Journal of Business Models (2019), Vol. 7, No. 1, pp. 13-38

Business Models for Sustainability—Change in Dynamic Environments

Jessica Lagerstedt Wadin [1] and Kajsa Ahlgren Ode [2]

Abstract

Purpose: The purpose of this paper is to enrich the debate on business models for sustainability in contingent situations.

Approach: We employ literature on business models for sustainability and a contingency framework advanced in previous literature. We apply qualitative methods and investigate multiple cases of business models for sustainability dynamics in contingent situations and examine how four solar companies manage to align their business models with changes in the business environment.

Findings: We provide detailed insights into business model for sustainability changes, made to align to dynamic environments, as well as empirical evidence that confirms and supports the contingency framework on business model dynamics and how it can be extended. Adding a conceptual framework helps to understand the roles of the components in more detail, revealing that each component can face multiple environmental dynamics. For example, dramatically reduced policy-supporting schemes and customers wanting to be green led to adjustments to the value proposition and the revenue model. All companies in this study developed sensitivity toward intangible customer values and needs and tried to incorporate the customer experience into their business models. We therefore suggest *customer sensitivity* as a way to better understand the interaction between the firm and the customer.

Originality: Combining contingency theory and business models for sustainability approaches provides a novel way of studying and explaining alternative modes of sustainable value creation. Jointly, our findings provide new detailed insights on business models for sustainability changes in dynamic environments.

Keywords: business model dynamics; business models for sustainability; contingency theory; solar energy

Please cite this paper as: Wadin, J. L. and [1] and Ode, K. A. (2019), Business models for sustainability - change in dynamic environments, Vol. 7, No. 1, pp. 3-38

1–2 Innovation Engineering, Department of Design Sciences, Lund University, tel: +46 76 7682841, jessica.wadin@design.lth.se; tel: +46 734 207002, kajsa.ahlgren@design.lth.se

Acknowledgements: The authors acknowledge the financial assistance of research by grant P 40639-1 from Swedish Energy Agency. We are also grateful for valuable feedback from anonymous reviewers on how to improve the paper. A special thanks to Prof. Lars Bengtsson for valuable discussions on contingency theory perspectives.

INTRODUCTION

Scholars increasingly recognize that business models can constitute an important link in transforming high potential sustainable ideas to marketable sustainable innovations (cf. Boons & Lüdeke-Freund, 2013; Stubbs and Cocklin, 2008) and in scaling up sustainable solutions, thereby contributing to the sustainable transformation of markets and society (cf. Wadin et al. 2017; Schaltegger et al, 2016a). The literature on business models and business models for sustainability has, however, often focused on then business model outcome, rather than acknowledging the continuous adjustments made to business models (Teece, 2018; Evans et al., 2017; Foss and Saebi, 2017). These adaptations are due to different market circumstances (e.g., Johnson et al., 2008; Voelpel et al., 2004), especially the changing conditions associated with the adaptive transformation that characterizes sustainable development (Roome and Louche, 2016). In their review of the business model innovation literature, Foss and Saebi (2017) suggest there is a need for further research on contingency and moderating variables (macro-, firm-, and micro-level moderators) influencing business model innovation. Haas (2018) argue that it is essential to determine the interaction effects between business model components to predict the effects of business model change. In addition, Strupeit and Palm (2016) point to a lack of research on the dynamics of business models for solar photovoltaics (PV)[1] and to the response of business models to changes in the business environment. Although earlier studies on business models for solar PV contribute to our understanding of drivers and barriers for bringing PV technology to the market in different countries (cf. Strupeit and Palm, 2016; Ahlgren et al., 2015; Karakaya and Sriwannawit, 2015), they do not explore how business models for sustainability change in response to environmental contingencies. This understanding is essential for the future success and development of new business models for sustainability, as well as for current business models for sustainability, to adapt to maturing market conditions (Strupeit and Palm, 2016; Overholm, 2015). It further influences the potential success of business models for solar PV developed on new markets with differing conditions. Business models for sustainability, in general, and business models for solar PV, in particular, illustrate the importance of considering the value destroyed by maintaining an old, less sustainable business model (Evans et al., 2017; Roome and Louche, 2016). The energy sector contributes to one fourth of global GHG emissions (IPCC, 2014), so to increase the use of renewable sources and create a shift in the energy sector is of great importance. Hence, by leading to a reduction of destroyed value, an increased understanding of business models for sustainability will decrease environmental and social damage.

In this paper, we respond to current calls for studies on business model change in contingent situations (Teece, 2018; Foss and Saebi, 2017), especially business models for sustainability (Evans et al., 2017) and solar PV (Strupeit and Palm, 2016). We do this by exploring multiple cases of business models for sustainability dynamics in contingent situations. Provided the rapidly changing circumstances on the residential solar energy markets in Germany and California during the last decade, these two markets constitute suitable settings for our study. The Californian market can be described as a high-velocity marketplace with intense competition, whereas the German market has gone through a major regulatory shift and discontinuous transformation. The term business model change is used as an umbrella term for business model evolution, business model adaption and business model innovation, and the term change is interchangeably used with adjustment.
To achieve the aim of enriching the debate on business models for sustainability in contingent situations, this paper answers the following research questions:

1. What environmental dynamics, i.e., what relevant market drivers, prompt business model change?
2. What kind of business model changes do they cause? and
3. What kind of dynamic capabilities are needed to manage those changes?

Building on a contingency framework on business model dynamics provided by Saebi (2015), we investigate business model changes for solar PV under two distinct market conditions. This conceptual framework was developed to understand the conditions in the business environment that prompt different types of business model change and the dynamic capabilities

[1] PV = Photovoltaics; a system generating electricity from solar radiation

that support this business model change (Saebi, 2015). We apply the contingency framework as a lens to analyze the business model dynamics of our four business model for sustainability cases as they develop.

The paper consists of five additional sections. Next, we provide a theoretical background to business models, business models for sustainability, business models and residential solar PV, and a contingency framework on business model dynamics. Thereafter, we present the case-study setting, methods applied, followed by the results of the study. We then discuss the implications of our research and end with the contribution to literature, limitations, and avenues for future research.

THEORETICAL BACKGROUND

The business model concept

The business model concept has gained increased attention as a unit of analysis among both academics and practitioners during the last 20 years (for a review, see, e.g., Massa et al., 2017; Wirtz et al., 2016; Zott et al., 2011). Scholars from various fields participate in the discourse on the topic, which has led to a heterogeneous understanding of the concept and a realization that terms and definitions are not always consistently applied (Massa et al., 2017). However, scholars seem to agree that the business model offers a system-level and holistic approach to how firms do business and that an emphasis on customer value creation is central (Zott et al., 2011). A number of studies have especially pointed to the importance of understanding who the customers are and engaging in their needs (Baden-Fuller and Haefliger, 2013; Magretta, 2002), creating customer surplus (Zott and Amit, 2010), and delivering customer satisfaction (Baden-Fuller and Haefliger, 2013). According to Foss and Saebi (2017), there seems to be a convergence toward a unified understanding that the business model involves how a company creates, captures, and delivers value (Teece, 2010). Moreover, there are four constructs commonly defined as part of the business-model concept, namely, value proposition, business structure, customer interface, and revenue model (c.f. Osterwalder et al., 2005; Chesbrough & Rosenbloom, 2002). In this four-component framework, the *value proposition* is the value that the firm offers the customer with its products and/or services. A firm's *business structure* explains how the firm delivers value to the customer (key resources, activities, and partnerships). The *customer interface* constitutes communication channels, market segments, and customer relationships, and the *revenue model* describes the financial set-up, i.e., costs and benefits from the other business model elements and their distribution across business model stakeholders.

