setting. [Geels and Verhees’s \(2011\)](#) study reveals how nuclear protagonists tapped into the themes of modernization and technological progress in building cultural resonance and demonstrate how they linked nuclear energy to potential improvements in everyday experiences to increase familiarity in the local context. The authors further note how the nuclear protagonists aimed to frame the antagonist actors as presenting irrational and emotional arguments, and thus discredit the need for an actual conversation. While [Geels and Verhees \(2011\)](#) illuminate how strategic frames interact with the deeper cultural frames in achieving cultural resonance, they do not analyze in detail how different actors alter their framings as a response to each other’s actions or provide a detailed account of the meaning-making process. Hence, even though [Geels and Verhees’s \(2011\)](#) framework advances the incorporation of cultural understanding into innovation studies, it still falls short of addressing the interactive framing process in a detailed manner.

2.2. Socio-cultural framing for emerging technological fields

Socio-cultural frames help people make sense of complex surroundings, and include socially shared assumptions of the meaning of particular events and actions ([Goffman, 1974](#)). Frames are integral to what individuals embedded in particular (national) cultures consider valuable and relevant as they determine how they relate to happenings and messages encountered in their everyday life ([Diehl and McFarland, 2010](#)). Frames are deeply rooted in culture and, in that sense, there is a “cultural repertoire” of frames ([Van Gorp, 2006](#); [Williams, 2004: 106](#), [Kubal, 1998](#)) that individuals draw from when conducting their framing activity ([Entman, 1993](#)). People embedded in the same national culture have usually learned a shared set of values, attitudes, and assumptions, which form a culturally specific meaning system ([Smith et al., 2009](#)). This means that certain framing activities a) are more likely to be used and b) gain greater resonance in a certain culture. Even though actors can (and often naturally will) adjust their framing activity to fit the meaning system of a particular culture, the implicit nature of the cultural repertoire of frames makes the framing process difficult to control. The fact that the attribution of meaning is ultimately conducted by the recipient and constructed in interaction further adds to this unpredictability ([Van Gorp, 2006](#)).

These framing processes are central in determining if and how a

novel technology (or practice) gets diffused and utilized ([Ansari et al., 2010](#)). Aptly [Lounsbury et al. \(2003\)](#) have depicted how the “fate of industries” is tied to field-level struggles over meaning and resources. By ‘field’ we refer to the collection of actors and organizations (e.g. suppliers, technology developers, consumers, and regulators) that constitute a recognized area of social and institutional life ([Dimaggio and Powell, 1983](#)). It is important to note, however, that a field is more than just a collection of organizations, as it is formed around a central issue “whereby competing interests negotiate over issue interpretation” ([Hoffman, 2001, 135](#)). A technological field, more specifically, refers to a pattern of relationships and a set of shared meanings between actors in a product-market domain ([Garud et al., 2002](#)). During the emergence of a field, these relationships are yet to be formed and the meaning system is in flux and highly malleable ([Van Merkerk and Robinson, 2006](#)). In emerging fields, framing processes have a considerable impact in determining not only the emerging meanings, but also the interaction patterns and power relationships within the field.

During field formation, different actors aim to influence the meaning-making process with strategic framing efforts, that is, goal-oriented development and deployment of frames ([Benford and Snow, 2000](#); [Cornelissen and Werner, 2014](#)). Actors often organize themselves into tighter or looser coalitions, which align their framing activities to a reasonable degree (see e.g. [Werner and Cornelissen, 2014](#)). These coalitions tend to form around a protagonist or an antagonist position related to the novel technology. Hence, majority of the literature on field framing talks of the framing activities undertaken by protagonist and antagonist coalitions, both of which aim to mobilize like-minded actors and gain public support ([Snow and Benford, 1988](#); [Rosenbloom et al., 2016](#)). Through these activities, different actors introduce new meanings to the emerging field by drawing from cultural, political, and economic elements ([Granqvist and Laurila, 2011](#)) and engage in framing contests or struggles over alternative meanings ([Geels and Verhees, 2011](#)). [Meyer and Hölleren \(2010\)](#) point out that, in addition to competing meanings, framing contests are about who gets heard and who has the most legitimacy to present credible framings (see also [Granqvist and Laurila, 2011](#)). Different actors can have a consensus over frames on one analytical level while engaging in framing struggles on another. Such larger frames are called master frames, which can encompass various different types of framing activities, perspectives, and actors ([Benford and Snow, 2000](#)).

Cultural resonance has been highlighted as an important outcome of strategic framing efforts. With cultural resonance of a technology, we refer to its perceived salience through the alignment of the meanings associated with it and the “cultural repertoire” of frames in the surrounding society ([Williams, 2004, 106](#); [Van Gorp, 2006](#); [Kubal, 1998](#)). Simply put, cultural resonance makes a novel technology (or an issue) feel important, appropriate and meriting of action in a particular cultural context. In achieving this, the importance of making the issue feel relevant for the local communities has been highlighted. For example, research on climate change show how advocates aim to make an issue, which is seen to impact “geographically and temporally distant places and people”, feel more actionable ([Spence and Pidgeon, 2010, 657](#)). They have noted that situating the phenomenon in the individual’s present locality ([Lorenzoni and Pidgeon, 2006](#)), using imagery to create more personal meaning to complex global issues ([O’Neill and Hulme, 2009](#)), and highlighting local impacts of climate change ([Rayner and Malone, 1997](#)) all help to break down inertia in local communities. Timing has also been noted as important, and a particular frame becomes regarded as sensible and realistic because it is activated at the right time ([Cornelissen and Werner, 2014](#)).

It is important to remember that socio-cultural framing operates simultaneously on the level of the strategic framing activities and the deep, cultural framing processes. According to [Goffman \(1974\)](#) framing processes involve both conscious framing efforts from strategic actors and the tacit influence of cultural frames. What this means is that all strategic framing efforts make sense only against a more implicit

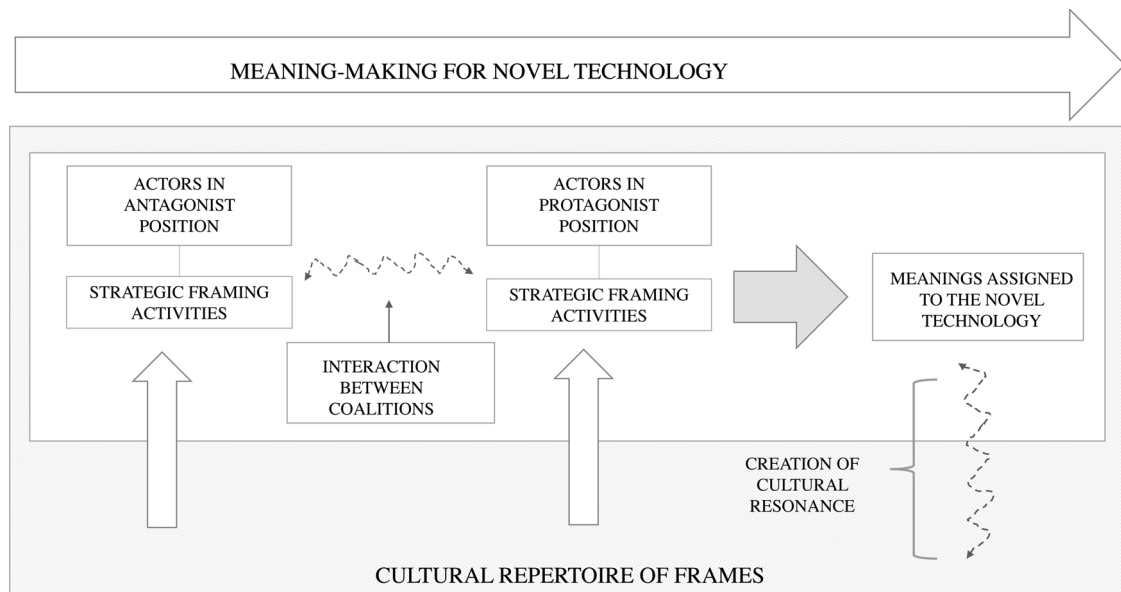


Fig. 1. Framework of the study: Focus on the interactive meaning-making process.

“background structure of shared reality” (Diehl and McFarland, 2010, p. 1719); that is, the cultural repertoire of frames discussed at the beginning of this chapter. This cultural repertoire offers a preliminary understanding of the issue to individuals embedded in a certain culture and fosters a shared orientation through a foundational understanding of roles and relationships of the central actors (Diehl and McFarland, 2010). The strategic framing activity is, then, interpreted against this initial understanding of what is culturally relevant and appropriate, and what are the social positions of the actors that conduct the framing activities. It is worth emphasizing that on all levels the framing process is fundamentally interactive as frames are “mutually sustained in interaction”, which means that the formation and resilience of any frame is a result of the interplay of the actions undertaken by the field actors (protagonist or antagonist) (Diehl and McFarland, 2010, 1718; also Cornelissen and Werner, 2014; Van Gorp, 2006). Therefore, frames but also roles and relationships in the field are mutually formed and sustained in the framing process.

Thus, the establishment of a set of shared meanings for the emerging field involves numerous socio-cultural factors that interact with each other (Benford and Snow, 2000; Garud et al., 2002), which makes the meaning-making process all but straightforward. This social complexity is, however, scarcely represented in much of the extant literature, which has focused on depicting strategic framing activities of protagonist and antagonist coalitions (cf. Benford and Snow, 2000; Granqvist and Laurila, 2011; Rosenbloom et al., 2016; Snow et al., 1986). Diehl and McFarland (2010, 1717) position this tendency as a misinterpretation of the framing concept itself as “something consciously created” instead of “culturally defined”, and continue to state that this misconception has led to a lost opportunity in understanding how “actors create the shared experience that makes frame contests meaningful and understandable in the first place”. What this means is that much of the field framing literature tends to miss the important step of setting the cultural scene wherein the strategic framing activities make sense and are noticed. Furthermore, predominantly the extant research highlights the consciously created strategic frames and their interaction with equally consciously created “counterframes”. Through this focus, the creation of a set of shared meanings, which is at the core of field formation (Garud et al., 2002), becomes displayed as overly strategic where actor groups design frames and compete over their dominance.

2.3. Theoretical approach of the study

Our study aims to add to recent efforts to better understand the social nature of socio-technical transitions by drawing from transition studies (Markard et al., 2016; Geels and Verhees, 2011), institutional research on field emergence (Ansari et al., 2010; Granqvist and Laurila, 2011; Snow and Benford, 1988) and, most importantly, research on socio-cultural framing (Goffman, 1974; Diehl and McFarland, 2010; Van Gorp, 2006; Benford and Snow, 2000). Our focus is on the meaning-making process for the novel technology, which has been placed in the center of the emergence of technological fields (Garud et al., 2002; also Hoffman, 2001; Van Merkerk and Robinson, 2006). The set of shared meanings established during field formation enables field actors to form a shared understanding of the area of social and institutional life that constitutes the particular field, and to develop a meaningful set of roles, rules and relationships to organize the field (ibid., also Dimaggio and Powell, 1983). The “cultural meaning of technology” has also been recognized as a central aspect of socio-technical transitions (see e.g. Rip and Kemp, 1998), although to date rarely explicitly examined.

