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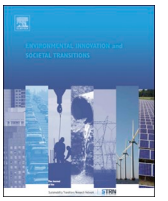

Original research paper

Temporal echoes and cross-geography policy effects: Multiple levels of transition governance and the electric vehicle breakthrough

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ABSTRACT

This article analyses the Norwegian electric vehicle transition from a socio-technical perspective, shedding light on the emergence of one of the most important EV markets globally. The Norwegian strategy to promote this transition is often understood as a set of targeted policies to create EV demand. Here, we illustrate how visions and incentives for a Norwegian EV transition have emerged over a period of 40 years, highlighting how many of the incentives were actually introduced as mechanisms to stimulate the creation of a Norwegian EV industry niche. Conceptually, we contribute to understandings of the complex geographies of niche creation through discussions of how local policies can have trans-local and global effects. Further, we identify dynamics we describe as temporal echoes, which illustrate how visions, strategies or policies introduced at a specific point in time to serve a particular purpose might unexpectedly re-appear later, transformed, to serve different purposes.

1. Introduction

Decarbonizing transport is a key societal challenge in the quest for CO_2 emission reductions. Many see the mass adoption of electric vehicles (EVs) as one of the cornerstones in the work to destabilize automobility regimes based on fossil fuels (e.g. Sovacool and Axsen, 2018). While the first EV models appeared as early as the late nineteenth century, the petrol vehicle has remained dominant thanks to its entrenchment in automobility regimes made up of actors, materials, technologies, practices and policies that reinforce individual- and fossil fuel-based mobility (Urry, 2004), in what has arguably become a path dependant trajectory (e.g. Schwanen, 2018). However, during past years, the production, proliferation and use of EVs have posed challenges to the practices, technologies and economies of fossil fuel-dominated auto mobility regimes, particularly in countries with aggressive EV policies such as Norway (Ryghaug and Toftaker, 2016; Kester et al., 2018).

The aims of this article are twofold. Empirically, we analyse the Norwegian EV transition from a socio-technical perspective, shedding light on the emergence of a key EV market. At its core, our perspective is relational, which means that we are interested in how actors, technologies and strategies co-produce the conditions for transition through interaction (e.g. Chilvers et al., 2018; Skjølsvold et al., 2018). More specifically, our interest lies in how such interaction might transgress geographical and temporal scales. Conceptually, we contribute to transition studies' understanding of how policies and strategies, implemented for different purposes and in different geographical locations, can come to interact and create favourable conditions for niche technology development. Further, we are interested in the temporal dynamics of transition, and of policy effects. Based on the observation that policies,

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strategies and ideas can have unintended effects subsequent to the time of their initial formulation, we propose the concept of 'temporal echo' as a means to describe and understand these dynamics that bring about deferment.

According to their literal meaning, echoes are sounds that bounce off a surface, and in so doing re-appear to the listener in new forms at subsequent points in time, following the initial sound production. The transformation occurs in the encounter between the sound and a surface, which means that the character of the echo depends both on the original sound and on the 'behaviour' of the surface. The notion of a temporal echo in our account describes a situation where a policy, strategy or idea is formulated at one point in time, but where some of its effects only become visible much later, as that policy, strategy or idea becomes part of new relations with entrepreneurs, new technologies, organisations and other actors. By entering into such relations, the policies, strategies and ideas might also be transformed. Much like a sound bouncing off a wall, the temporal echo is also different: in our case, policies originally intended to stimulate industrial development become policies to stimulate EV demand.

To analyse such spatial and temporal dimensions of transitions, we focus broadly on the socio-technical characteristics of the Norwegian EV transition. This sets our study apart from earlier analyses of Norwegian EV development, which have focused on individual customer decision-making (Klöckner, 2014), user practices (Ryghaug and Toftaker, 2016; Ingeborgrud and Ryghaug, 2017), policy instruments (Bjerkan et al., 2016) and economic incentives (Mersky et al., 2016). Through the comprehensive analysis carried out here, we are both able to paint a rich empirical picture of the Norwegian EV transition, and provide new conceptual insights into transition processes more broadly.

The Norwegian EV strategy is most often understood as a set of targeted climate policies driven by national financial and regulatory incentives to create EV demand. While such policy instruments (taxes, subsidies, economic exemptions) are important elements in our account, we will argue that they only emerge as a coordinated set of strategies to increase EV demand in retrospect. In this paper, we emphasise how these policies have often been formulated with very different goals in mind, and how the government strategy of increasing EV demand has co-evolved with, and sometimes been produced by, the work and strategies of many different actors. When observed as a longitudinal process, it becomes clear that landscape changes such as the OPEC oil crisis in the 1970s and policy changes in California have been important elements in furthering EV use in Norway.