Business models for sustainability

A decade ago, Stubbs and Cocklin (2008) introduced the concept of business models in the sustainability literature. Various attempts have been made to define a sustainable business model (c.f. Raith and Siebold, 2018; Schaltegger et al., 2016a; Lüdeke-Freund, 2013; Stubbs and Cocklin, 2008), and the "sustainable business model" concept is emerging and evolving (Breuer et al., 2018; Dentchev et al., 2018; Lüdeke-Freund and Dembek, 2017). One stream of literature stresses the importance of incorporating a triple bottom line approach, including a wide range of stakeholder interests, environment and society (cf. Schaltegger et al., 2016b; Bocken et al, 2014). Boons & Lüdeke-Freund (2013), on the other hand, suggest that a business model for sustainability can be considered a vehicle to bring sustainable innovations – technological, organizational, or social in character – to the market. Building on the four components presented in the business model literature, they extend them to include social and environmental value creation. They propose that the *value proposition* generates social and/or environmental value in addition to economic value, and that the *business structure* (in Boons and Lüdeke-Freund, 2013, called the *supply chain* or *business infrastructure*) concerns how value is delivered to the customer in a responsible way. The *revenue model* (in Boons and Lüdeke-Freund, 2013, called the *financial model*) covers how value – economic, social, and environmental – is captured both within the firm and among its stakeholders, and the *customer interface* includes how the firm communicates with customers and motivates them to consume in a responsible way.

Similar to business model literature in general, business models for sustainability are also underpinned by the concept of values, e.g., to support the value proposition to the customer (Evans et al., 2017). While the concept of the business model has been specifically focused on the realization of economic value (Chesbrough and Rosenbloom, 2002), business models for sustainability have looked at the concept of value through other lenses too, e.g., societal and environmental (Evans et al., 2017).

In this study, we rely on the broad definition of a business model for sustainability provided by Boons and Lüdeke-Freund (2013, p. 10), who argue that the business model can constitute an important link in transforming high-potential sustainable ideas to marketable sustainable innovations, i.e., through business model innovation, companies can commercialize new sustainable technologies. Hence, the definition is relevant for the spread of solar PV. Furthermore, this four-component framework provides a useful lens to analyze business model component change.

Business models and residential solar PV

During the last decade, the rapid growth of residential solar energy markets in countries and regions such as Japan, the Netherlands, Germany (DE), and California (CA) have contributed to a rapid development of PV technology, a globalization of the value chain, and an enormous price reduction for modules, as well as a development of business models for bringing solar PV to the residential market. Even though business models have shown the potential to bring PV technology to the market (cf. Strupeit and Palm, 2016; Ahlgren et al., 2015; Overholm, 2015), they are continuously subjected to conditional changes in their business environment. For example, the rapidly falling prices of PV systems, policy changes, and hypercompetition, are changes to which the firms have to adapt their business models in order to survive, and for PV to diffuse on the market.

Various types and characteristics of business models and markets for solar energy deployment have been studied, for example, energy communities (Hamwi and Lizarralde, 2017), cross-sales offers (Strupeit and Palm 2016), Products Service System (PSS2) (Overholm, 2015), and host-owned offers (Strupeit and Palm, 2016). In the energy community business model, resources are pooled and shared between the community members, allowing citizens the opportunity to participate according to their financial capacity (Hamwi and Lizarralde, 2017). In the cross-sales model, the PV system is included in another offer, such as prefabricated homes, which allows companies dedicated to non-PV-related activities to capitalize on existing customer loyalty and relationships, which reduces the cost for customer acquisition (Strupeit and Palm, 2016). Overholm (2015) examined how various alliances for initiating and offering PSS in California can contribute to firm performance. In a PSS or Third Part Ownership (TPO3) offering, which is an example of service-based business models (Kindström, 2010), the firm offers a service instead of a product and transforms the up-front investment of the product into a monthly fee for the service, which also removes hassles with maintenance and other ownership-related issues (Strupeit and Palm, 2016). Another type of non-purchase business model is the Power Purchase Agreement (PPA4), which is an electricity contract between two parties, a seller and a buyer, where the buyer agrees to buy all electricity produced (from the PV system installed on the buyer's roof) at a predetermined price. In the host-owned business model (Strupeit and Palm, 2016), sometimes referred to as plug and play (Provance et al., 2011) or customer-owned business model (Huijben and Verbong, 2013), focus is on the traditional method of direct product purchase to turn the consumer into a prosumer (customer and producer at the same time). Strupeit and Palm (2016) explored a host-owned feed-in model in Germany and a PSS model in California, and they identified a wide range of factors in the specific national and contextual conditions that shape the business model design, such as homeowners' savings rate, access to capital, how accustomed the customers are to leasing in general, and national policy instruments to build the revenue model. Ahlgren et al. (2015) and Provance et al. (2011) showed that business model development differs between markets and depends on the local context. Even though these studies thoroughly address various types of stakeholder collaborations, alliances, and barriers to overcome renewable energy diffusion, they only provide a snapshot of a

[2] PSS = Products Service System; the firm offers a service instead of a product and transforms the up-front investment into a monthly fee

[3] TPO = Third Part Ownership; a kind of PSS where a third party owns the product or system

[4] PPA= Power Purchase Agreement; a kind of TPO, an electricity contact between two parties, a seller and a buyer, where the buyer agrees to buy all electricity produced (from the PV system installed on the buyer's roof) at a predetermined price

specific moment in time and, therefore, offer limited insights on business-model dynamics in the perspective of business environment change.

A contingency framework on business model dynamics

Contingency theorists argue that, since the fit of organizational characteristics to contingencies leads to high performance, organizations seek to attain fit (c.f. Donaldson, 2001). In line with this reasoning, organizations are motivated to avoid misfit, which results after contingencies change. Hence, an organization becomes shaped by its contingencies. Contingency theory contains the environment (Burns and Stalker, 1961), organizational size (Child, 1974), and organizational strategy (Chandler, 1962). For example, environmental stability, e.g., the rate and amplitude of change in competition or a technological breakthrough, affects whether the structure of the organization is mechanistic (i.e., hierarchical) or organic (i.e., participatory; Burns and Stalker, 1961), (Pennings, 1992). Pugh and Hickson (1976) argue that, as a hierarchical approach is efficient for routine operations, a mechanistic structure fits a stable environment, while an organic structure fits an unstable environment as a participatory approach is required for innovation. In an early work by Lawrence and Lorsch (1969), they suggest that each organizational unit in a firm needs to anticipate the relevant environmental changes of its relevant environmental sector.

The emergence of business models has, however, predominantly been viewed from a static perspective (Amit and Zott, 2011). Even though this static view is about to be replaced by a dynamic and transformational take on business models (cf. Haas, 2018; Doz and Kosonen, 2010; Sosna et al., 2010; Teece, 2010), there is a need to study business models from a more dynamic perspective (Teece, 2018; Saebi, 2015).

To better understand what conditions in a firm's external environment prompt different types of business model change and the dynamic capabilities that support these changes, Saebi (2015) introduced a contingency framework on business model dynamics. This framework builds on a comprehensive literature review and constitutes three parts (see Tab. 1.). It uses a business model definition that includes the firm's configuration of intra- and extra-organizational activities and relations geared toward creating, delivering, and capturing value.

