Local Design & Global Dreams – Emerging Business Models creating the Emergent Electric Vehicle Industry

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Electric cars hold the potential to completely alter the interrelationship among actors in the automobile industry architecture. They may not only be able to alleviate environmental externalities but also revolutionise the automobile industry as such. This paper is concerned with the processes of industry creation for the electric car industry, which is a particular fascinating topic matter as it allows the analysis to provide an understanding of the processes of innovation and of some of its inventors in concert. In continuation of this, the aim of this paper is to describe and analyse which emergent business models and corresponding value capturing capabilities can be found in the emerging market for electric cars.

Introduction

Over the past decades the negative impacts of transport on the environment have developed into a generally accepted discourse depicting a growing concern for our environment (Van Wee 2007). Concomitant to this growing concern, industries are pushed to become more sustainable. With respect to the car industry, current dominant measures to reduce the demand for car usage have concerned assessments of how to reduce *car use* rather than reducing *the environmental impact per car* (Gärling and Loukopolos 2007), and consequently there exists no standard solution for sustainable car usage. Accordingly, as part of the growing awareness on sustainable development, changing the core technologies of cars as reflected in the emerging electric car industry appears to hold promises for a more sustainable automobile usage. Such developments are in alignment with the general growing concern of the population as well as among politicians. This is also reflected in the increasing interest taken in the electric car by automobile manufacturers such as General Motors, Chrysler and Ford, who are part of the growing set of stakeholders on the global scene that may form the future industry of electric cars.

Edison constructed an electric car as early as 1881, but in spite of the technology of electric cars having existed for more than a century, attempts to construct a market for electric cars have never gained convincing success. However, along with an increased institutional pressure from political bodies as well as normative pressures from research, more novel attempts of innovation appear to have the potential to create a "disruptive" or Schumpeterian innovation

(Henderson and Clark 1990), where the linkages between core actors are changed and core concepts constituting the vehicle and fuel provisions are replaced.

Entrepreneurs emerging with novel ideas on how to design the electric car industry hold the potential to completely alter the interrelationship among actors in the industry architecture of automobiles. These inventions contribute to improving the quality of life of citizens through less polluting means of personal transport that are more in line with progressive environmental policies. Although sustainable technological alternatives such as bio fuels rival this development, there are strong forces in favour of developing an infrastructure around the electric vehicle, suggesting that this design will become commercialised prior to the hydrogen car (Mathiesen, Lund and Nørgaard 2008). It appears to potentially hold promise of not merely being able to alleviate environmental externalities, but also revolutionise the automobile industry as such. Therefore, shifting to more emission free technologies is an industrial change which marks a classic disruption or discontinuity in an industry (Christensen 2001). One of the focal interests with respect to such disruptions is the questions of which market participants hold the largest probability of being able to define the business models of the future, or in other words which capabilities will frame the future market. Industrial rivalry and competition remains at the core of this problematic.

This paper is concerned with the processes of industry creation for the electric car industry, which is a particular fascinating topic matter as it allows the analysis to provide an understanding of the processes of innovation and of some of its inventors in concert. In continuation of this, *the aim of this paper is to describe and analyse which emergent business models and corresponding value capturing capabilities can be found in the emerging market for electric cars*.

The analysis takes its point of departure from the most prevalent stakeholders in a Danish context. Hence, although many global firms are found among the stakeholders in the emerging industrial field of electric car manufacturing, and scope economies are decisive for capitalising on the investments in this new technology, the competitive battles are fought on a more local basis. Local market access is necessary, since particularly in the early phases of developing electrical cars into a viable alternative to fossil-fuel based private transportation, systems call for massive investments in public infrastructure; for example Better Place in conjunction with DONG Energy invested approximately €103 million Euro (770 million Danish Kroner) in equity and convertible debt for the *initial* deployment of their electric car charging network in Denmark (Better Place 2009). Evidently, the range of the batteries is decisive for the geographical scope, which will change over time according to the technology of the battery. From the demand side, market conditions differ, for instance with respect to energy availability. Denmark constitutes an interesting lead country for the development of an electric car market. First, Denmark has a surplus of electricity production, given problems relating to integrating surplus energy production from wind power plants into the existing consumption pattern. Moreover, Denmark is a small and highly developed country, where private transportation needs (i.e. work commuting) are critical and take place over distances which fit well with the operative charging range of electric vehicles. Very important is also the Danish governmental interventions regarding the support of a relatively large production of wind energy providing more than 20% of the electricity produced, and the exemption from tax on electric vehicles in contrary to the burdensome Danish taxation regime on privately owned cars. Finally, Denmark, despite its limited size and lack of critical mass regarding relative consumer purchasing power, has a very visible profile in the environmental debate and therefore appears to constitute an excellent demonstration market. The early experiences in this market will contribute in shaping the competences of participating actors and with it possible appropriation regimes.

The paper is structured as follows: First, a general theoretical framework for understanding competitive organising of business activities in emerging industries is presented. Secondly, general data on Denmark for the development of an infrastructure based electrical vehicle is presented. Thirdly, in the analysis strategies followed by relevant stakeholders are typified and analysed according to the dimensions developed in the theoretical section. In the final part of the paper, we discuss implications including how diverse strategies may lead to rather different futures once the industry moves from a nascent to a more mature phase.

Innovation and Competitive Organising of Business Activities in Emerging Industries: A Theoretical Framework

A critical framework for understanding the organising of innovation activities in emergent industries is provided by the so-called Profiting from Innovation (PFI) framework, which comprises a stream of research stressing the importance of the architecture of the enterprise and the wider industrial field in shaping the competitive outcomes when a new technology is commercialised (Pisano and Teece 2007). The architecture of the company concerns the ownership boundaries of the firm as well as the power boundaries with respect to control of complementary assets important for reaping the fruits of investments in new technologies. In order to create massive customer adaptation and with it market value, a technology must be embedded in a business system to yield end-user value (Porter 1985). In this sense, the commercialisation of most technologies depends on complementary assets which may be more or less scarce and thus critical for commercial success.

