Department of Management Studies

‘Life after Nokia?’ Business model innovation and niche upscaling in the emerging Finnish demand response industry

Ruggiero, Salvatore
Kangas, Hanna-Liisa
Annala, Salla
Ohrling, Tiina

Aalto University

BUSINESS + ECONOMY

WORKING PAPERS

Aalto University publication series
BUSINESS + **ECONOMY** 2/2020

‘Life after Nokia?’ Business model innovation and niche upscaling in the emerging Finnish demand response industry

Ruggiero, Salvatore
Kangas, Hanna-Liisa
Annala, Salla
Ohrling, Tiina

Aalto University
School of Business
Department of Management Studies
Smart Energy Transition

Aalto University publication series
BUSINESS + **ECONOMY** 2/2020

ISBN 978-952-64-0041-9 (pdf)
ISSN-L 1799-4810
ISSN 1799-4810 (printed)
ISSN 1799-4829 (pdf)
http://urn.fi/URN:ISBN:978-952-60-6906-7

www.smartenergytransition.fi

Unigrafia Oy
Helsinki
2020

Finland

‘Life after Nokia?’ Business model innovation and niche upscaling in the emerging Finnish demand response industry

Abstract

Demand response (DR) can be considered a complementary innovation with the potential to accelerate the transition towards renewable energy sources. Various business models are developing around this technology to provide value to both firms and consumers. Building on the multi-level perspective (MLP) on socio-technical change and previous studies that have introduced the concept of business models in sustainability transition research, we investigate the role of different business model innovation patterns in niche upscaling and breakthroughs. Empirically, the study relied on 25 semi-structured interviews with representatives of Finnish companies operating in the emerging DR industry. It identified three main business model innovation patterns, which are labelled as follows: 1) *phoenix rise*, 2) *business model expansion*, and 3) *incumbent catch-up*. The analysis of these business model innovation patterns revealed that niche–regime interaction is not fixed, but rather, can change over time from adaptive to potentially transformative according to the changes in firms’ business model. Moreover, niche–regime interaction occurs in a multidirectional rather than unidirectional way, that is, not just from niche to regime but also from regime to niche and from alternative regime to niche.

Keywords: Business model, Niche–regime interaction, Demand response, Multi-level perspective, Innovation, Energy transition

1. Introduction

Energy production and consumption is the largest source of global greenhouse gas emissions and a climate change contributor (IEA, 2018). Therefore, there is a need for a rapid transition towards a low-carbon energy system based on renewable energy sources. However, as the share of fluctuating renewable energy in energy production increases, balancing supply and demand is becoming a significant challenge.

Demand response (DR) is a complementary innovation that can add reliability and flexibility to the energy system and accelerate the transition to renewable energy sources (Geels et al., 2017). The EU's new electricity market directive 2019/944 defines DR as

> the change of electricity load by final customers from their normal or current consumption patterns in response to market signals, including in response to time-variable electricity prices or incentive payments, or in response to the acceptance of the final customer's bid to sell demand reduction or increase at a price in an organised market… whether alone or through aggregation. (Directive 2019/944)

In practice, DR may mean shifting consumption from one time slot to another (e.g. based on the availability of renewable generation or prices in the wholesale market) or reducing demand during peak times without shifting it due to, for example, network constraints. DR services that optimise and control energy use are becoming more common due to the increasing convergence between information and communication technology (ICT), renewable energy technologies and new business models, which are helping to popularise flexibility services in mainstream energy markets.

In recent years, scholars have increasingly used the concept of the business model in transition research (Hannon, 2012; Tongur and Engwall, 2014; Wainstein and Bumpus, 2016; Bolton and Hannon, 2016; Schaltegger et al., 2016; Sarasini and Linder, 2018; Bidmon and Knab, 2018; van Waes et al., 2018). They have found that, on the one hand, business models can hamper sustainability transitions by reinforcing regime stability, and on the other, they can accelerate them by fostering niche upscaling and the building up of new regimes (Bidmon and Knab, 2018).

Since the literature on business models and transitions is still in its infancy, more attention needs to be paid to the role of business models in fostering the upscaling of technological niches (Sarasini and Linder, 2018). Moreover, the implications for transitions of business models based on flexibility and servitisation (of energy, in our case) are not yet well understood (Köhler et al., 2019). Therefore, the aim of this study is elucidating how business models based on services contribute to the upscaling of technological niches. More specifically, we use the concept of business model innovation patterns to suggest different pathways through which business models emerge. To fulfil our research aim, we use the case of the nascent DR industry in Finland. We choose this country because it is a pioneer in automated DR services (Fingrid, 2018) and has one of the most well-developed legislative frameworks in Europe (SEDC, 2017). The research questions we address are as follows:

1. What are the drivers and barriers of business model innovation for DR services in Finland?
2. What business model innovation patterns exist, and what niche–regime dynamics do they activate?

Conceptually, the study builds on the multi-level perspective (MLP) on socio-technical transitions (Geels, 2002; Geels, 2005), and in particular, the strand of research focussing on the dynamics of niche–regime interaction (Ingram, 2015; Geels and Schot, 2007; Elzen et al., 2012; Mylan et al., 2018). We contribute to research focussing on business model innovation in socio-technical transitions (Bidmon and Knab, 2018; Bolton and Hannon, 2016; Sarasini and Linder, 2018; van Waes et al., 2018), showing how different business model innovation patterns determine different niche–regime dynamics.

The rest of this paper is structured as follows: Section 2 introduces the concept of DR and describes the nascent DR sector in Finland. Section 3 presents our theoretical framework, while section 4 clarifies our data and methods. Then, in section 5, we report the findings, and in sections 6 and 7, we discuss them and draw some conclusions.

2. Demand response in the energy system

Traditionally, the short-term balance between demand and supply in the energy system has been maintained primarily by adjusting energy generation according to fluctuations in consumption. However, the increasing proportion of weather-dependent renewable generation, promoted by the goal of decarbonising the economy and the decreasing prices of renewable energy technologies, is making this traditional approach to energy balancing less effective. In contrast, developments in ICT and control technologies have made DR an increasingly feasible option.

However, while DR is often seen as a necessity in power systems relying on an increasing amount of intermittent generation, it also leads to energy market disruption. This is because of the following features: (i) DR enables high shares of renewable energy in energy production, and (ii) it provides alternatives for flexible generation, such as natural gas in the balancing markets, that is, markets operated by the transmission system operator (TSO) to maintain the balance between demand and supply at all times.

DR schemes can be categorised as either explicit (also referred to as incentive based) or implicit (also referred to as price based; SEDC, 2017). In explicit DR, the end users are paid to change their consumption patterns upon request, for example, when an aggregator (with whom the end users have a contract) has offered the load reduction for a TSO to maintain system stability. In implicit schemes, end users are exposed to dynamic retail or network tariffs and can save on their energy bills by reacting to them. In both types of schemes, the response can be facilitated by automation or external control of end users' appliances.