The first part of the framework, *environmental dynamics* (Venkatraman and Prescott, 1990) identifies different types of environmental change that prompt business model change, i.e., opportunities and threats in the firm's external environment (Saebi, 2015). The occurrence of business model change can be attributed to different environmental conditions, e.g., change in competition or a technological breakthrough, meaning that the business model needs to be matched with adjustments to the firm's business model to purposefully reflect the new circumstances (Doz and Kosonen, 2010; Teece, 2010). Regular environmental change refers to stable environments with low-intensity gradual changes (Suarez and Oliva, 2005), where the pattern of change is highly predictable, the pace of change

	Environmental dynamics		
	Regular environmental change	**Environmental competitiveness**	**Environmental shift**
Type of business model change	Business model evolution (BME)	Business model adaption (BMA)	Business model innovation (BMI)
Type of dynamic capability	Evolutionary change capability	Adaptive change capability	Innovative change capability
Underlying capability dimension	Dynamic consistency	Customer agility, strategic flexibility, exploitation	Exploration, business model know-how, dedicated org. units for BMI

Table 1: Contingency framework on business model dynamics (Saebi, 2015)

is slow, and the amplitude is limited. Hence, the need for business model changes is related to incremental adjustments and improvements. Environmental competiveness is characterized by periodically changing competitive demands and high-velocity environments in perpetual flux or churn (Eisenhardt and Tabrizi, 1995). Intense competition (Matusik and Hill, 1998; Miller, 1987) is, furthermore, often associated with intensive pressure for higher efficiency and lower prices (Pablo et al., 2007; Matusik and Hill, 1998). This situation is sometimes referred to as *hypercompetition* (Brown and Eisenhardt, 1997; Eisenhardt and Tabrizi, 1995; D'Aveni, 1994) or *environmental turbulence* (Easterby-Smith et al., 2009). Thus, firms need to quickly change their business models to the new market demands (Saebi, 2015). Environmental shifts can be described as dramatic or discontinuous change to a firm's environment, e.g., by disruptive technologies (Tushman and Anderson, 1986), new competitors (Simon et al., 2007), or major regulatory or political regime changes (Dixon et al., 2013; Suarez and Oliva, 2005). These shifts appear infrequently and rarely repeat themselves. Moreover, they are highly unpredictable and cause a high degree of instability in the environment (Dess and Beard, 1984). Such situations require firms to make changes along multiple dimensions of their business models, often including radical changes in the organization and a shift in a firm's core values and beliefs, as well as the firm's strategy, structure, and control systems (Agarwal and Helfat, 2009).

The second part deals with types of *business model change*, which can be defined as the process by which management actively alters the intra- and/or extra-organizational systems of activities and relations of the business model in response to changing environmental conditions (Saebi, 2015). The kind of changes caused in the business model are dependent on the pace, frequency, amplitude, predictability, and velocity of disturbance in the external environment (cf. Doz and Kosonen, 2010; Teece, 2010; Bourgeois and Eisenhardt, 1988). Three types of business model change processes are identified in the business model literature: business model evolution (BME) (Demil and Lecocq, 2010), business model adaption (BMA) (Teece, 2010; Sosna et al., 2010), and business model innovation (BMI) (Chesbrough, 2010). *Evolution* refers to the effective implementation and maintenance mode of an existing business model occurring under stable conditions and low-intensity gradual changes (Demil and Lecocq, 2010). BMA refers to the need for continuous change to attain alignment with changing market conditions (Sosna et al. 2010; Teece, 2010), often associated with intensive pressures for higher efficiency and lower prices (Matusik and Hill, 1998). *BMI* is the need for creating disruptive innovation in response to dramatic and discontinuous changes in market conditions (Chesbrough, 2010), a so-called environmental shift, which could be brought about by disruptive technologies (Tushman and Anderson, 1986), new competitors, or major regulatory changes.

The third part constitutes *dynamic capabilities*, which is defined as the "capacity of an organization to purposefully create, extend or modify its resource base" (Helfat et al., 2007, p. 4). Furthermore, a firm's capabilities are involved when business model changes are translated into organizational transformation, requiring excellent asset orchestration skills to effectively manage new business structures (Tecce, 2018). Like dynamic capabilities, a firm's abilities to change its business model effectively (Demil and Lecocq, 2010; Doz and Kosonen, 2010) are underpinned by managerial skills and organizational routines (Teece, 2007). While skills are embodied in individuals, routines are found at the organizational level, operating as rules of conduct or best practices for the members of the organization (Saebi, 2015). Saebi (2015) suggests that firms should, therefore, cultivate preparedness for business model change by developing a *business model change capability* that enables them to change their business models in a systematic efficient and organized way. *Evolutionary change capability* is centered around the standardization, implementation, and maintenance of the existing business model. Doz and Kosonen (2010) suggest a *dynamic consistency capability* embodied in managers' understanding of what their BM is and how it works, and how to fine-tune and make their BM effective and preserve its efficiency (p. 243). *Adaptive change capability* is related to sensing and quickly responding to changes in customer preferences (Day, 1994; Jayachandran et al., 2004). These capabilities are manifested in sensing and responding capabilities (Teece, 2007), and they relate to a firm's ability to quickly scan, learn, and interpret market and competitors' movements, as well as the ability to mobilize the firm's current resources and processes to respond quickly to these movements, sometimes also referred to as *organizational agility* or *customer agility* (cf. Haeckel, 1999; Zaheer and Zaheer, 1997). These types of capabilities are building on search for routines (Helfat, 1998) or exploitative learning (March, 1991) and are found both on the organizational level, as well as on the individual level. Given that environmental shifts are often brought about by radical changes in the marketplace, business model innovation can enable firms to get ahead of the competition, requiring *innovative change capabilities*. Under such circumstances, exploratory learning processes become central, both on a cognitive (individual) and organizational level. Managements' extensive understanding of the firm's business model and underlying assumptions, and dedicated organizational units for explorative learning are important factors for innovative change.

CASE STUDY SETTING

An in-depth background to the environmental dynamics of the Californian and German solar PV markets is provided in this section, as well as business model characteristics during the stable period before environmental change. A brief background to the four company settings (the names are fictitious) in which we study our business model cases is also presented.

Market background

The Californian residential solar PV market

After failed efforts to deregulate the Californian energy market in the late 1990s, the market is now regulated again, and a few utilities provide energy to residential customers. The pricing is set in negotiation between the utilities and the Californian government and follows a tier system, meaning that the price per kWh increases according to the more energy a household consumes.

Solar energy is seen as the primary opportunity to shift towards renewable energy sources in California, and national incentives, in combination with state subsidies, have created an opportunity for new businesses to enter the solar energy market. National subsidies provide a tax reduction on the installation, and since 1996, net-metering (NEM[5]) allows Californian residential customers to consume the same amount of energy they feed into the grid at zero cost (SEIA). This has created incentives for residential customers to reduce their use of energy provided by utilities, i.e., to reach a lower tier and thereby decrease their electricity bill. Due to the monopoly-like situation on the market, utilities are not allowed to enter the Californian residential solar energy market.

In 2005, solar PV start-ups adopted a business model for leasing that was previously applied on cars and heat pumps, for example (Overholm, 2015). The so-called TPO business model turned out to effectively address barriers for residential customers to "go solar" by making it possible to install a PV system without any initial down payment (Strupeit and Palm, 2016). Rather, a third party financed and owned the system, while the customer paid a monthly fee over a 20-year period to cover the costs. Based on the four components of the business model presented in this paper, the TPO business model can be described as follows. The *value proposition* consisted of a turnkey solution with an immediate electricity cost saving, no upfront cost, a predictable electricity cost over a 15- to 25-year period, including maintenance and guarantees. The *customer interface* included door-to-door sales, advertising campaigns, and retail store partnerships. The *business structure* was built on a partner network of PV panel suppliers, PV system installer and maintenance firms, insurance companies, and financial institutions. The *revenue model* consisted of periodical payments associated with the TPO fee, covering all costs included and expected interest rates on invested capital.