In the following we refer to an emerging understanding of business systems as industry architectures, which both focus on the co-evolving nature of organising dynamics of the industry structure per se as well as the strategies followed by industry actors (Jacobides et al 2006; Pisano and Teece 2007). By industry architecture we refer to the structure of co-specialised economic actors and public agents, activities and resources, which define division of work as well as patterns of coordination, which through the interdependence specifies and regulates a roster of feasible activities within the business system. The industry architecture is shaped by several forces.

One concerns the technical possibilities so far discovered within a specific technology which lends both possibilities and also restraints to the organising of the industry architecture.

The powerful contingency of industry architectures on technical possibilities is evident in a number of cases, as discussed for instance in the steel industry, where the technical development of mini-mills led to production of steel of compatible quality with integrated mills, albeit at a much lower price (Christensen and Raynor 2003).

A second and important force affecting the development of industry architectures concerns the influence from institutional contingencies; notably the regulatory (what is allowed), the cognitive (what is imaginable) and the normative (what is preferable/social acceptable) institutional pillars (Scott 2007; Andersen and Drejer 2008). The important impact of institutions on the shaping of industry architectures can be witnessed by noticing how industry architectures differ across national boundaries with diverging institutional arrangements (Whitley 1992). Institutional differences and their impacts on the organisation of industry architectures may be witnessed for instance in *de facto* and *de jure* standards as expressions of an important subset of the rules governing exchange, coordination and scope of business among actors in an industry. An example of *de facto* standards may be the diverging role of trust for understanding how suppliers and manufacturers of the Japanese and the US automobile industry organise exchange activities (Sako and Helper 1998).

Organisation and interaction patterns in industry structures reflect an underlying degree of co-specialisation among the actors involved. By co-specialisation we mean the degree to which – on an aggregate level - assets of one actor are adapted to the specific needs of another actor. In cases of strong co-specialisation and heterogeneity, markets for co-specialised assets are thin, meaning that few exchanges across exchange dyads are possible in the industry structure. This is a typical trait of craft-based production (Storper and Saias 1997). For instance, in parts of the wine industry, special types of grapes are grown by growers (viticulturists) at excessive costs to the tastes and whims of particular wine makers (vintners). The winemaker is only able to produce a particular blend using this particular grape. The growers on the other hand, given the cost bound in the production and harvesting of the grapes, would not be able to sell these grapes on the mass market for wine grapes without a great loss. This also begets strong interdependence among actors. Following Garud and Kumaraswarmy (1995), we refer to industry architectures with high degrees of co-specialisation as *integral*, where substitution possibilities are limited. In comparison, weak co-specialisation is the situation where interfaces between components are standardised, making substitution possible at little or no cost. This enables a market for specialised components to develop, which can be integrated across manufacturer platforms, as seen in the stereo component industry (Langlois and Robertson 1992). This type of industry architecture is referred to as *modular* and is often associated with large volume production, such as bicycles (Galvin and Morkel 2001).

An important distinction with respect to the role of modular and integral industry architectures relates to the evolutionary cycle of the industry. According to Utterback (1996), industrial developments may be considered going through a cycle consisting of three phases, which explain the pace of innovation. The emerging phase is marked by fluidity and innovation is normally highest during the formative years in which a high level of experimentation also takes place. The “fluid phase” is typically followed by a “transitional phase” in which the rate of innovation slows down with respect to products and speeds up with respect to process innovation. The final phase suggested by Utterback is the “specific phase”, where major innovation diminishes with respect to products and processes and the industry increasingly focuses on cost, volume and capacity.

In emerging industries where the industry architecture is at a nascent stage, each actor has a strategic interest in shaping the industry architecture favourable to their business model. Action asymmetries, i.e. who can do what and who cannot, and rules for interaction among industry actors will shape division of work, and with it render some capabilities more critical and thus valuable than others. Hence, an important competitive arena the rivalry unfolding in an emerging industry concerns which market participants have the largest probability to be able to define the future, or in other words which capabilities will be framing the future market. A key strategic consideration for any innovator in the emergent industries concerns the scope of the activities optimally controlled internally by the firm and which can be relied upon form external providers. These considerations are based both on concerns related to marginal efficiency of organisational boundaries as traditional associated with Coasean economies, as those associated with defining the boundaries of the as well as on the capabilities controlled by the power boundaries of the firm (Santos and Eisenhardt 2005).

Controlling assets necessary to conduct activities are costly, and few companies have the resources or the interest in owning and/or controlling all complementary activities necessary for converting a technology into a system capable of delivering market value. Hence, strategic players, Like Ford in the 1920s owning the fully integrated industry architecture end-to-end for manufacturing the Ford T, are rarely found.

An important distinction can be made between the strategies of *technology specialists* and those of *business system architects*, which reflect principally different managerial mind sets, business models and underlying capabilities to develop a competitive position in a fluid stage of industry architecture formation. By a managerial mind set we refer to the mental representations of the business realities which managers use to make sense of ongoing events, these include strategic beliefs that drive managerial decisions, including the identity of the competitors and customers (Weick 1995). One derivate of managerial mind sets is the business models followed by a particular firm, which presents the template for describing the underlying theory of managers on how in a specific business enterprise, market value can be created and appropriation of appropriate cost for the firm (Magretta 1992). Thus, it includes notions about the identity of customers and strategic posture in the industry architecture towards competitors and collaborators. By capabilities, we refer broadly to competencies, assets and resources of the firm (Tripsas and Gavetti 2000).

