EVS27
Barcelona, Spain, November 17-20, 2013

New Business Models for Electric Cars

Mats Williander[1], Camilla Stålstad
[1]*Viktoria Swedish ICT, Lindholmspiren 3A, Gothenburg, Sweden, mats.williander@viktoria.se*

Abstract

Why does the commercialization of plug-in cars remain sluggish when they are ascribed the potential to contribute significantly to the development of a sustainable society? The risk- and cost transfer that comes with the purchase of a car under the current dominating business model is not well suited for technologies that are novel to customers, like plug-in cars. Therefore, the commercialization of plug-in cars can benefit from alternative business models. The purpose of this paper is to present four alternative business models that are better suited for plug-in cars. They are based on already existing business models that have proven themselves in other industries and they have been chosen in regards to their suitability to address important hindrances for a rapid plug-in car adoption like perceived risk, high purchase price and limited range. The four models are: All-electric car leasing chain, where the operational lease company keeps ownership of the car through a sequence of lease cycles until its end-of-life; All-electric car subscription, where the carsharing company uses suburban commuters to extend their carsharing market by moving vehicles to where people are; Free floating all-electric city cars which can be picked up at one place and left at another without requiring booking in advance; Fringe benefit plug-in cars which utilizes that the lower fringe benefit tax on cars with low CO_2 tailpipe emissions makes the plug-in car economically competitive as fringe benefit car. Each of these business models are judged as potentially viable but fragile and dependent of contextual factors like the price tag gap difference between plug-in and ICE cars, battery warranty limitations of the plug-in car, the technology improvement speed, and the energy cost gap for plug-in cars versus ICE cars. Governments and car manufacturers can mainly influence these factors.

Keywords: business models, plug-in cars, commercialization

1 Introduction

Why does the commercialization of plug-in cars remain sluggish when they are ascribed the potential to contribute significantly to the development of a sustainable society by drastically reducing local emissions, helping make the vehicle fleet fossil free, reducing dependence on foreign oil, reducing the transport sector's impact on climate change and increasing the energy efficiency of transports?

Private households seem to have difficulties finding electric car offerings sufficiently attractive, even when significant governmental subsidies are included. Considerable efforts are put into development and innovation of plug-in car related technology such as battery chemistry and technology, charging infrastructure, inductive charging etc., indicating a general belief that if only technology can be improved, plug-in cars will become sufficiently attractive. That may be true, but business model innovations are important complements to technology innovations and should also be explored.

The researchers Chesbrough and Rosenblom [1] stated that:

> *The inherent value of a technology remains latent until it is commercialized in some way; obviously, the extent to which its value is realized is contingent upon the manner in which that takes place*

This statement shows how important a role they view the business model to play for a technology's final perceived market value. Today, electric cars are mainly sold by using the business model used for selling traditional ICE cars. The modest plug-in car sale outcomes can be read as that the value of the plug-in car, *as the business model provides it,* is too small, maybe even negative relative to a comparable ICE car.

The most common business model for cars, which we call "sell-and-disengage", transfers the risk of ending up with a useless car to the buyer. Actually, it's not a risk but a given. The question is only how soon and what costs I will have along the way. As consumers, we may have become used to accept this for well-known and proven technologies where we can judge the risks we take. But we don't accept it as easily for new and unproven technologies [2]. The new technology must prove itself substantially before we are prepared to buy it. We want peers to recommend it, we want it to be visible in society, and we must value the advantages the new product and technology provides - advantages for me who pays, not necessarily advantages for society [3].

The risk- and cost transfer that comes with the purchase of cars under the current dominating business model is hence not well suited for technologies that are novel to customers. Therefore, there are reasons to believe that the commercialization of plug-in cars can benefit from alternative business models.

The purpose of this paper is to present four alternative business models that are better suited for plug-in cars than the currently dominating sell-and-disengage business model, and the process under which they were developed. By this we hope to contribute to a more rapid commercialization of plug-in cars by inspiring business actors to consider other business models to increase growth of plug-in car sales.

Due to the lack of alternatives to the common "sell-and-disengage" business model the research study was based on an entrepreneurial Customer Discovery procedure for business model development and validation [4]. Following this procedure, four alternative business models were created and tested.