Table 1. Benefits of Demand Response from Different Stakeholders' Perspectives

Stakeholder	**Benefit**
Transmission or distribution system operators (TSOs, DSOs)	Delaying or avoiding network reinforcements Reducing losses Reducing voltage drops Improving reliability during unpredictable contingencies Maintaining balance between demand and supply (He et al., 2013; Safdarian et al., 2016)
Retailer	Purchase costs minimisation

	Hedging against spot–price volatility and uncertainty in customers' loads (He et al., 2013; Safdarian et al., 2014)
End user	Reducing electricity costs through shifting/reducing consumption based on time-variable prices or other incentives Utilising own generation Environmental motives (SEDC, 2015; McKenna and Thomson, 2014; Chen and Sintov, 2016)
Aggregator	Aggregating (and controlling) end-user loads and offering them to meet other stakeholders' needs (e.g. reserve markets) (Heleno et al., 2016)

The benefits of DR in the electricity sector have been discussed widely (for a review, see e.g. O'Connell et al., 2014), and recently, the potential benefits of DR in the district heating sector have gained increasing attention (Guelpa et al., 2019). Table 1 summarises the potential benefits of DR for different stakeholders. However, at the same time, DR is still a largely underutilised resource; in many countries, either market rules prevent DR participation in organised markets completely or eligibility is limited to large individual loads because aggregation is not allowed (SEDC, 2017). From distribution system operators' (DSOs') viewpoint, the economic regulation typically favours infrastructure investments instead of buying services. From the end-user perspective, the benefits of DR may seem small or unclear. Furthermore, most small end users (such as households) are not currently equipped with control systems facilitating DR or even smart meters that would allow billing based on dynamic tariffs. Finally, the DR needs of different stakeholders may not occur at the same time, which can lead to conflicts of interest. For example, controlling loads based on wholesale market prices (i.e. to minimise energy costs) may cause new demand peaks in distribution networks (Belonogova et al., 2013). In contrast, retailers procure energy based on their customers' forecasted consumption. This process becomes increasingly complicated if other stakeholders, such as aggregators, initiate DR actions among their customers.

2.1. Demand response in Finland

Finland is among the forerunner markets for DR in Europe (SEDC, 2017). All the marketplaces for balancing services operated by the Finnish electricity TSO Fingrid (e.g. frequency-controlled reserves for normal operation [FCR-N] and FCR for disturbances [FCR-D]) are open to DR resources (Fingrid, 2019a). Although the minimum bid sizes in Fingrid's markets (ranging between 0.1 and 5 mW depending on the market) prevent direct participation of small end users like households and small businesses, they are eligible resources through aggregators. Currently, independent aggregators (i.e. parties that do not supply electricity to the end users but whose flexibility they utilise) are eligible in the FCR-N and FCR-D markets, and arrangements related to their participation in other markets are currently being piloted (Fingrid, 2019b). Furthermore, a Finish legislation required DSOs to roll out smart meters by the end of 2013. The almost 100% penetration of hourly registering smart meters enables offering time-variable electricity pricing to small end users as well. By the end of 2018, about 9% of Finnish retail customers had an electricity contract with prices bound to the hourly spot market prices (Energy Authority, 2019).

3. Theoretical framework

3.1. The multi-level perspective on socio-technical transitions

Conceptually, this paper builds on the MLP on sustainability transitions, and in particular, the strand of literature that has focussed on the dynamics of niche–regime interaction (Ingram, 2015; Geels and Schot, 2007; Elzen et al., 2012; Mylan et al., 2018). The MLP is a heuristic model for understanding socio-technical transformation. It proposes three analytical levels—the niche, socio-technical regime and landscape (Geels, 2002; Geels, 2005).

A niche is a protected space (Geels, 2002) within which specific societal needs can be met in new and 'unorthodox' ways (van den Bosch and Rotmans, 2008, p. 31). Niches are formed under purposely created or naturally occurring conditions that allow for the experimentation or use of a new technology, which would otherwise not be mature enough for a mainstream market (Berggren et al., 2015). Technological niches are often proto-markets, that is, they exist before the market niche stage (Kemp et al., 2001). To thrive, niches at the proto-market stage need some forms of support, such as subsidies or research and development (R&D) programmes. However, with time technological niches can mature into market niches. The MLP does not propose a clear definition of a market niche, but here, we understand it as 'a narrow part of the [larger] market that displays

differentiated needs' (Toften and Hammervoll, 2013, p. 280) [in Schaefers (2014)]. In light of this definition, the emerging DR industry in Finland can be understood as a market niche.
If a technological niche represents a new and 'unorthodox' way of meeting certain societal needs, a regime can be thought of as the conventional or mainstream way of fulfilling that particular need. Thus, a socio-technical regime can be defined as 'shared, stable and aligned sets of rules or routines directing the behavior of actors on how to produce, regulate and use transportation, communication, food, and energy technologies' (Schot et al., 2016, p. 2). The rules characterising a regime not only determine favourable institutional arrangements and regulations but also the shared beliefs, capabilities, lifestyles and practices of mainstream society (Geels, 2011). Socio-technical regimes are formed over a long period by the interaction of various forces, including technology, industry, science, culture and policy (Geels, 2011; Smith, 2007). Although regimes are not static, they tend to retain stability. As a result, they are often affected by inertia precluding change and technological lock in (Unruh, 2000).

In this paper, we look at DR niche innovation against the electricity and heat regimes in Finland. These two regimes both have a strong orientation towards technological expertise. The electricity regime has been shaped over the years by a few powerful market actors, such as the paper and metal production industries and the main incumbent energy companies in the country. These actors have historically had a strong say in national energy policies. Their main objective over time has been securing cheap electricity prices for energy-intensive industries by giving priority to large centralised solutions (Huttunen, 2014). Similar trends can also be found in the heat regime. However, while the electricity markets in Finland are open to competition, the heat regime is characterised by local monopolies. Therefore, the heat regime may be less open to business model innovation.

In the MLP framework, the landscape includes both global trends (e.g. demographics, ideology, urbanisation, climate change) and macro-events (e.g. wars, environmental disasters, economic crises) influencing the niche and regime (Geels, 2011; Schot et al., 2016). These landscape factors are considered exogenous, because in the short term, neither niche nor regime actors can influence them. However, landscape events can put pressure on regimes and open windows of opportunity for radical innovations, which can break through regimes if they are mature enough.

According to the MLP, transitions to more sustainable socio-technical systems take place when there is an alignment of processes within and between the three levels described above. Therefore, socio-technical change occurs when landscape forces put pressure on destabilising regimes, creating a window of opportunity for radical innovations that develop in niches.

3.2. Niche–regime interaction literature

Niche–regime interaction illustrates the process through which new rules and practices developed in niches make their way into the regime. This process is also described by some transition scholars as niche upscaling (see, e.g. van den Bosch and Rotmans, 2008). In the niche–regime literature, several interaction pathways have been described. Ingram (2015) classified them on the basis of their degree of adaptation. He suggested that niche–regime pathways can range from adaptive to potentially transformative. In the case of an adaptive relationship, niche innovations tend to conform to the regime's rules and practices, and thus, niche novelties can be easily incorporated into the regime. In the case of a potentially transformative relationship between the niche and regime, niche innovations can radically change the regime's rules and practices. Consequently, socio-technical regimes often tend to resist the latter type of niche innovations.

The two extremes of Ingram's (2015) continuum, adaptive and potential transformative interactions, correspond to what Smith and Raven (2012) call *fit and conform* and *stretch and transform* niche empowerment strategies. Adaptive and potentially transformative niche–regime relationships imply different types of socio-technological interaction, which can range from symbiotic to competitive. Geels and Schot (2007, p. 406) offer the following description of symbiotic and competitive niche innovations:

> Niche innovations have a competitive relationship with the existing regime, when they aim to replace it. Niche innovations have symbiotic relationships if they can be adopted as competence-enhancing add-on in the existing regime to solve problems and improve performance.