Technology specialists have a relatively strong focus on developing one particular technology and a strategic focus on how to progress this technology to be used either within one single industry architecture or across a range of industry architectures. This follows their capabilities and is reflected in both their managerial mind sets and corresponding business models. The capabilities of technology specialists often focus on engineering insights and their resource investments concern how to push the perimeter of technological performance within their particular areas of specialism. This reflects a managerial mind set, locked on focusing on rivals' technical advancements as well as the needs of lead users at the forefront of technological advancement. Correspondingly, business models are about developing an exchange system, where value is appropriated through technological advancement and perhaps learning from particular customers. Strategic suppliers acting as technology brokers represent a particular subset of this type of company. For instance, Bosch Rexroth, an engineering firm, offers its customers all drive and control technologies, specialised as well as integrated. For technology specialists, modular architectures provide potential advantages as they via the effect of standardised interfaces, create potential economies of scope (in terms of market expansion) from more efficient economies of substitution. Intel is an example of a technology specialist who thrives on the scope economies fuelled by low substitution costs in the modular industry architecture found in the industry for personal computers. However, a modular architecture also means low entry costs and a hypercompetitive environment where resource based advantages are limited. Therefore, depending on their capabilities and corresponding mind sets, technology specialists may also seek to act as institutional entrepreneurs in favour of an integral production technology.

Business system architects design architectures that provide the contours and framework within which actors interact; by creating standards and by means to coordinate economic activities (Jacobides et al 2006). The role of business system architects has been studied in relation to the IT industry architecture (Shapiro and Varian 1999). Business system architects typically control a single specific resource in order to legitimate their right to design a specific architecture, and they use this control to dictate the terms of their suppliers. For instance, the Swedish-owned furniture outlet IKEA controls designs; the brand name and parts of the retail system, and the computer manufacturer Dell controls the distribution system and the interface with customers, but holds no ownership control over hardware suppliers. Like Technology generalists, business system architects may focus on single industry architectures or focus on developing generic architectures which may span multiple industry architectures. In the wind energy industry, Siemens is an example of the former: Less than 10% of the components of a wind turbine are manufactured by Siemens. However, this business model is not representative of Siemens' business models in other industries. In comparison, the system architect business model of the General Electric Wind division is representative of the business model.

Combining the strategic typology with the concept of *integral* and *modular* industry architecture, we come up with the matrix presented in figure 1 to describe the principal strategies to be followed by business actors in emerging industries.

Figure 1: Principal Strategies for Business Actors in Emerging Industries

	System Architects	Specialist
Integral Industry Architecture	*Proprietary Systems*	*Integrated Products*
Modular Industry Architecture	*Open Innovation*	*Standard Products*

The business model of *Proprietary Systems* can often be understood as a semi-open standard where the membership charge is the subscription to an established standard that is covered by appropriation rights, such as for instance a patent or copyright which is intended to give the system architect exclusive control of the technology to the (current or future) exclusion of others. An example could be the Microsoft Windows programming language, which was open for business actors who accepted Microsoft's terms. Other examples of system architect structures are found in computer game consoles, where Microsoft, Nintendo and Sony all take on roles as system architects in an integral industry architecture, where interfaces are standards among club members only.

Opposite to this exclusion strategy, we find *Open Innovation* (Chesbrough 2003), where the business model of the firm determines what external information to bring inside, and what internal information to take outside. The central idea behind open innovation is that firms cannot afford to rely entirely on their own research, but should cooperate with other firms in order to create network externalities because standards enhance compatibility or interoperability and thereby generate greater value for the actors by making the network larger (Shapiro and Varian 1998). An example of an open innovation architect may be IBM with its Eclipse platform, where competing companies are invited to cooperate inside an open innovation network.

The specialist developers of S*tandard Products* also seek to create network externalities and their business model will often be more incremental and focused on the innovation activities of other actors in the industry, where the specialist developers of *Integrated Products* are radical in their approach to innovation in order to create new concepts and therefore do not need to create relationships with other actors (Henderson and Clark 1990). Producers of integrated products provide systems in which elements are co-specialised and production therefore calls for close interaction which specialises in integrated products. These specialists typically follow this strategy because co-specialised component designs allow for a stronger functionality and form are integrated, on the cost of for instance production costs in integral architectures. The functionality of a product therefore calls for tight coordination among actors. Hence, integral product designs often call for internalised production with little or no division of work across organisational boundaries (Chesbrough and Teece 2002). An example would be Cabinplant A/S, a world leading provider of tailor-made processing solutions for the food industry. Cabinplant has over the years created a thorough knowledge of processing, building layouts, equipment setups, electrical installations, hardware and software by having all the expertise in house. Thereby Cabinplant is a one-stop-shop option when a buyer is in need for a complete processing plant related to fish, shellfish, fruit, vegetables, berries and convenience food processing. Producers of standard products and components rely on standardised interfaces allowing them to mix and match their own output with those of other actors. However, the strong degree of specialisation and internal competence development makes knowledge sharing across organisational boundaries immensely difficult. Following this strategy provides the standard product producer with the ability to specialise in one component, while leaving the production of other components to suppliers or customers. An example could be Robert Bosch GmbH which is a German diversified technology-based corporation that is the world's largest supplier of automobile components and has business relationships with virtually every automobile company in the world. Bosch has developed a leading standard within spark plugs and contributes in developing spark plug related technologies to a wide array of automotive manufacturers' worldwide.

Denmark as an Industrial Field for the Development of Electric Vehicles

Denmark has three main characteristics which are important when considering it as an industrial field of development for electric vehicles, namely: a relatively large production of wind energy, a burdensome taxation regime on privately owned cars, and Denmark may be characterised as a world leader in clean electricity generation, thus wind turbines provide more than 20% of the electricity produced (Andersen and Drejer 2008). However, compared to coal-fuelled power plants, production of electricity from wind turbines cannot be matched to the ebbs and flows of demand. Due to climatic conditions, a significant proportion of wind energy is produced at night, when demand is limited. As a consequence, Danish utility companies such as DONG are forced to sell their electricity at low prices or even to send it into the grid at no charge, since the demand on the European spot market for surplus electricity is very limited. Consequently, electric vehicles could provide a suitable neat solution – as 'mobile storage devices'. This is exactly how the Danish utility DONG Energy views electric vehicles and why it is so keen to be a partner in the roll-out of a Better Place electric vehicle charging grid in Denmark (Holm 2008).