Our analysis show that the Norwegian EV policies were initially meant to instigate a new national EV industry. As instances of niche creation and protection, these efforts were quite successful in a national context. However, as Norwegian niche EV industry actors entered international automobility regimes, they were exposed to pressures and expectations from within these regimes from which they had previously been shielded. By tracing and examining the unfolding of this story, we make three conceptual contributions to the transitions literature:

a) We illustrate the complex geographies of actor-networks, and how unexpected links and strategies formulated in various places might work in a concerted manner to create favourable niche conditions.
b) We illustrate the complexities involved in measuring policy success, and the importance of broad system boundaries when evaluating where and how policies have effect. The analysis made in this paper allows us to address both spatial and temporal boundaries.
c) We introduce the concept of 'temporal echo', which illustrates how policies, strategies and ideas produced or introduced at one point in history, deigned to serve one purpose, might unexpectedly re-appear later in a transformed way, or to serve different purposes.

The remainder of this paper is structured as follows. We begin with a brief note on the contemporary status of electro mobility in Norway, as a way to introduce the context of the study. We proceed by introducing our analytical perspective, which is rooted in multilevel perspective (MLP) (Geels, 2002), but with a distinct focus on the spatial aspects of transitions (Geels and Raven, 2006; Sengers and Raven, 2015), and on the role of policies and policy mixes in transitions (Kivimaa and Kern, 2016). We then proceed with our analysis of the Norwegian EV transition, before concluding with an account of the practical and theoretical implications of our study.

2. Electric mobility in Norway

Electric vehicles (EVs) have been visible on Norwegian roads since around 1990, but it is not until in recent years that they have become a mainstream part of Norwegian mobility culture (Ryghaug and Skjølsvold, 2019). In the subsequent empirical analysis carried out in this article, we look at the relationship between policy implementation and market uptake, and argue that modern Norwegian EV policies can be understood as a two-phase development where the first period (1990–2009) was a technology niche creation phase. Here, the political goal was primarily to nurture a Norwegian EV industry, and to create a domestic market for this industry. In the second period (2009-present), EV policies were legitimised through the pursuit of climate goals and designed to create a market for EVs, regardless of their origin. This division echoes previous historical accounts that make the distinction between five phases of EV development in Norway: 1) concept development (1970–1990), 2) testing (1990–1999), 3) early market (1999–2009), 4) market introduction (2009–2012), and 5) market expansion (2013-present) (Figenbaum and Kolbeinstvedt 2013).

When discussing the current Norwegian development as a socio-technical transition, the year 2010 serves as a pragmatic starting point. While some have labelled 1999–2009 an early market phase, there were still relatively few EVs on Norwegian roads, mainly in the larger cities (Asphjell et al., 2013). From this point on, the Norwegian EV fleet steadily grew, from the 3360 battery electric vehicles in circulation that year (see Fig. 1) to close to twice that number of new EVs registered on a monthly basis eight years later

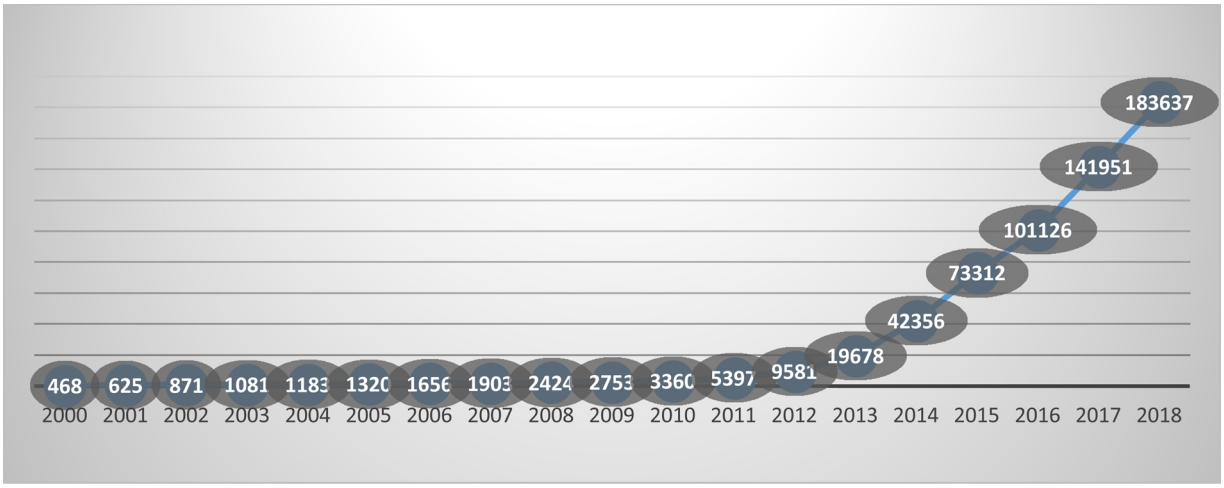

Fig. 1. Number of registered EVs in Norway. Adapted from Asphjell et al., 2013 p. 278 and https://elbil.no/elbilstatistikk/elbilbestand/.