Some authors have argued that the linking of niche novelties to the regime is less straightforward than often thought. For instance, Elzen et al. (2012) proposed the concept of anchoring to indicate that, in niche–regime interaction, it is only some specific social or technical aspect of a niche that becomes linked up to the existing structures and institutions.

The extant niche–regime literature has two major limitations: First, it has offered a one-sided view of the role of certain key regime actors, such as firms. In truth, transition scholars have often characterised incumbent companies as resisting radical innovation (Köhler et al., 2019). However, incumbent companies can also experiment with radical niche innovations, while at the same time, continuing to rely on traditional methods of business (Berggren et al., 2015). This property of companies involving simultaneously fostering radical and incremental innovation is known in the management literature as organisational ambidexterity (March, 1991). For example, Ruggiero and Lehkonen (2017) have shown that energy companies that adopt ambidextrous behaviour try to ensure an optimal mix of exploration and exploitation activities to ensure success in the short and long terms. Second, niche–regime interaction studies have implicitly assumed that niche and regime interact in a bottom-up way. However, as Mylan et al. (2018, p. 3) propose, niche–regime interaction may require a more symmetrical and bidirectional analysis that addresses not only niche-to-regime processes (e.g. 'translation' or 'empowerment') but also regime-to-niche dynamics.

3.3. Business model and socio-technical transitions

A business model describes how an organisation creates, delivers and captures value (Chesbrough, 2010; Osterwalder and Pigneur, 2010; Teece, 2010; Zott and Amit, 2010). Various conceptualisations of the business model's elements can be found in the literature (e.g. Chesbrough and Rosenbloom, 2002; Boons and Lüdeke-Freund, 2013). For instance, Teece (2010), Osterwalder (2004) and Tongur and Engwall (2014) suggest that business models consist of three key elements, which are as follows:

1. Value Proposition: The value a company offers to its stakeholders, that is, the value embedded in the product;

2. Value Creation: How this value is created and delivered; and
3. Value Capture: How this value is monetised and distributed.

A business model is seen by some scholars as ‘an activity system’, that is, a set of boundary-spanning activities allowing the focal firm to create and capture value via multiple networks of suppliers, partners and customers (Zott and Amit, 2010). Due to its boundary-spanning nature, in recent years, the concept of business models has gained increasing attention in transition studies (Hannon, 2012; Tongur and Engwall, 2014; Bolton and Hannon, 2016; Schaltegger et al., 2016; Wainstein and Bumpus, 2016; Bidmon and Knab, 2018; Sarasini and Linder, 2018; van Waes et al., 2018). According to Bidmon and Knab (2018), business models can have three important roles in socio-technical transitions. First, they can hamper transitions. As part of the regime, incumbent business models provide stability to socio-technical systems. Second, business models can boost transitions by acting as intermediates between the technological niche and the regime and supporting the institutionalisation of novel technologies (Bidmon and Knab, 2018). Third, a business model can be a divergent innovation—a business model niche—that drives the transition without necessarily having to rely on technological innovation (Bidmon and Knab, 2018). Bidmon and Knab (2018) suggest that novel business models emerge at a higher level of structuration than technological innovation, and therefore, they can potentially disrupt the regime more severely than technological innovation can.

For business models to affect regimes, they need to scale up. Van Waes et al. (2018) maintain that the scaling up of business models in an emerging industry implies increasing returns to adoption in conjunction with the parallel co-evolution of the institutional (regulations, norms and beliefs) and industry structure (size, experience and embeddedness of firms). In a novel industry, there is initially a variety of business models, but with the progressing growth of the sector, one dominant model arises or multiple business models serving specific market segments remain. In addition to increasing returns, the scaling up of a business model also requires institutional work, such as research, lobbying and campaigning to gain legitimacy in a regime. Only when this legitimacy has been obtained will ‘firms and investors […] be willing to invest heavily to roll out a new service’ (van Waes et al., 2018, p. 1302).

4. Data and methods

Our empirical data consist of 25 qualitative interviews with representatives of DR companies and experts in Finland. We use this case because Finland is one of the leading countries in Europe in the rollout of ICT-based solutions for DR (SEDC, 2017). In total, 22 companies providing both direct and indirect DR services were studied. The interviewees were suggested by the companies after they had been identified. They represented the views of both traditional electricity and district heating suppliers active in DR, as well as companies with no background in energy generation or retailing. Along with the interviews, we collected other data from reports on DR and company websites. The interviews centred on the following key themes: company background, demand for DR services, characteristics of energy markets, changes in the socio-technical system of electricity and heat provision, conflicts and barriers. All the interviews were recorded and transcribed verbatim. Subsequently, the transcripts of the interviews were coded with the support of NVivo 12 software against the theoretical framework described in section 3.

The sample of companies selected was chosen via two steps. First, we performed an internet search for identifying companies that may provide DR services, using the search words 'demand response' (*kysyntäjousto*), 'flexibility' (*jousto*) and 'energy management' (*energianhallinta*). The initial sample of companies was then evaluated by performing a desk study on company websites and telephone calls to find out what their service offerings included and if they had business plans considering participation in the DR markets. Eventually, the sample was limited to 22 companies that were either currently developing or had launched business models for DR services.

5. Results

The results are divided into two sections. In section 5.1, we describe the factors that were considered by the interviewees as external drivers for business model innovation. In section 5.2, we present the identified business model innovation patterns, their (internal) drivers and the key barriers to upscaling.

5.1. Background and external drivers of business model innovation

Irrespective of their companies' background and adopted business model, all the interviewees acknowledged that the energy markets are changing dramatically, and therefore, they can either try to adapt, or more proactively, seize the new business opportunities. Most of them also stated that they saw a general trend in both the electricity and heat sectors that would lead companies to provide more product and service bundles. Therefore, along with the conventional supply of electricity and heat products, they expected that there would be more DR services in future. As yet, the Finnish DR market does not appear to be completely mature. Nevertheless, the emerging niche is not a proto-market because most of the experimentation has already occurred and DR services are available in the market.

The main external drivers of business model innovation were the increasing share of nonflexible energy generation, especially intermittent renewable energy (but also the new nuclear power) and phasing out of fossil fuel–based generation (mainly coal). In addition to the changes in the generation infrastructure, the energy demand was seen as changing due to, for example, electric vehicles. These factors contributed to more volatile electricity prices and increased risks for power system stability, creating a need for flexible demand. However, one interviewee stated that the need for DR is not as big in Finland as it is in some other countries, although he conceded that a forward-looking approach could contribute to developing useful technologies for export purposes. Other drivers included digitalisation and ICT development, the fall of Nokia, early adoption of smart meters, decreasing prices of sensor technologies, free weather data from the Finnish Meteorological Institute and R&D projects funded by the state and municipalities in the early 2010s. The fall of Nokia was important for the development of the Finnish DR business, especially in the cities where Nokia employed many people:

> In our city, Nokia was a very strong actor, and now that their influence has decreased, the know-how is left in this area. Many companies in the fields of IoT [Internet of Things] and digitalisation got their start from that. [Interviewee 9]

The EU electricity market opening and harmonisation has also played a role in driving the DR business model development. In Finland, the role of the TSO was especially emphasised. The national TSO, Fingrid, opened the ancillary service market to DR services, including aggregated solutions. Other external drivers were the changes in energy pricing, such as hourly pricing or capacity-based tariffs. Finally, many interviewees pointed out that, although there is not yet a clear growth strategy for the sector, DR is attracting attention because it could be an important business area for Finnish companies.