The Danish government may be equally enthusiastic about creating more sustainable car transport. Hence, the Danish taxation regime on privately owned vehicles is among the most onerous in the world. Currently, there is to be a complete tax exemption for new electric vehicles (at least up until 2012) and in the 2008-1011 budget there is provision of DKK 35 million for research into a test scheme for electric vehicles. In that connection, the Danish Minister for Climate and Energy said "We need more electric vehicles on Danish roads… We are in the preliminary stages. Only few electric vehicles are on the market, but we have to get started in order to obtain practical experience" (Klima- og Energiministeriet (Danish Ministry of Climate and Energy) 2008). Other planned supportive policies include prioritised car parks in larger cities with free recharging facilities. University research funding focusing on the development of efficient charging systems and system export possibilities has also been proposed.

The technology of batteries for electric vehicles is still in its infancy and is continuously improved; however, for electric vehicles to constitute a viable and realistic alternative to other means of transport, it is relevant to compare the capacity of the battery and the daily transportation need. Consequently, with respect to the Danish market, the current maximum driving range of electric vehicles does not constitute a substantial problem because 90% of all home to work commuting is less than 100 km (Mathews et al. 2009), probably due to the country's limited size.

Emergent Business Models for Electric Vehicles in Denmark

The present section outlines and analyses the emergent business models for the electric vehicle industry. The analysis is based upon secondary data as research reports, news articles, websites, etc. Figure 2 below illustrates a series of stakeholders that are active in creating the foundation for a market for electric vehicles and constituting the most central emerging business models. The system architects design industry architectures that provide the contours and framework within which actors interact. They do so by creating standards and by means to coordinate economic activities (Jacobides et al 2006).

Figure 2: Emergent Business Models for Electric Vehicles in Denmark

	System Architects	**Specialist**
Integral Industry Architecture	*Proprietary Systems* EDISON Project Denmark	*Integrated Product* BYD · REVA · CityEl · Buddy · Mega e-City
Modular Industry Architecture	*Open Innovation* Better Place Denmark EDF/Renault	*Standard Product* Renault/Nissan · Tesla Motors Th!nk · Mercedes Smart Car · DONG · IBM · Siemens · Eurisco · Østkraft · Dong Energy · Nokia · Samsung · Bosh · A123 · NEC

The system architects are created by specialists with either a modular product which creates *Proprietary Systems* such as EDISON or *Open Innovation* as Better Place Denmark and the EDF/Renault alliance. The remainder of the specialists with *standard products* that have entered or said they will enter the Danish market are manufacturers of vehicles without batteries as Renault, Th!nk, and Mercedes Smart Car (Cleantech 2008) and battery manufacturers as A123 and NEC. Tesla Motors is an exception as they consider themselves a technology firm rather than a car manufacturer (Djursing 2008). Tesla Motors is also in consideration as battery supplier for the Mercedes Smart Car (Ehrlich, 2008). Lastly, some *Integrated Product specialists* in vehicles and batteries that have entered or said they will enter the Danish markets are car manufacturers with integrated batteries such as Indian REVA, German CityEl , French Mega e-City, and Norwegian Buddy. Build your Dreams (BYD) was originally a manufacturer of batteries for mobile phones and laptops. When they developed a new type of battery (lithium ferro), they built a car factory in order to be the world leader in electric vehicles (Gården 2008).

The electric vehicle charging network start-up, Better Place, is a central stakeholder in developing the electric vehicle market worldwide. Project Better Place, a mobility operator, was constructed in autumn 2007 and can be characterised as a venture capitalist company (Roth 2008). It works with business partners to build charging stations in geographically small areas. Its first project concerned building a network of charging stations across Israel and selling electronic vehicles manufactured by Renault (Better Place, 2008b; Renault and Nissan 2008; Roth 2008). The second Better Place project concerns a similar project in Denmark where DONG Energy, a major electrical producer of energy, and Better Place have created a joint ventured called *Better Place Denmark* (Better Place 2008a; Dong 2008; Holm 2008).

The first Better Place enabled vehicle will be manufactured by Renault/Nissan which also has a partnership with EDF. *"EDF, owner of the world's biggest fleet of electric vehicles, has considerable experience and expertise in electric power storage technologies and recharging infrastructures, and in operating fleets of rechargeable vehicles. EDF is committed to expanding the availability of clean mobility solutions. Through the agreement signed today, the Renault Nissan Alliance and EDF aim to provide consumers access to zero emission mobility from 2011. In support of this objective, the Renault Nissan Alliance and EDF will jointly develop an innovative commercial project, open to other interested parties, leading to the set up of an Electric Mobility Operator in the longer term. The role of the Electric Mobility Operator will be to supply customers with the infrastructure to recharge an electric vehicle and to manage its range"* (EDF et al. 2008). The French EDF Group ranks among the leaders in Europe's energy market. It is an integrated energy company with presence in a wide range of businesses: generation, transmission, distribution, supply and energy trading. EDF is Europe's biggest electricity producer. The role of EDF in Denmark will probably be to provide consultancy (Teiner 2008).

Both Better Place Denmark and EDF seek an *open innovation model* to create a complete infrastructure for electric vehicles in order to achieve expanded network externalities and to reduce the uncertainty of the concept and the consumer lock-in by acting as a system architect of modular product architecture.