The theoretical framework of our study is presented in Fig. 1. Based on the literature reviewed above, we focus our examination on four socio-cultural factors that influence the meaning-making on the emerging field: 1) central field actors and their positioning, 2) strategic framing activities of both protagonist and antagonist actors, 3) cultural repertoire of frames and, 4) interaction between actors. As fields are fundamentally formed of actors who tend to take a protagonist or antagonist position with regards to the novel technology (Dimaggio and Powell, 1983; Rosenbloom et al., 2016), it is natural to ask who are the protagonist and antagonist actors on the field at a particular time, and what kind of coalitions they form. Following e.g. Rosenbloom et al. (2016), we use the term coalition loosely to depict the constellation of actors that put forth protagonist or antagonist frames on the field at a particular point in time. We do not perceive protagonist and antagonist coalitions to be stable throughout the process or them to be perfectly aligned in their discursive activities.

As indicated in Fig. 1, we examine the strategic framing activities conducted by antagonist and protagonist actors conjointly with the cultural repertoire of frames. This is important as the cultural repertoire of frames both influences which strategic frames the actors use and how they are interpreted by others (Van Gorp, 2006; Diehl and McFarland, 2010). The fourth element of our framework, interaction between

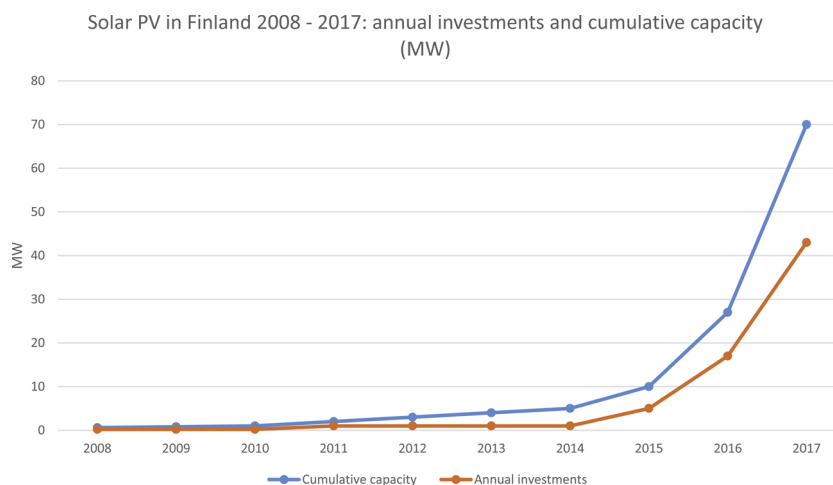


Fig. 2. Annual major investments and cumulative capacity of solar PV systems in Finland, MWp.

coalitions, also influences the way the strategic frames are constructed and perceived as protagonist and antagonist frames often draw from one another and are interpreted in relation to each other. The interaction between the actor coalitions is also a part of setting the “public stages” (Geels and Verhees, 2011; Goffman, 1956) on which the framing activities are performed, and which further influence the way these frames are interpreted.

Even though the strategic framing activities of the protagonist and antagonist actors are central to our examination, it is crucially important to understand that the meanings on the field are not directly formed as a result of these conscious framing struggles. All the four elements of our framework come together to produce the dominant meanings on the field at a particular point in time. Furthermore, as the meanings are in flux during field emergence (Van Merkerk and Robinson, 2006), it is important to understand how they evolve when the field moves towards cultural resonance. We thus examine the meaning-making process temporally and aim to understand how cultural resonance is gradually created, that is, how the sense of appropriateness of the technology is increased by aligning the meanings associated with it with the cultural repertoire of frames (Williams, 2004, 106; Van Gorp, 2006; Kubal, 1998).

3. Methods

3.1. Research approach and case selection

Our study aims to extend existing theories by examining a phenomenon in its naturally occurring context (Eisenhardt and Graebner, 2007; Piekkari et al., 2009), and therefore we chose a qualitative case study as our research approach. We have followed a holistic approach to case studies where the researcher is expected to iterate between empirical data and theory (Dubois and Gadde, 2002). Our case selection followed strategic sampling (Flyvbjerg, 2006) and was guided by an interest in following an emerging technological field in real-time. This permits observation of the social gatherings and events in the field and allows the researcher to enter the field without pre-existing knowledge of the outcome of the process. Thus, this facilitates the formation of a realistic image of the different framing activities and meanings in the field at a particular time. Bearing this in mind, we adopted a process perspective for our study (Langley et al., 2013) and used a wide range of qualitative data including ethnographically oriented observations, in-depth interviews, and document analysis of presentations, policy documents, website materials, and media articles.

We chose solar PV technology as our case study due to its potential to yield a rich understanding of the field emergence process. Verhees et al. (2013, 287) have called for studies “focusing on specific periods

where contestations and tensions are clearly visible” to yield a more in-depth understanding of the socio-technical transition process. During the time period of our case study, solar energy in northern latitudes had the potential to act as such a case for two main reasons. First, energy production is a field with a strong tendency for stability through robust established structures, large fixed investments, and powerful incumbents while simultaneously experiencing pressures to change to a more sustainable direction. Solar PV is one of the forefront technologies that has emerged to challenge this stabilized setting and, for instance, is envisioned to be among the top sources of electricity by the year 2050 (International Energy Agency IEA, 2014). Framing struggles and tensions can thus be expected in the field of energy production. Second, the cultural resonance of solar energy in the northern latitudes is challenging due to the lack of sun in the winter time. This makes it likely that the case will involve strong framing efforts and the emergence of the novel field necessitates clear shifts in current societal meanings.

In Finland, achieving cultural resonance is particularly challenging as traditionally societal meanings have displayed sun seen as a fleeting element in Finland, belonging to southern countries. Another feature adding to the challenging nature of the framing efforts is that in Finland renewables (particularly biomass) already accounted for over 38% of total energy consumption in 2014. As 78 percent of Finland’s surface area is commercially utilizable forest and the Finnish economy has a long tradition of producing wood-related products, it has both the political and cultural resonance that solar lacks. Third, after a long period of stagnation, during our case study the field went through an intensive period of framing struggles, shifting meanings, and overall field development. Between 2008 and 2016, we can see an upswing in solar activity, including new solar demonstration projects, growing number of households with solar system installations, increased media attention, organization of solar events, and the establishment of new companies and protagonist groups in the field. Although the share of solar energy remains small in the Finnish energy mix, the change in field activity is notable. This is illustrated in Fig. 2, which depicts the growth of investments in solar energy as well as the growth of cumulative capacity. Note that year 2017 is included to indicate the continuous increase in activity, even though it is not included in our analysis.

These factors contribute to the fact that our empirical case can be categorized as an extreme case of framing efforts for an emerging field. Due to their tendency to activate more actors and basic mechanisms, extreme cases can “clarify the deeper causes behind a given problem” rather than its symptoms (Flyvbjerg, 2006, 229). Extreme cases have thus been found useful in revealing rich data of a phenomenon and valuable for generalizable theoretical insight (Patton, 1990).

3.2. Empirical data

Our empirical data includes written material collected between the years 2008 and 2016, and real-time observations between the years 2011 and 2015 (which was the period of most intensive change in the field). Throughout our empirical data collection, we followed the principles of process research (Langley et al., 2013) and collected data from various sources (see Table 1). This approach allowed us to have a greater perspective on how the period of our intensive examination is situated within the wider trend of developments in the emerging technological field.

In our real-time data collection, we observed the field-configuring events and took thorough field notes of the interactions that took place during these events (including informal discussions). We also collected and analyzed all presentation materials. These events were highly useful in understanding both the framing activities of and the interactions between different actor groups as they acted as the primary arenas for discussions around the technology at the time. The fact that they included both formal presentations and informal interactions also gave us insight into both aspects of the framing process. We complemented these observations by conducting interviews with the key actors in the field to gain an understanding of the different perspectives represented in the process. The interviewees included relevant professors, solar entrepreneurs, non-energy incumbents engaged in solar activity, energy incumbents, environmental NGOs, interest groups for solar energy and renewables, and policy makers and politicians. These 30 interviewees were representative of the main actors in the field, and provided us with important background information about the interactions we witnessed during the events. Additionally, two of the authors actively interacted with the central actors during the field formation process.

In addition to the in-person data collection, we included press releases, blog posts, and reports from both antagonist and protagonist actors in our analysis. They were particularly important in analyzing the framing activities of energy incumbents, environmental NGOs, and politicians as these were the main channels through which these actors conducted their framing activities. We also analyzed articles published on solar technology in the popular press. The newspaper “Helsingin Sanomat” is the most widely read daily newspaper in Finland, positioned in the capital region, but distributed across the country. The magazine “Tekniikka ja Talous” (Technology and Economy) is published weekly and distributed widely in Finland.

3.3. Analysis

Following our holistic case study approach, our analysis process iterated between our empirical data and theoretical framework. We

structured our analysis initially by years and actor groups and determined the protagonist and antagonist nature of each actor on a year-to-years basis, based on their framing activity. If an actor supported the adoption of solar energy in Finland, we would categorize them as a part of the protagonist coalition that particular year and if they put forth negative framings on solar in the local context, they were placed in the antagonist coalition. When conducting our analysis, we followed the procedure of open coding (Miles and Huberman, 1994) and assigned the textual documents codes that summarized statements related to solar. We then constructed process documents for each actor, including illustrative quotes from each year of examination. Based on these, we derived higher order categories that described the framing activity of each actor during each year and then compared the years to each other to understand how the frames and activities changed over time. Finally, we aggregated framing activities of all protagonist and antagonist actors during each year to understand the strategic frames put forth by both coalitions and how they changed over the course of the field emergence process. Throughout our analysis, we paid attention to how the actors drew from the local cultural repertoire in their framing activities. In mapping out the cultural repertoire, we examined, for example, popular culture (such as songs and folktales), media texts and imagery, and commercials (often reflective of the values and meanings of the local culture). We also tracked the interaction between the coalitions, which was visible in either the interconnecteness (or lack thereof) of their strategic framing activities or concrete encounters in public stages (recorded in our observation field notes).

We used the media data, policy makers’ and politician statements, and public commentaries to understand how the framing activities were interpreted on the field and included concrete advancements on the field in order to form an overall image of the movement on the field. By combining the different sources of data, we formed an aggregate understanding of what the dominant meanings were on the field at a particular time period. These meanings were reflected in the public discourse as well as the political and economic actions taken on the field in addition to the strategic framing activities of the two coalitions.

During our initial analysis, we identified three overall tendencies in the data, which led us to make adjustments to our conceptual frame and further direct our analysis. First, the meanings in the field seemed to communicate a movement from an abstract sense of irrelevance towards increasing resonance with the local context. This insight led us to update our theoretical frame with the concept of cultural resonance, and directed our inquiry towards understanding how this movement was created. Second, when examining the similarities and differences between the different years, we discovered that years 2008–2011, 2012–2014, and 2015–2016 were similar in terms of framing activities, the antagonist and protagonist actors, and the interaction between

Table 1
Data sources.