(6418 in November 2018), pushing the total number of EVs in Norway above 180,000 (Elbilforeningen, 2018).[1] In terms of market shares for new vehicles, battery electric vehicles and plug-in hybrids amounted to 20.8% and 18.4% respectively in 2017 (IEA 2018, p. 114–115). When comparing these developments to those of other countries and regions, both China and the USA register more new EVs annually than Norway in absolute numbers (IEA 2018, p. 113), but total market penetration of EVs in these countries is 0.6% (USA) and 1.8% (China) (IEA 2018, p. 114). In the USA, California stands out, with approximately 50% of all US EVs being registered in this state. In 2017, 55,500 EVs were registered in California, amounting to a market share of 2.6%, while 45,040 plug-in hybrids amounted to a market share of 2.2% in a market where more than 2 million new vehicles have been registered every year for the last four years (California Auto Outlook, 2018). If we compare Norway to other European countries, recent statistics paint a similar picture. In the third quarter of 2018, 16,249 new EVs and plug-in hybrids were registered in Norway, compared to 14,399 petrol and diesel vehicles (ACEA, 2018). In absolute numbers these figures were matched only by one other European country, Germany, where 16,265 new EVs and plug-in hybrids were registered. This, however, is a relatively small share of the German market, where 786,917 new petrol and diesel cars were registered during the same period (ACEA, 2018).[2]

In this way, Norway stands out both in Europe and globally as a site where EV-sales numbers are large both in absolute terms and in terms of new vehicle market shares. A few years ago, the greater Oslo region was clearly the engine of this transition. Today, it is still the county with the largest EV market penetration (41.8% in 2018). However, municipalities in Western Norway follow closely behind (Hordaland: 40.6%, Rogaland: 37%), while Middle Norway ranks slightly below (Trøndelag: 30.6%). Of 18 Norwegian counties, only the two most northern currently have a market share of less than 20% (Troms: 16.1%, Finnmark: 6.7%) (Elbilforeningen 2018). This means that while there are still some geographical differences, the EV transition is a national, and increasingly rural phenomenon (Ydersbond, 2018). One plausible explanation is that the experiences of early adopters in Norway, with its vast distances, served to indicate that range was less of a problem than many potential EV users feared (Ryghaug and Toftaker, 2014). Recent case studies have also illustrated how the EV transition is increasingly a transition that spans across socio-economic groups: there are, for example, long wait lists for EVs and charging equipment in areas that score amongst the lowest on socio-economic welfare rankings (Carrus et al., 2018). This unequal distribution is also reflected in the brands of cars sold in Norway. While the proliferation of Tesla vehicles has received much attention, the Nissan Leaf was by far the most sold EV in 2018, followed by the Volkswagen E-Golf (OFV, 2019), indicating a more nuanced story than the one focusing on conspicuous consumption. Further, a less discussed element of Norwegian mobility policies is the heavy taxes on petrol cars, which makes the price of a new EV roughly the same as an equivalent petrol car.

The situation discussed above has resulted in retailers struggling to meet current EV demand, and today roughly 40,000 Norwegians are queuing for various EV models (NAF, 2018). In Norway, the transition is also making its way into the market for used vehicles. According to the largest site for used vehicle advertisements in Norway, 7% of all used vehicles advertised in 2017 were electric, with an average turnaround time of one week, illustrating a popular demand for less expensive EVs (Finnspirasjon, 2018).

Recent studies into the cultural aspects of the Norwegian EV transition suggest that EVs also play an important role in transforming broader mobility culture (Anfinsen et al., 2018), practices of driving (Ryghaug and Toftaker, 2014), and that EV experiences are contributing to an increase in many Norwegians' interest in other green technologies such as solar panels (Throndsen et al., 2017; Ryghaug et al., 2018; Winther et al., 2018). Construction companies and real estate developers increasingly see smart charging

[1] https://elbil.no/elbilstatistikk/elbilsalg/ (accessed 02.01.2019).

[2] In absolute numbers, all of the following countries registered fewer EVs than Norway: Austria, Belgium, Bulgaria, Czech republic, Denmark, Estonia, Finland, France, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK.

infrastructure as an essential component of most projects in order to alleviate the increasing pressure from the rapidly growing EV fleet on the electricity grid (Carrus et al., 2018).

In light of the situation described above, one can say that the Norwegian EV transition is a technological, practical and cultural transition, that currently showcases many of the opportunities, but also challenges, associated with the mass diffusion of EVs. A popular narrative explaining the Norwegian case suggests that it is primarily the result of demand-oriented climate change policies. To cite one example, an article in the *Guardian* highlighted that "*Norway's lead on electric cars has been driven by the government backing them with a wide range of generous incentives and perks, as a way of meeting its climate change ambitions*" (Vaughan, 2017). In what follows we will substantially nuance and complicate this narrative by probing the role of various measures to stimulate the Norwegian EV industry.

3. Research methods

The analysis in this article is primarily based on the synthesis of efforts from past research projects that the authors of this article have been involved in, combined with a close reading of key secondary sources and historical accounts. The background material analysed includes 20 qualitative interviews with various stakeholders in EV-related industries representing national and local authorities, governmental organizations (GOs) and non-governmental organizations (NGOs) that work to promote electrification of transport, EV manufacturers and distributors, mobility agents, and energy suppliers (see Ryghaug and Toftaker, 2016 for details). This background research has been triangulated with key historical accounts on the Norwegian EV transition, as well as with other accounts of the transition, such as contemporary innovation studies' analysis of the Norwegian EV industry from the 1990s. Further, we draw on insights from official policy documents and other grey literature.