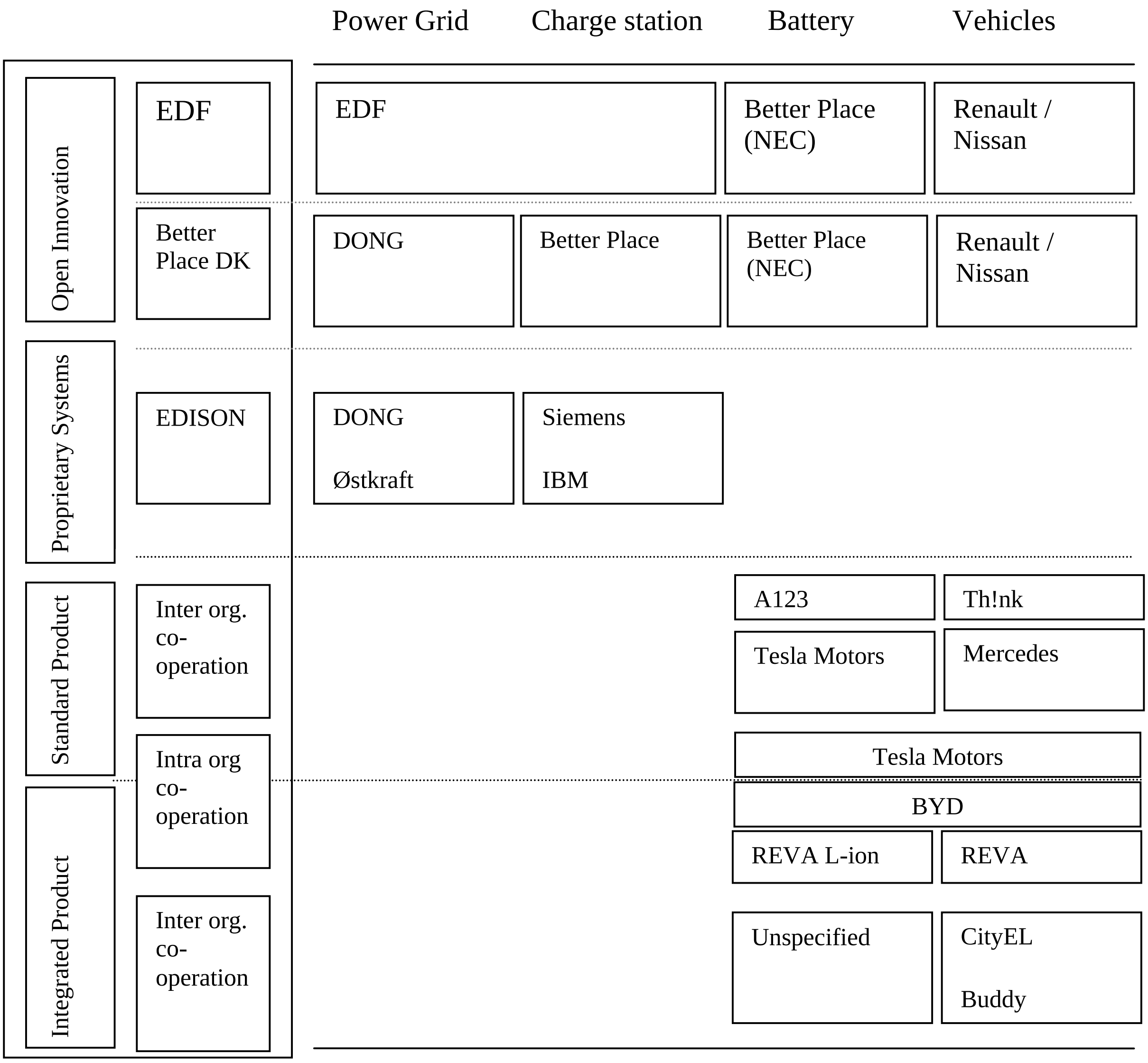
The EDISON (Electric vehicles in a Distributed and Integrated market using Sustainable energy and Open Networks) project in Denmark does act as a *Proprietary System* architect, but with an integral product architecture in focus in order to "*develop optimal system solutions for EV system integration, including network issues, market solutions, and optimal interaction between different energy technologies. Furthermore, the Danish electric power system provides an optimal platform for demonstration of the developed solutions, and thereby, provides the commercial basis for Danish technology export. Furthermore, the advantage of being a "first mover" constitutes a business advantage, as well as, a possibility of a strong Danish influence on future standards for system integration of EVs whereby optimal utilization of the EVs in the power system is obtained*" (Dansk Energi (Danish Energy Association) 2008). The EDISON project consists of several specialists with modular product architecture such as IBM, Siemens, Eurisco, Østkraft, and DONG Energy together with the industry organisation Dansk Energi and The Danish Technology University (Dansk Energi 2008; Invest in Denmark 2008).

Value Capturing in the Emerging Market for Electric Vehicles

According to Jacobides et. Al (2006) *"industry architecture [will] emerge on the basis of the interfaces defined by firms that initially happen to hold superior capabilities, in terms of technical efficiency"*. The analysis therefore discusses the strategies pursued and how they may lead to very different futures once the industry moves from a nascent to a more mature phase.

Different stakeholders take different approaches already in their engagement in the design platform for realising a market for electric vehicles. The design platform consists of four parts which are needed in order to realise a market for electric vehicles: 1) An *electric vehicle* is a type of alternative fuel car that utilises electric motors and motor controllers instead of an internal combustion engine. 2) The electric power is usually derived from *battery* packs in the vehicle which often cost approximately 30-40% of the total vehicle, said Mitsuhiko Yamashita, Nissan's R&D chief (Rendell 2008). According to a series of industry experts, the battery is the focal part of the electric vehicle development (Deutsche Bank 2008; PwC Automotive Institute, 2008). Today, rechargeable lithium ion batteries can reliably deliver driving distances of over 100 miles on a single charge. 3) The *charging station* is a point that supplies electricity for the recharging of electric vehicles. These units will be available for use in parking garages, retail spaces, street curbs, as well as at the homes of car owners. The charging station will be the regular point of interface between the vehicle and the electric power grid. 4) An electrical *power grid* is an interconnected network for delivering electricity from suppliers to consumers. The battery-powered vehicles use their excess rechargeable battery capacity to provide power to the electric grid during peak load periods. These vehicles can then be recharged during off-peak hours at cheaper rates while helping to absorb excess night time generation. Here the vehicles serve as a distributed battery storage system to buffer power. The figure below takes its point of departure in the design platform and illustrates different types of strategies utilising part of or the whole design platform for value capturing.