Type of data	Amount of data	Description of data
Observations of field forming events (2011–2015)	14 events in total Observations & materials from 8 events; only materials from 6 events	Events organized by the Finnish Funding Agency for Innovation, Finnish Solar Energy Association, and Aalto University. Events predominantly populated by protagonist actors, but participants diversifying towards the end of our examination.
Analysis on party documents (2008–2016)	36 documents*	Election programs, energy policy, and related documents from Finnish political parties: National Coalition Party, Center Party, Left Alliance, The Finns Party, Social Democrats, Greens, Swedish People’s Party, Christian Democrats.
Web and media data from energy incumbents (2008–2016)	200 documents*	Two of Finland’s largest energy companies: press releases (103 documents), customer magazines (19 magazines), blog texts (78 blog texts)
Web, media & report data from associations & NGO’s (2008–2016)	4 associations, 194 documents*	Trade association Finnish Energy (105 documents), WWF (25 documents), Greenpeace (17 documents), The Finnish Clean Energy Association (47 documents)
Interviews among key actors	30 interviews	7 professors, 5 solar entrepreneurs, 3 incumbents (non-energy) engaged in solar, 4 energy incumbents, 5 policymakers, 3 trade association representatives, and 3 NGO representatives
Newspaper articles on solar (2008–2016)	570 articles*	Two leading papers in Finland: daily newspaper <i>Helsingin Sanomat</i> and economic magazine <i>Tekniikka ja Talous</i>

* Key words used: “solar”, “solar energy” and “energy”.

coalitions. As a result, we grouped together these years to form three time periods and deepened our analysis in terms of how the different aspects of the meaning-making process evolved between them. Third, the framing activities appeared to happen under three master frames (Benford and Snow, 2000) that were inclusive of the different interpretations put forth by the different actors. We then deepened our analysis of the meaning-making that took place under each of the master frames and aimed to understand the movement under each master frame.

4. Negotiating meaning in the emerging technological field

When analysing the myriad of framing activities that took place on the field during our examination, we found that across time periods, individual frames, and actors there were three master frames under which the meaning-making was conducted. In other words, despite differing stances with respect to the novel technology, the various actors considered these topics as relevant to be addressed when determining the local appropriateness of the novel technology. We entitled these master frames as Temporal Proximity, Geographical Proximity and Societal Proximity. The first deals with the immediateness of the adoption of the novel technology, the second with its geographical appropriateness, and the third with its compatibility with the existing society. In the following sections, we demonstrate how the meaning-making on the emerging field happened under each of these master frames, and how they all interacted in creating the meanings that dominated the field during each time period.

Interestingly, the overall development of the three master frames during the field emergence process represents a movement from an abstract sense of irrelevance for the current time, place, and society towards a sense of appropriateness for and actionability in the local context. We demonstrate below how the four elements of our theoretical framework – protagonist and antagonist actors, strategic framing activities, cultural repertoire of frames and interaction between actors – jointly create this movement from perceived distance to perceived closeness, which helps in breaking the inertia on the emerging field.

We discuss the movement on the field during three time periods (2008–2011, 2012–2014, and 2015–2016), as they represent different (rough) stages in the field emergence process. Under each period, we discuss movement under each of the three master frames and the overall resulting meanings on the field.

4.1. Period 1 (2008–2011) — solar as a solution for others and at other times

At the beginning of field development, the protagonist coalition mainly consisted of solar entrepreneurs, academics, and environmental organizations who came together once or twice per year at field-configuring events (Garud, 2008) organized by the Finnish Funding Agency for Innovation, an agency responsible for supporting technology and innovation policy. With these events, the policy body aimed to explore the possibilities of solar technology in Finland, and the solar advocates aimed to convince them – as well as the larger audience – that solar should be viewed as a source of competitive advantage in the local context. While the protagonists came together at the field-configuring events, the antagonist coalition remained disconnected from the protagonists and generally did not take part in the field-forming events. The antagonist position was occupied at this time by incumbent energy companies, who engaged in framing activities individually as well as collectively through the trade association Finnish Energy (FE).

4.1.1. Temporal proximity — solar as a solution for a future society

The protagonist framing activity in the early stages of the process was largely characterized by future-oriented framings. At the early events, the protagonist actors put forth a strong image of solar energy as cutting-edge technology and an exciting future energy solution. In

particular, the solar entrepreneurs, cities, and academics presented long-term market scenarios, potential development paths, and future societal promises of solar PV. These future scenarios were often related to wider societal changes that were required or would coincide with the growth of solar energy. For example, a representative of the city of Helsinki presented solar as part of the “*city of the future*” linking it with electric cars and electricity-based public transport. An incumbent automation and power company stated that the competitiveness of solar would require development in political support, markets, and standards as well as architectural and land development. These early events often featured solar researchers and developers presenting “*future emerging technologies*”, which added to a sense of solar being technology in development, emerging with future societies. With these framing activities, protagonist actors aimed to connect solar to technological progress, modernization, and science (as noted also in Nissilä et al., 2014). This can be considered a sound strategy as these were culturally resonant values for Finland, a country that has been recognized as, and takes pride in, excelling in technological development and STEM (science, technology, engineering and mathematics) education. Furthermore, as these early field-configuring events were organized by the innovation policy actors, it made sense to emphasize the innovation potential of solar technology. However, simultaneously these future-oriented frames opened up a possibility to push solar far into the future, which was utilized by the antagonists.

During the first period, the antagonist actors rarely commented on solar energy. When they did address the topic, they commented its global potential in an abstractly positive manner while simultaneously pushing its potential as a local energy source far away into the future. For example, FE referred to 2050 visions for solar energy and two large energy incumbents portrayed solar as technology-in-development: “*most of the energy forms of the Solar Economy are still developing and require significant support from the society*”. Energy incumbent Fortum drew attention to the significant changes and challenges in the shift towards solar economy (to be achieved in year 2050). This sense was shared by the majority of politicians who stated that solar was not a current priority because it was not high enough in the cost-efficiency ranking of renewables. For example, the National Coalition Party’s and the Christian Democrats’ climate and energy policy work group reports claimed that “*theoretically*” solar energy could provide huge opportunities, and more funding should be allocated to research activities — which framed solar as being at a stage of investigation rather than implementation. Furthermore, FE highlighted Finland’s progressiveness in utilizing renewable energy, thus reducing a sense of urgency in deploying solar energy: “*in Finland the share of renewable energy in electricity production was almost double last year [2009] compared to Germany*” (FE, 2010b).

4.1.2. Geographical proximity — solar as a solution for other countries

In geographical proximity, the meanings arising from the cultural stock of frames, representing Finland as a nation pining for sunlight, had a particularly strong influence. Many Finnish folktales and popular songs present the sun as an element that is desperately missed in the Finnish context. There are, for example, songs such as “*Päivänsäde ja menninkäinen*” (the sunray and goblin) and “*Lapin kesä*” (Lapland’s summer) that talk of the fleeting nature of sunlight, and sayings such as “*Short as the Finnish summer*”, which highlight Finland as a cold, dark country. This type of cultural imagery can also be seen in commercials (often reflective of the values and meanings of the local culture) where Finns are portrayed as, for example, having their summer barbeque in the midst of piles of snow and stopping to wonder at the sun that re-emerges after a long winter. At later stages of the process, one municipality advertised its solar solution with a slogan “*solar power, even where the sun doesn’t shine*”, demonstrating the persistence of these cultural beliefs.

In order to highlight the wide market potential of solar energy, protagonist framings during the first period emphasized global

developments in the solar market. Trade associations, researchers, and solar companies frequently presented global growth curves and highlighted the phenomenal growth with statements such as “*Growth is so fast that anything I say is already outdated*” (solar PV entrepreneur) and “*Solar will be competitive in Italy in 2013 and in many EU countries by 2020*” (trade association representative). Although this was a sound strategy in building positive expectations, it simultaneously invited meaning-making where solar became seen as “others’ solution”, external to the local geographical location. This was amplified by the fact that the examples of completed projects were often international whereas the presented domestic projects were still in the planning phases. This contributed to the fact that while the message of great global potential was recorded in the wider societal discussion, this potential did not localize in the Finnish context. The sense of solar as an opportunity for warmer countries was also displayed in the environmental organizations’ reports and political scenarios. The political party Greens, argued for, in line with WWF’s report on 100% renewable energy, the production of solar in Mediterranean and North African regions and envisioned the electricity being transmitted to Northern Europe. Greenpeace, on the other hand, envisioned a concentrated solar thermal plant in the warmer European countries. In addition, while communicating a generally promising image of solar energy, newspaper articles at the time focused on impressive global developments whereas domestic solar was only occasionally mentioned as a convenient energy source for summer cottages.

During the first period, the antagonist coalition amplified these distancing meanings by casually pushing solar to remote locations with comments such as: “*Facilities will be located in regions with the best production conditions. Solar electricity is not expected to be profitable when connected to the grid in Finland.*” (FE, 2010a). In addition to direct commentaries, the antagonist coalition’s way of casually disregarding solar energy as a credible option resonated well with the cultural dissonance of the general public. Accordingly, the critical voices from the general public conducted their framing activity in a disengaged manner and often simply deemed the use of solar energy in Finland as “nonsense” without any deeper argumentation or factual debate. Rather, the critics aimed to question the rationality of “solar enthusiasts” and present them as unrealistic environmentalists who had failed to think through the consequences of their actions (compare with Geels and Verhees, 2011). This is well captured, for example, in a readers’ letter where solar power was perceived to be “*a trick with which the ‘green lefties’ force us to continue the use of fossil fuels and to keep the solutions that are known to work well, such as nuclear power plants, forbidden*” (HS, 2009). Another readers’ commentary to a newspaper article stated that “*Finland is not Germany or Morocco ... a piece of info to the researchers: during the winter the sun doesn’t shine [here] ... Why is energy research so out of touch with reality?*” (HS, 1/2012). Actual irradiation rates were not part of these arguments, which stemmed rather from a deeper sense of dissonance with cultural frames. Interestingly, despite the lack of factual justifications, the antagonist actors and their supporters were still able to frame themselves as the rational actors in the field, which had much to do with their positioning in terms of societal proximity.

4.1.3. Societal proximity — solar as a challenger of the current energy system

The fact that the protagonist and antagonist coalitions were highly polarized during the first period contributed to the perceived societal distance of solar technology. The energy incumbents dominated the societal discussion on energy policy whereas the solar protagonists operated largely in the field forming events and other arenas connected to innovation and science. Furthermore, the two coalitions did not interact in a meaningful way and both displayed a rather homogeneous profile in terms of membership (antagonists with energy incumbents and protagonists with solar entrepreneurs and scientists). This positioning contributed to presenting solar as a challenger of the current system and pushing solar technology to the margins in the energy

debate. It also attributed to the ability of the incumbents to deploy silencing and discrediting tactics instead of engaging in explicit framing struggles. The casual and vaguely positive disregard of the antagonist coalition was effective in framing solar as irrelevant for the current energy debate.