4. Analytical framework: A socio-technical transition perspective

In this article, we have drawn inspiration from understandings that view systemic automobility transitions as multi-dimensional interactions between industry, technology, markets, policy, culture and civil society (Geels, 2012). From the multi-level perspective (MLP) (Geels, 2002; Geels et al., 2017) we borrow the three three-level distinction between niches, regimes and a landscape (Geels, 2002). Considered from this perspective, the landscape is understood as stable and difficult to change. Regimes are understood to be constructed of relatively stable, institutionalised and large networks, while niches are smaller with less stabilised rules of conduct. Transitions entail regime shifts: either through the transformation of existing regimes or by new regimes taking over the societal functions fulfilled by old regimes. In exploring this idea, our perspective is relational, which means that we focus on how actors, strategies and material elements come to co-produce conditions that are conducive to transition.

In the past, electric vehicles have been discussed in the sustainability transitions literature as a niche technology, with the potential to challenge the interests invested in dominant automobility regimes (e.g. Kemp et al., 1998; Geels, 2012). Our key interest is, therefore, to explore niche–regime relationships in a transition process where EVs and the socio-technical systems of which they are part, appear to challenge the actors, practices and actor-networks of a petrol-based automobility regime. At first, this transition might appear distinctly rooted in and sparked by one national context, and a few specific local places within this context. Yet, closer scrutiny makes it clear that that the Norwegian electro mobility transition involves policies and actor strategies enacted across multiple sites. Further, the transition we analyse might at first glance appear as instigated by contemporary climate and sustainability concerns in Norway, however, our analysis reveals traces of relevant policy and strategies over a period over more than 40 years.

These dynamics have yielded a special interest with respect to two matters to be scrutinized further in this paper. First, we examine the role of and the relationship between policy implementation and the effects of such policies across geographical places and scales. An entry point into this discussion can be found within the local-global niche model developed by Geels and Raven (2006), which highlights the relationship between hands-on, local and implicitly often nationally oriented niches and global networks. Here, learning and aggregation in niches may amount to more generic knowledge, fostered by global networks: "*The global network and knowledge field provides coordination and guiding frames for local experiments, but leaves room for local interpretations and variations*" (Ibid. p. 378). Hence, there is a co-productive dynamic between the local and the global, which is important for thinking about scaling up niche innovations.

For transition scholars, however, the 'global' does not signify a spatial category, but has rather referred to a high level of aggregation, resulting in criticism levelled by geographers for a lack of sensitivity to a spatial understanding of the geographies of niche development (e.g. Hansen and Coenen, 2015). This is a particular problem for policy and decision makers, since it might lead to the naïve conclusion that place-specific lessons might be applied anywhere, or that one ends up making arbitrary geographic boundaries around an area where a transition is expected to be 'managed' in isolation. Hence, Coenen et al., 2012, p. 977) highlight that "*trans*-local and *trans-national network relations and institutional interdependencies need be acknowledged by policy-makers and 'transition managers' even though they may extend beyond their sphere of influence*".

As a response, Sengers and Raven (2015), have engaged with key geographical literatures to sensitise the local-global niche model to spatial analysis. They highlight how this move enables them to see: 1) the way production is embedded in particular places, and the transfer of knowledge between such places, for example from places of 'best practice' to other places, 2) the degree of complexity of geographies of actor-networks involved in niche development, and 3) how projects become embedded locally, for example as generic ideas become embroiled in place-specific narratives and interpretations. Similarly, Fontes et al. (2016) highlight how 'global' or 'local' niche processes are performed by actors that belong to specific territorial settings, and that cross-territorial networks are key to understand niche creation. Such networks have been said to provide complementary capabilities to those of local territories

(Wieczorek et al., 2015). Others have highlighted how policies circulate and mutate within cross-territorial networks, thus producing new conditions for transitions (e.g. Affolderbach and Schultz, 2016). Another approach to cross-territorial and scalar relations in transitions has been inspired by Neil Smith (1993), and highlights how actors can 'jump scales' to mobilise actors and resources to reach their own goals, for example through engaging with actors in different geographies or higher orders of organization (Dijk et al., 2018). In our case study we ask whether similar dynamics may characterise the production of EV industry niche conditions in Norway.

Secondly, we are interested in the effects of policies, policy mixes and governance strategies, which transition scholars have deemed essential as tools to destabilise existing regimes (e.g. Kivimaa and Kern, 2016), but also to create new innovation paths (Mäkinen et al., 2015). On the one hand, policy mixes typically consist of a set of policy instruments meant to achieve specific goals (e.g. promoting innovation, increasing the demand for solar power), but the literature on policy mixes also emphasises the emergent quality of such mixes, as complex arrangements of multiple goals that emerges incrementally over years, sometimes decades (Kern and Howlett, 2009). Yet, the effects of policy instruments and complex policy mixes are typically analysed as contained within confined geographical entities such as the UK or Finland (Kivimaa and Kern, 2016), Germany (Rogge and Reichardt, 2016) or specific cities such as Helsinki (Mäkinen et al., 2015). While the literature is sensitive to indirect and unintended effects of different policy instruments that unintendedly work together, it has so far been less sensitive to the potential of unintended policy effects across geographies, for example the indirect effects of the German energy policy mix on innovation in the UK. In our case study, national policies implemented with different goals, and in locations separated by the Atlantic Ocean interact with inter-local policies to produce favourable conditions for the development of an EV market niche in Norway.