Fig. 3: The Design Platform for Value Capturing for Electric Vehicles in Denmark



Both Open Innovation business models seek to cover the whole platform, but the two models are very different in their approach to strengthening the network between partners. EDF as the visionary project leader and supplier of consultancy services together with Renault/Nissan alliance with NEC battery producer represent a loosely coupled network where the intention seems to be a combination of superior capabilities related to the power grid and charging stations (EDF) and vehicle (Renault/Nissan) and battery production (NEC) in order to create a technical efficient design platform, and the value capturing is based upon each partner's special capabilities. Better Place is a more closely coupled network where the two main partners (DONG and Better Place ltd.) have created a joint venture called Better Place Denmark that owns and controls the central elements, namely the charging points and the batteries that can be leased by the consumers who buy a vehicle from Renault Nissan (DONG 2008; Roth 2008). The value capturing of Better Place Denmark will be based upon a re-intermediation, coordinating both information as well as electricity flows. In this sense, the company would have a central role in unfolding the industry architecture (Mathews et al. 2009) moving from a nascent to a more mature phase.

The EDISON project's intention is also to move from a nascent to a more mature phase by creating a proprietary system of hardware and software in the infrastructure solution with intelligent battery charging stations. The value capturing is based upon the created de-facto standards the involved actors can benefit from in the further development of the local Danish as well as the global market of electric vehicles (Dansk Energi 2008; Invest in Denmark 2008).

The three last models for value capturing are managed by manufacturers of electric Vehicles, where CityEl (Bertelsen 2007), Buddy (Henriksen 2008) and Mega eCity (Larsen 2009) act as traditional car manufacturers. They sell a ready to drive electric vehicle with a battery manufactured by an unspecified supplier. The value capturing is based upon the simple profit of the sold vehicles together with profitable inter-organisational cooperation with battery producers. Th!nk and Mercedes SmartCar also get batteries through inter-organisational cooperation with battery producers. However, these standard product producers create a value capturing similar to co-branding strategies. The car manufacturer creates a perception of high quality by using some of the most well-known experts in battery design and production because batteries are recognised as the most important component in an electric vehicle. The last group of car producers have based their value capturing on intra-organisational cooperation and are all focused on the technical efficiency of the battery in the sense that they all seek to create vehicles with a big driving range. Tesla Motors has made the Tesla Roaders – today's mass-produced electrical vehicle with the longest driving range (Djursing 2008). However, Tesla Motors consider themselves as a technology provider, so the product is a standard product that can be sold as sub-supplies as well. REVA and BYD are integrated products, REVA created a subsidiary REVA L-ion in order to create a car with a longer driving range (REVA 2009) and BYD was originally a battery producer with a unique battery technology they now seek to utilise through their new car factory (Gården 2008).

Which of the presented models for value capturing will be the winner of the future, remains to be resolved. However, Better Place Denmark comes out as a potential winner since it provides a total solution. In the future, Better Place Denmark as a system architect can, because of its open innovation business model, also join forces with specialists of standard products if they (Th!nk, Mercedes SmartCar and Tesla) let Better Place own their batteries and make their vehicles open for Better Place's software. However, making Better Place enabled vehicles may be too costly. Another potential winner is EDISON's Proprietary System; if they manage to create an efficient charging technology with a de-facto standardised interface which the integrated product specialists can hook up to. This could be the most technical efficient design platform and thereby will the electrical vehicle "… industry architecture emerge on the basis of the interfaces defined by firms that initially happen to hold superior capabilities" (Jacobides et. al 2006).

Conclusion and Implications

The aim of this paper is to describe and analyse the emergent business models and corresponding value capturing capabilities in the emerging market for electric vehicles. For that reason we have developed a framework for understanding the principal strategies for business actors in emerging industries, which we have applied to the emergent electric vehicle market in Denmark. This framework has succeeded in illustrating four types of business models. The EDISON project (Danish DONG, Østkraft and Eurisco, German Siemens and American IBM) as a Proprietary System which seeks to create de-facto standards for charging the battery and managing the power grid. Better Place Denmark and the EDF/Renault alliance as an Open Innovation strategy to create a coherent infrastructure for electric vehicles, where EDF will act a consultant and Better Place Denmark as an intermediary controlling the central elements as charging stations and batteries. Manufacturers of vehicles without batteries such as French Renault, Norwegian Th!nk, and German Mercedes Smart Car and battery manufacturers such as American A123 and Japanese NEC wish to act as specialists in standard products. American Tesla Motors is also in consideration as battery supplier for the Mercedes Smart Car. Tesla Motors is an exception as they consider themselves a technology firm rather than a car manufacturer. Integrated Product specialists in vehicles and batteries that have entered or said they will enter the Danish markets are Chinese BYD, Indian REVA, German CityEl, French Mega e-City, and Norwegian Buddy. In other words, we succeed in outlining the emergent business models for electric vehicles in Denmark; even though this market is barely established yet.

Additionally, by outlining the design platform for value capturing for electric vehicles in Denmark, we have found some interesting perspectives on different futures once the industry moves from a nascent to a more mature phase. The first scenario is Better Place Denmark as the dominant system architect while they offer a coherent solution together with their partners (Danish DONG and French Renault/Nissan). The second scenario will be that Better Place Denmark joins forces with specialists of standard products (Th!nk, Mercedes SmartCar and Tesla), if they let Better Place Denmark control batteries and produce the vehicle’s software. The third scenario will be dominated by EDISON’s Proprietary System’s de-facto standardised interface connected to vehicles manufactured by the integrated product specialists (BYD, REVA, CityEl , Mega e-City, and Buddy) and/or the specialists of standard products (Th!nk, Mercedes SmartCar and Tesla).