5.2. Business model innovation patterns and their barriers to growth

The analysis of the interviews with the Finnish DR firms revealed that there are three main patterns of business model innovation, which we label as follows: 1) *phoenix rise*, 2) *business model expansion* and 3) *incumbent catch-up*. We describe these three business model innovation patterns in the next sections. The details of the companies belonging to each of these patterns of business model innovation can be found in appendix.

5.2.1. The phoenix rise

The *phoenix rise* consists of four firms that developed a business model that can be said to have emerged from the 'ashes' of Nokia. The mobile phone company worked on building automation solutions until about 2010. After Nokia's collapse, some of its former engineers established start-up companies and became involved in DR. Besides the four companies that emerged directly from Nokia's ashes, this category also includes two foreign companies that recently entered the Finnish market. The companies in this group share some similar features: They are all new (started after 2010), they are either in the start-up or growth phase (in most cases, under five employees), and they are all in the smart energy domain. Business model innovation in the *phoenix-rise* companies was driven mainly by entrepreneurial factors—the entrepreneurs saw new business opportunities in DR. Other important motivations were environmental values and the desire to be on the technological frontier.

Initially, the *phoenix-rise* companies allocated significant amounts of resources to programming, but once their software had all the fundamental elements working, the programming costs decreased, and they only needed to engage in updates and software maintenance. As the start-up firms in this group grew, their business models evolved from being centred on software development to a more customer-oriented service company utilising ICT and sensor technologies. One interviewee explained their product development in the following way:

> We started from the same principle as when we were developing mobile phones at Nokia in the old times. What is the device, and how does it have to work for me? If it works for me, it should work for many others as well. [Interviewee 2]

Therefore, with time, the companies following the *phoenix-rise* pattern required new knowledge, especially about marketing, customer care, customer needs and technology maintenance. At present, companies in this first group are active in sectors where the DR resources are the heating and cooling of buildings, which can range from small detached houses to large-scale warehouse facilities. Not all the *phoenix-rise* companies have mature business models. Some are still focussing on software development. The *phoenix-rise* companies do not appear to collaborate with each other, although they share similar expectations about the future of the DR sector in Finland.

The business model of the *phoenix-rise* firms relies on the collaboration with incumbent energy actors, such as TSOs, DSOs and energy retailers. Their main source of revenues comes from annual or monthly customer fees for energy services provided to building owners, as well as from selling their software to *incumbent catch-up* companies and *business model expansion* firms (see sections 5.2.2 and 5.2.3). Since the Fingrid markets require minimum aggregation amounts between 0.1 and 5 mW, it is still difficult for the *phoenix-rise* companies to have enough load from their customers to participate in such markets. However, two of them are already taking part in the Fingrid markets, and three more plan to do so in future.

In the current phase of business model development, the *phoenix-rise* firms prefer to collaborate with established energy players because the DR market in Finland is still relatively small and they lack the customer base. However, they plan to gain a wider customer base and independence from the incumbents. One interviewee talked about how the *phoenix-rise* companies are preparing for market disruption:

> We don’t want to shoot ourselves in the foot by going against the business of the energy companies. So, everyone is still waiting. Everyone is getting ready. Everyone knows it [disruption] is coming. Someone in the field will make the first step and then it starts. [Interviewee 3]

The interviews revealed that the further expansion of this business model innovation pattern is hindered by several factors. First, their current business is not profitable in all the market segments. For instance, the household and small enterprises segments are not yet profitable for all companies. Second, there are uncertainties due to a lack of regulation and market volatility. For instance, some interviewees stated that, in the current situation, incumbents benefit from DR services with no payments. Third, customers lack awareness of the benefits of DR services. Fourth, some incumbent energy companies try to retard DR development and have strong lobbying power that threatens the business model of the smaller DR firms. One interviewee explained incumbent energy companies’ opposition to DR as follows:

> There are always opponents to development, people who don’t believe in it [DR] and don’t think it’s necessary. We have also experienced this with Finnish energy companies. Energy companies that are still thinking in an old-fashioned way and are cold towards us. Their reaction is ‘no, there is no need [for DR]’. [Interviewee 1]

5.2.2. Business model expansion

The second development pattern, *business model expansion*, includes 10 companies that have added DR to their service and technology portfolio. These are small and medium-sized enterprises (SMEs) and large international corporations with core business areas in electronics, ICT, building automation, renewable energy and energy services. Therefore, some of the *business model expansion* firms operate in markets adjacent to the DR market, but some of them have their core activities in unrelated sectors. This makes them different from the *phoenix-rise* firms because the former group of companies were initially started to operate in the smart energy and DR sector, while the latter consists of firms already existing and operating in other industries. Their main competences lie in the development of hardware and software that enable the provision of DR

services. These companies have a consolidated customer base, which they use to expand to DR services. Business model innovation in these firms has been driven by their experience in adjacent markets to DR, long-term partnership with energy companies, desire to better serve their customers and environmental and entrepreneurial factors.
It is important to note that, for the *business model expansion* firms, the DR part of their business was typically not yet generating profits at the time of the interviews. This is because these companies are currently using their resources to nurture the DR business before expecting growth and increased revenue streams. Four of the *business model expansion* companies were taking part in the Fingrid markets directly or doing so indirectly through business partners. Two instead planned to join these markets in the near future to increase their business opportunities. In addition, three *business model expansion* firms also captured value by providing DR-enabling technology, mainly for incumbent energy companies.

The interviews revealed that energy companies tend to trust the firms in this category more than they do those in the *phoenix-rise* category. This is because some energy companies have a long history of collaboration with many of the *business model expansion* firms. The relationship of these companies with the incumbents has taken different routes. Whereas some of them started by collaborating with the energy companies and have recently started to compete with them (although not necessarily directly in the energy/DR market, but rather, in providing DR-enabling technologies to end users), others started developing DR services independently from energy companies but have now started to collaborate with them.

The customer relationship strategy of *business model expansion* companies seems to depend on the size of the customer. For instance, they may target households only via *incumbent catch-up* companies but offer services directly to large (e.g. industrial) customers. Some of the companies that have a more competitive strategy in this group have recently started to acquire start-up firms from the *phoenix-rise* group to develop the software and IT platforms; the ultimate aim of doing this is providing DR services directly to the end user. That the *business model expansion* companies are starting to provide their services directly to large customers and not via the energy companies causes tensions and conflicts with them.