This claim feeds into a related interest in the evaluation of policies: when should one conclude whether or not policies are successful? This has not been a central concern in the transitions literature, beyond discussions about niche experiments and their role in the governance of transitions. Here, it has been highlighted that the effects of such experiments on broader transitions might be more indirect, and that their effects often become visible much later than in the immediate wake of their execution (Hoogma et al., 2002; Sengers and Raven, 2015). Hence, when transitions reach 'take-off' or 'acceleration' phases, one can retrospectively appraise the relative contribution of individual experiments. In our case study we will explore and conceptualise similar dynamics for policy effects.

5. Case study: the unexpected dynamics of the Norwegian EV transition

Intuitively, EVs appear to be a good match with the Norwegian energy system and contemporary climate abatement ambitions. The Norwegian energy mix mainly consists of renewable electricity production based on hydropower (98%), which is also used for space heating (e.g. Skjølsvold et al., 2013). Hence, without a CO_2 intensive energy system, transport is key to reducing climate gas emissions (Aamaas and Peters, 2017). Norway has been described as a particularly mass-motorized society (Østby, 2004). Living standards and wages are high, with a "comfort oriented" energy culture (Aune, 2007). For these reasons, the electric car would appear to be a good fit for this national context. However, Norway is also a large exporter of oil and gas, and this industry is important both for Norway's GDP, and for the country's culture and self-understanding as an 'energy' nation, which might lead us to the conclusion that promoting electrification of the transport sector would be at odds with incumbent oil and gas interests.

In what follows, we will discuss the Norwegian EV transition as an unfolding series of processes that can conceptually be distinguished as occurring in two phases: a) a technology niche creation phase and b) a demand-side policy niche creation phase. This narrative renders many details and complexities invisible, but they can be illuminated elsewhere (see e.g. Ryghaug and Skjølsvold, 2019). In particular, our narrative here downplays the period between the years 2000–2010.

5.1. The complex geographies and temporalities of Norwegian EV-niche creation

The first modern visions of Norway as an electric-vehicle producing nation emerged in the 1970s in response to the OPEC oil embargo of 1973. At the time, Norway had vast hydropower resources. Developing an EV industry and challenging the fossil fuel mobility regime was therefore seen by a set of industrial pioneers as an ideal way of strengthening energy security in Norway. The idea was that, while Norway at the time was poor in oil, it was rich in hydropower, and this strength should be reflected in the country's preferred mode of transport (Asphjell et al., 2013).

Several initiatives were launched, the most prominent of which was at Bakelittfabrikken, a small and rurally-located factory in eastern Norway, which at the time mainly produced chassis for plastic boats. Their vision was to produce a small plastic chassis EV designed for urban transport. The factory produced a prototype, but as the OPEC oil crisis faded, the initiative lost momentum. The dynamics, however, were important. The OPEC incident was an event with global ramifications (see e.g. Solomon and Krishna, 2011; Araújo, 2014; Ornetzeder and Rohracher, 2013 for examples of implications from the transitions literature), which created a political and entrepreneurial spirit amongst some Norwegians seeking local alternatives. Hence, while there were no policy mechanisms implemented at the time, the economic dynamics of the period provided niche shielding rooted in new cultural ideas about energy security, anchored in locally embedded interpretations of how to respond to a global crisis that allowed new visions and innovation practices to emerge locally.

Towards the end of the 1970s, while the fossil fuel automobile regime remained stable and Bakkelittfabrikken abandoned their EV prototyping activities, the vision of an alternative EV industry remained dormant amongst the company management. Towards the end of the 1980s and in the early 1990s, however, these visions were re-articulated. In 1989, company owner Jan Otto Ringdal secured a small grant from the research council of Norway to do a feasibility study. In 1990, the owners of Bakkelittfabrikken started

the company PIVCO (Personal Independent Vehicle Company) (Andersen, 2013). While the activities in the 1970s can be interpreted as a response to an external landscape shock (e.g. Geels, 2002), the activities in the early 1990s had a different dynamic.

The primary motivation for the activities came from the enactment of the Zero Emission Vehicle (ZEV) legislation in California, which established a credit system whereby car dealers had to earn credits from the sale of non-emission vehicles to legally be able to continue selling petrol cars (Hoogma et al., 2002). The scheme has later been dubbed "*one of the most daring and controversial air quality policies ever adopted*" (Collantes and Sperling, 2008). Transition scholars have highlighted that the legislation was geared towards an 'innovation pull', producing 'windows of opportunity' for battery electric vehicles (Kemp, 2005), and has been deemed central to the development of EV friendly policies in places like Japan (Åhman, 2006). The entrepreneurially-oriented PIVCO founders believed that ZEV would open the doors anew to offer future commercial opportunities, thereby reviving the vision of the 1970s: to produce a small, plastic chassis urban EV – a 'personal independent vehicle' named ´PIV´ (Hoogma et al., 2002; Buland, 1994; Andersen, 2013).