The theoretical frame description in the next section, Section 2, should be read as the guidance we have used in the selection of business models and in designing them rather than read as constituting a platform for theory development. In Section 3, we define some terminology and the study's focus. Section 4 describes the design of the study, including the rationale for choosing the customer development and lean startup approach. The business models are presented in Section 5, followed by a discussion of strengths, weaknesses and challenges in Section 6. Conclusions and implications are presented in Section 7.

2 Theoretical frame

2.1 Business Model

A business model is a description of how a company creates, delivers and captures value [5]. It is a viable business when a sufficient amount of paying customers perceives the value of the offer as higher than the cost the company has for creating and delivering it.

A lot of different business models have been developed and tested through history of business. There is the Bate and Hook model, used by John D Rockefeller at Standard Oil in the early 1880th to increase demand for kerosene in China, later used by Gillette as their famous Razor-Blade business model, and now used in its reverse by Apple with iPod/iTunes. There is the Crowd sourcing model, used by Wikipedia and Youtube, and there is the Disintermediation, used by Dell and which nowadays has become much wider used because of the ease with which Internet makes it possible. These are but a few that one can be inspired by when creating new ones [6].

2.2 Capturing customer perception of value

The customer's perception of value is multifaceted as it incorporates many elements of value such as economic value, comfort and convenience, social prestige and so forth [7]. One way to comprehend potential customers' perceptions of value is to approach them with hypothetical value propositions in iterative interaction-modification cycles [8] where objections and thoughts guides the further business model development until actual purchases at required prices validates its potential viability. These interaction- modification cycles can start with early problem-oriented interviews and continue through solution-oriented interviews, to sales of prototypes to early adopters before any scale-up of the business takes place [8]. In this case studies on attitudes and ownership experiences from owners of plug-in cars (i.e. customers to the sell-and-disengage business model) are now showing up [9] and can also be a good input in the development of alternative business models.

2.3 Customer Categories

The relative speed of which potential customers adopt an innovation depend on the characteristics of the innovation and on the characteristics of the potential customer [10]. There are five main potential customer (adopter) categories: Innovators (2,5%), early adopters (13,5%), early majority (34%), late majority (34%) and laggards (16%) [10][11]. These five adopter categories adopt a new innovation at different times during the diffusion process of a new innovation, and for different reasons. Claims are made that there is a considerable chasm between the group early adopter and early majority because of a big difference in purchasing reason [11]. While innovators and early adopters have more of a focus on the technology as such and on its potential, the early majority adopts an innovation if it improves their lives personally and relative to existing alternatives [11]. This is an important group to win and hence the group we focus on in this study, both because of its sheer size but also because it is the first of three big groups who require personal benefits relative to existing alternatives in order to adopt a new innovation.

2.4 Perception of gains and losses

There is an asymmetry in customers' perception of gains versus losses. The perceived joy of winning is less than the perceived punishment of losing an equal amount of value [12]. Outcomes are not perceived as states of wealth but as gains and losses relative to a reference. This means that even a small disincentive compared to a current state may be magnified to become an obstacle in a diffusion process. In addition, customers are more uncertain about new and unproven technology that has not yet become socially embedded [13]. This uncertainty is reflected in a higher implicit discount rate for new innovations in customers' purchase decision process. Sometimes, the implicit discount rate can be as high as 800% and often around 30%-50% compared to a more normal 4%-12% [2]. Customers can hence easily disregard plug-in cars even at relatively small deteriorations of attributes, like range, charging time and towing capacity relative to ICE cars.

Whether a product attribute represents deterioration or a feature can often depend on the context in which an innovation is used. The charging of an electric car can be perceived as inferior when one has to fast charge repeatedly on a long highway trip. The ease of plugging in the car at home ensuring that it is always fully charged in the morning and hence one never have to go to a gas station can be perceived as a valuable feature [14], and still - it is the same attribute. How the various product attributes are perceived is an important consideration when developing business models and choosing customer segments.

2.5 Attitude trends

People's attitudes to "stuff", including cars are changing, especially among younger generations [15]. For many customer segments, access may be more important and interesting than ownership, especially when it comes to new and unproven technologies. It is also beneficial for the diffusion of a new technology to let potential customers easily try it out for a longer period without the commitment that comes with ownership [3].