Hence, in California, a plethora of sunny days, supportive solar energy policies, statewide carbon reduction targets, and renewable energy goals contributed to long-term favorable market conditions. Net-metering and tax reduction incentives in combination with falling technology prices and rising electricity prices (see Fig 1) laid the foundation for the introduction of a TPO offer on the Californian market.

[5] NEM = net-metering, which allows customers to consume the same amount of energy they feed into the grid at zero cost

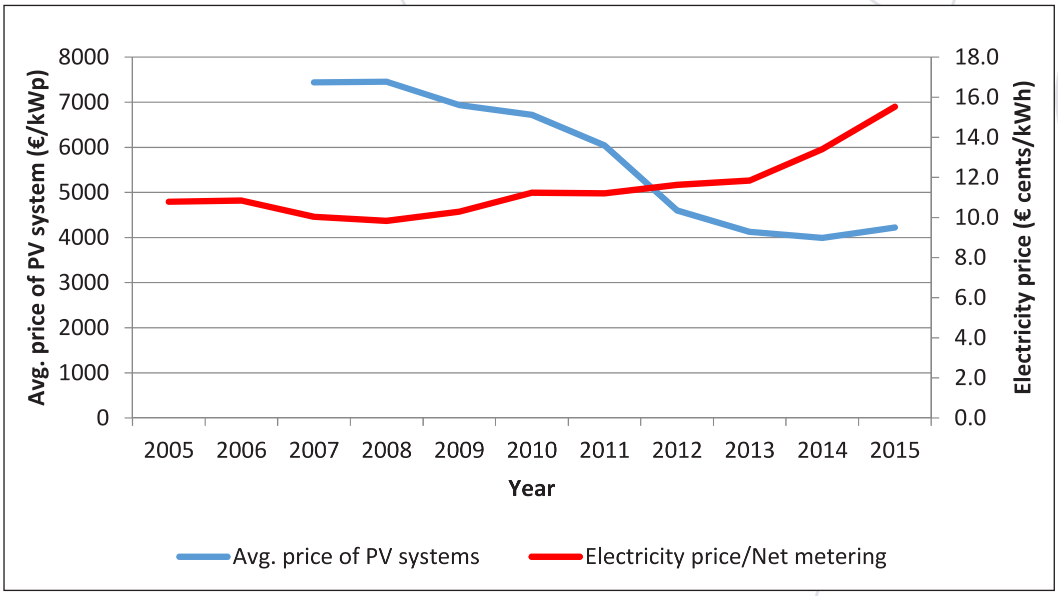

Figure 1: Graphical illustration of the development of electricity price, net-metering, and price of PV systems in California. The blue line refers to the average price of PV systems in €/kWp, and the red line refers to the electricity price / net-metering, €/kWh

Company 1 - business model case California Horizontal TPO

California Horizontal was established in California in 2007. Their mission is to make as many people as possible "go solar" and to create a global network of distributed solar PV through their business model. In California, they primarily focus on a TPO offer. Their global network is dependent on partnerships with suppliers, investors, insurance companies, and installers who manage installations and maintenance. California Horizontal is a certified B Corporation, meaning that they, for example, meet the highest standards of verified social and environmental performance, and they are third-party certified by the nonprofit B-Lab (www.bcorporation.net).

Company 2 – business model case California Vertical TPO

California Vertical is among the biggest solar providers in the US, providing solar energy in a large number of states. With its headquarters in California, the company started operations in 2007 and entered the leasing market in 2008. California Vertical focuses on vertical integration and operates sales, system design and system installation, and maintenance themselves. They primarily collaborate with financing partners and insurance companies to be able to provide a TPO offer. Moreover, California Vertical is a profit-driven company.

The German residential solar PV market

With the Energiewende (energy transition), Germany set the target to achieve a share of 60% renewable energy, and consequently, numerous mechanisms and policy instruments were initiated to foster the development of the PV sector. From 2000 to 2011, the German solar market was characterized by high governmental subsidies consisting of high Feed-In-Tariffs (FiTs[6]) and tax credits on installed systems. This paved the way for the domestic PV solar industry to take off and played an important role in stimulating the global PV industry (Hansen, 2018).

During this era, a rooftop add-on PV system purchased by the property owner dominated the German residential PV market. This so-called host-owned feed-in business model was based on residential customers getting a high return (much higher than the average electricity price) on each kWh of solar energy they fed into the electricity grid. This high rate of return, in combination with the tax credit on installed systems, contributed to short payback times on the investment, despite the rather expensive PV panel systems at the time. The business model was mainly applied by small existing

[6] FITs = Feed-In-Tariffs = electric utilities are obliged to purchase electricity generated from a renewable energy source (e.g., PV) on a fixed-period contract and a fixed price.

businesses with an already established customer base (e.g., electricians and plumbers).

The host-owned feed-in model can be described as follows. The *value proposition* included a green and low-risk investment, offering residential customers the opportunity to produce their own green energy at a favorable rate of return. The *customer interface* consisted of both personal and already established relations between installer firms and customers and between customers by word of mouth. The *business structure* was built on partnerships with PV panel suppliers and wholesalers of PV systems. The *revenue model* was based on systems sold and installation fees.

Hence, in Germany, generous state incentives paved the way for a business model dependent on high FiTs and tax credits on installed capacity. These incentives made it lucrative for residential customers to buy a PV system at a rather high price. Without these incentives, the PV installers would have to offer PV systems at a lower price in order to have an attractive offer. However, this would not cover their costs and would thereby make their business model obsolete.

Company 3, business model case German TPO

German TPO is a small start-up company established in 2012 with the goal of providing the German market with decentralized energy in a new way. The company is located in northern Germany, but aims to serve the whole country through a large network of installers. One of the founders worked in the solar energy industry in California during 2007 and 2008 and was involved in the early development of the TPO offer there. German TPO was one of the first companies to provide a leasing offer on the German market.

Company 4, business model case German Smart Grid

German Smart Grid is an established and locally well-known family-owned architect firm in northern Germany. Since 1980, they have been selling plots for building family houses and have established a long-term business relationship with the city authorities. In 2013, German Smart Grid saw an opportunity to diversify their business and contribute to a sustainable society (the disruptive market situation opened an opportunity for the company to do something different and test a new idea). In collaboration with the city authorities, they sell plots for family houses, including a solar panel system, an electrical vehicle, and a community grid for independent energy production and consumption.

RESEARCH METHOD AND DESIGN

In this study, we use a multiple-case-study approach (Yin, 2014; Eisenhardt, 1989) and a multidisciplinary perspective (cf. Bansal and Roth, 2000) to retrospectively

