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Energy Security, Employment and the Policy-Industry Interlock: Explaining the Role of Multi-Scalar Socio-Spatial Embeddedness in Industry Destabilization

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Energy security, employment and the policy-industry interlock: explaining the role of multi-scalar socio-spatial embeddedness in industry destabilization[1]

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Abstract

Existing literature on industry destabilization has relatively neglected the embeddedness of industries to their regional and national contexts. This might result in overestimating the potential for industry destabilization in specific localities. Combining the Dialectic Issue LifeCycle (DILC) model and the geography of transitions literature this article analyses the developments in the Estonian oil shale energy industry between 1995-2016. We show that the ties between the industry and its local context serve as an important stabilizing mechanism offsetting the destabilizing pressures as conceptualized by the DILC model. The cancelling out of two mechanisms on a local level leads to a misalignment of scales where the continued presence of global pressure of climate change is not matched by local dynamics. Hence in contrast to what the DILC model implies, there is no straightforward transmission of international pressures on local industries: instead this process is mediated through and likely heavily influenced by national and regional considerations. The findings imply that for industry destabilization and energy transitions to occur, not only the regime but also its connections to the local context need to be destabilized and transformed.

Keywords: energy transitions, industry destabilization, geography of transitions, socio-spatial embeddedness, multi-scalarity

1. Introduction

The destabilization of industries has recently gained attention in transitions literature (Penna and Geels, 2012, 2015; Karltorp and Sandén, 2012; Turnheim and Geels, 2012, 2013; Ottosson and Magnusson, 2013; Bosman et al., 2014; Geels and Penna, 2015; Kungl and Geels, 2017; Roberts, 2017; Sovacool et al., 2017). This focus is timely given that current environmental issues necessitate a radical transformation of energy industries based on the centralized generation of electricity from fossil fuels. Indeed, a heavy fossil fuel lock-in of incumbent industries has been

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identified as a major source of resistance to the broader transformation of current energy systems (Unruh, 2000; Unruh, 2002; Unruh and Carrillo-Hermosilla, 2006). Hence the focus of existing work on successful cases of industry destabilization which has led to the identification of different types of external pressures facing industry regimes (Geels, 2014a), impact of these pressures on the industry (Turnheim and Geels, 2012, 2013) as well as the basic patterns of industry destabilization (Penna and Geels, 2012). It has been demonstrated that industry reorientation emerges through a multi-dimensional struggle involving techno-economic and socio-political pressures of varying intensity, heterogeneous responses from industry players, temporary setbacks and reversals (Penna and Geels, 2015), and a range of outcomes from dissolution (Sovacool et al., 2017) to re-creation (Kungl and Geels, 2017).

In some ways then the theorization of the industry destabilization process has been based on rather exceptional cases where notable shifts in industrial activities can be observed. Yet as the concepts like carbon lock-in (Unruh, 2000; Unruh, 2002; Unruh and Carrillo-Hermosilla, 2006), path dependency (Arthur, 1994; Pierson, 2000), entrapment (Walker, 2000) and technological momentum (Hughes, 1994) suggest, more often than not industries remain remarkably resilient to change. From the industry destabilization perspective this raises a challenge of dealing with cases in which the preconditions for large-scale industrial transformation seem to be present yet little of it actually occurs. This framing suggests a shift in attention from the mechanisms facilitating industrial change to the interaction of mechanisms facilitating and hindering it.

This paper is based on the intuition, derived from recent advances in the geography of transitions (Coenen et al., 2012; Coenen and Truffer, 2012; Raven et al., 2012; Truffer and Coenen, 2012; Bridge et al., 2013; Hansen and Coenen, 2015; Murphy, 2015; Truffer et al., 2015; Becker et al., 2016; Truffer, 2016; Haan, 2017), that the high degree of stability and lock-in of industries has much to do with the ways in which they are embedded to their local (that is, regional and national) contexts. However, so far the notion of embeddedness has largely remained a sensitizing heuristic in the transitions literature and has not been operationalized in empirical research on industry destabilization. As such neither the nature of different types of embeddedness on different spatial scales nor their interactions with destabilizing pressures are currently well understood. In this paper we seek to address this gap by combining the insights of the Dialectic Issue LifeCycle Model (Penna and Geels, 2012) and the geography of transitions literature to answer the following research questions:

1. What are the main forms of socio-spatial embeddedness of industries on different geographical scales?
2. How do global pressures interact with local embeddedness and what is the result of this interaction for industry destabilization?

We explore these questions through a multi-method case study on the destabilization of the Estonian oil shale industry between 1995-2016. The case was selected because of Estonia’s globally unique reliance on oil shale as the primary source of energy. This has placed specific burdens on the Estonian energy regime such as the contribution of oil shale to Estonia’s ecological footprint, one of the largest (per capita) in Europe. (Global Footprint Network, 2017). Combined with increasing worries about climate change and the growing availability of renewables one would expect the Estonian industry to be on the path of major re-orientation. Yet in 2016 about 85% of electricity in Estonia still continued to be produced from oil shale. From the perspective of industry destabilization, Estonia thus constitutes a deviant case, suitable for uncovering factors and mechanisms missed by existing theoretical accounts overly focused on “successful” cases.

Section 2 provides an overview of existing literature followed by the outline of research methodology in section 3. Section 4 describes the developments in the Estonian oil shale industry between 1995-2016. The analysis of the case is presented in section 5. Section 6 concludes and summarizes the broader implications of our study for destabilization literature in particular and for transitions literature more generally.

2. Theoretical framework

2.1. Industry regime and industry destabilization

Much of the existing literature on industry destabilization is based on the Triple Embeddedness Framework (Geels, 2014a) that focuses on the interaction of an "industry regime" with its environment. The industry regime is defined as a set of industry-specific rules (e.g. technical knowledge and capabilities, mindsets and values, regulations and standards) guiding the behaviour of and providing stability for industry actors. It is situated in two types of environments: 1) economic environment, consisting of various actors in direct commercial transactions with the industry (e.g. suppliers of resources and raw materials, finance, technologies, knowledge as well as consumers), and; 2) socio-political environment, consisting of policy-makers, civil society and the public. Industry destabilization might therefore be described as a process in which the accumulated pressure from economic or socio-political environments (e.g. changing demand, increasing competition, normative contestation by activists, adoption of new laws) weakens the reproduction of core regime elements (Turnheim and Geels, 2012). This involves an array of strategic responses from the industry such as economic positioning (e.g. marketing, supply chain management), investments and innovation, corporate policy-making (e.g. lobbying) and framing (e.g. advertising, awareness campaigns) (Kungl and Geels, 2017). In general, one can distinguish between internally- and externally-oriented strategies: whereas the first attempt to alter the firm itself, the second are aimed at shaping the environment of the firm (Geels, 2014a).

Application of this framework to industry destabilization has shown that the growing intensity of external pressures is matched with changes in responses from industry players whereby the gradually weakening commitment to the industry regime elements creates chances for more expansive industrial transformation (Turnheim and Geels, 2012, 2013). Moreover, the sequence and alignment of different pressures might considerably facilitate industrial downfall (Kungl and Geels, 2017). The Dialectic Issue LifeCycle (DILC) model (Penna and Geels, 2012, 2015; Geels and Penna, 2015) conceptualizes how this destabilizing effect is mediated through chains of interactions between various social groups (figure 1). It proposes the following ideal-typical explanation of industry destabilization:

1. A specific issue with the industry (e.g. the high carbon emission rates of fossil fuel industries are linked to climate change) is first framed by social activists while industry actors fail to recognize it or downplay its importance;
2. Social movements are formed that push the issue on the public agenda and give rise to public concerns. Industry actors engage in defensive responses such as closed industry fronts while exploring incremental technological solutions;
3. Policymakers feel the pressure to become involved, creating investigative committees and organizing public debates. Industry actors bring up reasons why radical change is unnecessary or impossible. They promise to implement incremental solutions while secretly hedging into radical alternatives or diversifying into new product markets;

4. New substantial legislation is introduced and implemented by policymakers. Industry actors contest the new policies while increasing investment in R&D. A new market share emerges as "moral consumers" adopt early radical alternatives;
5. Changes in policies, consumer preferences or public discourse bring about the rise of new markets. Some industrial actors see this as an opportunity to reorient towards new markets while also recreating themselves with a new identity and mission related to addressing the issue at stake (Penna and Geels, 2015).

Actors	Problem mobilization in socio-political environment			Spillovers to economic environment	
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Activists and social movements	problem framing	organization into movements, raising public concerns	organized framing and political lobbying		
Policymakers		expressing concerns, creating informal com-mittees	engagement in political debates and formal hearings	implementation of substantive policies	policies influence economic frame conditions
Consumers and suppliers			early demand from "moral" consumers	growing "moral" market niches	changes in mainstream preferences
Industry	problem denial or downplaying	organization into closed industry front, domain defence by contestation, incremental innovation	radical solutions portrayed as unfeasible, defensive hedging	opposition to policies, diversification	re-orientation, re-creation or dissolution

Figure 1. Accumulation of problem-related pressures and industry responses in the 'linear' DILC model (based on Geels and Penna, 2015; Penna and Geels, 2015).

Although the DILC model provides a promising avenue for explaining industry destabilization, it currently suffers from two oversights. First, its focus on the interplay of actor coalitions and strategic industry responses tends to stress the linear unfolding of industry destabilization towards a more sustainable solution although empirical research has indicated that issue lifecycles usually exhibit a "cyclical" path where the external pressures and industry responses move forwards and backwards between different phases (Geels and Penna 2015; Penna and Geels 2012, 2015). While the DILC model does not offer a good explanation for this, Geels (2014b) has suggested that one of the key factors might be political intervention at the local level where industry actors tend to form close alliances with policymakers, thereby influencing political decisions related to the industry. Second, the DILC model is not very sensitive to the importance of geographical context: while in principle it allows for the possibility that pressures from the global environment might differ from those exerted by the local context of industries, these distinctions have not been explored in empirical research.