3 Terminology and focus of the study

Terminology concerning plug-in cars is to some extent inconsistent. In our work we have chosen to define plug-in cars as all types of cars that can be plugged into the grid for charging, that is both cars that are *all-electric*, i.e. that has no internal combustion engine (ICE), and cars that are *plug-in hybrid electric vehicles* (PHEV) or *range extender vehicles* (REV) i.e. that combines an electric engine with an ICE.

When developing the business models we have primarily focused on business models suitable for all-electric cars, due to the greater challenges that this technology is facing. A PHEV or REV could more or less straight off replace an ICE car and hence should have less need for alternative business models. This however does not imply that the business models we have developed would not be suitable for PHEVs and REVs as well.

4 Method

Because of the lack of alternative business models to the rife "sell-and-disengage" in Sweden it was deemed necessary to design a research study based on an entrepreneurial Customer Discovery procedure [8]. Following this procedure, four alternative business models were created and conceptually tested.

The Customer Discovery procedure is basically an iterative hypothesis refinement procedure of interaction-modification cycles where you start with a set of hypotheses that constitutes your business model and then test them through interactions with potential customers and similar businesses, modify them based on interaction results, and then iterate until you have an offer that instances of the would-be customer segment actually buy [4].

To keep a low threshold for adoption, we decided to base the four business models on already existing ones that have proven themselves in other industries. We picked and choose business models based on their suitability to address important hindrances of a rapid all-electric car adoption like perceived risk, high price and limited range compared to an ICE car. We used a list of business model analogies from Johnson [6] as source for inspiration.

Initially we created 17 business model hypotheses, which we discussed, compared, combined and briefly checked against potential customers and then reduced in a selection process incorporating knowledge from the theoretical frame in Section 2 until four business models remained. We then contacted potential customers for each of the business models and interviewed them in order to identify flaws in our hypotheses. We also contacted businesses we believed were relatively close to the business models in terms of customer segments and/or cost structures, to get their feedback on customer-, cost-, price- and revenue assumptions. Such businesses were typically car rental companies, financial and operational lease companies, carsharing companies and car manufacturers. After 2-3 rounds of interaction-modification, we decided to settle since our ambition was not to commercialize the business models but rather to create and confirm them on a conceptual level.

The result was four business models that were built from well-founded theories and then conceptually validated against customers in Sweden: All-electric car leasing chain; All-electric car subscription; Free floating all-electric city cars; and Fringe benefit plug-in cars.

These business models will now be shortly described.

5 The Business Models

In this section, the four alternative business models, BM1 to BM4, are briefly presented. Detailed descriptions, storyboards and descriptive movie clips of the four business models can be found at www.viktoria.se/projects/believe/bm . All four business model calculations are based on an interest rate of 4%, a fuel price of € 1,59 per liter petrol or diesel, and an electricity price of € 0,1225 per kWh. These are valid amounts as of June 2013 in Sweden at an exchange rate of 9,10 SEK per €. We have used the Nissan Leaf with an electricity consumption of 0,173 kWh/km and CO_2 tailpipe emission of 0 g/km and a VW Golf 1.6 TDI BMT with a fuel consumption of 0,38 l/10km and CO_2 tailpipe emission of 99 g/km as reference cars in business models BM1, BM2 and BM3. A Volvo V60 DrivE Momentum and a broader range of plug-in cars are used as references in BM4 due to a significant difference in customer segment preferences.

5.1 BM1 – All-electric car leasing chain

Some claim that all-electric cars already today provide lower total cost of ownership (TCO) than comparable ICE cars for many consumers [16]. Since most car owners don't own a car during its entire lifecycle, the idea with this business model is to let a lease company own the car and lease it out to a chain of customers until its end-of-life. The potentially lower TCO can be shared between the lease company and its customers, and the residual value risk is significantly reduced. The offer, operational lease, is also in line with a general trend of lower interest in car ownership among younger generations.

As all-electric cars are expected to have lower maintenance costs as they grow old, compared to ICE cars, used-car operational lease may show to be a reasonable business *only* with all-electric cars. If so, it is a unique operational all-electric car lease offer to the used-car market, which today is worth more than new car sales in many countries [17].