> The energy company dared to tell us that they don’t know if they want to continue the collaboration with us because it is difficult for them [to accept] that we have customers without their involvement. […] Then they wanted to negotiate and have lower prices. They said, if you give us a share of profits from your DR customers, we don’t need to renegotiate our agreements. [Interviewee 6]

For the firms in this group, there are also several factors that hinder the growth of their business model. Low profitability, customers’ lack of awareness of the benefits of DR, insufficient regulation and energy companies’ vested interests were the most important barriers. Other hindering factors were the time and resources needed to test new business models, a lack of standardised procedures to connect DR resources and improper working of smart meters. One interviewee pointed out the role of regulation and competition in the following way:

> Now there is uncertainty about the regulation. Payback times have to be really short, because there is no guarantee that the market will still be there in future. […] In the end, if Fingrid and regulation make this [DR] business possible, it [the business] will go to whoever provides it. [Interviewee 4]

5.2.3. Incumbent catch-up

The third business model innovation pattern, *incumbent catch-up*, consisted of six incumbent energy companies that recently developed new business models for DR services. This business model innovation pattern emerged as a response to the *phoenix rise*. Apart from two cases, all the *incumbent catch-up* firms are municipally owned companies. It is important to note that most of the Finnish energy companies are not active in DR. Therefore, the *incumbent catch-up* group consists of the frontrunners. These companies are changing their business models to better adapt to the ongoing changes in the energy markets. One interviewee described the motivation behind this as follows:

> If we stick to our current ways of working and the current energy system, then it’s likely that [in future] there will be surprises and we [may] have lost our competitiveness. So, we try to think about this every day. [Interviewee 9]

Apart from one company, all the *incumbent catch-up* firms operated in both the electricity and district heating markets. In the case of heat production, they used DR to reduce the peak load (and thus their costs): In the short term, covering the peaks may require using generation with higher variable costs. Therefore, handling such variable costs in the long term may require investments in new generation capacity. Another factor that leads energy companies to adopt DR technology is its use for minimising the difference[1] between electricity procurement (i.e. electricity produced independently or bought from the wholesale market) and demand (i.e. the electricity they or their customers use). Some interviewees also mentioned that the new business opportunities related to the possibility of combining DR with hydropower in Fingrid's flexibility markets, need to cut costs to keep customers loyal and decreasing demand for district heating (e.g. due to heat pumps becoming more common) were other drivers of business model innovation.

In general, the business models of the firms in this group are targeted at residential customers. DR is provided as an additional service to energy provision. However, for larger (e.g. industrial) customers, DR services are offered without any energy supply contract. Incumbent energy companies have a solid customer base and marketing channels, but they lack the know-how to aggregate dispersed loads. To overcome this limitation, they collaborate with *phoenix-rise* companies and large ICT firms from the *business model expansion* group. These companies provide the incumbent energy companies with the programming skills, software and hardware needed for operating their DR services. Thus, the *phoenix-rise* companies have access to the *incumbent catch-up* companies' customer base, and they may gain a greater market share in future. Since the *incumbent catch-up* companies can access all electricity marketplaces, they can capture more value than the *phoenix-rise* and *business model expansion* companies can. Under the current market rules, the latter are eligible only for FCR-N and FCR-D markets, whereas in other Fingrid markets, only retailers can aggregate small loads.

Initially, the *incumbent catch-up* companies were not active in DR technology development, but lately, they have started to develop the software as well. Thus, while the *incumbent catch-up*

[1] The larger this difference is, the costlier it is for the energy companies, which are financially liable for the imbalances they cause.

companies started with DR service and then shifted to technological development, the *phoenix-rise* companies started with technological development and then moved into DR service development. One *incumbent catch-up* company interviewee described this shift in the following way:

> Before, we handled the customer process and outsourced the technical solutions. Now, we are responsible for a growing share of the technical part, and we produce the core technical functionalities in house. Thus, our role [in DR] is changing. [Interviewee 7]

The incumbent energy company representatives thought that their companies would be the main providers of DR services in the future, while the *phoenix rise* and *business model expansion* companies would only have a limited role as technology suppliers. To fulfil their strategy, these companies had established start-up companies and acquired or were considering acquiring *phoenix-rise* start-up firms to be ready to assume a dominant position in the market. Despite the long-term collaboration with the *business model expansion* firms, lately, they had had conflicts with some of the firms in that group about their roles in the DR markets.

Although most of the *incumbent catch-up* companies tried to enter a dominant position over the new entrant firms, there was an exception. Interestingly, one of the interviewed incumbent energy companies aligned more with the *phoenix-rise* start-ups than with other *incumbent catch-up* companies. They had sold their electricity sales business and acquired a *phoenix-rise* company; at the time of interview, they were fully focussed on developing novel renewable energy and smart energy services, including DR.

Different from the other two groups of companies, the *incumbent catch-up* companies are highly active in the energy policy arena and have strong lobbying power:

> There are some energy companies that are suspicious and worried, and they do proactive lobbying. They want to ensure that, if there is a change, they will not pay for it. And if someone is benefitting, they want to be involved or ensure that they have the biggest

> benefits. So, they want to prevent anyone else from coming into their territory. [Interviewee 5]

The *incumbent catch-up* company respondents expressed that the energy market regulations were ‘built for them’, so they perceived that the *phoenix-rise* and *business model expansion* firms could threaten their position in the market. One interviewee representing an *incumbent catch-up* company talked explicitly about this:

> Market actors have traditionally had clear roles, but DR is a new technology, so there are third parties [new entrants] distorting the market. This creates disturbance among those for which the regulation was initially created. [Interviewee 10]

However, another interviewee from an *incumbent catch-up* company emphasised that not all the energy companies are trying to resist the change; rather, some have decided to embrace it.

> It does not make sense to fight the change. Energy consumption is decreasing. Either you are part of it or against it. Yes, it is probable that we will sell less energy in the future; all changes around us are pushing in that direction. So, it is a strategic decision to be part of the change. I know that some energy companies are against it because they will sell less energy. [Interviewee 7]

The interviews with the *incumbent catch-up* firms showed that the main obstacles to the growth of their business models for DR are as follows: 1) the lack of awareness and interest combined with scepticism towards DR services, and 2) the lack of standardised procedures for utilising DR resources. Another important factor was that, since most of the *incumbent catch-up* firms are local energy utilities owned by the municipality, they encounter difficulties in scaling up their business model for DR services for heat due to different customer needs (e.g. customers in urban and rural areas) and pricing models in other local markets. Furthermore, while the *phoenix-rise* companies see the *incumbent catch-up* firms receiving free benefits from DR as an obstacle to their growth that, the *incumbent catch-up* companies perceive new entrant firms’ lack of balancing responsibilities as problematic for their business model. Table 2 summarises the main drivers and barriers found for each business model innovation pattern.