It is clear that the local Danish design is populated with many global firms seeking the dream of being part of the promising electric vehicle market. Local market access is necessary, particularly in the early phases of developing electrical vehicles into a viable alternative. Global perspectives are decisive for capitalising on the investments in this new electric vehicle manufacturing technology. Our findings are in line with these considerations, where we see that the system architecture tends to be developed on regional and national bases, since the power grid and the electricity supply management systems have a national – and even regional - heritage and tend to be bound by national/regional borders. All nations – and even regions in larger nations – have developed business systems in their own right. Nations with a strong wind power, such as Denmark, or similar sustainable power supply are thus eager to promote storage systems paving the way for further expansion of sustainable power supply systems. Therefore national power suppliers are strong stakeholders in the development of national system architectures for electrical traffic systems. As power storing users they constitute a strong force in the development of the system architecture. However, the innovation cycle of the electric vehicle system is still in a fluid phase, mainly because the battery capacity is still limited. The range of the electric vehicle without recharging batteries is still restricted. Therefore the business recipes developed still seem to be dominated by innovative perspectives that still seem to be regional – in support of city commuting systems and short range traffic systems. However, no doubt improvements in the battery technology will support cross border traffic perspectives over time and thus pave the way for cross national business development and put the dominant regional system architecture under pressure. Different perspectives seem to evolve from this. On the one hand, strategic alliances among power suppliers in Europe, eventually supported by the European Commission, may pave the way for cross border business models in which the Electric Mobility Operator takes a key role in a viable value capturing model supported by common charging standards. On the other hand, the international oil corporations operating across borders along the established highway systems may also take strong positions on the development of an integrated network of charging stations along the highways they serve today.

More research is needed in order to understand the models' ability to depict the strategic behaviour of actors in the emergent market for electric vehicles. The models presented in this paper have the character of a causal model which needs to be further corroborated by data. So far, we have used secondary data to make a first overview of the industrial landscape, as already suggested by Denzin (2005). This could be supplemented with another analysis where possible lines of discussions and comparisons can follow either predictions based on classical strategic alliance theories and frameworks, or by adopting a historical perspective looking into industries that emerged in the past and are now mature. Also it will be needed to support and/or challenge the models with primary data. This is important for two reasons. First, it is important to test and further develop the robustness of the models as such. Secondly, when dealing with emergent business models and corresponding value capturing capabilities in the fluid phase of emerging markets, secondary data can be the only type of data suited for generating an overall scenario before it is too late when the "transitional phase" dominates while the rate of innovation slows down with respect to products and speeds up with respect to process innovation. In relation to the empirical issues, there is a call for research that discusses the local/global configuration of emergent industries, especially in relation to standardisation of the interfaces between the power grid and the charging station, between the charging station and the battery, and between battery and the vehicle. In a more longitudinal perspective it would be interesting to investigate especially the success of Better Place in Denmark and other countries with regards to their role as a re-intermediator, coordinating information as well as electricity flows focused on exchange facilitation and the re-configuration of distribution channels and on marketing alliances. Finally, since this is an industry in the making, we recommend that the current study will be followed by a follow-up study in a few years, matching the ideas with the actual developments by analysing why certain scenarios prevailed over others.

References

Andersen, P. H.. & Drejer, I. 2008. Systemic Innovation in a Distributed Network: The case of Danish Wind Turbines, 1972-2007. *Strategic Organization* 2008 (6): 13-46.

Bertelsen, J. 2007. January 2. Danmarks elbil får comeback. *Børsen*.

Better Place. 2008a. *Denmark*. [cited March 2008]. Available from http://www.betterplace.com/denmark.

Better Place. 2008b. *Israel*. [cited January 2008]. Available from http://www.betterplace.com/denmark http://www.betterplace.com/israel.

Better Place. 2009. *Better Place, Dong Energy Close 103M Euro (770M Danish Kroner) Investment for Denmark Electric Car Network*, [Press Release]. [cited 2009 January 27]. Available from http://www.betterplace.com/press-room/press-releases-detail/better-place-dong-energy-investment-for-denmark-electric-car-network

Chesbrough, H. W. 2003. *Open innovation: the new imperative for creating and profiting from technology*. Boston, Mass.: Harvard Business School Press.

Chesbrough, H.W. and Teece, D.J. 2002. Organizing for Innovation: When is Virtual Virtuous? HBR Classic, *Harvard Business Review* August: 127-134.

Christensen, C. M. 2001. The past and future of competitive advantage. *MIT Sloan Management Review* 42 (2): 105-109.

Christensen, C. M. & Raynor, M. E. 2003. *The Innovator's Solution*. Harvard Business School Press, Boston.

Cleantech. 2008, October 30. Electric Smart cars head to Denmark. *Cleantech*.

Dansk Energi. 2008. *The EDISON project Electric vehicles in a Distributed and Integrated market using Sustainable energy and Open Networks*. [cited 3 December 2008]. Available from http://www.danskenergi.dk/~/media/EDISON/EDISON_hand_out%20pdf.ashx.

Denzin, N. K. 2005. The First International Congress of Qualitative Inquiry. *Qualitative Social Work* 4 (1): 105-111.

Deutsche Bank 2008. *Electric cars: Plugged in. Batteries must be included*. New York: Deutsche Bank Securities Inc.

Djursing, T. 2008, June 10. Test af Tesla Roadster: Den retter op på alt, hvad Ellerten ødelagde. *Ingeniøren*.

Dong. 2008. *DONG Energy and California-based Project Better Place to introduce environmentally friendly electric vehicles in Denmark*. [cited 27 March 2008]. Available from http://www.dongenergy.com/EN/Media/Press+releases/Press+releases/data/DONG+Energy+and+California-based+Project+Better+Place+to+introduce+environmentally+friendly+electric.htm.