We also identified a possibility to gather and sell real-time battery data to car manufacturers and battery producers, but this potential revenue stream has not been included in the calculation. One concern among potential business model operators was that as new all-electric cars with better attributes enter the market, too few customers might want to lease the older cars. This Technology Improvement Speed issue is important for all-electric cars and will be further discussed in the Discussion Section.

The typical customer segment for this business model is households in suburban with two cars used for daily commuting. The reason to focus on households with two cars is that the other car then can cover the cases of usage where the all-electric car range isn't sufficient. Based on a Leaf price that is 1,6 times that of a VW Golf, and an annual commuting distance of 20.000 km, it is almost possible to achieve a monthly total all-electric car cost that is the same as for an ICE car for the second and later leasing cycles. The fuel consumption 0,38 liter diesel per 10 km is significantly below today's average fuel consumption and many ICE cars consumes more than that. When we use the more reasonable 0,48 l/10km, the all-electric car can compete. It has however shown difficult to achieve a lower cost also for the first leasing cycle. The business model assumes four lease cycles within 8 years which gives a total driving distance of 160 000 km. That is beyond the current battery warranty. An annual driving distance of 12 500 km brings us closer to today's battery warranties, but then the all-electric car becomes about 12% more expensive than the ICE car and in the first lease cycle 21% more expensive. An annual driving distance of 22 435 km makes the all-electric car cheaper in every lease cycle, but then again - the warranted distance is exceeded.

The most important factors for the all-electric car's competitiveness in this business model, beyond the obvious price tag issue are the battery warranty time, warranty distance, and the technology improvement speed for all-electric car technologies. They are all crucial as they affect the depreciation cost per driving distance or per time unit.

5.2 BM2 – All-electric car subscription

One trend in society is that cars are losing position as status symbols. An increasing number of households own a car because they have to rather than want to. As a consequence interest in carsharing services increases. But for people living in the suburban, who depend on their cars for their daily commuting, carsharing is generally not an option since frequent usage makes the carsharing offer rather expensive compared to a privately owned car. A possible solution of interest for carsharing operators in the city could be to offer these people a subscription for an all-electric carsharing car intended for commuting. All-electric car subscribers sign up for long-time use and contribute to expand the market for the carsharing operator by moving a subset of cars into the suburban after work and moving them back into the city in the morning.

In this business model the carsharing car is used by a subscriber for commuting, but during the rest of the day as well as during weekends it is available for regular carsharing customers. This way the utilization of each carsharing car increases, which is beneficial for all-electric compared to ICE. Customers avoid the risk of ownership and the cost of the all-electric car is distributed among several users. The residual value problem is also addressed by assuming that the all-electric car is retained within the business until its residual value is zero. With a carsharing offer that includes a suitable mix of all-electric and ICE cars any travel distance need can be met. The carsharing offer works as a bundle of all-electric and ICE cars and hence can replace 100% of ICE car ownership.

The subscription fee is based on the daily driving distance of the subscriber. When the daily driving distance is within the range of 0-50 km the all-electric subscription fee can easily compete with the costs of owning a corresponding ICE car. If the daily range exceeds 50 km the depreciation of the all-electric will make the subscription fee too high for the subscription to be able to compete with ICE car ownership. If the distance limit in the battery warranty is increased to 120 000 km the subscription fee would be able to compete with car ownership up to a daily driving distance of 70 km.

We have assumed that the residual value of the all-electric car will be zero when the battery warranty expires. Due to the high utilization degree of the all-electric car in this business model this occurs after a very limited time period. If the daily driving distance of the subscriber is 50 km the battery warranty will expire after only 40 months. The fast deprecation enhances the impact of the relatively high purchase price of the all-electric car in the calculations. If the purchase price is reduced by € 4.400 (equivalent to the Swedish super green car bonus) the subscription fee would be able to compete with the cost of car ownership up to a daily driving distance of 66 km.

In addition to the factors discussed above the business model competitiveness is also affected by the relative difference between fuel price and electricity price, the interest rate and other external factors, but the impact of such factors are of much less importance.

5.3 BM3 - Free floating all-electric city cars

You go by taxi but you are the driver. That is how free floating carsharing work. In this business model, the city contributes with free parking if the cars are all-electric cars, firstly because an all-electric car doesn't contribute to local air pollution and secondly because a carsharing car replaces 4-20 privately owned cars and hence help reduce car density per citizen. As user, you pay per minute of use, and that's it! The typical customer is a city dweller who finds it increasingly annoying to own a car in the city but want personal mobility beyond what public transport and taxis can provide. With free-floating all-electric city cars, you don't have to pre-book, stick to a certain time interval or leave the car where you took it. It's as a taxi, but you drive yourself.