2.2. Socio-spatial embeddedness and multi-scalarity

In contrast to the literature on industry stabilization the importance of place is strongly stressed by geographical approaches to transitions. Truffer and Coenen (2012) have invoked the notion of "socio-spatial embeddedness" to signify the multiple territorial, social and cultural advantages enjoyed by socio-technical regimes in particular locations. Examples of place-specific elements include urban and regional visions and policies, informal localized institutions (Hansen and Coenen, 2015; Raven et al., 2012), natural resource endowments, physical infrastructure (Bridge et al., 2013; Hansen and Coenen, 2015), regional technological and industrial specialization as well as the role of consumers in local market formation (Hansen and Coenen, 2015). Others have stressed the importance of linkages across national and international scales such as multi-level governance and policy mobilities (Hansen and Coenen, 2015; Sengers and Raven, 2015), buzz-pipelines, international transfer of knowledge, global production networks (Sengers and Raven, 2015), epistemic communities, transnational advocacy networks and the global civil society (Raven et al., 2012). The most recent studies have consequently attempted to encompass both local and global processes, focusing on scale effects (Dahlmann et al., 2016; Haan, 2017; Ramiller and Schmidt, 2017), actor-networks and relatedness (Chandrashekeran, 2016; Debizet et al., 2016; Boschma, 2017; Boschma et al., 2017), global innovation systems (Truffer, 2016; Binz and Truffer, 2017) or politics and power (Becker et al., 2016; Hess et al., 2017). The geographical approaches thus make a good case that sustainability transitions (which also involve the destabilization of incumbent industries) are shaped by the simultaneous embeddedness of industries across regional, national and international scales. In other words, sustainability transitions and industry destabilization are inherently multi-scalar processes.

However, Hansen and Coenen note that while the increased emphasis on the geographical dimension in transitions literature has led to the acknowledgement of the role of geography in transition dynamics as an empirical matter-of-fact, there is currently “little generalisable knowledge about how place-specificity matters for transitions” (2015: 92). In order to systematize existing insights we thus draw on Hess’s (2004) critical overview of the notion of embeddedness in economic geography literature which distinguishes between three different dimensions of the concept:

1. Territorial embeddedness: the extent to which an actor is “anchored” in particular territories or places;
2. Societal embeddedness: the influence that the social and cultural background of the actors has on their action;
3. Network embeddedness: the involvement of the actor in a social network, i.e. a structure of relationships among a set of actors regardless of their local anchoring in particular places.

Figure 2 applies these dimensions to findings from geographical approaches to transitions. It is important to note that each of these forms of embeddedness can serve as a stabilizing resource for incumbent industries. For example, an industry might draw on existing natural resource endowments, national energy strategies and/or favourable conditions in global energy markets - combining forms of territorial, societal and network embeddedness respectively - to argue against the need for a fundamental regulatory intervention. The degree to which the industry is successful in doing so indicates the degree of its embeddedness to various contexts across multiple scales. Our mapping suggests that territorial embeddedness exhibits itself mainly on the local scale while societal and network embeddedness can also indicate non-local influences on the industry through global economic, political and cultural ties. Hence in contrast to what the DILC model implies, there is no straightforward transmission of international pressures on local industries: instead this process is mediated through and influenced by national and regional considerations.

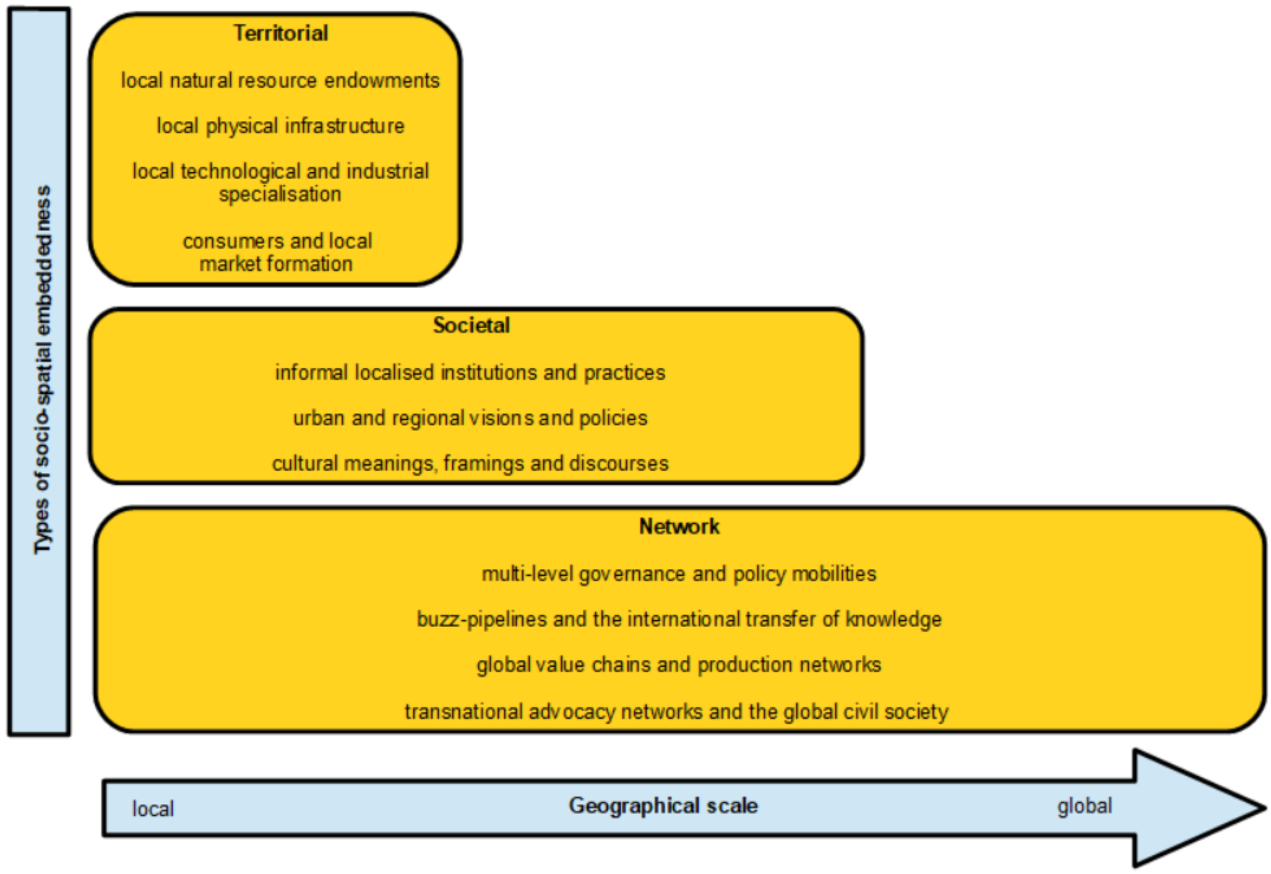

Figure 2. Types of socio-spatial embeddedness across multiple scales (based on Hess, 2004; Raven et al., 2012; Truffer and Coenen, 2012; Bridge et al., 2013; Sengers and Raven, 2015; Hansen and Coenen, 2015).

2.3. Synthesis: industrial transformation as an interaction of embedding and disembedding mechanisms

The literature review leads us to see industrial transformation as a process that involves two forces pulling in opposite directions:

1. The DILC model as a mechanism that, through the interactions between industry insiders and external actors, mediates broader international pressures from socio-political and economic environments thereby leading to industry destabilization. In other words, we conceptualize DILC as a disembedding mechanism aimed at severing the ties between the industry and its regional, national and international context;
2. This pressure is countered by activities of various social groups, aimed at consolidating the societal, territorial and/or network-related ties of the industry to its regional and national context. That is, we see these locally-oriented strategies as a (re-)embedding mechanism providing stability to the incumbent industry.

The rest of the paper is devoted to exploring the interaction of these two mechanisms.

3. Methodology

3.1. Case selection

The research was based on a single longitudinal case study design (Yin, 2003), employing a deviant case selection strategy. A case is deviant if, by reference to a general theoretical understanding, it demonstrates a surprising and anomalous value (Seawright and Gerring, 2008). Selecting a deviant case is the most useful strategy for detecting omitted variables and mechanisms and discover unknown causal pathways (Seawright, 2016).

While the Estonian oil shale industry has been previously analysed as an exemplary case of path dependency (Holmberg, 2008), it can be considered deviant in relation to existing theory on industry destabilization. On one hand, there are multiple pressures on the industry regime:

1. Broader socio-political environment: the Estonian energy regime has been subject to the pressures of climate change during the last decades, reinforced by its ratification of the Kyoto protocol in 2002 and becoming a member of European Union in 2004.

2. Availability of alternatives: similarly to other countries Estonia is in a position to benefit from the increasingly cost-effective renewable energy technologies. The renewable energy market niche has already grown to 25% of final energy consumption while the potential of wind, biomass and biogas energy is still largely unused (Eesti Taastuvenergia Koda, 2016).

3. Issues specific to the Estonian energy regime: a) oil shale has a low Energy Return of Investment compared to traditional liquid fuels. Some studies estimate the value to be as low as between 1:1 and 2:1 when internal energy is included as an energy cost (Cleveland and O’Connor, 2011; Hall et al., 2014); b) oil shale usage has a large negative impact on the environment as producing energy from it emits twice as much greenhouse gases than from conventional fossil fuels (Cleveland and O’Connor 2011). Due to the impact of the oil shale industry, Estonia has one of the largest ecological footprints per capita in Europe (Global Footprint Network, 2017); c) the major oil shale deposits are located in North-Eastern Estonia close to the Russian border (figure 9). Since Estonia used to be occupied by the Soviet Union and the tensions between Russia and Estonia are ongoing the location of oil shale deposits can be considered a hazard from the energy security perspective.

One should expect the combination of these factors - broader environmental pressures, increasing viability of alternatives and the fragility of the oil shale based energy regime - to have had a substantial impact on the Estonian industry regime toward destabilization and re-orientation. Yet the actual share of oil shale in primary electricity supply has remained fairly stable over the last two decades (see figure 5). Moreover, the latest National Development Plan of the Energy Sector foresees only a modest rise in the share of renewables, with 28% of primary energy consumption and 45% of total energy consumption coming from renewables by 2030 (Energiatalgud, 2016). Hence the discrepancy between observed pressures and relative stability of the industry regime makes the Estonian case a deviant one, implying the presence of certain mechanisms neutralizing different pressures.