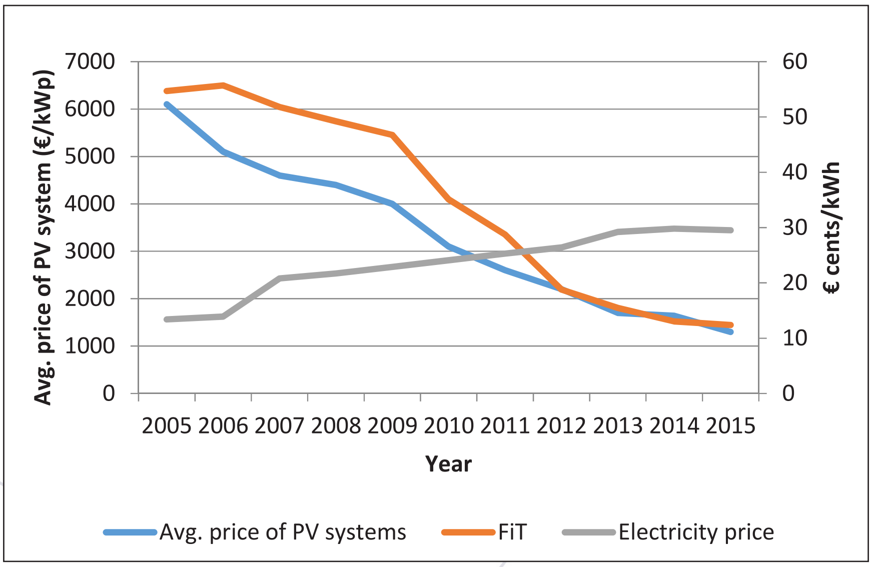

Figure 2: Graphical illustration of the development of the FiT, electricity price, and the price of PV systems on the German PV market. The blue line refers to the average price of PV systems in €/kWp, the red line refers to reimbursement from the FiT, €/kWh, and the grey line refers to the electricity price, €/kWh

examine the business model dynamics of four business models in the context of emerging or small firms. The business models were found in three start-ups and one established small firm offering solar PV on two distinct markets undergoing conditional change. Given the unstructured and blurry phenomena, a qualitative approach was best suited, since it emphasizes an understanding of the critical elements involved and how they change over time (Eisenhardt, 1989). Furthermore, a multiple-case design allows replication logic to compare or confirm the emerging insights derived from each case (Yin, 2014).

Research design

The aim of this study was to explore multiple business models to understand how they changed over time due to environmental dynamics. In this paper, we see the business model as a means to potentially reduce barriers for adopting sustainable technologies, specifically, in this study, PV technology. We use the business model for sustainability concept provided by Boons and Lüdeke-Freund (2013) as our unit of analysis, a lens of four clearly defined components, through which we investigate changes in our four business model cases.

The starting point of the study was to explore business model development on two leading markets for residential solar PV. In Germany, the total installed capacity in 2014 exceeded 15.5 GW (IEA, 2014) and contributed to a share of solar energy above 5% of national energy production (Wirth, 2014). In California, the total installed capacity of PV solar was 6.4 GW (IEA-PV, 2014), which corresponded to almost 50% of the US PV market (SEIA). At the time, many other markets were experiencing a deadlock due to withdrawn subsidies, as a consequence of drastically falling prices on PV systems (e.g., Italy, Spain, and Denmark). Although these were initially potential markets to investigate, they were not selected due to the deadlock on the markets. As the United States differs broadly in terms of market regulations and stimulations, California has been treated as a separate market.

The pre-study phase (Swedberg, 2012) consisted of interviews with selected PV experts, e.g., city planners, consultancies, and other firms offering PV. We also attended an official workshop in California to gain market insights, and met with potential PV customers. In addition, we conducted an extensive desktop research, e.g., PV industry reports and news-letters of various PV companies. During this phase, we concluded that business model development on the two markets was dependent on current market conditions; a contingency perspective was therefore applied. Based on the pres-tudy, we selected two business model cases on each market, which were considered representative (Yin, 2009) for each market, i.e., one case equals one business model found in a specific company setting. The two business models in California were found in California Horizontal and California Vertical, which have been part of the development of the TPO business model founded there. At the time of the study, these companies were also two of the largest companies offering residential solar PV in California, hence, competeting on this market. The two business model cases in Germany were found in German TPO and German Smart Grid, which illustrates two innovative business models born out of the disruptive market conditions caused by heavily reduced governmental subsidies on the German solar market. Due to limited examples of offers from large incumbents in the early phases of industry transformation toward sustainability (Hockerts and Wüstenhagen, 2010; Schaltegger et al., 2012), we have only chosen to study business models in three emerging firms and one established small firm.

Data collection

Between December 2013 and December 2014, we collected both retrospective and real-time data, applying multiple data-collection techniques. In the pre-study phase, we collected a broad range of data, including industry reports, industry news, press releases, and a wide range of company websites. We also conducted a number of semi-structured interviews (Kvale, 1996), following the business model theme (60 – 90 minutes each) with PV market experts on the German and Californian market to access a better insight to the current market dynamics. Finally, we reviewed the literature on business models for solar PV (see Table 2 for an overview of data collection and analysis in the pre-study and case-study phase), which, at the time, was rather scarce.

The case-study phase partly relies on data collected in the pre-study phase (e.g., industry reports and statistics). In addition, more in-depth desktop research was carried out for each case company, and semi-structured interviews with top managers or founders were conducted (see Table 2). The interview guideline (see Appendix 1) was based on the four components of the business model framework that we applied, as well as the relation among environmental dynamics, business model change, and firm capabilities. Each interview lasted 60 to 120 minutes, and all interviews except one were tape-recorded. The two researchers took on different roles during the interviews; one was in charge of the interview, and the other was taking notes and listening on several levels, i.e., observing nonverbal communication, like body language (Yin, 2011).

Data analysis

The data collected in the pre-study phase was structured and analyzed under a number of categories, such as national subsidy schemes, energy market regulations, and types of actors on the market. Numerical data was compiled in Excel, and qualitative market information was summarized in a write-up of each market. To structure the analysis of the business models of the four case companies and their interplay with the business environment, data from the case-study phase was mapped out in the business-model construct, presented by Boons and Lüdeke-Freund (2013), and together with the data from the pre-study, analyzed according to the contingency framework provided by Saebi (2015).

As a first step, a within-case analysis for each case was conducted (Eisenhardt, 1989; Yin, 2009). The two authors independently followed a summary-aided approach analysis, including field notes, write-ups, and coding (Miles and Huberman, 1984; Miles et al, 2014). In the write-ups, we made extensive use of citations from the interviews, as well as notions of body language and feelings expressed by the interviewees, which allowed us to fine-tune our understanding of the cases.

	Data collection	Data analysis
Pre-study phase: market background	• Industry reports (e.g., renewable energy capacity statistics, 2015 (IRENA), IEA PVPS reports: T1-24:2014, T1-27:2015, T1-29:2016, Global Status Report (REN 21), Rethinking Energy, 2014 (IRENA), Recent fact about Photovoltaics in Germany (Wirth, 2014) • Desktop research of actors on the solar energy market on the German and Californian market, e.g., website of PV firms, and in PV green tech industry news such as Cleantechnica, Greentechmedia, and Eurostat Newsrelease • 6 expert interviews: 1 solar consultant (GER) 1 utility manager (GER) 3 utility managers (CA) 1 government representative (CA) • Academic literature on business models for solar PV. • Attended a solar PV workshop for prospective customers (CA)	• Numerical data compiled in Excel. • Qualitative data summarized in market write-ups. • Data analyzed according to predefined categories: background information (e.g., population), energy market, regulations, solar PV actors, type of solar PV offers, installed capacity, PV subsidies and incentives, PV system prices, electricity prices, etc.
Case study phase: conditional change	• Desktop research on case companies (e.g., press releases, websites, media) • Industry reports (see above) • 7 qualitative interviews at case companies: 2 top managers (Case 1) 1 top manager (Case 2) 2 founders (Case 3) 2 with one founder (Case 4) • 1 Solar PV customer on each market	• Building on business model components and contingency framework. • Summary-aided analysis by each research individually • Analysis meeting to compare independent analysis and reach consensus. • Cross-case analysis according to standard techniques (Miles et al., 2014)

Table 2: Overview of data collection and analysis

The coding was related to the four business-model components and the three parts of the contingency framework (environmental dynamics, business model change, and dynamic capabilities). It was considered especially important to capture the changes made to the business models. During the analysis meeting (Miles et al., 2014), the two researchers compared and discussed their analysis until a common understanding was reached.