This societal distance was amplified by protagonist frames aimed at demonstrating the massive potential of solar energy. In particular solar companies and trade associations frequently presented solar as a superior energy source, capable of solving the world’s energy problems. Solar was praised for its abundance and affordability, and future scenarios were shown where solar was the main energy source in the global energy mix. For example, a solar entrepreneur stated that “*Each year, over 1,080,000,000 TW hours of power arrive at the earth from the Sun – 60,000 times the world’s electricity requirement.*” Although these frames were sensible in terms of creating positive expectations and valid in terms of global potential, they also invited problematic meanings in terms of the way they were viewed in the local context. With the emphasis on massive global potential instead of moderate local possibilities, solar accrued a meaning as a challenger to the current system instead of the complementary energy source it was expected to be.

4.1.4. Resulting meanings

During the first time period, the emerging field was dominated by meanings pushing solar energy to future times, warmer countries, and improved societies, thus creating an abstract sense of distance under all three master frames. The framing strategy chosen by the protagonists made sense in terms of linking solar to the culturally important values of science, technological excellence, and modernization. Accentuating solar’s vast global potential was also sound from the perspective of creating positive expectations. However, when interacting with the other elements of the meaning-making process these framing activities unexpectedly contributed to directing solar’s promise away from the local context and the current time.

The general sense of disbelief among the wider public and politicians appeared to stem from the dissonance between the protagonist framing activity and the cultural stock of frames that included meanings of Finland as a dark, cold country. This was further fortified by the antagonists’ silent disregard, which they combined with vague positive statements of future potential. Furthermore, the polarization and disconnect between the two coalitions amplified the marginalization of solar energy in the societal energy debate, framing it as interesting but irrelevant for the current energy debate. Through this interactive process, solar gained societal meaning as a future global promise — thus losing momentum in the present time and place.

Despite this, solar protagonists were still successful in attracting continued interest from the innovation policy institutions who had initiated this wave of field-configuring activities. This was particularly important as the energy incumbents dominated the formal energy policy arenas at the time and were able to keep the solar protagonists outside of legitimate domains of the energy discourse. Still, after the initial uptake, the field was stagnant — solar was not viewed as a credible energy solution for the near future nor for Finland, and as an innovative technology its fruition was pushed far into the future (Fig. 3).

4.2. Period 2 (2012–2014) — paradoxical meanings and temporalities

During the middle phases, the protagonist and antagonist coalitions continued to operate in their separate arenas. Protagonists continued to meet at the field forming events organized by the innovation policy body whereas the antagonists continued to dominate the formal energy arenas. The two did not interact in a direct way although more explicit framing struggles were visible as the antagonists had to come out of their silent disregard. The protagonist coalition had begun to diversify and consisted at the time of solar entrepreneurs, academics, solar and

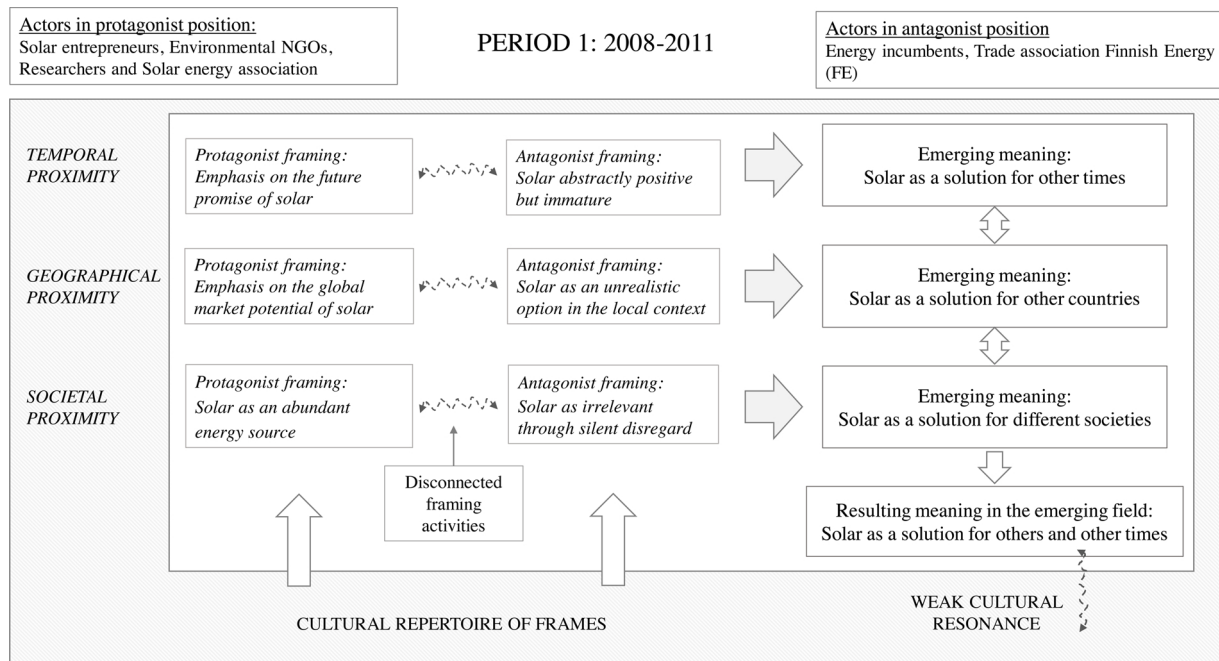


Fig. 3. The temporal, geographical and societal master frames during period 1.

clean energy associations, environmental NGOs, a few construction and housing companies, and three cities. The antagonist coalition was formed by most of the energy incumbents and FE. Two large energy incumbents, Fortum and Helen, started to test and pilot local solar solutions, which marked the first steps towards a shifting of their position.

4.2.1. Temporal proximity — solar as simultaneously too early and too late

After the first years of the framing activity, the solar protagonists became increasingly concerned about the distancing meanings that dominated the field and refocused their emphasis on arguing for urgency of action. Solar entrepreneurs asserted that Finland was already late in utilizing solar opportunities and pointed out that it was amongst the few European countries that had not (yet) taken any measures to support solar energy. Once again, these entrepreneurs presented diagrams of global market growth of solar and urged Finland to make use of this rapid development. The environmental organizations joined in by questioning why Finland lagged behind both in attitudes and statistics with respect to renewables and energy efficiency. Although this framing made sense in terms of communicating the urgency for action, it was problematic due to solar's positioning in the innovation domain. When the solar advocates claimed that Finland was *late*, this signaled a loss of competitive advantage for some politicians and policy makers. They began to communicate a need to turn their gaze towards other, more innovative technologies where Finland could be first. A panel discussion at an event organized by the innovation policy maker was kicked off by the question: "Are we too late in Finland and should we pack our things and go home?". A member of parliament presented a written question on Finland's tardiness in utilizing solar energy and asked: "Why has Finland not deployed solar energy more? There are also business opportunities in relation to energy efficiency, decentralized renewable energy, smart grids and energy storage that haven't been used at all?" (Eloranta, 2012). The sense of lateness was exemplified by the fact that the discussion at solar events and in the media still largely revolved around panel manufacturing, which was intended to display the most attractive and innovative parts of solar. However, it contributed to a limited understanding of what the local business opportunities could be and made it easy to argue that the business possibilities for solar were disappearing as other countries (such as China and the USA) began to dominate the panel manufacturing business.

This was an alarming development for solar advocates as it signified that solar could lose the support of those policy bodies that had most passionately backed its development so far. The solar advocates aimed to fight off the 'too late' meaning with commentaries in the media urging that "it is still not too late for Finland" (HS, 2014), and convincing the audience at the field-configuring events that "... it is like quitting a 100 m race because you are behind the others at 3 m". Simultaneously, they continued to present the future promise of solar and argue that the current rapid development was only a fraction of what was ahead.

Interestingly, the antagonist coalition was not involved in the late-stage framings during these middle phases but maintained their previous stance and continued to position solar in the future. They continued to present positive statements of future business opportunities while simultaneously stating that the economic conditions for utilizing solar heat on a large scale were not met yet. In the energy domain, then, solar energy was still perceived as being too early to utilize effectively.

4.2.2. Geographical proximity — fighting off myths of darkness

In terms of geographical proximity, factual knowledge of the irradiation rates in Finland (equaling those of Northern Germany) became the most popular theme in protagonist framing activity during the second period. Also, the unused potential of solar energy in the Nordic countries was heavily emphasized. For example, a keynote speaker at a protagonist event stated that: "When I lecture around the world, I sometimes say that solar can be used in Scandinavia, although they cannot believe it themselves." The solar entrepreneurs, researchers, and trade associations addressed the general disbelief towards solar energy. For example, during his presentation at a solar event, one solar professor stated that the inhibiting factors can currently be found "between the ears", not in technology development or the lack of sunlight. The environmental NGOs, Greenpeace, and WWF Finland also started campaigning extensively to challenge the myths of solar energy as being ill-suited for the Finnish climate conditions. Both launched energy campaigns in 2013. Greenpeace published an energy revolution report and WWF Finland launched a campaign called 'Seize your power' where it challenged cities and companies to invest in new solar panels.

The antagonist coalition, and particularly FE, argued against the idea that the future energy system should be based on wind and solar power (promoted by WWF in their report on 100% renewable energy).

FE framed this as a threat to energy security and stated that it would increase the vulnerability of energy availability in Finland: “*Finland cannot be lulled into the idea that solar electricity could be transmitted from southern countries and wind electricity from the northern sea regions*” (FE 2012b). Furthermore, FE commented on the ongoing discussion on EU-wide harmonized subsidies, claiming that it would not benefit Finland because the benefits would flow to regions with the best cost efficiency: wind for windy regions, solar for sunny regions, and bioenergy for regions with ample forest resources, such as Finland. The implicit message of the framing aligned with the cultural stock of frames in communicating that solar was not a natural choice for Finland.

During the second period, two large energy companies, Fortum and Helen, took their first steps towards the utilization of solar energy by testing solar in pilot projects. This helped reduce the sense of geographical distance of solar as it led to these incumbents advocating Finland as an ideal location for solar while explicitly acknowledging the dark winter: “*Solar energy production from November to January is practically non-existent. In spite of that, Finland has ideal production conditions to produce solar electricity... Because the days are long in summer, in Finland we have as much light as in Northern Germany*” (Helen, 2013). They accentuated solar energy as an excellent local energy source in the summer months but still continued to assign indirect antagonist meanings by highlighting marginal yield and implementation in the future.

4.2.3. Societal proximity — solar juxtaposed with other energy forms and the system

In terms of societal distance, juxtapositioning between solar and other energy sources increased during the second period, particularly in the framing activities of solar entrepreneurs and solar association representatives. To demonstrate solar’s superiority, these actors often contrasted solar against nuclear energy, but also other renewables. Production quantities in Germany were compared to the yield of nuclear power plants and solar’s growth curves were presented next to the stagnant figures of other energy sources. Solar advocates responded to the cost-efficiency order requirements with statements entitling solar as “*the only one [of renewables] that’s growing and with the largest potential*”. Instead of a complementary energy source, solar’s framing as a challenger of other energy sources and the contemporary system was further strengthened.

Concurrently, however, movements in actor coalitions countered this juxtaposition and reduced the societal distance. Representatives of different renewables joined forces to combat the cost-efficiency order arguments of politicians and established the Finnish Clean Energy Association in 2013. Moreover, a new set of actors entered the solar field: incumbents from automation, construction, and housing industries, whose interest was to find new business potential within the field. The division between the protagonist and antagonist actor coalitions also became less clear as the two energy incumbents Helen and Fortum entered the solar business and began to shift their position towards solar advocacy.