Car2Go and other initiatives already provide this type of service, both with ICE cars and with all-electric cars, but it should be possible to offer a whole range of car sizes and models in order to fulfill a city dweller's complete transportation needs. We have based our calculations on a Nissan Leaf, which is a more traditionally sized car than the Smart Fortwo that Car2Go uses. According to our calculations, a Leaf can be offered at € 0,32 - € 0,37 per minute, depending on the inclusion or not of a super green car bonus and free parking in the calculations. Car2Go charges € 0,29 per minute in Amsterdam, and a privately owned used car typically cost at least € 0,31 per minute at an average speed of 40 km/h and 10 000 km annual driving distance.

An economic comparison between free-floating all-electric cars and free-floating ICE cars shows that without access to free parking, and either improved battery warranty conditions or a somewhat lower car price, it is very difficult to match the ICE car minute price. In our model, when we compare the Nissan Leaf with the VW Golf, no super green car bonus and the same parking costs, the all-electric minute price is 23% higher.

The main issue in this model, beyond the price tag of the car, is the battery warranty period and warranty distance since that sets the depreciation, which is the biggest cost for the operator of this model.

5.4 BM4 - Fringe benefit plug-in cars

More than 50% of new car sales in Sweden are fringe benefit cars, so if electric cars can be made attractive for those customers, a substantial share of the new car market becomes accessible. However, the fringe benefit car customer segment is somewhat special. Mostly, the fringe benefit car is the family's primary car, i.e. they chose one that can take them wherever they need and want to go. The fringe benefit car may also implicate status to some extent - not everyone gets a fringe benefit car offer. So the brand and model matters as status markers. In Sweden, fringe benefits are subject to tax additions, but cars with CO_2 tailpipe emissions below 50 g/km are taxed significantly lower. While the fringe benefit tax of traditional cars is based on their prices, the fringe benefit tax of plug-in cars is based on the closest comparable traditional car minus the least of 40% or € 1.758. This rule ensures that plug-in cars always receive a lower tax. That lower tax plus a lower energy cost usually more than well compensate for the higher purchase price.

During the validation process of this business model, three main causes were identified as to why the plug-in car uptake currently was so low: 1) Fringe benefit car receivers lacked knowledge about plug-in cars and the lower tax, so these cars were not on their consideration list; 2) Some employers have an upper car price limit based on the price base amount. Cars above that limit are considered "luxury" and are therefore not allowed. Some plug-in cars, especially PHEV and REV are priced above that limit and hence are not eligible as fringe benefit cars in all companies; 3) The most popular fringe benefit car brands currently don't have plug-in cars that are suitable as a family's primary car.

A suitable car technology in this business model is typically a PHEV or REV, i.e. a bundle of a plug-in and an ICE within one car, but a company-wide car swap service allowing colleagues to temporarily swap cars with each other or with a car rental company was considered an interesting potential means to also make all-electric cars interesting choices as fringe benefit cars.

A growing number of companies offer fringe benefit cars that are cost-neutral to the company, i.e. the fringe benefit car is paid by the employee through a gross salary reduction giving them a somewhat lower cost for the car than if they bought it privately. In this case the higher price of the plug-in car has to be covered by the employee through a higher gross salary reduction, which needs to be offset by the lower fringe benefit tax on the chosen car. Since this is the worst case scenario for plug-in cars as fringe benefit cars, this is the concept we have used in our calculations.

The calculations show that plug-in cars mostly cost the employee less per month than a comparable ICE car, and the cost difference increases with annual mileage. The monthly difference between a plug-in car and a comparable ICE car is relatively small for plug-in cars when there is a corresponding ICE car of the same make and model but for plug-in cars that have no ICE counterpart it can be significant (up to € 250 per month). The reason seems to be that taxes for these cars often are based on a traditional car which have less equipment and hence are much less expensive.