Two things are worth noting here. First, this is the earliest example in our case study of a temporal echo. The vision to produce a small, urban EV emerged in the 1970s. The entrepreneurs of the 1970s sustained these visions, and in the early 1990s they re-emerged, to interact with a new policy reality and a potential new market abroad, as well as a growing awareness of pollution and sustainability issues (Andersen, 2013). Second, this is an example of a jump in policy effects, where local policies in California created favourable conditions for niche development in Norway. These prospects were used by Bakkelittfabrikken to create better niche protection. R&D funding was eventually also secured from the EU through the joint programme EUREKA (Røste, 2004). Further, support from a significant number of private actors was made available, in part, because of the prospects of a booming future represented by the Californian EV market (Hoogma, 2002).

The first prototype ('PIV1') was successfully tested in 1993, resulting in a new project for which PIVCO delivered a fleet of 13 EVs ('PIV2') to be tested in extremely cold conditions and high visibility during the Winter Olympic Games in Lillehammer in 1994 (Asphjell et al., 2013). For the trials, the PIV2 was re-branded as the 'CityBee', signalling the company's clear aspirations to create a new form of urban mobility. This highly visible niche experiment worked in the sense that it demonstrated the potential of the vehicles and that it attracted the interests of incumbent actors in the Norwegian electricity sector, who saw EVs as another means to sell electricity (Buland, 1994), and in so doing, strengthen the Norwegian hydroelectric regime further.

This new mobility niche was now primarily shielded from other automobililty regimes by actors in the Norwegian hydropower regime, who also supported the development financially (Røste, 2001). Meanwhile, Norwegian authorities implemented a series of policies during this period, which were primarily geared towards helping this new niche gain foothold. EVs were exempt from purchase and import taxes in 1990. Some places implemented free EV parking already in 1993, and most municipalities offered free parking from 1999. EVs benefited from low annual road taxes from 1996 and were exempt from toll roads taxes in 1997. These policies were first and foremost pushed forward by a set of intermediary actors (Kivimaa, 2014) consisting of new EV interest organisations and environmental organisations, who promoted the development and diffusion of EVs (Asphjell et al., 2013).

However, the national policies and work of interest organisations did not translate into a substantial Norwegian EV market. Following the success of the CityBee trials in Lillehammer, CityBee's further growth was propelled further by another unexpected local policy implementation, this time in the city of San Francisco, where the city's profile as a pioneer of clean urban transportation was expanded through developments around the light rail system 'BART' (Bay Area Rapid Transportation System). The city had plans to implement a 'station car program', a proto mobility service similar to what is today often called 'last mile transport'. This latter was indeed a policy meant to enable a new form of niche mobility service, and this niche service became the first commercial market for the CityBee, as PIVCO was commissioned to deliver 50 vehicles to the city (Asphjell et al., 2013). In the end, these vehicles were used in a two-year trial project, but the vehicles did not manage to meet the Californian safety criteria needed to become permanent parts of San Francisco traffic (Andersen, 2013).

On the other side of the world, the Norwegian policies aimed at nurturing this niche were largely ineffective. Shielding was provided by the hydroelectric power regime, and a real market impact was not achieved before unexpected aid emerged in the form of San Francisco city policies. This raised the expectations for a substantial Norwegian EV industry even higher. Consequently, what can be described as a small cluster of EV-related industries emerged at the end of the 1990s, increasing the political pressure to stimulate a domestic market for the Norwegian EVs and resulting in a set of new incentives. The incentive package included exemption from VAT from 2001 (25% in Norway) and experiments allowing EVs to drive in the bus lane in the larger Oslo region from 2003. Further, a few publicly owned companies acquired small fleets of electric vehicles, actively using their procurement capacity to shield the niche.

Notably, in Norway, these policies were still seen as a failure because despite "wide-ranging political visions, far-reaching networks, and elaborate engineering scripts", the number of electric vehicles on Norwegian roads was still small (Gjøen and Hård, 2002, p. 275) and a market did not materialise.

5.2. A brief note on the end of the Norwegian EV industry

PIVCO, who had been struggling both in Norway and the US, eventually became Th!nk. In 1998, Ford became interested in the company at an exhibition in Brussels. Following an intense year, Ford became the main shareholder in 1999, and gained full ownership in the year 2000 (Andersen, 2013) making protection of this EV niche no longer necessary, primarily by Norwegian public actors and the Norwegian hydroelectricity regime. Instead, it became a niche within the traditional automotive industry, heavily rooted in American car culture. The outcome was a series of backlashes, which came as the result of what Andersen (2013) has described as "guerrilla attacks" from within Ford, who argued that the simple, plastic cars would not succeed on the US market. Ford

discontinued Th!nk in 2003. While several attempts were made by new owners to revive the company, it eventually filed for bankruptcy in 2011 marking the end of the Norwegian EV industry venture.