In the second step of the case study analysis, we conducted a cross-case analysis (Eisenhardt, 1989) to compare the finding of the cases within each market, followed by comparisons of the cases between the two markets. This was done using standard techniques, e.g., matrix analysis (Miles and Huberman, 2014), to analyze linkages between cases (Miles et al., 2014). In the results, both similarities and differences within and between each market are presented.

RESULTS

In this section, we present our business model for sustainability case findings, using three parts of the contingency framework (Saebi, 2015) as a lens to identify: environmental dynamics, different type business model changes, including changes in the business model components, and dynamic capabilities supporting these changes. We use examples and citations from the cases to illustrate the business-model adjustments made to the new market circumstances to flesh out our arguments rather than to present exact theoretical concepts.

Case study findings

Applying the contingency framework, overall findings from the case studies are summarized in Table 3. Zooming in on the four business model components, more specific findings are summarized in Table 4.

	Market			
	California		**Germany**	
Environmental business dynamics	Environmental competiveness, low amplitude, and high pace, generating a hypercompetitive marketplace		Environmental shift, high amplitude, and slow pace, creating a disruptive market condition	
Driving forces for business model change	Multiple pressures, e.g., long-term stable policy, increasing utility electricity prices, falling prices on PV systems, customer isomorphism, low entry barriers for new firms and set-up of the TPO business model		Dramatic policy change, heavily reduced FiTs	
Business model case	California Horizontal TPO	California Vertical TPO	German TPO	German Smart grid
Type of business model change	Business Model Adaption	Business Model Adaption	Business Model Innovation	Business Model Innovation
Type of dynamic capability	Adaptive change capability	Adaptive change capability	Innovative change capability	Innovative change capability
Underlying capability dimension	Strategic understanding to rapidly adjust and implement improvements, efficiency in organizational routines: standardization, flexibility, customer sensitivity, culture / employee commitment, strategic partnership for lead generation	Strategic understanding to rapidly adjust and implement improvements, standardization, flexibility, efficiency in organizational routines, customer sensitivity, and common organizational culture	Business model know-how, explorative learning, strategic partnerships with investors and installers, customer sensitivity, and agility	Explorative learning, strategic partnership with city authority, customer sensitivity, and agility

Table 3: Summary of overall findings from the case studies

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	Market			
	California		Germany	
Business model case	California Horizontal TPO	California Vertical TPO	German TPO	German Smart grid
Environmental dynamics	Stable customer base and long-term policies	Stable customer base and long-term policies	Policy shift, new customer preferences, e.g., to go off-grid	Policy shift, new customer preferences, e.g., to go off-grid
Value Proposition change	Evolution: well-known and successful, fine-tuning the offer	Evolution: well-known and successful, fine-tuning the offer	Innovation: simplified turn-key solution, leasing set-up,100% green	Innovation: turn-key solution, cross sales, sharing, 100% green
Underlying capabilities	Dynamic consistency, incremental adjustments	Dynamic consistency Incremental adjustments	Business model know-how, experimentation, explorative learning	Experimentation, explorative learning
Environmental dynamics	Stable financial institution	Stable financial institution	Shift to new financial bodies	Shift to new financial bodies
Revenue Model change	Evolution Well-known and successful, fine-tuning billing	Evolution Well-known and successful, fine-tuning billing	Innovation: new sources of revenues built on portfolios of long-term contracts	Innovation: new sources of revenues based on a sharing community and units sold
Underlying capabilities	Dynamic consistency Incremental adjustments	Dynamic consistency Incremental adjustments	Business model know-how, experimenting, explorative learning, strategic partnerships	Experimenting and explorative learning
Environmental dynamics	Intense competition and rapid ICT development	Intense competition and rapid ICT development	Stable channels of suppliers and installers	Stable channels of suppliers and installers
Business Structure change	Adaption and Innovation: standardized sales process, dedicated functional teams, ICT-based quotes and design, customer qualification scheme	Adaption and Innovation: standardized sales process, dedicated functional teams, ICT based quotes and design, customer qualification scheme	Evolution: established a network of installers doing sales and installations	Evolution: collaboration with local city authority and friends who can design and purchase systems
Underlying capabilities	improvements, efficiency, and flexibility in routines, sensing and responding to new technology	improvements, efficiency and flexibility in routines, sensing and responding to new technology	Strategic partnerships with well-known network of partners	Strategic partnerships with well-known network of partners
Environmental dynamics	Intangible customer desires, rapid ICT development	Intangible customer desires, rapid ICT development	Stable channels of suppliers and installers	Stable channels of suppliers and installers
Customer Interface change	Adaption and Innovation: single point of contact, extremely positive experience, lead generation through network, remote contact using ICT	Adaption and Innovation: single point of contact, partners, remote contact using ICT	Evolution: via established and well-known installers	Evolution: via established channels for sale of land
Underlying capabilities	Customer sensitivity, organizational culture, employee commitment, strategic partnership, sensing and responding to new technology	Customer sensitivity, sensing and responding to new technology	Strategic partnerships with installers, education, customer, agility, and sensitivity	Strategic partnership with city authority, education, customer agility, and sensitivity

Table 4: Summary of detailed findings from the case studies

The Californian market - a hypercompetitive market for solar PV

Since its introduction in 2005, TPO has become the dominant offer on the Californian market (Overholm, 2015), leading to the solar energy market growing exponentially and converging into a hypercompetitive situation around 2013-2014, when leasing offers peaked at above 70% of the residential market.

"...an unbelievably dynamic industry – things change very fast", a manager at California Horizontal

Numerous factors created multiple pressures on the solar companies, contributing to a highly competitive situation associated with intense pressure for increased efficiency and lower prices: a "race to the bottom" among solar companies. First, the long-term and supportive policies led to a stable market situation. In 2014, however, the NEM policy was proposed to end in 2016, leading to an increased interest among solar firms to close as many contracts as possible under prevailing conditions. Second, the residential electricity prices of utilities have been increasing over the last decade, a motivation for customers to turn to cheaper sources of energy. Third, with falling prices on PV systems, the margins on components decreased, leading to a need for increasing volumes to stay economically viable. Fourth, isomorphism, a mimetic process that encourage imitation (DiMaggio and Powell, 1983), was observed to play an important role among customers wanting to go solar, meaning that customers, just like everyone else down the street, wanted to save money on their energy bill. Fifth, the solar firms pioneering the TPO model had already established trust and legitimacy among financial institutions, which together with all of the other factors, created low entry barriers for new solar firms to enter the market. Finally, the actual set-up of the TPO business model in itself affected the competitive market situation as well. As the business model is built on scale, a certain number of contracts are required to establish and secure a portfolio. Closing a number of portfolios is essential for economic viability, increasing the competition even further. All together, these multiple market demands created intense pressure on the firms to quickly adapt their business models to new circumstances.

Keeping a well-known and successful offer

During this period, purchase offers were beginning to increase; the main part of the offers (more than 70%) were, therefore, still associated with the successful *value proposition* of the TPO, including immediate electricity cost savings on the electricity bill, no upfront costs, no administrative hassle, a predictable long-term electricity price (20-year contract), and no technology risk.

"... (more than 70% of) the offers were still associated with the successful value proposition of immediate electricity cost savings...", a manager at California Horizontal

Even though different variants of billing were elaborated, e.g., power purchase agreement (PPA), no major changes in the offer in any of the firms were observed, which in these cases that the *revenue model* was also kept as before.

Standardization of the sales process and trusted advisor

Both companies were experiencing enormous pressure from competitors, and therefore, were constantly introducing new efficiency measures in the *customer interface* and the *business structure* to keep costs for customer acquisition down. For example, in the *customer interface*, there was an emphasis to establish a strong customer relationship and build trust, "holding the hand of the customer" throughout the process, as well as an emphasis on the strategic importance of being the single point of contact for the customer. In California Horizontal, they wanted to make the journey "*going solar*" more personal and an unduly positive experience. One of the reasons for doing that was to increase the possibility to achieve more referrals of a positive encounter with the company and, thereby, generate new leads (route of means to become contracts).