3.2. Process-tracing

The case study employed a process-tracing approach (Beach and Pedersen, 2013). Process-tracing is a technique for causal inference developed to detect whether a specific causal mechanism mediating between certain initial conditions (X) and an outcome (Y) exists or not. Three different variants of process-tracing can be distinguished: theory-testing, theory-building and explaining-outcome analysis. In this study the primary focus was on explaining the relative stability of the industry regime despite the existence of multi-level pressures. Moreover, we hypothesized this outcome to be caused by multiple interacting mechanisms. Because of these considerations the explaining-outcome was deemed the most suitable research strategy.

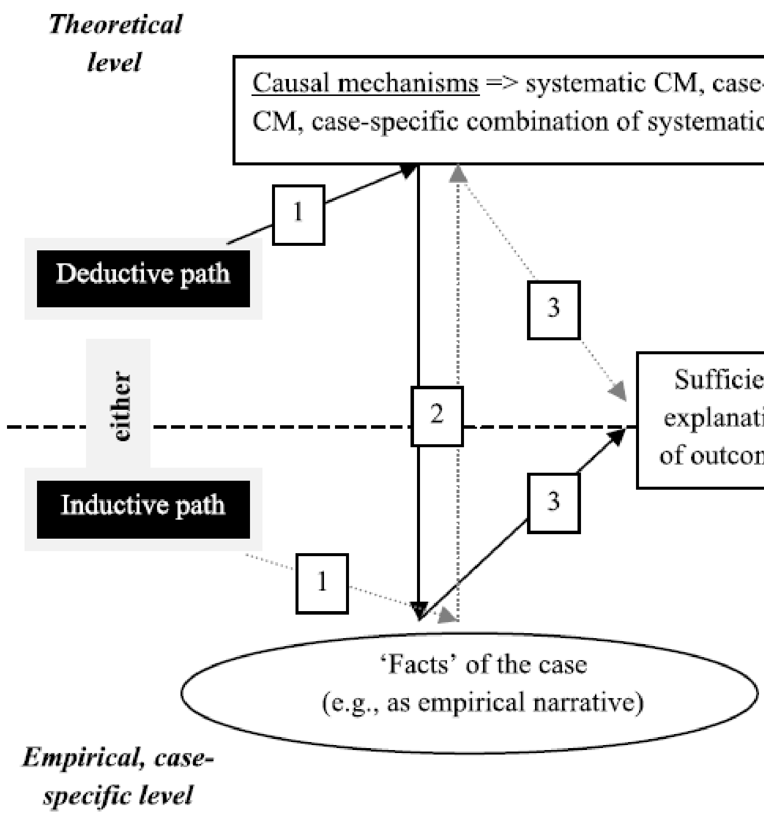

Figure 3. Explaining-outcome process-tracing (Beach and Pedersen, 2013).

Explaining-outcome process-tracing uses a combination of deduction and induction (figure 3). In the deductive part the theoretical causal mechanism, obtained from the existing literature, is tested against empirical data to assess its ability to account for the observed outcome. In this case, we first assumed that the Estonian case follows the DILC model which is depicted as a five-phase process between external pressures and industry responses leading to industry destabilization. However, for deviant cases the existing mechanism is unable to explain the full extent of the outcome by definition. The inductive strategy is then used to gather additional empirical evidence and build a more comprehensive explanation. In this case, additional evidence that did not fit with the DILC model was collected and systematized under the categories of socio-spatial embeddedness.

The application of process-tracing strategy involves a systematic search for and combination of various pieces of empirical evidence to demonstrate the existence and interaction of mechanisms. For this purpose data was collected and combined from the following sources:

1. 603 online news items about environmental problems related to the oil shale industry from the two biggest Estonian online news portals *Postimees* and *Delfi* covering the period between 1995 and 2016. The newspaper articles were found from the online databases with a Boolean search by combining the key words (*keskkon** OR *kliima*) AND *põlevkivi*[2]. The results of these searches were then manually reviewed and irrelevant articles excluded;
2. Official public documents, including a) annual reports and yearbooks of the enterprises in oil shale industry and the Estonian Renewable Energy association and; b) strategies and development plans of the Ministry of Environment and the Ministry of Economic Affairs and Communications of Estonia;

[2] Translation from Estonian: (*environment** OR *climate*) AND *oil shale*

3. Secondary literature to find additional evidence about the activities of policy-makers and industry actors;
4. Statistical databases and public opinion polls to represent environmental pressures on the industry.

Data analysis proceeded in four consecutive steps:

1. Visual observation of time series data to divide the case into periods. As an indicator of socio-political pressure, we counted the number of articles on climate change in the online databases of two of the most popular Estonian newspapers, *Delfi* and *Postimees*. As an indicator of economic pressure, we used the average annual OPEC crude oil price because the competitiveness of the oil shale industry depends to a large extent on the fluctuations of world crude oil price (Eesti Energia et al. 2016). The year 1995 was chosen as the starting point because of several key events related to the focal issue of climate change (the first Conference of Parties (COP) in Berlin and the publication of the IPCC Second Assessment Report) as well as for reasons related to the availability of data (the online news archives which constituted the main source of data only dated back to 1995);
2. Content analysis of online news items to identify key actors, events, the sequence of events and causal relations between them. All the news items were read and coded based on the coding manual (see Appendix A for details). Deductive coding was used for DILC categories and open-ended coding for events related to various dimensions of socio-spatial embeddedness. In the latter case the coding scheme was amended through successive iterations;
3. The findings of the quantitative content analysis were amended with qualitative evidence from public documents and secondary sources in order to construct detailed narratives and event timelines of each phase (see figure 5);
4. As a final step, we relied on the pattern-matching technique (Seawright, 2016; Yin, 2003) to compare the observed events with the theoretical pattern as described by the DILC model. The findings on socio-spatial embeddedness were then used to see whether they could account for deviations from the model.

4. Case study

4.1. Periodization

Based on the combination of socio-political and economic pressures we divided the case into four phases. The first period from 1995 to 2002 saw climate change being framed as an issue for the first time in Estonia following the agreement of the Kyoto protocol in 1997 and the preparations for joining the EU. The industry was troubled by economic problems tracing back to the Soviet era and amplified by the Russian financial crisis in 1998. In the second period from 2003 to 2009, climate change reached the political agenda mainly due to Estonia's unification with the EU in 2004 and the subsequent build-up for the COP15 in Copenhagen. However, the industry grew steadily because of favourable oil prices, experiencing only a minor shock at the end of the period due to the global financial crisis. The third period was characterized by a decreasing interest in climate change due to the failure of the parties to reach a global agreement in Copenhagen while the industry prospered as the crude oil price increased rapidly again after the shock of 2009. The societal and economic pressures aligned in the fourth period beginning in 2014 with an abrupt drop in crude oil price and the global agreement on climate change adopted at COP21 in Paris. These pressures sent the industry into an acute crisis the results of which are still to be determined.

Figure 5 provides a visual summary of the case, putting the timeline of main events in the context of socio-political and economic pressures, and indicating the changes in the energy mix (expressed as the ratio of oil shale and renewable energy supply).

4.2. The de- and re-stabilization of the Estonian oil shale industry regime (1995–2016)

4.2.1. Framing of the climate change issue and post-Soviet economic struggle (1995–2002)

In the 1990s, the oil shale industry was grappling with severe problems the causes of which can be traced back to the Soviet period and the subsequent transition to a market economy after Estonia restored its national independence in 1991. First, the industry was still using the heavily contaminating pulverized fuel combustion technology developed in the 1930s. The technology had a big environmental impact, including air pollution and waste, and was also economically inefficient. Huge investments into new technologies were needed but the firms were struggling with large debt instead. The technological problems were magnified in 1998 by the eruption of the Russian financial crisis and a subsequent drop in the world crude oil price that abruptly decreased shale oil export revenues. The changed market conditions proved to be too difficult to overcome for one of the companies, Kiviter, which went bankrupt in 1999 but was subsequently recreated as Viru Keemia Grupp (VKG). However, the permanent dissolution of the industry was to be avoided at all costs as this scenario was seen as a serious threat to national security because of high unemployment rates in the mainly Russian-speaking industrial region and the legacy of the failed regional autonomy referendum in the border city of Narva in 1993 (referred to as the “Narva crisis”). The government made several exceptions for the industry such as implementing pollution and waste charges that were 10 times smaller than the charges for similar toxic waste in other sectors. Consequently, the industry had made barely any attempts at recycling the spent shale that was the by-product of the dry distillation process and the waste was simply dumped in big piles around the industrial regions of Kiviõli and Kohtla-Järve that eventually formed distinctive hills on the landscape of Ida-Virumaa (figure 4). This led to serious problems like groundwater contamination and the spontaneous combustion of waste.

Figure 4. Spent shale hill near Kiviõli. **Source:** Olev Mihkelmaa, Wikipedia.

Doubts over the economic and environmental sustainability of oil shale utilization sparked a wider debate about the future of the national energy system. Some environmental organizations called for drawing up a long-term national energy strategy based on the principles of sustainable development. They argued for the advantages of renewables and proposed a direction towards the decentralization of the energy system as laid out in a new long-term plan for the utilization of alternative energy until 2050 presented to the government by the Estonian Green Movement. However, both policymakers and industry representatives largely ignored these proposals and were supportive of an oil shale based system. They emphasized that the survival of the industry was crucial for regional and national energy security as well as for the local job market in the industrial Ida-Virumaa region – arguments that have remained the same over the years (figure 6).