Researchers who have probed the Norwegian EV market have dubbed the period between the years 2000–2009 as the early market phase (Figenbaum and Kolbjørnstvedt, 2013). While this is an apt description of the market situation, the policies implemented in this period did not differ much in their goals from the policies introduced earlier. While Th!nk was struggling, new policies such as VAT exemptions sought to stimulate the sales of these very EVs to help the industry thrive. Some exceptions of this can be seen, however, in local experimentation with EV access to bus lanes in Oslo (2005), which eventually became permanent, and was implemented in most urban areas across the country. The continued focus on EV policies can be understood in light of the gradual collapse of Th!nk. While they were struggling, Norwegian policy makers still firmly believed that this could be turned around.

5.3. Norway as a policy niche laboratory and the making of a niche market for the global EV industry

Towards the end of the 2000s, the role of EVs in Norwegian discourse changed. The climate issue was now high on the political agenda, and significant technological progress was seen in EV and battery technology. Figenbaum and Kolbjørnstvedt (2013) date what they call the start of "the market introduction phase" of the Norwegian EV transition back to 2009. This timeframe coincides roughly with the time when the last Norwegian-produced EV models were sold, just one year before industry leaders like Mitsubishi, Peugeot, Citroën and Nissan began launching new flagship models, which were immediately imported by Norwegian dealers. The Norwegian EV market boomed quite significantly after the introduction of the Mitsubishi i-MiEV in 2010 and the Nissan Leaf in 2011 (Lorentzen et al., 2017).

In terms of policy effects, the dynamics of the situation in this period represents the second temporal echo identified in this case study. From 1990 and up until the late 1990s national and local authorities gradually implemented a range of policy instruments, which were designed to create favourable conditions for a Norwegian EV industry. These policies were criticised by contemporary scholars as inefficient (e.g. Buland, 1994), but they also had a clear positive impact on EV sales, resulting in a total of around 2500 EVs on Norwegian roads in 2009 (Figenbaum and Kolbjørnstvedt, 2013). Climate change then emerged as a key societal challenge, and actors within international automobility regimes began mass-producing a new generation of EVs. In this terrain of new relations and political issues, the same policies stood out in a new way – not as a policy mix to stimulate Norwegian innovation, but rather as a policy mix promoting the import and mass diffusion of EVs as a means to decarbonise Norwegian transport. As Tietge et al. (2016) writes in a relatively typical account comparing national EV policies in Europe: "*In order to curb the transport sector's environmental impact, the Norwegian government put in place a number of policies to decarbonize passenger transport*" (p. 47). This new framing of Norwegian EV policies was further institutionalised through the establishment of Transnova in 2009, a government agency mandated to work for transport decarbonisation (Figenbaum and Kolbjørnstvedt, 2013).

In terms of thinking about spatial relationships, the irony of the situation is that while these policies were originally intended to create a national market for a small, domestic and presumably, vulnerable, technological development niche, Norway was now effectively established as a central niche market for global automobility regime actors. The country had a small, but visible and vocal base of first generation EV drivers, who likely helped in what Sengers and Raven (2015) call the embedding of EVs locally by producing positive narratives and working actively to change entrenched patterns in car culture (Ryghaug and Toftaker, 2014; Ingeborgrud and Ryghaug, 2017; Figenbaum and Kolbjørnstvedt, 2013). As Norway was transformed into a niche market for global actors, it is likely that the Norwegian policies indeed had effects on propelling innovation, but primarily amongst other actors, located elsewhere than initially intended, again signalling the need to cast a broad temporal and territorial web when assessing the effects of policies.

Seen together, these dynamics also illustrate the emergent qualities of policy mixes (Kern and Howlett, 2009), highlighting the merits of a processual understanding, particularly when asking when and where one should evaluate their effects. Here, the combined set of policy instruments in Norway emerged as a success long after their implementation as the EV transition accelerated. Similar observations have been made with respect to experiments in the past (Hoogma et al., 2002; Sengers and Raven, 2015), and we believe there is a need for further studies to examine unexpected, temporally delayed, and spatially surprising policy effects.

Since 2009, Norway has actively embraced its role as a policy niche, in which new policies have been experimented heavily with both locally and nationally. This includes a combination of policies intended to stimulate increased demand, and to enable an easy transition for fossil fuel drivers switching to electric cars. This also includes free or reduced cost on ferries and VAT exemption for car leasing. Further, a governmental support scheme for public charging infrastructure was implemented during the years 2009–2010, followed by the public coordination of a fast-charging infrastructure and charging facility developments across the country. Small municipalities with few chargers can today seek financial support, and the goal is to have fast charging stations at approximately 50 km intervals on Norwegian roads. The network of chargers throughout the country is probably a culturally important safety net designed to mitigate what is commonly referred to as 'range anxiety' (Noel and Sovacool, 2016) and is something that contributes to the further expansion of the EV market. Several municipalities and cities have also followed Oslo in allowing EVs to drive in bus lanes.

Today, EV incentives have become an institutionalised element in the Norwegian automobility regime, which has become hybridised with the clear goal of phasing out fossil fuels. The jurisdiction over many incentives such as free parking and bus lane access is anchored in municipalities. Despite some signs of public controversy over the costs of these policies, as well as the rolling back of benefits such as free parking in several cities to reduce traffic, and unexpected consequences such as bus lane congestion, the instruments remain relatively popular.