The calculations are based on a 60-month leasing period, a zero residual value, and a driving distance that is within the battery warranty distance, i.e. a maximum of 20.000 km per year.
Since the Volvo V60 DrivE Momentum, with a price of € 30.989 and a fringe benefit tax of € 392 per month, is a very popular fringe benefit car in Sweden we have used it as reference car in this business model.
The plug-in cars have been Volvo V60 PHEV, Opel Ampera, Nissan Leaf, Ford Focus Electric, Tesla Model S and Toyota Prius PHEV.

6 Discussion

In the project behind this paper, we have found that the most deviating attributes of an all-electric car compared to an ICE car, the higher price, the shorter range and the higher energy efficiency, can to a considerable extent be offset or amplified through business models.

Despite the higher price, the higher energy efficiency can under certain conditions give a lower total cost of ownership for the all-electric car. This can be utilized in an operational lease chain business model. The shorter range can be offset through various kinds of bundling with ICE cars. In BM1, the bundling is achieved by focusing on 2-car households where an all-electric car can be one of them. In BM2, the bundling is achieved through a carsharing service, offering a whole range of cars, and in BM4, the bundling is achieved either within the car, by hybrid technology, or through a company-wide car swap service.

The four described alternative business models seem possible to make competitive to similar services based on ICE cars and to traditional car sales business models, judged at a validated conceptual level. By competitive, we mean equal to or more attractive to the target customer segments at prices, costs and taxes that are valid in Sweden today.

Although the business models seem competitive, it isn't with large and obvious margins. Rather, we consider them being fragile and highly dependent on external factors that neither their operators nor their customers can influence. These factors are: the relative all-electric car price; the energy cost gap, i.e. the difference in energy cost per distance driven between all-electric and ICE cars; the battery warranty conditions; and finally the technology improvement speed for all-electric cars.

6.1 The price gap

Even if an all-electric car can drop considerably in price, that will only happen if production volumes of all-electric cars go up. Meanwhile, the fierce price competition in the automotive industry continues to keep ICE car prices down.

One way for governments to help reduce the price gap between all-electric cars and ICE cars without spending tax money can be to implement a bonus-malus (i.e. fee-bate) system based on CO_2 tailpipe emissions on new car sales. Such a system can be designed to be self-financed and by that also be an easily understood, foreseeable and long-stay measure.

6.2 The energy cost gap

The price on diesel and petrol is in Sweden somewhat above the EU27 average and higher than in many other countries in the world. The price on electricity is lower in Sweden than the EU27 average, so the Swedish energy cost gap is favorable for all-electric vehicles. Still, the situation for our four business models is fragile and full of future uncertainties.

The tax on petrol and diesel for instance is an important revenue stream for the Swedish government, and the measures that the government has to take if this revenue stream shrink due to a successful commercialization of all-electric vehicles are currently not known.

Electric motors are very energy efficient and can hardly improve very much. Petrol and diesel engines may however improve, not least because of EU's plan for further CO_2 tailpipe emission reductions, which will translate to more fuel-efficient cars. All this threatens to reduce the energy cost gap required to economically motivate all-electric cars.

One way to keep the energy cost gap can be for the government to annually increase the taxes on petrol and diesel based on the improvement of fuel efficiency of new cars so that the energy cost per km for a new ICE car will never decrease.

If revenues decrease from diesel and petrol sales, a distance-based tax that hits all cars equally can be an alternative to tax on electricity for mobility use.

6.3 The battery warranty

It is hard for anyone to say how long a battery will last, still that is one of the most crucial issues for the economy of all-electric cars next to their relative price, especially if one doesn't dare anything than to expect the residual value to be zero if/when the battery warranty ends. Nissan Leaf comes with a 5 year or 100.000 km battery warranty (whichever comes first) in Sweden. In California, carmakers are legally bound to give 10 years or 150.000 miles warranty (whichever comes first). Currently, batteries improve at a relatively high pace. We believe it would be better if carmakers used that improvement to improve battery lifetimes and battery warranties rather than to increase the range of the all-electric car in bootless efforts to get the range on electricity closer to the ICE car range.

6.4 The technology improvement speed

A high technology improvement speed depreciates the current all-electric cars faster, worsening the business case for all-electric cars. Some governments and municipalities gives various forms of incentives to all-electric car buyers like free parking, permission to drive in bus lanes, exception from congestion charges etc. These incentives can't last forever and will have to go when all-electric cars become a more frequent occurrence on the streets. One way to mitigate the depreciation of older all-electric cars can be to give incentives that follow the car until its end-of-life. An older-technology all-electric car can then keep an incentive that does not apply to a newer all-electric car, hence a more reasonable depreciation over time is supported.