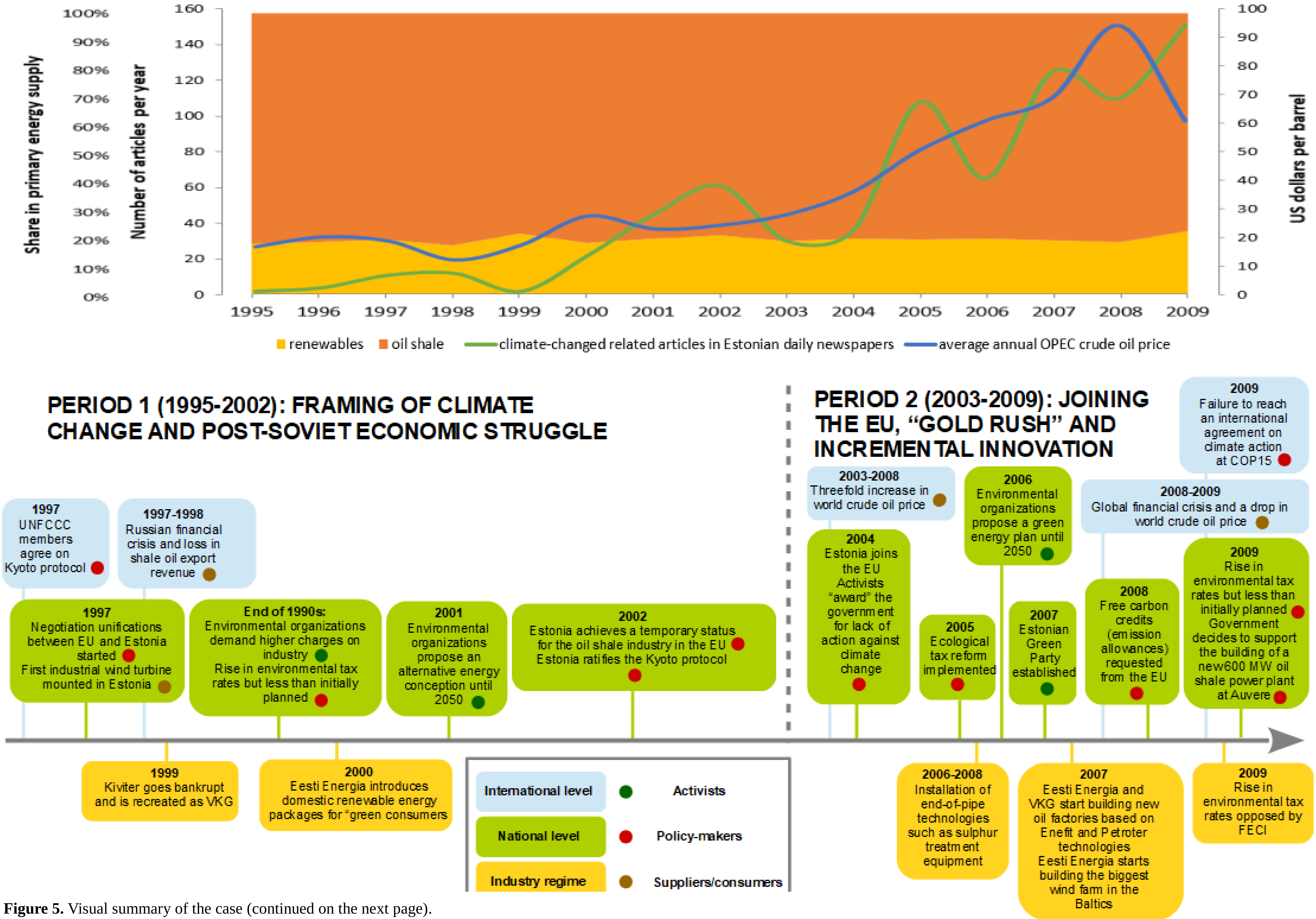

Figure 5. Visual summary of the case (continued on the next page).

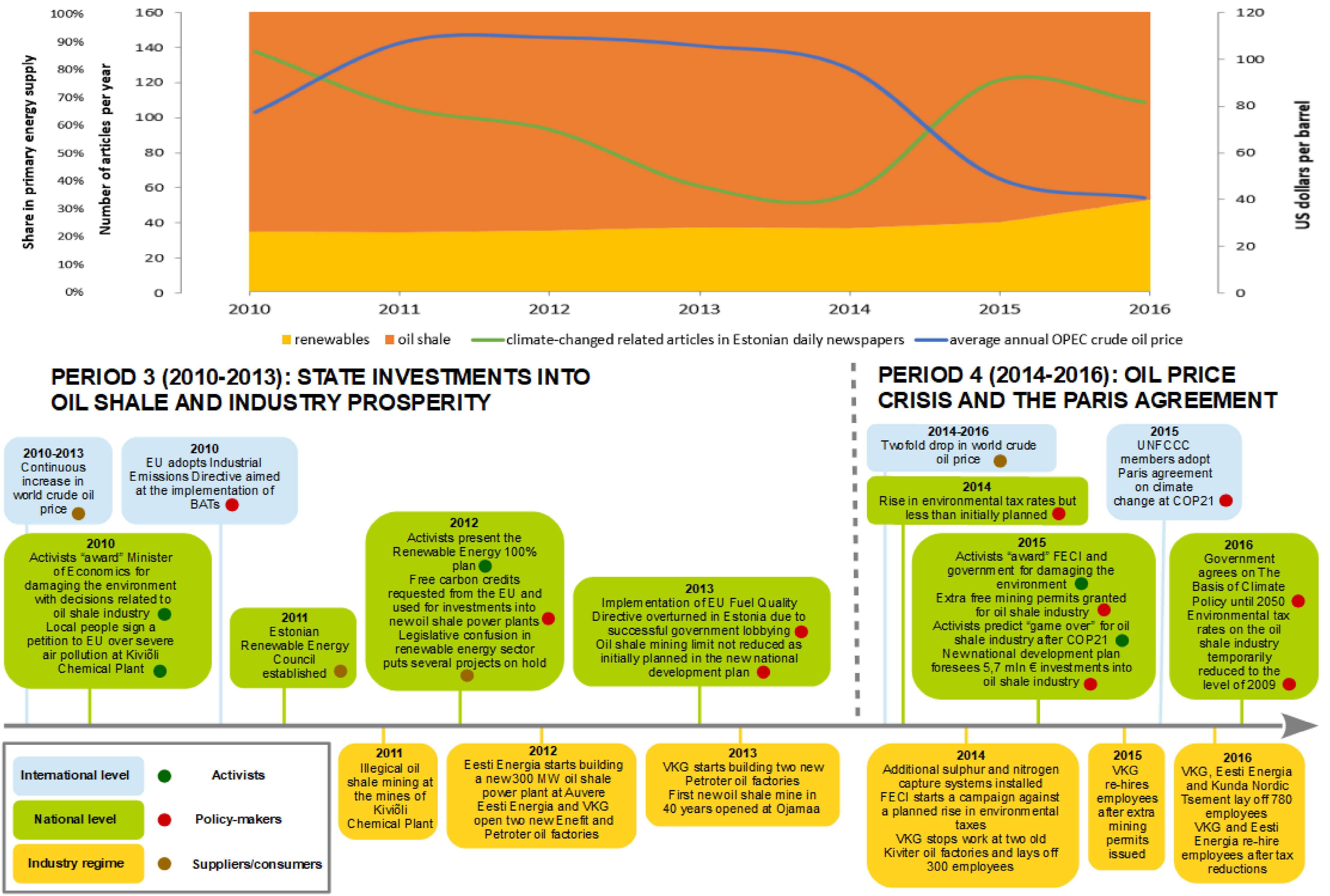

Figure 5 (continued). Visual summary of the case.

Environmental concerns slowly started to gain public attention. In 1994, Estonia ratified the United Nations Framework Convention on Climate Change, thus becoming a member of the countries dedicated to fighting against global warming and in 1995, Estonia had to present a national climate report for the first COP in Berlin. 1997 saw the international adoption of the Kyoto protocol which was ratified by Estonia in 2002. With this step, the government took on the obligation to reduce its greenhouse gas emissions by 8% in the period from 1990 to 2012. However, the obligation did not place any significant pressure on the Estonian government and the oil shale industry. The reason for this was that after Estonia gained its independence from the Soviet Union in 1991, the transition to a market economy led to the closing of several inefficient Soviet industries and production facilities and immediately reduced the country's greenhouse gas emissions by more than 50%. In spite of this, the environmental impact of the industry was still huge and environmental organizations started to make demands on the government to significantly increase taxes on air pollution and waste. The pressure eventually led to a slight increase of pollution and waste charges at the end of the 1990s.

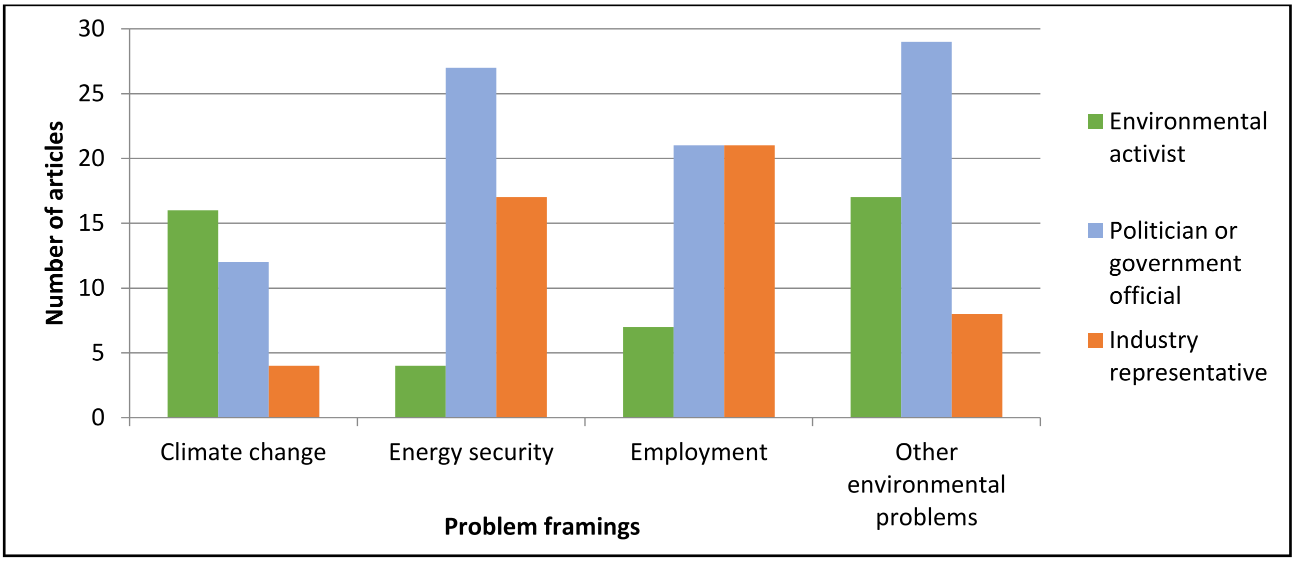

Figure 6. The importance of industry-related problems for different groups of actors from 1995 to 2016. The data was collected by the coding of online news items from Estonian daily newspaper archives (based on the categories A4.2-4, B1.1, C1.1-2 and C1.6 in Appendix A).