Table 2. Summary of the Main Internal/External Drivers of Business Model Innovation and Barriers to Upscaling

Business model innovation pattern	Internal drivers	External drivers	Barriers
Phoenix rise	• Environment • Business opportunity	• Fall of Nokia • Growth of renewables • Digitalisation • Smart meters • Free weather data • R&D projects • Expansion of electric vehicles • Regulation • Developed and open energy markets • Volatility in electricity markets	• Regulation • Free benefits for incumbents • Energy companies' vested interests and lobbying • Customers' lack of awareness/interest • Lack of profitability (e.g. households and small companies) • Company size too small to compete • Installation costs of DR equipment still high • Conflicts between retailers and DSOs and between aggregators and TSOs
Business model expansion	• Experience in adjacent market to DR • Business opportunity (e.g. reserve markets) • Environment • To better serve customers • Partnership with energy companies	• Fall of Nokia • Expansion of electric vehicles • Developed and open energy markets • Growth of renewables • Lowering energy prices • Internet and IT technologies	• Lack of profitability (e.g. in district heating main benefits only from shaving peaks) • Smart meters do not work well for DR • Customers' lack of awareness/interest • Lack of standards in connecting DR resources • Uncertainties due to market volatility and regulation • Energy companies' vested interests and lobbying • Installation costs of DR equipment still high
Incumbent catch-up	• Cost reduction • Business opportunities • Environment • To better serve customers (e.g. through energy packages) • Increased customer loyalty	• Early R&D activities by Nokia • Decreasing demand for heat • Developed and open energy markets • Growth of renewables • Expansion of electric vehicles • Digitalisation • Competition (especially from new entrants and other energy companies) • Volatility in electricity markets	• Customers' lack of awareness/interest • New entrant companies do not carry balancing responsibilities • High costs of technical implementation (e.g. lack of standardisation) • Different customer needs and pricing models

6. Discussion

6.1. Business model innovation patterns and niche–regime dynamics

Each of the business model innovation patterns identified entails a different type of niche–regime interaction. We discuss them here in light of Ingram's (2015) continuum of niche–regime linkage modalities.

In the *phoenix-rise* context, niche innovation mainly emerged from the collapse of a pre-existing industry. This could even be seen as an outcome of a landscape event, since Nokia had 24,400 employees (half of them working in R&D) in Finland in 2000, its peak year, and the company was the main engine of the national economy (Ali-Yrkkö et al., 2017). Firms in *the phoenix-rise* group developed their business model first around software development, with a view to switching to DR service provision. Therefore, the type of underpinning niche–regime interaction started as symbiotic, but it is changing from adaptive to potentially transformative. In the case of *business model expansion*, there was strategic niche involvement of incumbent actors from other industries. Niche–regime interaction has traditionally been symbiotic, but it has shifted towards a coopetitive if not competitive relationship. Finally, in *incumbent catch-up*, niche innovation instead emerged within the regime. Incumbent companies initially collaborated with *phoenix-rise* firms, which provided them with the software to run their DR services. This initial relationship implied a symbiotic interaction; however, as incumbent energy firms are increasingly investing in software development through the acquisition of *phoenix-rise* start ups, the niche–regime relationship is moving towards absorption.

The study results have theoretical implications. First, consistent with Pistorius and Utterback (1997), the findings that niche–regime interaction modes are not constant, but rather, change over time. Second, expanding on Mylan et al. (2018) and Geels (2018), who proposed that niche–regime interaction needs to be analysed in a more symmetrical and bidirectional way, our findings suggest that niche–regime relations can take place multi-directionally. This means that niche–regime interaction can occur from niche to regime (bottom up) and regime to niche (top down), as well as from other regimes (including industries that have declined) to the focal niche (sideways).

The top-down and sideways niche–regime interaction modes are particularly interesting in terms of their potential to accelerate transitions. First, that *incumbent catch-up* firms are involved in niche innovation challenges what Chandy and Tellis (2000) label the 'incumbent curse', that is, the argument that it is the new entrants who introduce disruptive innovation, while incumbents struggle to keep pace with it. Our results suggest that there are differences among incumbent companies. Some can promote radical innovations (Berggren et al., 2015) or even forge alliances with niche actors to promote niche innovations, although the latter strategy may be contingent on firm size and level of sunk investment. Therefore, future research should concentrate on better understanding the antecedents of incumbent companies' involvement in radical niche innovation and determining the factors that lead incumbent companies to change their core business model, as well as the influence this can have on accelerating sustainability transitions. In the sideways interaction mode, companies from adjacent or even other industries promote niche innovation. Although not always, firms from other industries entering the energy sector may enjoy a better reputation than incumbent energy companies do. Therefore, future research could investigate whether the strategic niche involvement of firms from other industries has any effect in terms of accelerating the diffusion of niche innovations.

6.2. Upscaling the potential of the demand response market niche

Our findings do not provide a clear indication of which of the three business model innovation patterns will prevail. The *phoenix-rise* firms still appear too small to compete against incumbents, although they have critical access to the energy companies' customer base. *Business model expansion* firms may choose to continue a coopetitive strategy because they also have an interest in providing DR-enabling technology on a continuing basis. *Incumbent catch-up* companies may assume a predominant position in the market due to their lobbying power and large resources. However, they may have limited interest in rapidly expanding their DR business models due to sunk investments in conventional energy generation, which could be affected by a rapid growth of DR services.

Expanding on Bidmon and Knab (2018), and in line with van Waes et al. (2018), our findings indicate that business model innovation alone may not automatically lead to the institutionalisation of novel technologies. Similarly to van Waes et al. (2018), we find that regulation will play a crucial role in determining which business models will scale up. For instance, the recent EU Directive 2019/944 on common rules for the internal market for electricity established that, in future, all customers must be free to purchase and sell electricity services, including aggregation, independently from their electricity supply contract. Furthermore, the national regulatory frameworks must include new elements, such as aggregators' right to enter electricity markets without other market participants' consent. Once implemented in the member states, these changes will strengthen the position of the *phoenix-rise* and *business model expansion* firms and provide them with better opportunities to expand their business to other countries as well.

We found that, in all the business model innovation patterns, lack of awareness of the benefits connected with DR was a major obstacle. This implies that another important factor for the upscaling of DR business models is market education (Stampfl et al., 2013). If the market is not educated—that is, if prospective customers do not understand why they might need DR services, business model upscaling will remain slow. In addition, the upscaling of DR business models appears to be contingent on the costs of DR equipment for households wanting to participate in DR schemes. The companies we interviewed reported that their customers perceive DR equipment to be expensive in relation to the benefits they receive. This leads to the timely question of the role of finance capital in niche upscaling and acceleration of socio-technical transitions (Köhler et al., 2019).

Beyond the factors discussed above, the development of the DR market may also depend on larger trends in the energy sector since changes in generation infrastructures may both accelerate DR business (i.e. increased need for DR if weather-dependent generation increases) and compete with it in providing balancing services. Furthermore, upscaling possibilities may be influenced by the potential growth of DR services in international markets. Future research could, for instance, explore the role of changes in generation infrastructures and Finland as a lead market for DR.

Although this study represents one of the first attempts towards establishing a better understanding of how business model innovation contributes to the diffusion of DR services, it has two important limitations. First, it considers only the firm's point of view, while the views of DR customers are absent. Second, the energy companies that are part of our sample are only those active in DR. Therefore, the views of the incumbent players we consider are only those of the frontrunner firms. These limitations can be addressed by focussing future research on customers' perceptions of DR services and including the views of policymakers, TSO and energy authority.

7. Conclusions

The aim of this study was better understanding the role of different business model innovation patterns in niche upscaling and breakthroughs. To this end, we studied the nascent Finnish DR industry through the lenses of the MLP and the literature that has used the concept of business models in transition research. We conducted 25 semi-structured interviews with representatives of Finnish DR companies.

The study identified three main business model innovation patterns, which were labelled as follows: 1) *phoenix rise*, 2) *business model expansion* and 3) *incumbent catch-up*. These patterns can be associated with bottom-up, sideways and top-down niche–regime interaction modes, respectively. The findings show that, while the first business model innovation pattern is potentially most disruptive, the latter may prevail due to the strong lobbying power and large resources of incumbent energy companies. Instead, companies following the second business model's innovation pattern may decide to maintain a more neutral position due to their primary interest in providing DR enabling technology. The study suggests that business model innovation per se may not necessarily be sufficient to promote niche upscaling. We found that several barriers, including a lack of awareness of the benefits of DR services and the high cost of DR equipment for householders, hinder market growth.