6.5 Limitations

The study has been made in Sweden with its unique taxes and relative prices. This certainly limits the possibilities to apply the four business models in other countries. We believe however that our analysis and the contextual factors we have identified are analytically valid and useful globally.

The business models were generated as hypotheses and then validated through interviews with similar businesses and potential target customer groups. Blank et al recommend more iterations of the validation process, up to the level where beta-versions of the value propositions actually are sold at full price. We have not taken these models that far, which means the business models still carry significant uncertainties.

Customers chose on more criteria than economy. During our interviews it was confirmed that convenience, assurance and image matters as well. We also noted that people are concerned about the environment and about climate change. They want to contribute to a more sustainable society, but not by sacrifices. We have mainly discussed the business models economically and may have both over- and underestimate the competitiveness of these models. Our thinking, however, has been that if potential customers have signaled appreciation of the business models' value propositions in interviews and the economic calculations are signaling that the value propositions also can be provided at equal or lower costs, then the probability that the business models are viable should be relatively high.

7 Conclusions

The risk- and cost transfer that comes with the purchase of cars under the current dominating sell-and-disengage business model is not well suited for technologies that are novel to customers, such as all-electric cars. To convince private households to choose an all-electric car, the value proposition must be perceived as better and simpler for them personally. The outcome must also be predictable, something the sell-and-disengage of all-electric cars currently doesn't provide, possibly with the exception of Tesla Motors with their battery warranty and resale value guarantee.

The four business models described in this article have been designed with this in mind. They have potential to be perceived as more attractive by potential customers and to be profitable for their operators. The financial robustness seems however fragile and dependent on contextual factors that neither the business operator nor its customers can influence.

These contextual factors, the price tag gap, the battery warranty, the technology improvement speed, and the energy cost gap for all-electric cars versus ICE cars can mainly be influenced by governments and car manufacturers.

Therefore, we conclude that alternative business models can be important tools for a faster commercialization of all-electric vehicles, but their long-term viability requires the price tag gap to shrink, the energy cost gap to remain or increase, the battery lifetime to improve and the technology improvement speed to be offset.

Governments can help. That help can be in the form of self-financed bonus-malus systems for CO_2 tailpipe emissions (France), legal requirements on battery warranties (California), benefits that follow the car (Sweden), and an increase of fuel tax offsetting ICE energy efficiency improvements.

Car manufacturers can also help. The first and most obvious would be to focus more on battery lifetime improvements that translates into better warranty conditions rather than on extending range. The range needed to fully replace an ICE car, we believe, is too far away. Various bundling alternatives can easier and cheaper offset that need. According to our findings, an all-electric car's competitiveness is more dependent on its price tag and battery lifetime than on its range.

Acknowledgments

We would like to thank the Swedish Energy Agency for funding this project and our project partner Ericsson AB.

References

[1] H. Chesbrough et. Al., *The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies.* Industrial and Corporate Change, ISSN 0960-6491, 11(2002), 529-555.

[2] H. Geiler et. Al., *The Experience with Energy Efficiency Policies and Programmes in IEA Countries - Learning from the Critics.* IEA Information Paper (2005), http://www02.abb.com/db/db0003/db002698.nsf/ca7e93ab03030d22c12571380039e8fc/0912873430b22467c12571da0032d460/$FILE/The+Experience+With+Energy+Efficiency+Policies+and+Programmes+in+IEA+Countries.pdf accessed on 2013-07-03

A. B. Jaffe et. Al., *The energy-efficiency gap What does it mean?* Energy Policy, ISSN 0301-4215, 22(1994), 804-810

[3] Rogers, *Diffusion of Innovations*, ISBN 0-7432-2209-1, New York, Free Press, 2003

[4] Blank, *The four steps to the epiphany – Successful Strategies for Products that Win*, ISBN 0-9764-7070-5, Pascadero CA, Lulu.com, 2006

[5] J. Björkdahl, *Technology cross-fertilization and the business model: The case of integrating ICTs in mechanical engineering products*, Research Policy, ISSN 0048-7333, 39(2009), 1468-1477