Also on the agenda of the government were preparations for joining the European Union. With regard to the oil shale industry, the aim of the government was to achieve exceptions from meeting some of the conditions of the environmental directives of the EU which were necessary for the survival and further development of the industry. As a result of the negotiations, the European Commission agreed to give oil shale a temporary status, thus postponing the implementation of several important EU directives. The special conditions guaranteed by the temporary status included: 1) a prolonged deadline until 2016 for the renovation of the old power plants to meet the air quality standards of the EU; 2) a prolonged deadline until 2013 for the transition to an open electricity market and; 3) financial support for research and development of best available technologies (BATs) for energy and shale oil production.

The unification negotiations with the EU clearly influenced the strategic decisions of the industry. For example, the new-born VKG that was created after the bankruptcy of Kiviter in 1999 immediately shifted its focus on R&D into BATs for oil production as well as diversification into fine chemical products and motor fuels produced from recycled car tires. Meanwhile, the state-owned Eesti Energia was leading the race and had already drawn up a plan by 1997 for partially replacing the old technologies with the new circulating fluidized bed combustion technology. The early investments into renewable energy remained rather small-scale in comparison to oil shale projects. Eesti Energia first experimented with renewables in 1997 when the first industrial 150 kW wind turbine was mounted off the coast of Hiiumaa. Some demand for renewables from "green consumers" is indicated by the fact that Eesti Energia started offering a "green energy" package for domestic households in 2000.

4.2.2. Joining the EU, "gold rush" and incremental innovation (2003–2009)

The actions of the government following the ratification of the Kyoto protocol and joining the EU did not live up to the expectations of climate activists and in 2004 the Ministry of Economic Affairs was presented with an annual "award" by the Estonian Green Movement for endangering the Earth's climate. Meanwhile, however, the Ministry of Environment revived the plan of an ecological tax reform initially proposed by environmental organizations. There were multiple reasons for this development, including the forthcoming unification with the EU and the successful lobby by activists. The reform foresaw the implementation of the "polluter pays" principle which meant that those responsible for pollution would also be held responsible for compensating the environmental damage. In 2005, the comprehensive "Environmental charges law" was adopted that included all the previous taxes and charges in a unified framework. The new law did not bring about any fundamental changes in the general system of the charges that had been in place from the early 1990s. However, the charge rates were significantly increased (figure 7) and fewer exceptions were allowed for the oil shale industry.

For the industry, the ecological tax reform as well as Estonia's unification with the EU led to an urgent need for developing new technologies and building production facilities that would meet the new and stricter environmental standards. Fortunately for the industry, the beginning of the 2000s marked the start of a long period of economic growth due to a fourfold increase in the world crude oil price between 2001 and 2008 which made big investments possible. Environmental innovation was mainly focused on the installation of new environmental management systems based on the ISO 14000 and ISO 14001 standards (2002) and the installation of sulphur treatment equipment for the old production facilities at VKG (2008) and Eesti Energia (2009). Perhaps the most radical technological change though was the opening of the first power plants using the new circulating fluidized bed combustion technology at Eesti Energia in 2004.

However, the biggest investments were made not into energy but oil production. Encouraged by the rocketing oil price, both Eesti Energia and VKG started developing new shale oil technologies (called Enefit and Petroter) that would allow for the full utilization of oil shale and all the by-products. This was achieved with a comprehensive technological process based on the recycling of spent shale as well as the surplus heat and gas which was reused for energy production. The building of the first Petroter oil factory started in 2007 and it was already working by the time the cornerstone was laid for the first Enefit factory in 2009. At the same time, the industry was also looking at ways of diversifying into new product markets, including 1) the large-scale production of fine chemical products (started at VKG in 2006); 2) the plans for developing a cement production technology based on the recycled spent shale and; 3) a new technology for the production of shale-oil-based motor fuels for which VKG received financial support from the government.

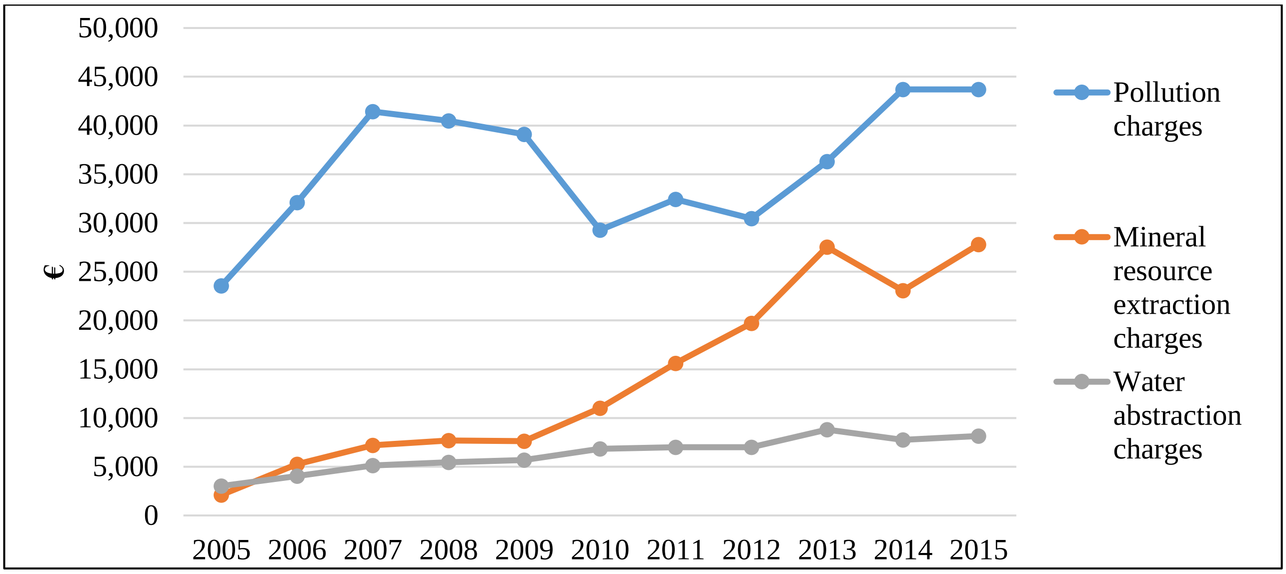

Figure 7. The collection of environmental taxes in Estonia from 2005 to 2015. **Source:** Statistics Estonia.

The huge investments into new oil factories meant that the industry was in need of more resources. This led to a "gold rush" demonstrated by the expansion of mining areas in the early 2000s. As all of the potential mining sites were situated in Ida-Virumaa (figure 8), this trend sparked heavy opposition from environmental organizations and local people who worried about the deterioration of living conditions in the local municipalities and the damage to the natural environment in and around the mining area. On the other hand, both local and national policymakers were mainly concerned with new employment opportunities and energy security. For example, the mayor of Kiviõli claimed that the failure to agree upon a new development plan would lead the whole city into a "social catastrophe" (Postimees, 07.08.2007) while the Minister of Environment added that oil shale is our "national wealth" and a guarantee of our energy independence (Postimees, 10.11.2006). These arguments were supported by the president of Estonia who stated that oil shale is "a matter of our security and independence" and that miners are "the backbone of Ida-Virumaa" (Postimees, 26.08.2007). However, after meeting with the opposition, the government decided to stop issuing mining permits to companies until a national development plan for the utilization of oil shale had been created. The plan was finally agreed upon in 2008 and it prescribed an annual limit of 20 mln tonnes for the extraction of oil shale. The government saw this as a compromise because mining permits for over 23 mln tonnes had already been issued and altogether, permit requests had been made by companies for the extraction of up to 26 mln tonnes of oil shale annually. However, the 20 mln tonnes limit was a significant increase when compared to the previous limit of 15 mln tonnes and the actual extraction capacities which were around 10 mln tonnes in the early 2000s (figure 9). In addition, measures and incentives aimed at the development of more efficient and environmentally friendly technologies that were initially included in the development plan had been removed from the document after

Figure 8. The location of actual (dark brown) and potential (light brown) oil shale resources in Estonia. **Source:** *Eesti põlevkivitööstuse aastaraamat 2014.*

criticism from industry representatives.

The period also marked a significant expansion in the renewables sector as the overall share of renewable energy in final energy consumption increased from 16% in 2006 to over 25% in 2011. However, these statistics are somewhat misleading as the growth of the niche was largely due to the use of wood which was burned in renovated oil shale power plants while the perks of more sustainable resources such as wind and solar energy remained still largely unused. The other developments in the renewable energy niche were rather small-scale, including the establishment of new local combined heat and power stations, the installation of new solar panels and wind turbines by microproducers and the renovation of hydropower stations. The industry invested into some new wind farms near Narva (built on an old ash field) and Aulepa (the biggest one in the Baltics so far) but also into a new waste-to-energy unit at the Iru power station. The development of the renewable energy sector was given some support by the government with the introduction of renewable energy subsidies in 2007 that enabled ongoing projects to be finished and some new projects to be planned. The Ministry of Economic Affairs used exactly the same arguments in support of the renewable energy subsidies that were used for the protection of the oil shale industry, namely that renewables were more efficient, created new jobs and that a decentralized energy system would significantly increase national energy security (Postimees, 06.11.2003).