The diversification of the protagonist coalition and the strengthening of its argumentation necessitated the antagonist coalition to break its silence. As a result, the energy industry association, FE, started to present solar as a risk for the current system. FE presented decentralized energy as reducing market competitiveness, destroying the credibility of emission trading schema, and most importantly, undermining the cost-efficiency of dominant large-scale energy solutions: “*Europe’s electricity markets have already been widely distorted due to production subsidies granted for solar and wind electricity. ... If this development occurs in Finland, the combined electricity and heat production faces again new (extreme) challenges.*” (FE, 2013b). They acknowledged global advances by describing how Germany was able to increase its share of solar by 47% in a single year while at the same depicted it with terms, such as “*Germany’s gamble*” and “*the mother of all feed-in-tariffs*” that deteriorated the German markets (FE, 2012).

4.2.4. Resulting meanings

During this time, the meanings that dominated the field placed solar energy in a position where it was simultaneously too late and too early. While the protagonists aimed to highlight the urgency for action, their framing activities were interpreted by the innovation policy bodies as lost competitive advantage due to delayed action. Concurrently, as the energy policy arenas were still dominated by incumbent actors who continued to frame solar as technology-in-development, solar was viewed as being too young to be utilized as a reliable energy source. This paradoxical combination of future and past orientations placed the protagonists in a difficult position as their strategic framing activities had to address two competing temporalities at once.

Intensifying comparisons with other energy sources emphasized solar’s position as a challenger of the current system while movements in actor positions reduced societal distance. The fact that the protagonist coalition became more diversified built bridges between the existing system and helped push the antagonist coalition out of their silent disregard. The antagonists still refrained from directly engaging with the protagonist coalition, and now indirectly framed solar as a foreign energy source through accentuating bioenergy as the natural choice for the local context. Furthermore, through an increased directness in addressing the myths stemming from the cultural stock of frames, the protagonist coalition was able to gradually steer the debate in a more factual direction, reducing its image as irrational enthusiasts. Solar protagonists also became more politically outspoken and criticized the lack of political support for solar energy in a more articulated manner, which helped situate solar more centrally in the societal energy debate. However, at the same time, it surfaced more concrete obstacles and new myths of lost opportunity, which reduced the momentum for acting on the solar opportunities. These framing activities brought local relevance for solar while simultaneously keeping solar temporarily and geographically distant (Fig. 4).

4.3. Period 3 (2015–2016) — meanings that mobilize the field

During the third period, the antagonist coalition as well as politicians and policy makers increasingly took part in the solar advocacy events and actively participated in the related discussions. The presentations and panels at the events now hosted a more diversified set of perspectives, which lead to more heated debates. At this time, the antagonist coalition only included FE and a few energy incumbents whereas the protagonist coalition included the same actor categories as during the previous period, but in larger quantities.

4.3.1. Temporal proximity — grounding in the present

To manage the push and pull of the “too early” and “too late” temporal framings, the protagonist coalition found new ways to ground solar in the present moment. Solar associations and entrepreneurs began to argue that change was already in process and emphasized the business-as-usual nature of solar energy. During the first and second phases, protagonist presentations at field-forming events included foreign examples of implemented projects whereas at this time the emphasis moved to presenting domestically implemented projects from a wide range of fields. Project presentations accentuated that even large systems are “*standard solutions*” and incumbents from the retail and construction industries presented solar as part of their regular business solutions. Several actors highlighted solar as a “*mainstream technology*” and presented the installation of solar systems with commentaries of its simplicity, ease, and speed. The solar advocates thus moved the argumentation towards “this is how we do it” rather than “this is what is needed to make it happen”. There was also a shift of attention from panel manufacturing to business opportunities found in the larger system, which was a natural consequence of the entrance of new actors.

The protagonist coalition did not, however, let go of the future-oriented framings altogether. Some solar entrepreneurs and particularly the advocate energy incumbents continued to communicate visions of

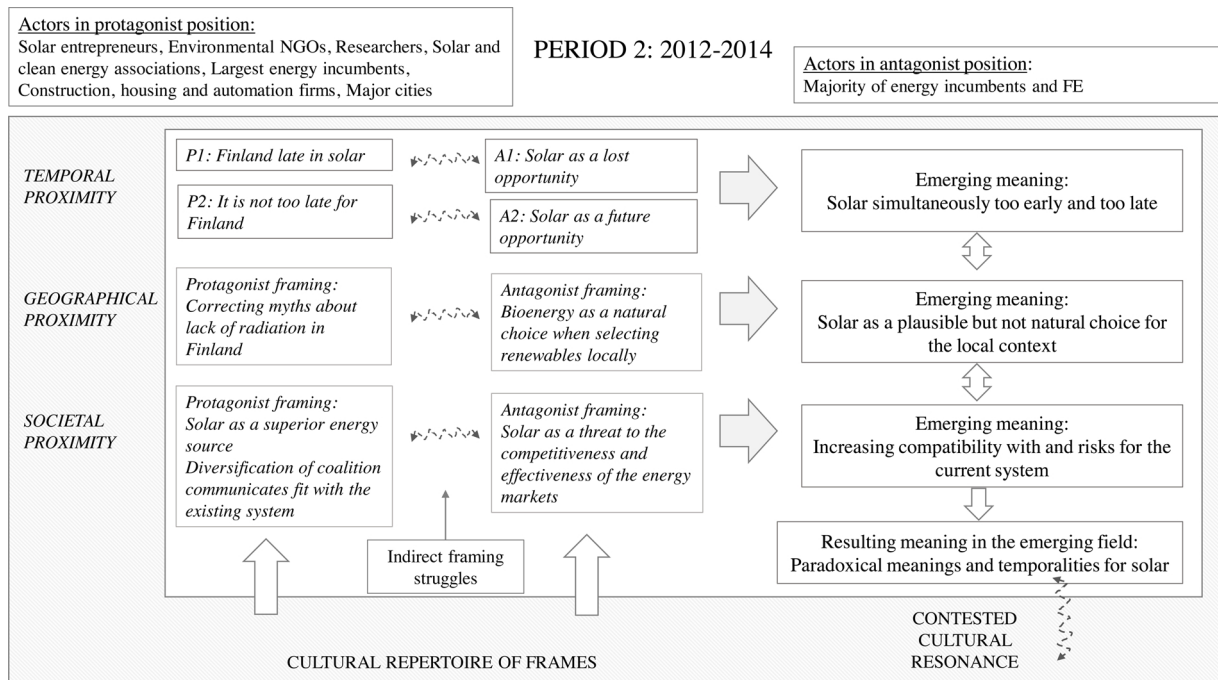


Fig. 4. The temporal, geographical and societal master frames during period 2.

future solar energy advancements and carbon-neutral societies by 2050. On the political front, the Green Party published an “energy vision 2035” where they outlined a fossil-free Finland where the majority of energy production was conducted through solar and wind power. This vision connected solar to a future society, but now simultaneously included strong connections to the present. The vision document emphasized that “all the needed technology already exist” and that certain policy measures needed to be implemented during the following year “in order to ensure the continuance of the valuable development of renewable energy production and to prevent the disappearance of the Finnish know-how” (Greens, 2016). The document also urged continued investment in “new innovations” in the area while simultaneously highlighting that they were not needed to achieve the future scenario depicted in the document.

In responding to the protagonist emphasis on the ease of change, FE began to argue that policy support was no longer needed for solar as the field was advancing well on its own: “The production subsidies for mature technology, which is already competitive in emission trading environment are inefficient, expensive and groundless” (FE, 2014). This framing placed the protagonist coalition once again in the push-and-pull of competing temporalities. FE now claimed that it was too late to establish the subsidies that solar advocates had been campaigning for throughout the field formation process while in the field of energy policy solar was still being framed as young and unreliable. The protagonist coalition aimed to counter the “too mature for support” frames by aiming to position solar strategically between the present and the future. The solar entrepreneurs and associations still emphasized the importance of current developments while emphasizing that in order to reap the full benefits, the field was still in need of support: “In Finland, investment support is preserved for old-fashioned energy production instead of directing support to deploy fully wind and solar energy” (Greenpeace, 2015), “The (solar energy) field needs to be supported because it has a significant market potential” (Finnish Clean Energy Association, 2015).

4.3.2. Geographical proximity — solar as an economic opportunity for the local context

In terms of geographical distance, the protagonist framing had been successful in that the solar myths were rarely mentioned outside of

occasional online comments to newspaper articles and the debate of the sensibility of solar in the local context increasingly gravitated towards economic aspects. The protagonist framing activities focused on the economic influence of solar in the local context through the profitability of investment and employment effects. Solar entrepreneurs began asking if solar could “pick us up from the swamp where we still unfortunately are”, referring to the economic downturn and rising unemployment rates. Solar entrepreneurs, researchers, and solar associations highlighted the job creation potential of solar energy, thus framing solar as the potential savior for Finland in its time of trouble.

To respond to the framing of solar as the savior of the Finnish economy, FE argued that its positive economic impact would mainly benefit other nations by pushing investments and jobs abroad and leaving the effect in the local context meager: This was countered by protagonists’ calculations of the amount of Finnish labor included in solar projects as well as the returns on domestic investments.

During the third period, the protagonists entitled the challenges resulting from a northern geographical position as “unique Finnish elements” of solar energy, instead of inhibiting factors. The solar entrepreneurs and solar associations also moved beyond talking about convincing sceptics of the plausibility of solar, and instead talked of “encouraging early movers”, thus communicating public interest and local potential as given. In addition, implemented projects were no longer presented as proof of general interest, but as detailed examples of best practices. The protagonist coalition also drew less attention to the political inhibitors of solar, which was more of a move in framing strategies than a direct result of increased political support (although small victories had been achieved in the form of e.g. tax exemption for small-scale electricity production).