Altogether, the paper confirms that, in Finland, there is considerable potential for DR in accelerating the transformation of the present energy markets. However, the speed and magnitude of the change brought about by DR will depend not only on business models but also the outcome of the power struggle between new entrants and incumbent players, as well as the consequent type of regulation that will be introduced, market growth potential and degree of societal acceptance.

Appendix

Details of the DR Companies Belonging to Each Business Model Innovation Pattern

Company	Energy market activities	Core DR businesses	Customers (energy end users)	Business model innovation pattern
A	DH DR	Building an automation service package that includes DR	Owners of large buildings	Phoenix rise
B	Electricity: aggregation	Building an automation service package that includes DR, product sales, taking part in Fingrid markets	Owners of large buildings	Phoenix rise
C	DH DR, electricity: spot–price optimisation, planning sub-aggregation	Building an automation service package that includes DR, planning to take part in Fingrid markets	Households	Phoenix rise
D	Electricity: spot–price optimisation, planning aggregation	Building an automation service package that includes DR, planning to take part in Fingrid markets	Households	Phoenix rise
E	Electricity: spot–price optimisation, planning (sub-)aggregation	DR service package for energy end users, planning to take part in Fingrid markets	Households	Phoenix rise
F	Electricity: spot–price optimisation, aggregation and storage	DR service package for energy end users and renewable energy producers, taking part in Fingrid markets	Owners of large buildings	Phoenix rise
G	DH DR	Building an automation service package that includes DR	Households and public buildings	Business model expansion
H	Electricity: spot–price optimisation and aggregation	Building an automation service package that includes DR, product sales, taking part in Fingrid markets	Large and semi-large building owners, piloting with households	Business model expansion
I	DH DR	Building an automation service package that includes DR	Households	Business model expansion
J	Electricity: spot–price optimisation and aggregation	Building an automation service package that includes DR, product sales, taking part in Fingrid markets	Households and owners of large buildings	Business model expansion
K	Electricity: enabling aggregation	Product sales, enabling large customers to take part in Fingrid markets directly	Owners of large buildings	Business model expansion
L	Electricity: spot-price optimisation and aggregation	Demand response service packages for energy end users and energy companies, taking part in Fingrid markets	Owners of large buildings	Business model expansion
M	Electricity: spot–price optimisation and aggregation	Taking part in Fingrid markets, demand response service package for energy companies and building an automation service package for energy end users that includes DR	Households	Business model expansion
N	Electricity: spot–price optimisation, planning (sub-)aggregation	Building an automation service package that includes DR, planning to take part in Fingrid markets	Owners of large buildings	Business model expansion
O	DH DR	Building an automation service package that includes DR	Owners of large buildings	Business model expansion
P	Electricity	Product sales, business to business DR services	-	Business model expansion
Q	DH DR in development phase, electricity: spot–price optimisation, aggregation	Electricity tariff with DR incentives (DR enabling technology via a partner), taking part in Fingrid markets	Electricity: Households (own energy customers), large buildings	Incumbent catch-up
R	Electricity: spot–price optimisation, aggregation	Electricity tariff with DR incentives (DR enabling technology via a partner), taking part in Fingrid markets	Households (own energy customers), large buildings	Incumbent catch-up

S	Electricity: spot–price optimisation, aggregation	Management of customer's multiple resources (loads, generation, storages)	Households and large buildings (NOTE: no own electricity customers)	Incumbent catch-up
T	Electricity: spot–price optimisation, aggregation	DR service package for electricity end users, taking part in Fingrid markets	Households (own energy customers) and large buildings	Incumbent catch-up
U	DH DR	DR as a part of heating service (main focus on cost savings)	Own DH customers (main focus on large buildings)	Incumbent catch-up
V	DH DR	Building an automation service package that includes DR (improved living conditions and cost savings)	Own large DH customers (large buildings)	Incumbent catch-up

Large buildings, e.g. rental housing, housing corporations, schools, supermarkets, shopping malls, hospitals, industrial buildings
DH = district heating
DR = demand response

References

Ali-Yrkkö, J., Lehmus, M., Rouvinen, P., Vihriälä, V., 2017. Riding the wave—Finland in the changing tides of globalisation. Helsinki: Taloustieto Oy.

Belonogova, N., Valtonen, P., Tuunanen, J., Honkapuro, S., Partanen, J., 2013. Impact of market-based residential load control on the distribution network business. Proceedings of 22nd International Conference on Electricity Distribution (CIRED 2013), Stockholm, pp. 1-4.

Berggren, C., Magnusson, T., Sushandoyo, D., 2015. Transition pathways revisited established firms as multi-level actors in the heavy vehicle industry. Research Policy, 44(5), 1017-1028.

Bidmon, C.M., Knab, S.F., 2018. The three roles of business models in societal transitions: New linkages between business model and transition research. Journal of Cleaner Production, 178, 903-916.

Bolton, R., Hannon, M., 2016. Governing sustainability transitions through business model innovation: Towards a systems understanding. Research Policy, 45, 1731-1742.

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. Journal of Cleaner production, 45, 9-19.

Chandy, R.K., Tellis, G.J., 2000. The incumbent's curse? Incumbency, size, and radical product innovation. J. Market., 64, 1-17.

Chen, B., Sintov, N., 2016. Bridging the gap between sustainable technology adoption and protecting natural resources: Predicting intentions to adopt energy management technologies in California. Energy Research & Social Science, 22, 210-223.

Chesbrough, H., 2010. Business model innovation: Opportunities and barriers. Long Range Planning, 43(2-3), 354-363.

Chesbrough, H., Rosenbloom, R.S., 2002. The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. Industrial and Corporate Change, 11(3), 529-555.

Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU (recast).

Elzen, B., van Mierlo, B., Leeuwis, C., 2012. Anchoring of innovations: Assessing Dutch efforts to harvest energy from glasshouses. Environmental Innovation and Societal Transitions, 5, 1-18.

Energy Authority, 2019. National report 2018 to the Agency for the Cooperation of Energy Regulators and to the European Commission—Finland. https://energiavirasto.fi/documents/11120570/13026619/National+Report+2019+Finland.pdf/afd6e187-3f84-fac8-0895-896c6d897247/National+Report+2019+Finland.pdf.pdf (accessed 13 August 2019)

Fingrid, 2018. Finland a trailblazer in demand-side management in Europe. https://www.fingrid.fi/en/pages/news/news/2018/finland-a-trailblazer-in-demand-side-management-in-europe--transformation-of-power-system-calls-for-major-changes-in-electricity-market-structures/ (accessed 30 May 2019).

Fingrid, 2019a. Market places. https://www.fingrid.fi/en/electricity-market/demand-side-management/market-places/ (accessed 13 August 2019)

Fingrid, 2019b. Aggregation pilot project in the balancing energy market continues. https://www.fingrid.fi/en/pages/news/news/2019/aggregation-pilot-project-in-the-balancing-energy-market-continues/ (accessed 14 August 2019)

Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. Research Policy, 31(8-9), 1257-1274.