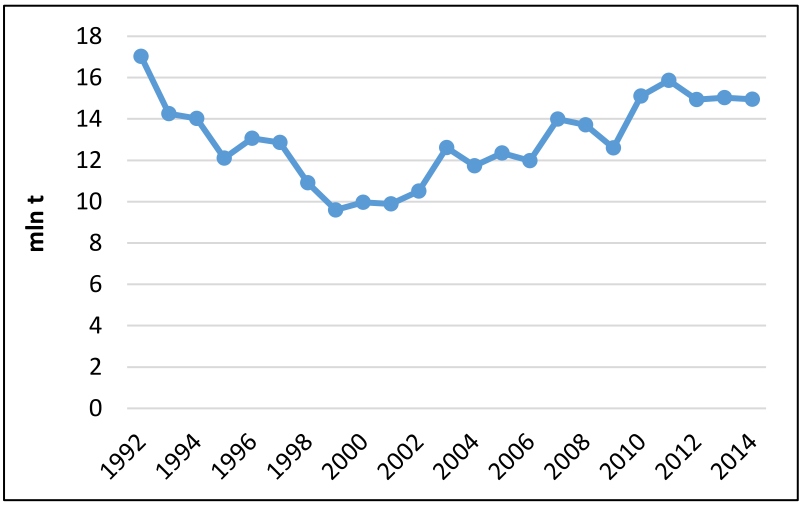

Figure 9. Oil shale extraction in Estonia from 1992 to 2014.
Source: Statistics Estonia.

In 2006, another long-term green energy plan was proposed to the government by environmental organizations which foresaw a transition to a renewables-based and decentralized energy system. In the same year, the Estonian Green Party was established. They won 6% of the seats in the parliamentary election the following year and developed into a strong advocacy organization for climate change. For example, before COP14 in Poznan in 2008, the party delivered a symbolic gesture by giving a small clock to the Estonian Minister of the Environment representing the fact that time for tackling climate change was running out. Public awareness of climate change was also significantly increased as a poll conducted in 2008 found that climate change was considered as the second biggest global environmental threat by Estonian people. In 2009, the government collaborated with the Green Party to implement another rapid twofold increase in environmental charges as part of the ecological tax reform. This plan was greeted with heavy opposition from the oil shale industry who were grappling with the economic difficulties caused by the global financial crisis and the subsequent drop in oil price. For example, the CEO of Eesti Energia claimed that “oil shale provides us with energy security and it would be unwise to place high taxes on the oil shale industry” (Postimees, 12.06.2009). Instead, he argued for a tax reform that would make the charging of taxes from the oil shale industry dependent on the world crude oil price. The contestation to the new policies also involved the Federation of Estonian Chemical Industries (FECI) the criticism of which focused on the loss of up to 4000 jobs in the industry. The dispute resulted in the implementation of lower tax rates than the ones that were initially planned. For example, the pollution charges that were supposed to be increased threefold were only raised by 20%. At the same time, the government was again trying to negotiate exceptions from the EU directives for the oil shale industry. The specific demands were that the oil shale industry should continue to get free carbon credits (emission allowances) under the emissions trading system which had previously allowed Estonian oil shale companies to raise extra funds by selling their surplus credits. The surplus of carbon credits was due to the fact that the base year for the reduction of carbon emissions was 1990 when Estonia was still part of the Soviet Union and thus had very high carbon emission rates. In an interview before an EU climate and energy framework meeting in Brussels, the Minister of Economic Affairs of Estonia said that "oil shale is a gift from the God", "the CO_2 emissions of the oil shale industry have no impact on the melting of ice on the North Pole" and that "no one can force us to give up oil shale [because] there are no alternatives and it is a matter of national security" (Postimees, 28.02.2008).

4.2.3. State investments into oil shale and industry prosperity (2010–2013)

After the failure to reach a much-anticipated global agreement on climate change at COP15 in Copenhagen in 2009, the public attention to the issue faded for a while. However, the government was still under fire at the beginning of 2010s for the decisions that had been made concerning the state-owned Eesti Energia, including massive state investments into the renovation of old energy blocks and the building of new oil factories as well as limiting renewable energy subsidies which put the construction of new wind farms on hold. Furthermore, heated debate resulted from the government's new plan of building two new 300 MW oil shale power plants near the village of Auvere in Ida-Virumaa. These plants were supposed to be based on the circulating fluidized bed combustion technology which was also used in the renovated energy blocks at old power plants and allowed for the utilization of up to 50% of biomass in energy production. The leaders of several environmental organizations signed an open letter to the Minister in which they expressed concerns over the growing environmental impact of the oil shale industry and accused him of working against the EU energy and climate policy. Despite heavy criticism, the government decided to start building the first 300 MW power plant in 2012. The 638 mln € facility which represented the biggest state investment ever into the Estonian economy was partly financed by free carbon credits requested from the EU that absolved the oil shale industry from the obligation of paying carbon emission charges.

The decision was seen by many to go against the national development plans as well as the strategy of Eesti Energia which aimed at a more efficient use of oil shale by focusing on oil production instead of energy. For example, the CEO of Eesti Energia said that the construction of the Auvere power plant "was a political decision with the goal of increasing energy security but economically it was not a reasonable solution" (BNS, 27.10.2014)[3]. The Minister of Economic Affairs agreed that the argument of energy security was "absolutely important" in making the decision which was heavily opposed by the Social Democratic Party who compared it to "playing Russian roulette", pointing out that it was based on inadequate economic calculations (Delfi, 17.10.2012). They also claimed that the argument of energy security amounts to nothing more than raising unaccounted fear towards Russia and that the building of new oil shale power plants "does not increase our energy security in any way" (Delfi, 28.10.2012). Instead, they suggested that real energy security

[3] In 2014, the economic aspects indeed proved to be decisive as Eesti Energia opted against the construction of the second 300 MW power plant that was also initially planned in Auvere.

for Estonia lies in a decentralized energy system with good overseas connections.

After the shock of 2009, the world oil price rocketed again in 2010 and 2011 which brought substantial profits for the industry and allowed for some additional investments. While Eesti Energia started building the Auvere power plant, VKG put lots of effort into the full utilization of oil shale and the recycling of by-products and residues. For example, a new lime factory was established in 2013 which used several by-products of the industry as an input in the lime production process and the lime was used in turn in sulphur treatment equipment. In addition, the residues of the mining process were used in road construction and the possibilities of biofuel production were explored. At Eesti Energia, new nitrogen capture systems were installed on old power plants and the installation of sulphur treatment equipment also continued. Apart from that, however, most of the projects for reducing the environmental impact of the industry were finished by 2011. Among these was the reconstruction of the oil container park as well as the closing of contagious landfills at VKG. In spite of that, the carbon and sulphur emission rates at VKG still increased as a result of the opening of the new Petroter oil factory.

At the same time, uncertainty prevailed in the renewables sector. Several projects were put on hold as the previously introduced subsidies were cut and the government could not agree on new legislation. This was also evident in the share of renewable energy in final energy consumption which rose by almost 10% between 2006 and 2011 but has not increased since then. Some rather small-scale developments included the establishment of new wind farms in Paldiski (40 MW) and Ojaküla (7MW) by the private company Nelja Energia as well as an increase in the installation rate of solar panels by domestic households. In 2011, the most important renewable energy entrepreneurs and associations united and formed the Estonian Renewable Energy Council which quickly assumed the role of a vocal advocacy group. Soon after, a heated discussion emerged over the decision by Eesti Energia to use woodchips for energy production in the renovated energy blocks which enabled up to 50% use of biofuels. While Eesti Energia tried to frame the decision as beneficial for the environment, the Renewable Energy Council argued that “not every use of renewables is environmentally friendly” and that burning woodchips for energy production is an extremely inefficient option (Delfi, 13.07.2011). The use of woodchips was stopped in 2012 after ongoing confusion over renewable energy subsidies. In the same year, the Renewable Energy Council came forward with a new plan called Renewable Energy 100% which again proposed a transition to a renewables-based energy system and included detailed analysis and steps for the transition to be achieved by 2030. The proposals were greeted by the chairman of the Estonian Green Party who said that “everything is ready for a shift to renewable energy” (Delfi, 29.08.2012).

4.2.4. Pressure alignment: oil price crisis and the Paris agreement (2014–2016)

In late 2014, the industry was hit by several simultaneous pressures which put it in a very difficult situation. First, there was an abrupt drop in the world crude oil price which eventually fell over twofold between 2014 and 2016. This caused serious economic difficulties for the industry as energy production in the facilities based on old technologies became economically infeasible.

Secondly, the government started planning an annual rise of environmental charges by 20% which was met by an unprecedented contestation from FECI. It launched a massive campaign called “Our welfare lies in our natural resources!” the message of which was that the tax raises would lead to the bankruptcy of the whole industry (figure 10). As a result, 24 000 people in Ida-Virumaa would become unemployed, annual tax revenue in the amount of 250 mln € would be lost and Estonia would lose its energy security and independence. The chairman of FECI said that there were no alternatives to fossil fuels and that “stories about wood and wind as the basis of our energy system belong to the fairy tale genre" (Delfi, 20.07.2014). The Ministry of Environment, the Renewable Energy Council and the Council of Environmental NGOs accused the federation of spreading false information and manipulating with public opinion, with the latter presenting the annual "award" for the most environmentally harmful deed to FECI. A counter-campaign was also launched by the Estonian Green Movement and the Renewable Energy Council with the aim to renegotiate the meaning of "energy security" (figure 11). The organizers of the campaign stressed that the import of fossil fuels is unreasonably expensive for EU states and it supports the flourishing of undemocratic regimes.

Figure 10. Poster from the campaign "Our welfare lies in our natural resources!" ("How is it possible that Estonia is renouncing its energy security?"). **Source:** http://maavara.ee/.