In 2015, even FE started to express positive statements by framing Finland as a forerunner of electricity microgeneration. The trade association had to shift its strong antagonist position because several energy incumbents began to present solar as being applicable for their business. Still, FE continued to problematize the uneven distribution of irradiation and to draw from strong cultural imagery in doing so: “to compensate wind and solar energy’s variation we would need (electricity) storages so that the saunas and factories can stay on even during frosty winter nights” (FE, 2015a). FE also held on to the position that solar was

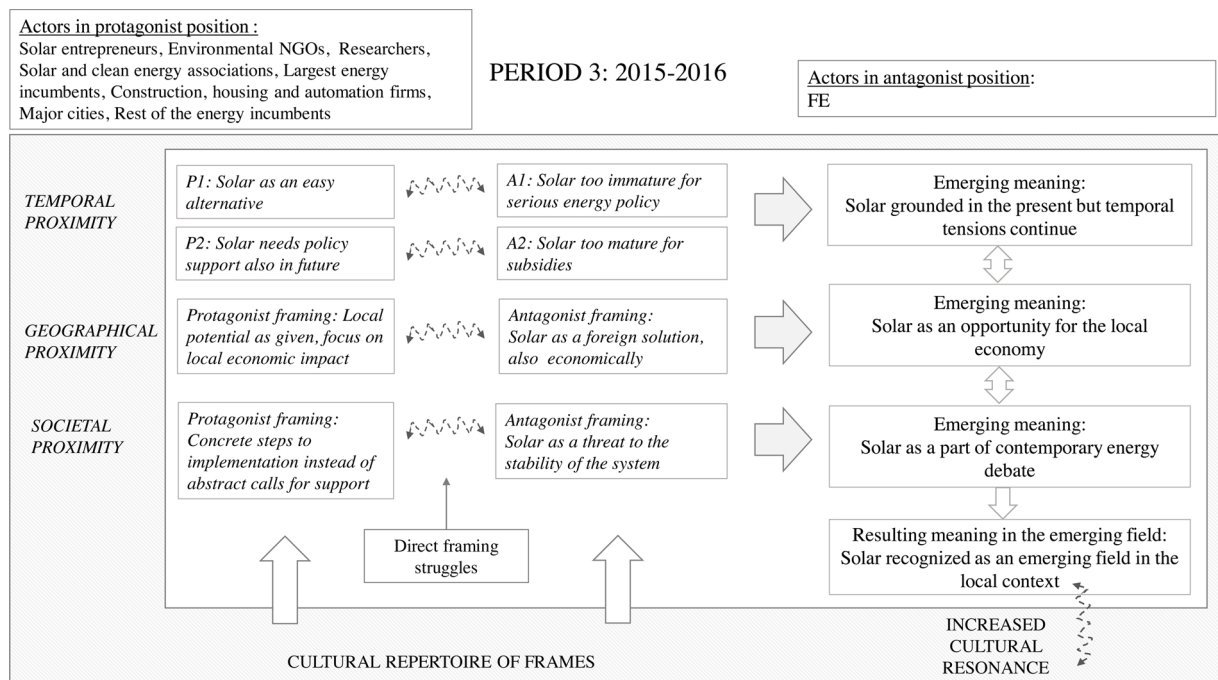


Fig. 5. The temporal, geographical and societal master frames during period 3.

not the most natural solution for Finland and renewables should be deployed following the “naturalness” of the energy source: “*Bioenergy is a natural choice for Finland. We have substantial amounts of biomass, unlike mid-European countries*” (FE, 2015c). When the majority of party leaders agreed to aim for the country to be run by 100% renewables by 2050, FE also reacted by accentuating bioenergy: “*Bioenergy is and will be in the near future the greatest renewable energy source*” (FE, 2015c).

4.3.3. Societal proximity — solar as a part of contemporary energy system

The fact that the protagonist and antagonist coalitions were increasingly connected in their debates during the third period contributed importantly to the reduction of societal distance. Importantly, the solar advocates were able to enter the formal energy policy arenas for the first time as the Finnish Clean Energy Association was invited to present their comments to the Finnish parliament on energy policy. These developments were fortified by further changes in actor coalitions as multiple new energy incumbents switched to a protagonist role in addition to the entrance of the construction and automation incumbents.

As the different actors met at the protagonist events, the debates in the field became more concrete and relevant. For example, when societal and political challenges for the implementation of solar were raised, this was done in a different tone than before. Instead of abstract calls for feed-in-tariffs to distant policy makers, the solar advocates now challenged particular policy bodies and demanded explanations for the current policies. This was enabled by the fact that the solar events hosted an increasingly diverse group of participants including relevant policy makers, politicians, and members of the antagonist coalition. Importantly, different actors began competing for the leadership position in the field and the resulting ability to define the meaning and the rules of solar energy in the local context. For example, we witnessed an energy incumbent and construction incumbent having a heated discussion at one of the events over who should be entitled to be regarded as a forerunner in the field. Furthermore, at times, the representatives of solar heat bitterly commented on how their part of the field gets forgotten despite its successfulness, and the large and small actors disagreed on the need for policy support.

FE continued to present solar as a threat for stable energy

production in the energy-intensive local economy. They presented cautionary examples of countries such as Sweden where “*political decisions are used to support renewable energy and weaken the production of nuclear energy, which is known for its stability*” (FE, 2015b). In the political arena, a lively debate spurred up on this theme when the decision was made to build a new nuclear power plant. Some politicians asked whether it would be more profitable to invest in solar energy instead (the Left Party), or in solar and bioenergy together (the Social Democrats) while others (The Finns Party) warned that larger investments in solar would, in the end, be paid by citizens.

4.3.4. Resulting meanings

During this time, solar made progress with respect to all three frames in terms of achieving cultural resonance. In addition to the strategic framing activities, the merging of the protagonist and antagonist debates into shared arenas had an important role in making this happen. When the different actors began to meet in the same policy arenas, the field frames gained more concrete meanings and moved from being scattered claims to a clearer image of the nature and direction of the field. Furthermore, the connectedness of the actors and debates reduced the marginalization of solar energy in terms of energy policy. As the coalitions were no longer clearly defined and polarized, it was harder to profile the protagonists as radical challengers of the current system. Although solar remained a contested energy source, it increasingly became a subject for intensified competition regarding who gets to define (and benefit from) the novel energy system.

However, the push and pull of temporalities continued. The main antagonist actor FE now activated future and past oriented frames where solar was simultaneously too late for societal support and too early to be considered as a reliable energy source. FE also cultivated frames that juxtaposed solar against other energy sources and renewables — a theme that fortified during the process. In fighting off these inertia-creating frames, the protagonists deployed frames that presented the change in the system as given, while still communicating future scenarios to maintain a sense of promise yet to be reaped. This balancing between temporalities was crucial in fighting off the inertia and navigating the two policy arenas.

With these activities, the societal relevance of solar increased. It

Table 2
Summary of evolving meanings, debates, coalitions in the field.

Stage in the process	Evolving meanings	Interaction between actors	Actor coalitions	Example phrases
Period 1 (2008-2011)	<p>Solar as a solution for others and other times</p> <ul style="list-style-type: none"> - Sense of temporal, geographical and societal distance in the local context - A vague sense of solar as positive, yet unrealistic - Polarized coalitions and disconnected frames marginalize solar from energy debate and position it as a challenger of the current system 	<p>Disconnected frames</p> <ul style="list-style-type: none"> - Actors operating in separate arenas - Actor coalitions like-minded and distinct from one another - Detached framing activities 	<p>Protagonist actors: Solar entrepreneurs, environmental NGOs, researchers and the solar energy association.</p> <p>Antagonist actors: Large incumbents and trade association Finnish Energy (FE).</p>	<p>Protagonist quotes: "City of the future", "Solar is able to provide enough electricity to cover the entire world's consumption" "Solar will be competitive in Italy in 2013 and in many EU countries by 2020", "Paradigm shift scenario", "Compared to fossil and nuclear power, there is no cost in solar" Antagonist quotes: "Most of the energy forms of the Solar Economy are still developing and require significant support from the society", "2050 vision", "Facilities will be located to regions with the best production conditions"</p>
Period 2 (2012-2014)	<p>Paradoxical meanings: a real but unlikely option</p> <ul style="list-style-type: none"> - Solar simultaneously too late for innovation and too early for energy production - Solar as a threat for and an extension of the current system - An increased sense of realism in considering solar in the local context, but a sense of dim possibility of due to societal inhibitors - Diversification of the protagonist coalition reduces solar's marginalization 	<p>Tangential frames</p> <ul style="list-style-type: none"> - Actors operating mostly in separate arenas - Protagonist coalition diversifying with two energy incumbents joining the advocacy coalition and the founding of the Finnish Clean Energy Association. - Framing activities tangentially connected - antagonists responding to protagonist framings without directly engaging in a debate 	<p>Protagonist actors: Solar entrepreneurs, environmental NGOs, solar and clean energy associations, researchers, advocate energy incumbents, incumbents from construction and housing industries, cities of Helsinki, Espoo, Tampere and Turku.</p> <p>Antagonist actors: Majority of energy incumbents and FE.</p>	<p>Protagonist quotes: "Sweden is in the first place in the CCPI barometers on climate change. Finland is 37th together with Ukraine." "Finland lags badly behind in development of solar energy deployment" "The train is leaving the station, hopefully, Finnish innovations are on board" Antagonist quotes: "Solar's intermittency and low energy efficiency makes it unable to mitigate climate change." "Energiewende - das grüne Ende: in 2013 Germany sacrificed taxpayers money to solar and wind power by almost 25 billion euros" "Significant subsidies to increase renewable energy have in their part directly reduced the demand of emission allowances. Investments to wind and solar power have reduced the emission without emission trading schema's steering influence"</p>
Period 3 (2015-2016)	<p>Increased cultural resonance: It is happening already</p> <ul style="list-style-type: none"> - Concrete meanings forming a clearer image of the field and adding to actionability - Dominance of economic frames on the field - Solar as an increasingly part of existing economic and energy debates - Solar temporally positioned in the present and future while still challenged by simultaneous present and past-oriented framings - Different actors competing over leadership on the emerging field 	<p>Interlinked frames</p> <ul style="list-style-type: none"> - Actors coming together in the same arenas - Negotiations of meaning under the same master frames - Actor coalitions further diversifying and internal debates intensifying - Increasing competition over leadership and defining power on the new field 	<p>Protagonist actors: Solar entrepreneurs, environmental NGOs, researchers, an increasing amount of energy incumbents, incumbents from construction and housing industries, various cities, solar and clean energy associations.</p> <p>Antagonist actors: FE</p>	<p>Protagonist quotes: "Standard solutions", "Mainstream technology", "Encouraging early movers" "When will the change happen? I am optimistic: it is happening right now by everyone present" "Conducting solar business "How do we create new jobs in Finland?" Antagonist quotes: "The production subsidies for mature technology, which is already competitive in emission trading environment are inefficient, expensive and groundless", "Expensive subsidies for mature technology are slowing down the technological development, which we can observe already in the poor success of European manufacturers of wind and solar power plants within international competition", "Future energy systems", "Future developments"</p>

Table 3
Development of strategic framing activities under each master frame.

	Temporal proximity	Geographical proximity	Societal proximity
Period 1 (2008–2011)	<u>Protagonist framing</u> Emphasis on future promise of solar, connecting with technological innovation and societal progress. <u>Antagonist framing</u> Abstractly positive accounts while presenting solar as immature Highlighting the need for large, slow changes in energy systems	<u>Protagonist framing</u> Focus on global market potential International examples of implemented solar projects <u>Antagonist framing</u> Solar as a promising solution for warmer regions, not profitable locally Solar in Finland as nonsense and protagonists as unrealistic enthusiasts	<u>Protagonist framing</u> Solar as an abundant energy source <u>Antagonist framing</u> Solar as irrelevant through silent disregard
Period 2 (2012–2014)	<u>Protagonist framing</u> Finland late in making use of solar opportunities It is not too late for Finland <u>Antagonist framing</u> Solar as an opportunity in the future, not currently Solar as a lost innovation opportunity	<u>Protagonist framing</u> Addressing the disbelief towards solar in Finland by challenging the myths regarding lack of radiation <u>Antagonist framing</u> Arguments of focusing on “naturally occurring resources” – bioenergy in Finland and solar in warmer countries	<u>Protagonist framing</u> Solar as a superior energy source <u>Antagonist framing</u> Solar as a threat to the competitiveness and effectiveness of the energy markets Antagonist coalition ends silencing tactics
Period 3 (2015–2016)	<u>Protagonist framing</u> Change as on-going and easy while presenting future visions to argue for policy support <u>Antagonist framing</u> Solar as too mature for subsidies Solar as too immature to be a priority among renewables or part of serious energy policy	<u>Protagonist framing</u> Positive effects on the local economy Treating public interest and local potential as given, “unique Finnish elements” rather than challenges. <u>Antagonist framing</u> Bioenergy as a natural choice for Finland, solar inferior in cost-efficiency Investments and jobs will flow abroad	<u>Protagonist framing</u> Challenging policy bodies to “correct mistakes” instead of abstract calls for support <u>Antagonist framing</u> Solar as a threat to the stability of the current system, weakening reliable energy sources

became a frequent topic in the media (both in print and broadcasting), now particularly from the perspective of its potential and status in the local context. In terms of geographical distance, the negotiations of meanings revolved around how relevant this impact was domestically, which was a significant shift from the casual disregard it received as “nonsense” encountered at the beginning of the process. The developments during the third period are presented in Fig. 5.