Geels, F.W., 2005. The dynamics of transitions in socio-technical systems: A multi-level analysis of the transition pathway from horse-drawn carriages to automobiles (1860–1930). Technology Analysis & Strategic Management, 17(4), 445-476.

Geels, F.W., 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. Environmental Innovation and Societal Transitions, 1(1), 24-40.

Geels, F.W., Schot, J., 2007. Typology of sociotechnical transition pathways. Research Policy 36, 399-417.

Geels, F.W., Sovacool, B.K., Schwanen, T., Sorrell, S., 2017. The socio-technical dynamics of low-carbon transitions. Joule, 1, 463-479.

Guelpa, E., Marincioni, L., Deputato, S., Capone, M., Amelio, S., Pochettino, E., Verda, V., 2019. Demand side management in district heating networks: A real application. Energy, 182, 433-442.

Hannon, M., 2012. Co-evolution of innovative business models and sustainability transitions: The case of the Energy Service Company (ESCo) model and the UK energy system. University of Leeds.

He, X., Hancher, L., Azevedo, I., Keyaerts, N., Meeus, L., Glachant, J.-M., 2013. Shift, not drift: Towards active demand response and beyond. http://www.eui.eu/Projects/THINK/Documents/Thinktopic/Topic11digital.pdf (accessed 27 August 2019)

Heleno, M., Matos, M.A., Lopes, J.A.P., 2016. A bottom-up approach to leverage the participation of residential aggregators in reserve services markets. Electric Power Systems Research, 136, 425-433.

Huttunen, S., 2014. Stakeholder frames in the making of forest bioenergy legislation in Finland. Geoforum, 53, 63-73.

IEA, 2018. CO_2 emissions statistics. https://www.iea.org/statistics/co2emissions/ (accessed 17 May 2019)

Ingram, J., 2015. Framing niche–regime linkage as adaptation: An analysis of learning and innovation networks for sustainable agriculture across Europe. Journal of Rural Studies, 40, 59-75.

Kemp, R., Rip, A., Schot, J., 2001. Constructing transition paths through the management of niches. In R. Garud & P. Karnoe (Eds.) Path dependence and creation. London: Lawrence Erlbaum, pp. 269-299.

Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Nykvist, B., Pel, B., Raven, R., Rohracher, H., Sandén, B., Schot, J., Sovacool, B., Turnheim, B., Welch, D., Wells, P., 2019. An agenda for sustainability transitions research: State of the art and future directions. Environmental Innovation and Societal Transitions, 31, 1-32.

March, J.G., 1991. Exploration and exploitation in organizational learning. Organ. Sci., 2(1), 71-87.

McKenna, E., Thomson, M., 2014. Demand response behavior of domestic consumers with photovoltaic systems in the UK: An exploratory analysis of an internet discussion forum. Energy, Sustainability & Society, 4, 1-12.

Mylan, J., Morris, C., Beech, E., Geels, F.W., 2019. Rage against the regime: Niche–regime interactions in the societal embedding of plant-based milk. Environmental Innovation and Societal Transitions, 31, 233-247.

O'Connell, N., Pinson, P., Madsen, H., O'Malley, M., 2014. Benefits and challenges of electrical demand response: A critical review. Renewable and Sustainable Energy Reviews, 39, 686-699.

Osterwalder, A., 2004. The business model ontology: A proposition in a design science approach. Université de Lausanne.

Osterwalder, A., Pigneur, Y., 2010. Business model generation: A handbook for visionaries, game changers, and challengers. John Wiley & Sons, Hoboken, New Jersey.

Pistorius, C.W.I., Utterback, J.M., 1997. Multi-mode interaction among technologies. Research Policy, 26, 67-84.

Ruggiero, S., Lehkonen, H., 2017. Renewable energy growth and the financial performance of electric utilities: A panel data study. Journal of Cleaner Production, 142, 3676-3688.

Safdarian, A., Fotuhi-Firuzabad, M., Lehtonen, M., 2014. Impacts of time-varying electricity rates on forward contract scheduling of DisCos. IEEE Transactions on Power Delivery, 29, 733-741.

Safdarian, A., Fotuhi-Firuzabad, M., Lehtonen, M., 2016. Benefits of demand response on operation of distribution networks: a case study. IEEE Systems Journal, 10, 189-197.

Sarasini, S., Linder, M., 2018. Integrating a business model perspective into transition theory: The example of new mobility services. Environmental Innovation and Societal Transitions, 27, 16-31.

Schaefers, T., 2014. Standing out from the crowd: Niche product choice as a form of conspicuous consumption. European Journal of Marketing, 48, 1805-1827.

Schaltegger, S., Lüdeke-Freund, F., Hansen, E.G., 2016. Business models for sustainability: A co-evolutionary analysis of sustainable entrepreneurship, innovation, and transformation. Organ. Environ., 29, 264-289.

Schot, J., Kanger, L., Verbong, G., 2016. The roles of users in shaping transitions to new energy systems. Nature Energy, 1, 1-7.

SEDC, 2015. Mapping demand response in Europe today 2015. http://www.smarten.eu/wp-content/uploads/2015/09/Mapping-Demand-Response-in-Europe-Today-2015.pdf (accessed 27 August 2019)

SEDC, 2017. Explicit demand response in Europe—Mapping the markets 2017. http://www.smarten.eu/wp-content/uploads/2017/04/SEDC-Explicit-Demand-Response-in-Europe-Mapping-the-Markets-2017.pdf (accessed 13 August 2019)

Smith, A., 2007. Emerging in between: The multi-level governance of renewable energy in the English regions. Energy Policy, 35, 6266-6280.

Smith, A., Raven, R., 2012. What is protective space? Reconsidering niches in transitions to sustainability. Research Policy, 41, 1025-1036.

Stampfl, G., Prügl, R., Osterloh, V., 2013. An explorative model of business model scalability. International Journal of Product Development, 18, 226-248.

Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Planning, 43, 172-194.

Tongur, S., Engwall, M., 2014. The business model dilemma of technology shifts. Technovation, 34, 525-535.

Unruh, G.C., 2000. Understanding carbon lock-in. Energy Policy, 28, 817-830.

Wainstein, M.E., Bumpus, A.G., 2016. Business models as drivers of the low carbon power system transition: a multi-level perspective. Journal of Cleaner Production, 126, 572-585.

van den Bosch, S., Rotmans, J., 2008. Deepening, broadening and scaling up: A framework for steering transition experiments. Knowledge Centre for Sustainable System Innovations and Transitions, TNO Strategy and Policy. https://repub.eur.nl/pub/15812/ (accessed 23 November 2018)

van Waes, A., Farla, J., Frenken, K., de Jong, Jeroen P. J., Raven, R., 2018. Business model innovation and socio-technical transitions. A new prospective framework with an application to bike sharing. Journal of Cleaner Production, 195, 1300-1312.

Zott, C., Amit, R., 2010. Business model design: An activity system perspective. Long Range Planning, 43, 216-226.

Aalto-BE 2/2020

ISBN 978-952-64-0041-9 (pdf)
ISSN 1799-4829 (pdf)

Aalto University
School of Business
Department of Management Studies
www.aalto.fi

ART +
DESIGN +
ARCHITECTURE

SCIENCE +
TECHNOLOGY

CROSSOVER

DOCTORAL
DISSERTATIONS