At the end of 2014, the Ministry of Environment surrendered to the lobby of FECI by announcing an annual rise in tax rates by 3-6% for the next ten years instead of the initially planned 20%. However, the industry was still struggling with economic problems caused by the falling world crude oil price and in late 2014, several hundred people in Kohtla-Järve became unemployed as VKG temporarily closed the old oil factories that were using the economically inefficient Kiviter technology. The unemployment shock caused panic in the government and a plan was made immediately for a tax reform proposed by the industry that would make the oil shale extraction charges depend on the fluctuations of oil price as well as for raising mining limits so that the company could extract more resources from its own mine instead of buying it from the mines of Eesti Energia. In the summer of 2015, the government implemented legislation that allowed the oil shale industry to use up all of the mining capacities that had been previously left unused from the limit of 20 mln tonnes since 2009. This meant that, for example, if the industry extracted only 15 mln tonnes of oil shale in 2010, it could now use up the 5 mln tonnes that was left unused that year. The decision was heavily criticized by the Estonian Green Party who called it "a crime against the ecosystem" and by the Council of Environmental NGOs who said that mining capacities should be decisively reduced instead (Postimees, 08.06.2015). However, the change of legislation worked for the industry as the closed factories were re-opened and people were re-hired. Months later, the construction of a third new oil factory based on the Petroter technology was finished and oil production began there too.

Figure 11. Poster from the campaign "Energy security? – Yes! With renewable energy we will be independent!". **Source:** https://www.facebook.com/eestiroheline liikumine/.

The oil price continued to fall though and in early 2016, VKG again had to lay off 500 employees, announcing that in these economic conditions, the company "could survive for no more than 24 months". The economic downturn also brought difficulties for Eesti Energia who were forced to make about 250 miners redundant. Demands were made by the industry for a temporary reduction of all environmental charges and once again the government reacted quickly by decreasing most of the tax rates on the industry to the level of 2009 until the end of 2017. The decision saved 43 mln € for the sector but was heavily criticized by the Minister of Environment who pointed out that the loss of tax revenue would mean heavy cuts for the government's budget for future investments into environmental projects. Moreover, the Renewable Energy Council claimed that the "favouring of oil shale production has become a norm in Estonia that the lawmakers are not willing to change even in a drastically changed economic situation" (Delfi, 18.03.2016). FECI responded that the state "needs to develop further that which has been accomplished and not destroy it" and advised the environmental organizations "not to bite the hand that feeds", referring to the fact that environmental NGOs are partly financed with the tax money collected from the oil shale industry (Postimees, 19.04.2016). As a result of the tax reduction, VKG re-hired 350 people as production continued again in the old Kiviter factories.

While the government was making concessions to the oil shale industry, climate activists were calling for a radical reform of Estonia's energy system and the oil shale sector. In the wake of COP21 in Paris, climate change featured heavily in the media again and a first-ever public demonstration demanding action against climate change was organized in the capital city of Tallinn. At the same time, the government had begun working on several new development plans. The first of them was a comprehensive national strategy on climate change called "The Basis of Climate Policy until 2050" the main objective of which was an 80% reduction in greenhouse gas emission rates by 2050 compared to 1990. This goal was to be achieved mainly by exporting oil and the emissions resulting from oil shale utilization. The document was criticized by environmental activists who stated that "climate change is a global problem and therefore attention should be paid to emissions resulting from the products made in Estonia regardless of whether these products are consumed here or exported" (Delfi, 16.08.2016). As the Paris agreement was successfully signed in late 2015, the prevailing opinion among activists was that the success of the Paris meeting meant "game over" for the oil shale industry (Delfi, 06.12.2015). However, in the same week, the Estonian parliament was also discussing a new national development plan for the utilization of oil shale. According to the new plan, the mining limit would remain at 20 mln tonnes for the next 15 years and two new mines would be opened during that period. In addition, the implementation programme for the new development plan foresaw government investments of 5,7 mln € into new oil shale technologies. The Minister of Environment acknowledged that while Estonia would eventually need to stop relying on oil shale, there was no chance of that happening in the next 15 years. Soon after, a new national development plan for the energy economy was also agreed upon which set a goal of a 50% share of renewables in domestic electricity consumption by 2030. This aim was described as "moderate", "unambitious" and "visionless" by energy experts (Müürileht, 30.01.2017).

5. Analysis and discussion

We start from comparing the expected pattern of DILC to the events observed in the case (see table 1 for a summary). We find that the model seems to perform fairly well - but for particular groups only. In the case of activists there is evidence of increasing public visibility of the climate change agenda, public concern about the unsustainability of oil shale energy and increasing organization on both national and local levels (e.g. establishing the Green Party, signing local petitions, arranging public protests). In the case of consumers one can observe early demand from "green consumers", the gradually increasing share of renewables and the emergence of a consumer organization (the Estonian Renewable Energy Council). Minor deviations in the third phase can be attributed to the decreased visibility of climate change agenda, reflected in local legislative confusion and stagnation in the renewables sector. On the other hand, the expected actions from the policy-makers (introduction of substantive legislation) and industry actors (large-scale diversification and investment into radical alternatives) deviate considerably from the DILC model. Instead, the industry was heavily investing into new oil shale power plants and mines in the third period and implementing fairly incremental technological improvements such as end-of-pipe solutions. This process was considerably supported by local policy-makers through various means (e.g. adopting plans to continue investments into oil shale energy and requesting free carbon credits from the EU to finance these investments).

This finding can be partially explained by reference to simultaneous changes in international economic and socio-political environments. During the first two periods (1995-2009) the climate change agenda gradually was intensifying and the world crude oil price steadily increasing: these counter-acting forces, one implying substantial change and another a continuation of the existing path, led to mixed responses by both the industry actors and the policy-makers on national and regional levels. Hence, on one hand industry actors continued investments into the existing regime while also experimenting with renewable energy packages for "green consumers". Policy-makers, on the other hand, attempted to cater to the expectations of the local energy industry while also dealing with emerging pressures towards sustainability. This resulted in a paradoxical situation in which Estonia was implementing gradual ecological reforms to conform to the regulations of the European Union while simultaneously negotiating exceptions for the oil shale industry from that very union.

Table 1. Environmental pressures and the destabilization of Estonian oil shale industry: expected vs. observed patterns. Green cells designate a match with the expected DILC pattern (see figure 1) whereas red cells mark deviations.

Period	Activists and social movements	Policymakers	Consumers and suppliers	Industry	Broad indicators of economic and socio-political pressures
1995-2002	Environmental organizations demand higher charges on the industry	UNFCCC members agree on Kyoto protocol	Eesti Energia introduces domestic renewable energy package for „green consumers“	Kiviter goes bankrupt and is recreated as VKG	**Economic:** 1st half: Russian financial crisis and loss in shale oil export revenue; 2nd half: gradual increase in world crude oil price
	Environmental organizations propose an alternative energy plan until 2050	Estonia starts unification negotiations with EU and achieves a temporary status for the oil shale industry		Eesti Energia mounts first industrial wind turbine	**Socio-political:** emergence and gradual increase of the climate change agenda
2003-2009	Environmental organizations „award“ government for lack of action against climate change	Ecological tax reform implemented	Share of renewables in final energy consumption increases to 25%	Rise in environmental tax rates opposed by the Federation of Estonian Chemical Industries	**Economic:** threefold increase in world crude oil price
	Environmental organizations propose a green energy plan until 2020	Estonia joins the EU and requests free carbon credits		Installation of end-of-pipe technologies such as sulphur and nitrogen treatment equipment	
	Estonian Green Party established	Government decides to support the building of a new 600MW oil shale power plant at Auvere		Eesti Energia and VKG start building new oil factories based on Enefit and Petroter technologies	**Socio-political:** more than twofold increase in the presence of the climate change agenda in the media
				Eesti Energia starts building the biggest wind farm in the Baltics and a new waste-to-energy unit at Iru power plant	

2010-2013	Environmental organizations „award“ Minister of Economics two years in a row for endangering climate	EU adopts Industrial Emissions Directive aimed at the implementation of best available technologies	Estonian Renewable Energy Council established	Eesti Energia starts building the new 300MW oil shale power plant at Auvere	**Economic:** after a brief drop during the global financial crisis the world crude oil price rises to a new high
	Local people sign a petition to EU over severe air pollution at Kiviõli Chemical Plant	Free carbon credits requested from the EU and used for investment into new oil shale projects		Two new Enefit and Petroter oil factories opened, building of two more starts	
		Free carbon credits requested from the EU and used for investment into new oil shale projects		First new oil shale mine in 40 years opened at Ojamaa	**Socio-political:** decreasing visibility of climate change agenda
	Environmental organizations present the Renewable Energy 100% Plan	Legislative confusion in the renewable energy sector puts several projects on hold		Additional sulphur and nitrogen capture systems installed	
2014-…	Environmental organizations predict „game over“ for oil shale industry after COP21	UNFCCC members adopt Paris agreement on climate change at COP21	Cost-competitiveness of renewable energy at global all-time high	Rise in environmental tax rates opposed by the Federation of Estonian Chemical Industries	**Economic:** twofold drop in world crude oil price
	Environmental organizations „award“ the Federation of Estonian Chemical Industries and government two years in a row for damaging the environment	The Basis of Climate Policy until 2050 adopted		Eesti Energia and VKG stop work at old oil factories and lay off several hundred employees	
		New national development plan foresees 5,7 mln € investments into oil shale industry		Eesti Energia and VKG re-hire employees after tax reductions and extra mining permits	**Socio-political:** renewed presence of the climate change agenda
		Environmental tax rates on the oil shale industry temporarily reduced and extra free mining permits granted for oil shale industry			

The situation changed markedly during the third period (2010-2013) when the temporary setback of the climate change agenda, combined with another rise in crude oil price, resulted in the dominance of immediate economic considerations. This led to an increased investment activity by the industry supported by regional and national-level policy-makers. The deviations from the model continued in the fourth period (2014-…) with the occurrence of another reversal of fortune, this time favouring the climate change agenda. Here the paradoxical behaviour of the policymakers became even more apparent: for example, both the Paris accord on climate change and a new oil shale development plan were agreed on during the very same week at the end of 2015, with the Prime Minister of Estonia publicly stating that the objectives of the two strategies were entirely compatible. In other words, the policymakers have pursued "hedging the bets" strategy throughout the whole observation period.