The evolution of the meanings, frames, and actor positions during the entire process is summarized in Table 2 and the development of the strategic framing activities under each frame is depicted in Table 3. The strategic framing activities are placed in their own table solely for communicational reasons — it proved impossible to fit everything into one grand table.

5. Discussion

Above, we have examined how solar technology gradually gained cultural resonance in the Finnish society as a result of continuous interaction between the four elements of our framework: 1) protagonist and antagonist actors and their positioning, 2) strategic framing activities, 3) cultural repertoire of frames, and 4) interaction between actors. We have demonstrated how these different facets of the socio-cultural framing process first created inertia in the field and then gradually moved towards field-mobilizing meanings. Figs. 6 and 7 summarize our findings with respect to this process. Fig. 6 presents the movement in the different elements of our framework whilst Fig. 7 communicates the evolution of the meanings on the field (Fig. 7).

In Fig. 6 we can see how initially the different elements conjointly create inertia in the field through the meaning of solar as a solution for others and other times. In these initial stages, the protagonist and antagonist coalitions are distinct and separate. The relatively homogeneous solar coalition puts forth strategic frames accentuating the global and future promise of solar, which interact unfavorably with the silent disregard of the diverse antagonist coalition and the positioning of the protagonist coalition as a marginal challenger of the current system. In Fig. 7, we can see how the meanings from the three master frames feed into the distancing meanings that are formed in the field at this time. As the meaning-making process progresses, the profile of the protagonist coalition becomes more diverse through the mobilization of various incumbent actors, as indicated in Fig. 6. During the second period, the antagonist actors are forced out of their silent disregard, and

engage in indirect framing struggles with the protagonist coalition. The temporal master frame is especially challenging at this time as solar becomes framed as being simultaneously too early and too late. From Fig. 7 we can see how the meanings from the different frames feed into the paradoxical meanings in the field during period 2. These developments lead to reduced marginalization of solar technology, but still create little movement and cultural resonance remains contested. During the last period, the two coalitions engage in direct framing struggles and negotiate over meanings under more detailed themes, such as the economic impact of solar in the local context (Fig. 6). The strong diversification of the protagonist coalition leads to increased credibility on the field, but also generates internal framing struggles over field definitions and leadership. The stronger temporal grounding in the present helps in mobilizing the field, but temporal tensions still persist.

5.1. Maintaining and breaking inertia on emerging technological fields

Importantly, our findings offer caution to using future-oriented framings for a technology that is marginalized and that struggles with inducing action in the local context. Technological progress, modernization, and economic promise have been frequently reported as being used to create positive expectations for solar and other novel technologies (e.g. Rosenbloom et al., 2016; Smith et al., 2014; Verhees et al., 2013). Our study indicates that such protagonist frames can have a negative impact on the actionability of the technology when the meanings arising from the cultural stock of frames characterize the novel technology as unnatural in the local context. Furthermore, when the antagonists and protagonist coalitions are polarized and their framing activities are disconnected, the silencing tactics of antagonist actors combined with the future-oriented protagonist frames are prone to create a sense of irrelevance and to marginalize the technology. Our study thus offers one explanation as to why it has been challenging to translate the wide interest in solar energy into action as depicted by Smith et al. (2014). This is an important corollary to the studies that have reported successful use of future-oriented frames — often in these cases they have been used by actors perceived as credible in the particular domain (as in Geels and Verhees, 2011).

Much like Curran (2012), our study demonstrates that creating a “knowledge and uncertainty gap” through silent disregard is an effective way to obstruct the implementation of a technology that enjoys

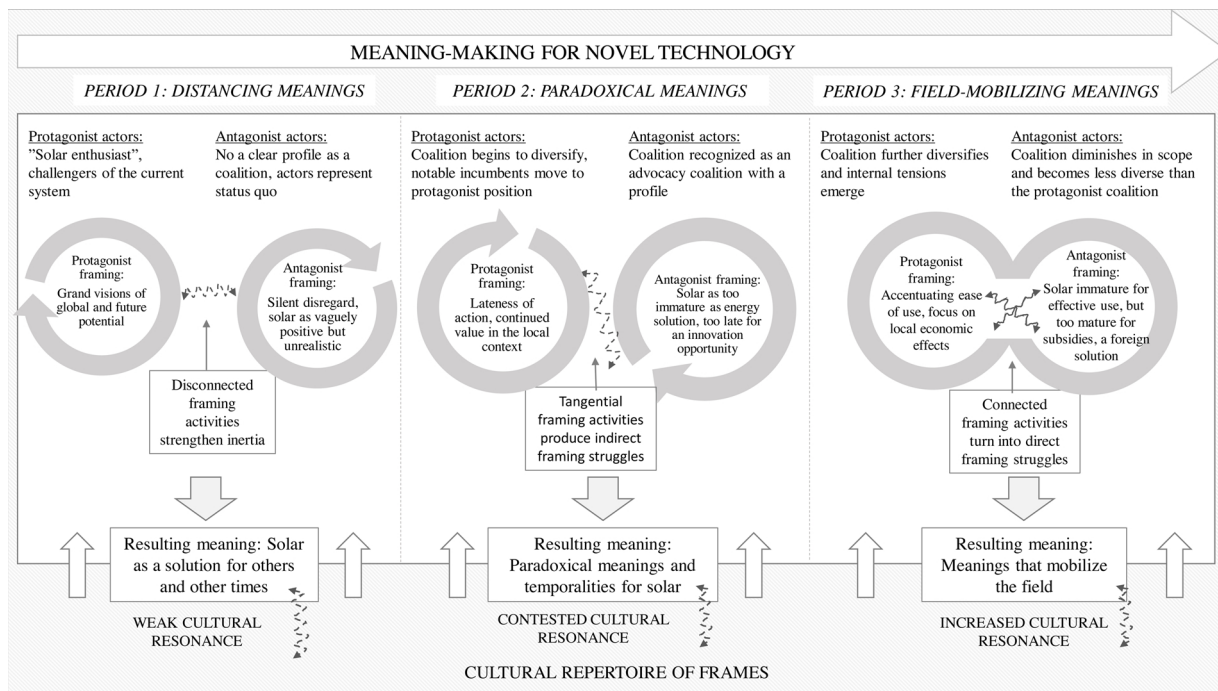


Fig. 6. The interactive meaning-making process during field emergence.

wide, yet abstract, public support. Interestingly, in our case, the antagonist frames are seemingly aligned with the protagonist framing activity in the early phases. As the protagonists present the future promise of solar energy, the antagonists simply accentuate the future orientation by presenting lengthy timelines, hence indirectly communicating solar energy’s irrelevance for the current time. And as the protagonists highlight the global promise of solar energy, the antagonists point out that its potential is largely directed at international locations. In the later stages, as the protagonists directly address the myths against solar energy in the Finnish context, the antagonists do not present conflicting arguments, but they continue their indirect tactics by highlighting bioenergy as the “natural choice” for Finland. In

this way, the antagonists can communicate an abstractly positive stance toward solar energy while still indirectly fighting off any serious action in the local context. The direct framing struggles, in fact, only arise at the end when the field is already taking off. Our results thus demonstrate that silencing and discrediting tactics (previously identified by Curran, 2012; Geels and Verhees, 2011; Rosenbloom et al., 2016) are particularly successful in marginalizing the novel technology when they interact with the future-oriented framings of the protagonists, disconnected coalitions, and with a vague sense of the cultural dissonance stemming from the cultural stock of frames.

In breaking the inertia, three developments in the field were particularly important. Firstly, the strategic framing activities of the solar

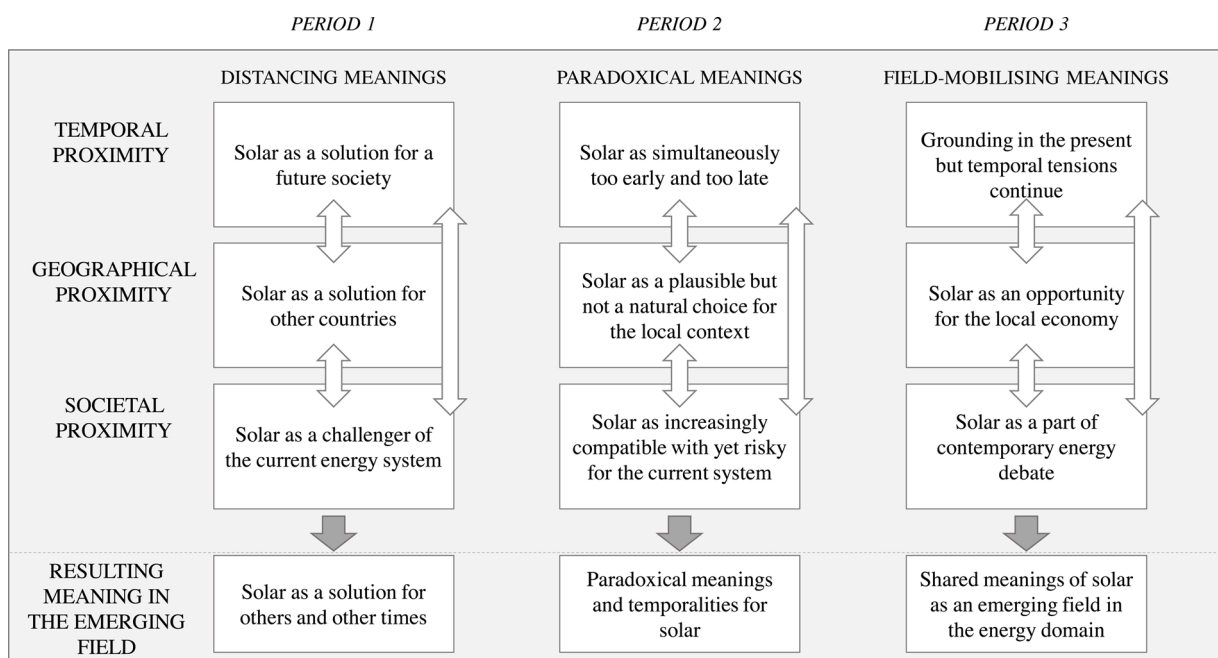


Fig. 7. Development of meanings on the emerging field.

protagonists moved from abstract grand visions towards more concrete economic opportunities in the local context. This type of development has been recognized in previous work (Geels and Verhees, 2011; Rayner and Malone, 1997) and the topic of economic relevance has been raised as a central storyline for solar in several studies (e.g. Rosenbloom et al., 2016; Smith et al., 2014). However, in contrast to Geels and Verhees (2011), our findings indicate that the shift in attention toward practical implementation contributes to the creation of cultural resonance instead of resulting from it. Our findings also demonstrate that this tendency is not merely a trend in protagonist strategic frames, but the changes in actor coalitions and field interactions enable the protagonists to use the new strategies in a way that is meaningful and credible in the emerging field. Furthermore, our findings indicate a shift from frustration to confidence in the communicated emotion in protagonist frames, which preceded, not stemmed from, the mobilization of the field. This resonates with studies on the sociology of expectations that highlight the importance of energizing future visions for field emergence (e.g. Konrad, 2006; Van Lente, 1993). Simultaneously, however, our findings offer caution to the use of broad visions in an attempt to “enroll a wide range of stakeholders” (Borup et al., 2006, 289) as they may not work well in a setting where other socio-cultural factors interact in distancing such visions from the local context. Our research indicates that a combination of long-term visions and specific, locally and temporally proximate promises work best in creating field-mobilizing meanings.