"...the customer experience we use is highly scripted – we want people to get excited about it (solar) right away...", a manager at California Horizontal

The companies also developed dedicated sales teams and a highly detailed, ICT-based, and standardized sales process with customer qualification schemes. To eliminate the time and cost of home visits, Solar

Horizontal was first to introduce and develop proprietary ICT-based sales tools. These remote design tools enabled the company to offer a quote and a PV system without visiting the customer's home, but it also meant that they had to earn the customer's trust over the phone. These ICT tools changed the customer interface completely and reduced the cost of customer acquisition, which has now become more frequent among all actors on the Californian residential PV market.
In terms of *business structure,* in both firms, we observed a bundling of offerings, indicating simplicity of information and transactions. Even though customers were offered a variety of financial solutions, all offers had a specific and predefined set-up, making the sales process and handling of contracts more standardized, efficient, and scalable. Various ICT tools were also used to design and quote PV systems. In addition, the firms also used early customer qualification schemes to make sure to spend as little time on non-qualifying customers as possible. To keep costs for lead generation down (in order to receive the attention of potential customers), both firms used various types of partners e.g., local do-it-yourself stores, however California Horizontal had established a network of partners.

Rapid adjustments and implementing improvements

Due to a need to quickly align resources to stay competitive, various types of dynamic capabilities were observed. First, the managers of both firms quickly scanned the market and sensed multiple external triggers (*managerial skills)*, leading to a hypercompetitive situation and realized that they had to rapidly adjust and implement improvements to stay competitive. Rapid adjustments in the customer interface and business structure were made, while not making any radical changes in the successful value proposition or revenue model. To quickly reduce transaction costs in the business structure, agility in *organizational routines* was observed.

"How do we get those transaction costs out of the model?", a manager at California Horizontal

With large sales forces organized in specialized units and pushing out numerous offers according to preset arrangements, early customer qualification, standardization, and professionalization of the sales process was evident. These factors made the sales organization both functional and more flexible, which allowed them quickly to reposition various groups in the sales team when needed. In addition, the managers at California Horizontal made sure to control bottleneck assets critical to value capture (Teece, 2018), i.e., controlling all contracts with the customers, while externalizing nonspecialized value chain activities, like outsourcing lead generation and installation. In addition, managers at both firms had the ability to innovate both the customer interface and the business structure. The managers sensed the rapid development of ICT and managed to develop and implement routines to make the customer interface (remote customer contact) and the business structure (access data to design and monitor PV systems) remote, using various ICT tools.

".....we want to keep control of a few partners", a manager at California Vertical

At California Vertical, on the other hand, they wanted to control the whole value chain and focused on integrating the business structure to keep control of a few partners. At both firms, however, the sales team exhibited extreme responsiveness to customers' experience and intangible needs.

"... to make sure that our customers love the experience (of going solar) so that they refer their friends and family", a manager at California Horizontal

In California Horizontal, we observed that managers also had laid the foundation, *managerial skills*, for a strong common culture (employee commitment) throughout the sales process and the whole company, for continuous understanding of the customers' needs in the customer interface, articulated in the *insane customer experience.* All together, these dynamic capabilities allowed for the companies to close deals with a higher turnover rate, simplify the handling of customer contracts, and enable scalability, thereby responding to the market triggers.

The German market - a disruptive solar PV market situation – a change of the game

In 2011, drastic amendments in policy instruments were made, i.e., FiTs were heavily reduced to fit current solar-energy industry conditions. Because of this severe situation, the game changed radically, making current "host-owned" business models obsolete and creating a disruptive situation on the solar market. Subsequently, this led to a shakeout of numerous market players. Many companies went out of business, and those left have reached a second and more mature phase; some companies were born out of this disruptive situation. This phase is characterized by modest FiTs, insecure regulation, and a high degree of market instability, prompting distrust in policymakers and utilities and a willingness among customers to go off-grid. In this situation, continuous adjustment of existing business models was no longer sufficient to fit the environmental shift, and there was a need for developing new and more innovative ways of doing business, which yielded various innovative business model outcomes.

Experimenting with new simplified turn-key solutions

Born out of environmental shift, both companies elaborated with, to the market, new offers to fit the new market situation. This indicated an ambition to create new value propositions compared to the earlier product purchase offers.

Following in the footsteps of Californian solar companies, German TPO experimented with new sources of revenues, e.g., leasing and crowd-funding, and new types of PV offers, like turnkey leasing solutions, including a battery for local energy storage. Even though the business model was not new per se, it was new to the German market. With an ambition to establish a cross-sale offer and turnkey solution, German Smart Grid experimented with a simplified package, i.e., selling land, including a roof-mounted PV system and an electric vehicle, at a fixed price.

"…it's a sharing system more or less…independent from the grid", a manager at German Smart Grid

The idea was based on a smart-grid community of, in this case, 30 households, each with a PV system, a battery for storage, and an electrical vehicle; all were connected with each other and independent from the regional grid, i.e., a community self-sufficient on renewable energy, creating a sharing community and their own energy market. As a response to the customers' distrust in large utilities and quest for environmentally conscious electricity solutions, both firms built their value propositions around being 100% green and independent from utilities. To reduce complexity in the new energy landscape, the companies stressed that they only wanted a few simplified offers for the customers.

"…a customer benefit is: NOT dealing with details around it (the solar offer)…", a manager at German TPO

Utilizing established and well-known networks

In both cases, the companies utilized already established networks to reach customers and deliver customer value. At the same time and to this end, both companies needed to invest time and money in educating all partners involved to make them understand the new value proposition.

"… most of them (installers/partners) we know for quite a while when we were making business with them in other roles…", a manager at German TPO

German TPO, being a small and young company with limited resources, was dependent on others. For example, since the business model is based on heavy assets, a critical aspect is to secure capital for the solar systems, but they are also dependent on installers to sell and install the systems. Therefore, German TPO utilized and trained an already existing network of installers, who had an established trust on the market, to reach prospective customers and install systems. These installer networks had been established during the high FiT era (2000-2011), and were now stranded after the shakeout of the market. German TPO also started to establish partnerships with green and local utilities to expand their customer base.

"…the city is our main partner in the project…" , a manager at German Smart Grid

Being a well-established architect firm on the market, German Smart Grid could utilize already existing contacts. For example, a long-term business relation with the local city authority helped them in the process of buying land in this district. Since projects like this are in line with the local authority's ambition to become CO_2 neutral, thus facilitating for German Smart Grid to gain access to land. Furthermore, they could reach prospective customers through their already established website and via reference customers (word-of-mouth).

However, as a small family-owned business with no previous PV experience, they were also dependent on external expertise. For example, a friend who was a consultant in the PV sector was helping them to design and procure the PV systems.

Sensing the conditions in the new market situation

As the business models in both cases were born out of the disruptive PV market situation, the managers at both firms were able to sense the conditions in the new market situation and develop offers and collaborations new to the German residential PV market. Our data indicated that the managers exhibited an ability to develop an understanding for new types of customer needs, like customers wanting to become independent from the grid, utility aversion, and the importance of being green, upon which they built new types of PV offers (*managerial skills)*. Even though the offers were completely different, the firms needed to educate the customer about the new offers, and therefore, develop a *customer sensitivity* in the customer interface. Both firms also developed new types of collaborations, e.g., with investors and municipalities, which had not existed on the market before.