A. Osterwalder et. Al., *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers,* ISBN 978-0470-87641-1, New Jersey, John Wiley & Sons, Inc. 2010

[6] Johnson, *Seizing the white space: Business Model Innovation for Growth and Renewal*, ISBN 978-1-4221-2481-9, Boston, Harvard Business School Publishing, 2010

[7] A.C. Ahuvia, *Beyond the Extended Self: Loved Objects and Consumers' Identity Narratives*, Journal of Consumer Research, ISSN 0093-5301, 32(2005), 171-184

R.W. Belk, *Possessions and the Extended Self.* Journal of Consumer Research, ISSN 0093-5301, 15(1988), 139-168

P. Dobers, *Design, lifestyles and sustainability. Aesthetic consumption in a world of abundance,* Business Strategy and the Environment, ISSN 0964-4733, 14(2005), 324-336

K. Wattanasuwan, *The Self and Symbolic Consumption,* Journal of American Academy of Business, Cambridge, ISSN 1540-1200, 6(2005), 179-184

O. Johansson-Stenman et. Al., *Honestly, why are you driving a BMW?*, Journal of Economic Behavior & Organization, ISSN 0167-2681, 60(2006), 129-146

[8] Blank & Dorf, *The Startup Owner´s Manual - The Step-by-Step Guide for Building a Great Company*, ISBN 978-0-9849993-0-9, Pescadero, K&S Ranch Press, 2012

Ries, *The Lean Startup: How Constant Innovation Creates Radically Successful Businesses*, ISBN 978-0-670-92160-7, London, Penguin Group, 2011

Furr & Ahlstrom, *Nail It then Scale It: The Entrepreneur's Guide to Creating and Managing Breakthrough Innovation*, ISBN 0-9837-2360-5, Provo, Utah, Furr & Ahlstrom, 2011

[9] R. Hjorthol, *Attitudes, ownership and use of Electric Vehicles – a review of literature,* ISBN 978-82-480-1430-0, Oslo, Institute of transport Economics, 2013

[10] Rogers, *Diffusion of Innovations*, ISBN 0-7432-2209-1, New York, Free Press, 2003

[11] Moore, *Crossing the Chasm: Marketing and selling disruptive products to mainstream customers,* ISBN 978-0-06-051712-0, New York, HarperCollins Publishers, 2002

[12] D. Kahneman et. Al., *Prospect Theory: An Analysis of Decision under Risk*, Econometrica, ISSN 0012-9682, 47(1979), 263-291

[13] M. Hård et. Al., *Alternative cars: The contrasting stories of steam and diesel automotive engines*, Technology in Society, ISSN 0160-791X, 19(1997), 145-160

T.J. Newton, *Creating the new ecological order? Elias and actor-network theory*, Academy of Management Review, ISSN 0363-7425, 27(2002), 523-540

[14] Green Car Report on Tesla owners, http://www.greencarreports.com/news/1083551_worst-thing-about-the-tesla-model-s-driving-anything-else-afterwards accessed 2013-07-04

[15] Gansky, *The Mesh: Why the future of business is sharing*, ISBN 978-1-59184-371-9, New York, Penguin Group, 2010

Automotive landscape 2025: Opportunities and challenges ahead, http://www.rolandberger.com/media/pdf/Roland_Berger_Automotive_Landscape_2025_20110228.pdf accessed on 2013-07-03

[16] M. Werber et. Al., *Batteries: Lower cost than gasoline?*, Energy Policy, ISSN 0301-4215, 37(2009), 2465-2468

[17] The Used Car Market Report 2012, http://www.buckingham.ac.uk/wp-content/uploads/2010/11/pnc-2012-usedcar.pdf accessed 2013-07-04

Authors

Mats Williander has a M.Sc in electrical engineering from Chalmers University of Technology, an MBA from University of Gothenburg and a Ph.D in Technology Management from Chalmers University of Technology. His current research focus is on business model innovation and environmentally sustainable business models. Mats works as senior researcher at the research institute Viktoria Swedish ICT.

Camilla Stålstad has a M.Sc in electrical engineering from Chalmers University of Technology, and a background within product development for the automotive industry. She is now working as a project manager and researcher at the research institute Viktoria Swedish ICT.