Overall, we find empirical support for DILC as a dis-embedding mechanism but with an important qualification: when exogenous signals are ambiguous or contradictory (environmental vs. economic pressures) local responses (policymaking, industrial activities) will be similarly mixed, thereby distorting the ideal-typical progression of the model.

Our findings also demonstrate the existence of different forms of embeddedness, operating on multiple scales (summarized in table 2). Furthermore, we find strong support for the claim that regional and national embeddedness serve as a stabilizing force for the industry. This is well evidenced by the fact that throughout the observation period the problem agendas of the industry and the policymakers were much more similar to each other than to the one advocated by activists and the same key points figured prominently in the arguments of both sides (see figure 6). The regional and national embeddedness of the industry enabled it to ignore certain issues (e.g. the multiple alternative energy plans by environmental organizations during the first two phases) and even expand production despite increasing contestation from activists (e.g. new plants and mines in the third phase). This process continued even in the context of increasing socio-political pressure ob international and national levels (e.g. the provision of favourable *ad-hoc* regulations by the government such as tax cuts to the industry-in-decline during the fourth phase). This is in line with Geels's (2014b) suggestion that local policy-industry alliances (network embeddedness) are one of the key factors in shaping industry destabilization pressures.

Table 2. Socio-spatial embeddedness of Estonian oil shale industry on different scales.

Type of embeddedness	Geographical scale		
	Regional	National	International
Territorial	Location of oil shale fields and power plants and oil factories in Ida-Virumaa		
	Local technological specialization and industry lock-in		
Societal	Cultural meaning of oil shale as 1) national wealth enabling international technology export, 2) guarantee of energy security and independence, 3) vital "backbone" of the local economy to avoid social catastrophe in Ida-Virumaa		
Network	Defensive reaction by the mayor of Kiviõli for the local chemical plant against the national government after plans of limiting mining permits or	Strategic investments of state-owned Eesti Energia controlled by Minister of Economics	Position of the industry in global value chains and production networks makes it sensitive to the fluctuations of the world crude oil price

	increasing taxes (2003, 2007, 2011)	Reactive policy support for firms-in-industry due to economic downfalls and industry lobbying (2009, 2014-2015)	National climate and energy policies strongly influenced by multi-level governance (EU and UN)

An important implication of our multi-scalar analysis is that environmental pressures do not translate automatically into local responses as the disembedding and (re-)embedding mechanisms might cancel each other out in a specific locality. This, in turn, leads to a misalignment of scales where the presence of international pressures is not fully matched by local responses. In the case at hand, the anticipated regional and national spill-over effects of global destabilization often overrode broader concerns for sustainability. For example, the historical legacy of the Narva crisis has conditioned the sensitivity of policy-makers towards the issue of regional unemployment. This became especially manifest in the fourth phase where Eesti Energia and VKG initially laid off several hundred employees yet immediately started rehiring once the policy-makers had temporarily alleviated environmental taxes and granted new mining permits. The need for policy-makers to find a balance between regional, national and international pressures has resulted in a situation in which the international climate change agenda shows a long-term trend towards increased visibility yet the Estonian oil shale industry, capitalizing on its regional and national embeddedness, has remained relatively durable. Another way to put this is to say that national and regional scales have largely managed to "filter out" the destabilizing impact of international pressures.

6. Conclusion and policy implications

This study combined the Dialectic Issue LifeCycle model and the geography of transitions literature. Based on the study of the Estonian oil shale industry between 1995-2016 it explored the following research questions: 1) what are the main forms of socio-spatial embeddedness of industries on different geographical scales? 2) how do global pressures interact with local embeddedness and what is the result of this interaction for industry destabilization? The main findings were as follows:

1. Actors in a given locality are simultaneously embedded on multiple scales and in different ways with territorial embeddedness operating on the regional scale, societal embeddedness extending to the national scale and network embeddedness being present on all three scales;
2. The DILC model performs fairly well in describing the increasing pressure by activists and consumers but fails to capture the activities of policy-makers and industry incumbents which lag more than expected. Moreover, the policymakers were employing a "hedging the bets" strategy throughout the observation period, addressing both the climate change issue as well as investing into oil shale. This contradicts the DILC model which expects the policy-makers to exert increasing pressure on the industry regime;
3. The realization of the DILC model as a disembedding mechanism depends on the balance between socio-political and economic environmental pressures. The process proceeds slowly towards destabilization in the presence of both pressures but intensifies in either direction when one of the pressures gains an upper hand;
4. National and regional embeddedness, especially the policy-industry interlock based on mutual societal background and territorial ties, serves as a powerful mechanism of industry (re-)stabilization enabling the incumbents to ignore challenges early on, increase activities during favourable economic conditions and ask for policy support during very difficult times;
5. Hence in contrast to what the DILC model implies, there is no straightforward transmission of international pressures on local industries as the socio-spatial embeddedness of industries on national and regional scales can largely "filter out" the destabilizing impact of

international pressures. This leads to a misalignment of scales where the existence of pressures on international scale is not necessarily matched by local responses.

Our findings have three broader implications for transitions studies. First, existing literature on industry regimes and transitions has largely focused on the role of environmental pressures in destabilizing the industry or an incumbent socio-technical regime. Our findings suggest that this view is incomplete: in order for industrial transformation (or transition) to occur the industry (or the socio-technical regime) also needs to be disembedded from its spatial context. Policy measures should thus target the territorial, societal and network embeddedness of industries and regimes. In the Estonian context activists have attempted to turn attention to the suitability of the North-Eastern industrial region for wind energy (territorial embeddedness) and to reinterpret the meaning of energy security, connecting it to dispersed energy production based on renewables (societal embeddedness); recent policy battles whether politicians should continue to be members of the boards of state-owned enterprises (such as Eesti Energia) can be seen as attempts to address the policy-industry interlock (network embeddedness). These examples show that local actors are constantly trying to reshape the territorial, societal and network ties between the industry and its environment.

Second, the study suggests that the design of “policy mixes” to facilitate transitions should go beyond the coupling of niche stimulation with regime destabilization (Kivimaa and Kern, 2016; Rogge and Reichardt, 2016). An important but overlooked dimension concerns addressing the spill-over effects of regime destabilization, reflected in the prevalence of concerns about energy security and regional unemployment issues in the Estonian case throughout the whole observation period. We suggest that attending to these issues, resulting from the socio-spatial embeddedness of industries, might necessitate a gradual phase-out strategy rather than the “shock therapy” of technological substitution (Geels and Schot, 2007) as the former enables a proactive management of the spill-over effects of regime destabilization.

Lastly, and in conjunction with the second point, the various ways that industries are embedded on regional, national and international levels and the resulting mismatch of scales indicates that different policy mixes are needed on different scales. Although it is easy for policymakers and incumbent industries to see the obstacles for implementing internationally agreed-upon policies on the regional level, we encourage them to pay more attention to the possibilities for regional reorientation (Boschma, 2017; Boschma et al., 2017; Steen and Weaver, 2017) and path renewal (Coenen et al., 2015; Hansen et al., 2017; Steen, 2016) based on the specific regional energy contexts (Lutz et al., 2017) and on the technical knowledge and capabilities of local actors (Hansen and Coenen, 2017).

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Appendix A. Coding manual for the content analysis of newspaper articles.

1. Overall parameters of the text

A0 Number
A1 Date
A2 Publisher
A3 Headline
A4 Whose views are mainly represented in the article?

- 1 Journalist
- 2 Environmental activist
- 3 Politician or government official
- 4 Industry representative
- 5 Renewable energy entrepreneur
- 6 Scientist
- 7 Other

2. Manifestations of evidence on industry destabilization

B1 Activism and issue framing

- 1 Climate change is mentioned as an issue
- 2 An organization or movement concerned with climate change is mentioned
- 3 Public opinion towards climate change is mentioned
- 4 New climate policies are advocated
- 5 Other

6 None of the above are mentioned

B2 Politics and policy
1 The creation of an informal committee concerned with climate change is mentioned
2 Formal hearings in the parliament about climate change are mentioned
3 New climate policies are mentioned
4 Changes in economic frame conditions are mentioned
5 Other
6 None of the above are mentioned

B3 Supply and demand
1 Rising renewable energy demand is mentioned
2 A renewable energy market niche is mentioned
3 Changes in mainstream preferences of energy use are mentioned
4 Other
5 None of the above are mentioned

B4 Industry strategies
1 Climate change is denied
2 The seriousness of climate change is downplayed
3 A closed industry front is mentioned
4 The claims of climate activists are contested
5 An incremental technological solution by a firm in the oil shale industry is mentioned
6 Renewable energy technologies are portrayed as unfeasible
7 Investment into renewable energy by a firm in the oil shale industry is mentioned
8 New climate policies are opposed
9 Diversification by a firm in the oil shale industry into new product markets is mentioned
10 Substantial technological or regulative changes by a firm in the oil shale industry are mentioned
11 Substantial changes in the mission or identity of a firm in the oil shale industry are mentioned
12 The bankruptcy of a firm in the oil shale industry is mentioned
13 Other
14 None of the above are mentioned

3. Manifestations of evidence on socio-spatial embeddedness

C1 Alternative issue framings
1 Energy security
2 Employment
3 Low oil price
4 Tax revenue from the oil shale industry
5 Oil shale as the national wealth
6 Environmental damage (other than climate change)
7 Hidden subsidies for the oil shale industry
8 Decreasing oil shale reserves
9 Inefficiency of oil shale as an energy source
10 Natural habitats of the flying squirrel

C2 Alternative energy policies proposed and /or implemented
1 Decentralisation of energy production
2 Limiting the oil shale mining capacity
3 Renewable energy subsidies
4 Privatisation of energy companies
5 Temporary status for oil shale industry by the EU
6 Temporary reduction of environmental taxes for the oil shale industry
7 Taxing based on the world crude oil price

C3 Alternative energy sources proposed
1 Nuclear
2 Wind
3 Solar
4 Woodchips

5 Other biofuels (including waste)
6 Renewable energy sources in general
7 All alternatives depicted as infeasible

C4 Alternative industry strategies
1 Opening a new oil shale mine
2 Establishing a new power plant
3 Establishing a new oil factory
4 Cutting costs by laying off employees

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