Second, the diversification of the protagonist coalition was an important factor in breaking inertia in the emerging field. It made it more difficult to characterize the protagonists as representing a particular ideology-driven perspective (a challenge noted by Barry et al., 2008; Geels and Verhees, 2011; Smith et al., 2014), and it reduced the ability of the antagonists to continue the marginalization of the novel technology through silent disregard. The new incumbent actors in the protagonist coalition placed pressure on the antagonist coalition to acknowledge the new technology and orient to it as part of the societal energy debate. This reduced the societal challenger position of solar energy and enabled bridging to the existing system. These findings reinforce the importance of the heterogeneity of the protagonist coalition for cultural resonance, noted by Geels and Verhees (2011) and Smith et al. (2014), and complement their findings by indicating that in addition to gaining political leverage it is central in framing the technology as part of a relevant societal debate. In fact, towards the later stages of the process competition arises both inside and in between coalitions as to who gets to define the novel field. Interestingly, then, our findings indicate that when the diffusion of the novel technology is perceived inevitable, the actors tend to move the focus of their framing activities from the technology to their own role in the field.

Finally, the increased interaction between coalitions was essential in building the societal credibility for the protagonist coalition and pushing the antagonist actors out of their effective strategy of silent disregard. When the two coalitions began to share public stages of field formation (Geels and Verhees, 2011; Goffman, 1956) and to engage in direct framing struggles, the emerging field became recognized as an area of social and institutional life (Dimaggio and Powell, 1983). This interaction was essential for the protagonists' locally grounded framing activities during the third period to be regarded as meaningful and it was central for overcoming the distancing meanings of the first period. Our research thus highlights a pattern of increasingly interlinked interactions between coalitions, progressing from disconnected framing activities to tangential frames and finally to interconnected framing struggles, in field mobilization.

5.2. Temporal tensions during field emergence

Our results draw attention to the central nature of temporal tensions during field emergence. The temporal proximity master frame was the most challenging of the three master frames, and intertemporal tensions

(Garud and Gehman, 2012) persisted throughout the process. First, solar technology was pushed to the future with distancing meanings, and then it was caught between paradoxical temporalities of past and future as key decision makers in the innovation domain began to view the novel technology as an opportunity lost while it was still perceived as too immature for the energy domain. Strong grounding in the present temporality was finally key in creating action on the field, but still the protagonists were caught in the middle of frames that suggested that solar was too mature for support while too immature for use as a reliable energy source. Our findings thus indicate that throughout the process, protagonists need to find a balance between past, present and future orientations in order to create a temporal mix that can create momentum for field emergence. This need is likely to be accentuated with technologies that are positioned in two societal domains with different temporal orientations, such as the innovation and energy domains in the current study. Markard et al. (2016) have reported a similar dual positioning dynamic with respect to biogas where advances in the energy domain were cancelled out by setbacks in the agricultural domain. Whereas Markard et al. (2016) attribute this to conflicting “institutional demands,” our study highlights the influence of conflicting temporal frames in effectively positioning the novel technology.

We believe that this type of temporal balancing between conflicting and even paradoxical temporalities is an essential part of creating momentum on an emerging field, and that it merits more attention in future research on field emergence. Granqvist and Gustafsson (2016) have recognized the importance of institutional temporal work and accentuate the need for constructing urgency by connecting proposed solutions to time-specific opportunities in the surrounding context. The need to build bridges between temporalities in inducing action has also been recognized in research on climate change that highlights the need to connect distant futures to current times and localities (Spence and Pidgeon, 2010; Lorenzoni and Pidgeon, 2006). Our research joins these studies in accentuating the importance of temporal work in institutional change, and adds to them in drawing attention to paradoxical temporalities that need to be simultaneously navigated by the protagonists. This is an important notion as it indicates that in addition to communicating temporal openings and linking future visions to the present, protagonists have to flexibly adjust their temporal frames as a response to the socio-cultural context they operate in. As the different aspects of our framework interact in creating temporal meanings, the strategies for temporal work cannot be fixed because the actors are likely to encounter unexpected temporal orientations as a result of their strategic framing activities.

5.3. Situating narrative themes

As our third set of contributions, we demonstrate that the narrative themes or storylines identified by the extant literature as being used to promote sustainable technologies can be categorized into early- and late-stage frames. According to our process depiction, frames that accentuate visions for technological progress, societal change, and a future energy system (identified also by e.g. Eames et al., 2006; Laird, 2003) are accentuated in the beginning of the field framing process, although to some extent they persist throughout the process. As these visions offered in the initial stages prove to be ineffective in creating cultural resonance and as new technology gets framed as belonging primarily to others (see also Barry et al., 2008; Curran, 2012), the protagonists then use arguments about the economic impacts and security implications for the local context (identified also by Nissilä et al., 2014; Rosenbloom et al., 2016; Verhees et al., 2013). At this point, the antagonists begin to offer alternative meanings for the themes raised by the protagonists, drawing particularly from the themes of energy security and the “foreign nature” of the technology (raised by e.g. Curran, 2012 and Rosenbloom et al., 2016). Our findings, thus, demonstrate that from the narrative themes identified in the extant research, technological progress, societal change, and presenting the energy source as

a natural part of the future energy system are particularly prominent in the beginning of the process, whereas job creation, energy security, and economic promise become more central in the later stages when the technology has gained initial cultural resonance in the local context.

Our research further demonstrates that the narrative themes recognized in previous research can be conceptualized as forming three high-order constructs or master frames (Benford and Snow, 2000): Temporal, Geographical, and Societal Proximity. Our research has shown how the creation of cultural resonance essentially happens as a gradual movement from an abstract sense of distance to grounding in the present time, place and society. The different narrative storylines identified in the extant literature interact under these larger constructs in varying ways as actors negotiate meanings of relevance in the local context. This conceptualization is useful as it helps, in addition to the processual perspective discussed above, to form a more holistic understanding of how different themes and storylines are connected in the emergence of novel technological fields. Currently, there is wide-ranging discussion on the different narrative themes used to promote and resist the emergence of sustainable technologies, but less integrative discussion of overall patterns across contexts. We attempt to take a step to that direction and offer a useful conceptualization of particular narrative themes are situated in a field framing process.

5.4. Interactional approach for studying the creation of cultural resonance

On a more general level, our study demonstrates the usefulness of an interactional approach focused on cultural meaning-making in examining socio-technical transitions. Diehl and McFarland (2010, 1713) have called for interaction to be put in the “front and center of historical explanations” as inspecting the “interactional nature of shared meaning” allows for a more holistic understanding of social change. We argue that when examining field framing processes, it is essential to account for the fact that frames are created, sustained and changed in layered interaction and that meaning-making on emerging fields involves more than competitions over consciously created strategic frames. While much of the existing research has acknowledged the interactive nature of the field framing process, the analytical focus in much of the field framing literature is still on depicting strategic framing activity (cf. Cornelissen and Werner, 2014; Granqvist and Laurila, 2011; Geels and Verhees, 2011; Rosenbloom et al., 2016). This is problematic as it is likely to lead to an overly simplified and overly strategic understanding of field framing processes, and, consequently, result in less effective approaches in supporting field formation of emergent technologies. Importantly, it can lead to a failure to understand how the cultural scene is created wherein the strategic framing activities make sense and lose sight of an important foundational stage in the field emergence process. Our study aims to address this gap and deepen the current understanding of the multifaceted interactions that constitute the meaning-making processes on an emerging field, and hence shed more light on the “deep cultural dynamics” within transition processes as called for by Geels and Verhees (2011) and Markard et al. (2016). In so doing, our study joins the growing number of research that draws attention to the creation of cultural resonance, and field emergence more generally, as an interactive, multi-actor process (Geels and Verhees, 2011; Markard et al., 2016; Meyer and Hölleren, 2010; Rosenbloom et al., 2016; Rosenbloom, 2018) and accentuates the fit between the content and context of technologies (Rosenbloom et al., 2016; Rosenbloom, 2018; Markard et al., 2016; Fuenshilling and Truffer, 2014).

5.5. Policy implications

In addition to theoretical contributions, our study offers implications for policy. First, our findings indicate the challenging position of a novel technology in two different political arenas: energy policy and innovation policy. The protagonist coalition for solar energy had to

navigate meanings in these two arenas, which contributed to the creation of paradoxical temporal orientations explained above. Our case shows that solar technology gained more ground within the innovation arena, whereas energy policy domain remained challenging. For example, solar gained small investment support in early stages, but energy tax reduction was only gained after long-term push of solar advocates and feed-in-tariff was never considered. Innovation policy is thus not sufficient alone, especially when there are no support measures in place for commercializing the technology. Especially in countries where the novel technology is driven by small and medium sized firms, without large exporting industrial clusters, and thus, without significant impact on national current account. Policy makers need to develop effective approaches for dealing with disruptive technologies whose potential spans various arenas, and address the lack of or weak coupling between innovation, energy and industry policies.

Second, we observed that the politicians mainly mirrored the framings put forth in the field by other actors and remained the only actor group which did not change their position in any notable way. As both protagonists and antagonists framings diverted attention away from solar's potential as a complementary energy source, leadership from the part of political parties would have been needed to position the novel technology appropriately in the societal context. Furthermore, policy makers could have demonstrated leadership in terms of the heterogeneity of actors in the nascent field. When incumbent industrial actors start to mobilize their resources to a novel field, there is a possibility for positive spillovers, which can increase legitimacy and resources available for the field and create space for various kind of actors (see also Apajalahti et al., 2017). Policy makers should develop ways to support these positive spillovers and take the different stages of field development into account when designing policy initiatives. Explicitly and actively supporting the plurality of actors could prevent the incumbents from gaining excessive market power while maintaining the effects of positive spillovers.

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.

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