EDF, Renault, & Nissan. 2008. *Partnership between Renault and EDF: objective: zero emissions*. [Press Release]. EDF. [cited 9 October 2008]. Available from http://presse.edf.com/fichiers/fckeditor/File/press/cp_2008/cp_20081009_va.pdf

Ehrlich, D. 2008, September 8. Berlin to charge up Smart cars. *Cleantech*.

Galvin, P. & Morkel, A. 2001. The effect of product modularity on industry structure: The case of the world bicycle industry, *Industry and Innovation* 8 (1): 31-47.

Gården, H. 2008, December 17. Kinesere klar med elbil i 2009. *Børsen*.

Gärling & Loukopolos 2007. *Effectiveness, Public Acceptance, and political Feasibility of Coercive Measures for Reducing car Traffic*. In: Threats from car traffic to the quality of urban life problems, causes, and solutions. Gärling & Steg ed., 313-324. Elsevier.

Garud, R. & Kumaraswamy, A. 1995. Technological and Organizational Designs for Realizing Economies of Substitution. *Strategic Management Journal*, 16 (Special Issue Summer): 93-109.

Henderson, R. M. & Clark, K. B. 1990. Architectural Innovation: The reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly* 35: 9-30.

Henriksen, K. 2008. December 3. Dansk elbil gør comeback via Norge *Børsen*.

Holm, T. V. 2008, June. *DONG Energy's elbilprojekt*, [PowerPoint Slides]. Dong Energy.

Invest in Denmark. 2008. *Siemens chooses Denmark for electric car infrastructure project Ministry of Foreign Affairs*. Ministry of Foreign Affairs of Denmark. [cited 17 October 2008]. Available from http://www.investindk.com/visNyhed.asp?artikelID=20525

Jacobides, M. G., Knudsen, T. & Augier, M. 2006. Benefiting from Innovation: Value Creation, value appropriation and the role of Industry Architectures. *Research Policy* 35: 1200-1221.

Klima- og Energiministeriet. 2008. *Ny tilskudsordning for at opsamle praktiske erfaringer med elbiler*. Energistyrelsen. [cited 5 December 2008]. Available from http://www.ens.dk/sw77988.asp.

Langlois, R. N. & Robertson, P. L. 1992. Networks and Innovation in a Modular System: Lessons from the Microcomputer and Stereo Component Industries. *Research Policy*. 21 (4): 297-314.

Larsen, L.-B. 2009. January 3. Franske elbiler er klar til Danmark. *Politiken*.

Magretta, J. 1992. Why Business models matter, *Harvard Business Review*. 80 (5): 86-92.

Mathews, J. A., Andersen, P. H., & Rask, M. 2009. Integrating private transport into renewable energy policy: The strategy of creating intelligent recharging grids. *Energy Policy.* Accepted for publication.

Mathiesen, B. V., Lund, H., & Nørgaard, P. 2008. Integrated transport and renewable energy systems. *Utilities Policy* 16 (2): 107-116.

Pisano, G. P & Teece, D. J. 2007. How to capture value form Innovation: Shaping Intellectual Property and Industry Architecture, *California Management Review*. 50 (1): 278-296.

Porter, M. E. 1985. *Competitive Advantage.* Free Press.

PwC Automotive Institute. 2008. *Global Powertrain: Plugging into Tomorrow's Vehicles and Battery Cost / Sustainability*, [Analyst Note]. Omnexus. [cited 19 November 2008]. Available from http://www.omnexus.com/resources/editorials.aspx?id=21294.

Renault, & Nissan. 2008. *Renault-Nissan and Project Better Place pursue their strategy of zero-emission vehicles in Denmark*, [Press Release]. Nissan. [cited 27 March 2008]. Available from http://www.nissan-global.com/EN/NEWS/2008/_STORY/080327-01-e.html.

Rendell, J. 2008. *UK: EV cost parity in seven years - Nissan*. just-auto.com editorial team. [cited 16 June 2008]. Available from https://www.just-auto.com/article.aspx?id=95131.

REVA. 2009. *Reva Introduces Lithium-powered Electric Car*, [Press Release]. EV World. . [cited 7 January 2009]. Available from http://evworld.com/news.cfm?newsid=20084

Roth, D. 2008. February. Driven: Shai Agassi's Audacious Plan to Put Electric Cars on the Road. *Wired, 16.09.*

Sako, M. & Helper, S. 1998. The Determinants of trust in Supplier Relations: Evidence from the Automotive Industry in Japan and in the United States, *Journal of Economic Behaviour and Organization*. 34 (3): 387-418.

Santos, F. M., K. M. Eisenhardt 2005. Organizational Boundaries and Theories of Organization. *Organization Science*. 16 (5): 491 – 508.

Scott, W. R. 2007. *Institutions and Organizations: Ideas and Interests*. Sage Publications.

Shapiro, C., & Varian, H. R. 1998. *Information Rules: A Strategic Guide to the Network Economy*. Boston: Harvard Business School Press.

Storper, M. & Saias, 1997. *Worlds of Production*, Boston: Harvard University Press.

Teiner, E. 2008, October 21. Projekt elbil snart en realitet. *Erhvevsbladet*.

Tripsas, M. & Gavetti, G. 2000. Capabilities, cognition and Interia: Evidence from Digital Imaging, *Strategic Management Journal*. 21: 1147-1161.

Utterback, 1996. Mastering the Dynamics of Innovation. Boston: Harvard Business School Press.

Van Wee, Bert 2007. *Environmental Effects of urban Traffic*. In: Threats from car traffic to the quality of urban life problems, causes, and solutions. Gärling & Steg ed. 11-32. Elsevier.

Weick, K. E. 1995. *Sensemaking in organizations*. Thousand Oaks, Calif.: Sage Publications.

Whitley, R. 1992 *The Social construction of Organizations and Markets – The comparative analysis of Business Recipes* in Reed, Michael and Huges, Michael eds.: Rethinking Organization. Sage Publications.