With good knowledge about business models and a systematic business model development approach, the managers at German TPO were able to organize themselves for explorative learning from other markets, partners, and competitors (*managerial skills and organizational learning*). They also realized that they needed to obtain funding for their heavy asset business model, and they experimented with various ways to access financing and secure capital. For example, they established new types of collaborations (e.g., with investors and crowd-funding) and new ways of improving the revenue model by testing different time lengths of the leasing contract. Furthermore, the managers recognized (*managerial skills*) that they were in need of an ICT sales toolkit to make the sales process more coherent and efficient for future competition, thus preparing for exploitative activities. They were for example trying to reduce complexity by simplifying offers for customers and using a network of installers for distribution of tasks (*organizational routines*).

"...we also learn from the project.... we are not in the electricity business...", manager at German Smart Grid

By collaborating with installers, the solar companies gained resources to do sales and perform installations, but they also acquired new competences, like the technical aspect of installing solar panels.

German Smart Grid, on the other hand, exhibited true explorative activities. Even though they lacked business model know-how and PV experience, and the business model components seemed loosely coupled, they knew how to establish a good relationship with the city authority to obtain access to land (*managerial skills*), which also became a competitive advantage for them. The fact that they started with a full-scale project of 30 households (and planned for another 800 during the coming five years) without previous PV experience indicated that they were brave and not afraid to test new concepts. Even though we did not observe any *(organizational) routines* for learning from experimentation and failures, managers at German Smart Grid were aware that they needed to learn and reflected on improvement in the set-up of their projects.

DISCUSSION

Our analysis reveals that, depending on the environmental dynamics, adjustments to the business model need to be performed, and related dynamic capabilities to support these changes are needed. These findings provide support for the overall approach of the contingency framework provided by Saebi (2015). Our study, however, also depicts a more detailed picture of the components in the business model for sustainability (Boon and Lüdeke-Freund, 2013). Zooming in on the BM components, we observe that each component does not necessarily face the same type of environmental dynamics. This implies that one BM component can face a stable environment, while another component, at the same time, might face a turbulent and/or competitive environment. Even though the contingency framework (Saebi, 2015) suggests that different types of environmental dynamics affect business model change, our findings clearly indicate that the business models for sustainability and its components can face not one, but multiple environments at the same time. In California, for example, both the *value proposition* and the *revenue model* components were facing a stable environment of customers wanting to save money on going solar, financial institutions wanting to invest in the TPO contracts and a stable regulatory environment; hence, no major changes in the *value proposition* and the *revenue model* were observed, suggesting BM component evolution. The *business structure* and *customer interface* were facing a completely different reality; theirs was an intense race among competitors, leading to small changes being made quickly to improve customer acquisition and efficiency, indicating BM component adaption. At the same time, the rapid development of ICT was bringing new ideas to remotely establish contact with prospective customers, leading to innovation in the *customer interface*. These findings imply that various environments can trigger several types of changes, even within the same business model component. In the altogether different situation on the German solar market, similar results were observed in the German cases. The governmental decision to dramatically reduce policy-supporting schemes led to an environmental shift (disruptive market situation), triggering radical adjustments to the *value proposition* and the *revenue model*, indicating BM component innovation. The *business structure* and the *customer interface* were, on the other hand, facing well-known and established channels of suppliers and partners, leading to small adjustments in the business model component, indicating BM component evolution. Hence, to attain business model environmental fit, each component needs to be considered with the relevant environmental dynamics it is facing. Even though it was in another context, transforming organizations, Gauthier and Gilomen (2016) observed the benefits of considering the role played by business model components.

Moreover, our analysis reveals that, no matter the market situations, the business models are geared toward a greater focus on understanding customer needs. However, this does not necessarily mean understanding customer preferences (what customers want) to be expressed in the value proposition, as in the contingency framework (Saebi, 2015). We rather observe understanding customer needs in the customer interface as a responsive action toward a more personal customer contact, indicating agility and sensitivity in the customer interface and the inclusion of intangible values in the customer experience. This sensitivity is, in all cases, expressed as an understanding of how customers perceive and understand a new offer, or the customer experience of going solar. At California Horizontal, the managers established a common understanding, creating an employee commitment embedded in the culture of the firm, for providing tentative customers an unduly positive experience of going solar. This situation can also be seen as a process to build trust and to improve customer acquisition and confidence in the companies, as previously observed by Kindström (2010) in studies of service-based business models. In the German cases, though, understanding customers' needs in the customer interface was equally important, although it was expressed in different ways. While the companies experimented with new offers and new sources of revenues, they simultaneously had to educate all stakeholders, e.g., prospective customers, partners, and investors, to make them understand what the new value proposition and revenue model was all about. The importance of educating customers during the introduction of the TPO business model in California has been observed by Overholm (2015).

Contributions to the literature - Extending the conceptual framework lens

Not only do our findings corroborate with the conceptual idea behind recent research, suggesting a contingency framework on business model dynamics (Saebi, 2015), we also go further to show that, to successfully change a business model in accordance with its environmental dynamics, the framework can be extended in several ways. By adding a four-component business-model for sustainability framework (Boons and Lüdeke-Freund, 2013) as a lens to analyze the business model dynamics, more detailed information about the role of each business model component is uncovered. Based on the findings of this study, we suggest that the contingency framework (Saebi, 2015) would be enhanced by including a conceptual business model framework, such as the four-component framework (Boons and Lüdeke-Freund, 2013), and a set of multiple environments facing the BM components. Building on the work of Lawrence and Lorsch (1969), who propose that different organizational units face multiple environments, we suggest that the BM components face the following environments: customers, competitors, partners, science and technology development, suppliers, financial institutions, and regulatory agencies. As these findings are related to the spread of sustainable technologies, they primarily contribute to business models for sustainability literature. Similar ideas could, however, be true for conventional business modeling processes as well.

Furthermore, we identified that customer values need not only be addressed explicitly in the value proposition, but also more implicitly in the customer interface, for example, by capturing intangible values of customer experience to obtain acceptance for sustainable technologies on a market. This situation implies developing new capabilities in order to create value for the customer, suggesting *customer sensitivity. Customer sensitivity* can be seen as a dynamic capability hard to copy, bringing an opportunity for competitive advantage, which is especially important for introduction or diffusion of sustainable.

Our findings are highly relevant for understanding business models for sustainability changes in dynamic business environments and, thereby, the spread of and scale up of sustainable technologies. As sustainable development is characterized by adaptive transformation (Roome and Louche, 2016), bringing these types of considerations into the business model for sustainability literature would enrich our understanding and acceptance of spreading and scaling up sustainable technologies in contingent environments.

Limitations and future research

The findings in this study are based on an in-depth examination of a limited number of cases in particular settings from two markets. Even though this research design allows us to compare the cases, its findings are contextualized. Other market development conditions might, of course, differ from those studied, especially in developing countries. We therefore encourage additional case studies that could add data from other markets under conditional change to support and be compared with the findings of this study. We also suggest further in-depth studies of specific processes of how these business models develop over time, and what effects various environments have on the decisions taken by managers as solar markets evolve.

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About the Authors

Jessica Lagerstedt Wadin is Associate Professor in Innovation Engineering, Lund University, Sweden. She received her PhD in ecodesign at Royal Institute of Technology, Stockholm, 2003. Jessica has more than ten years of experience from the railway manufacturing and technical consultancy business in the areas of sustainability, strategic analysis, project management, marketing and sales. Her current research focuses on sustainable business model innovation.

Kajsa Ahlgren is a PhD in Industrial Engineering and Management, Lund University, Sweden. Her thesis work focused on business models for distributed solar energy, and she is particularly interested in qualitatively exploring how these business models develop over time, and as they spread between markets.