6. Concluding discussion

Writing from a sociotechnical transitions perspective, we set out to do two things. Empirically, we conducted a case study of the Norwegian EV transition, which has been highlighted as a potential route to challenging the actors and systems of existing automobility regimes (Geels, 2012). This exercise has led us to suggest some conceptual innovations in dialogue with literature on the spatial aspects of transitions, and literatures on policy mixes and their effects.

First, we have proposed the metaphor of a temporal echo in order to describe the relational dynamics that occur as policies, strategies or ideas re-appear in new relational configurations as they are simultaneously transformed in the process. In our case study of the Norwegian EV transition, we have seen this dynamic in two different ways. First, the vision of developing a national electric vehicle industry niche in Norway, generated in the 1970s in response to the OPEC oil embargo, resurfaced and was amplified in the early 1990s, in an encounter with a network of entrepreneurs and innovators which also mobilised the Californian zero emission vehicle legislation to advance their own agenda of EV innovation. Hence, the emergence of such echoes are contingent on relations in the form of networks that are able to, on the one hand, sustain ideas over time, and on the other hand, mobilise past ideas in a new context. Thus, the concept of 'temporal echo' serves to refine ideas about what the transitions literature often discuss as 'windows of opportunity' (e.g. Geels, 2002). In particular, the notion serves to highlight relational aspects which might enable certain actor groups and networks to act on and take advantage of such windows. For policy makers, this implies that when crafting policies for new technologies, one should look not only at technical potential, but also look for active networks with ideas for whom to open such windows. By probing past innovations that have not yet materialised, one could fine-tune policy making efforts, targeting latent ideas and active networks. Hence, policymakers could 'listen' to the past, and through this process, attempt to produce echoes.

The discussion on temporality also relates to the production of a complicated narrative about the relationship between policies and effects. The zero emission vehicle legislation targeted a specific geographical location in the US, and has been framed as targeting supply (innovation) and demand specifically in California. However, as our narrative demonstrates, an important effect was also to interact with the pre-existing ideas of innovators in Norway, and to amplify such ideas and transform them into an agenda for new pilot activity.

Hence, due to alignment of interest, visions and past activities of this specific local group of innovators in Norway, we see effects from this particular local policy in our case study, an example of how cross-territorial networks can be important for the creation of niches (Fontes et al., 2016). These policies, however, did not produce similar effects all over the world. Hence, the explanation lies in the encounters and exchanges between new policies and already interested actors, as a form of what Sengers and Raven (2015) call 'local embedding,' in which additional capabilities are provided to the local setting from external policy (Wieczorek et al., 2015). Hence, actors with ideas and visions co-produce policy effects through their enactment of innovation strategies. Parts of these efforts took the form of 'scale jumping' (Smith et al., 1993; Dijk et al., 2018) where actors localised in Norway were able to mobilise resources from geographically remote locations and networks to realise their own goals.

Further, we have seen how a set of policy instruments that were originally introduced to nurture an electric vehicle industry niche in Norway in the 1990s, re-surfaced and were reinterpreted and given new meaning towards the end of the 2000s. In a new actor-network consisting of climate concerns, requirements to decarbonise transport and new EV technologies promoted by international automobility actors, the original policy instruments were transformed into a policy mix for increasing EV demand and EV diffusion. Through this transformation, Norway was also effectively established as a large-scale pilot or niche market in itself, where international automobility regime actors could experiment with introducing new models, and policy makers with new policies. Hence, this temporal echo brings to the forefront the complexities of understanding the formation of policy (see e.g. Weber and Rohracher, 2012; Normann, 2015; Kern and Rogge, 2017) and the processual traits of policy mixes (Kern and Howlett, 2009).

How, then, might the identification of temporal echoes, help us in advancing sustainability transitions? On one level, what we have described in this article might resemble an operationalisation of the simple notion that some ideas and some technologies emerge 'ahead of their time' – before a window of opportunity is fully present. How, then, can the technologies be brought 'back into' time? In the examples discussed in this article, we find that they have been brought back by entrepreneurial networks, which have been able to mobilise and transform ideas, strategies and policies when encountering shifting actors and interests, as well as improved technology. In the Norwegian case, one can convey the contrast with the idea of osmotic power, which also emerged during the oil embargo of the 1970s. This, too, was an idea that was sustained through an entrepreneurial-oriented engineering community, but which has not retained a network to sustain it. Hence, a temporal echo, at least in the Norwegian context, seems unlikely.

In terms of transition governance, our discussion suggests that there are potential benefits involved in actively cultivating, not only technological experimentation and experimental governance, as has been widely called for over the last years, but that there are also potential benefits in stimulating and cultivating epistemic communities that engage with ideas that are considered leftfield, immature or strange in the context of mainstream energy discussions. The quest to cultivate such groups has implications for policy makers and the ways in which one thinks about mission-oriented research and innovation, far beyond what we are able to discuss in this paper. In the end, our analysis also has implications for strategies of and questions about how to sustain communities of practice that may harbour, nurture and at later points develop knowledge and technologies that might break through later in time and that may become essential components in enabling future sustainability transitions.

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