Borderstep Institut

Tesla as a start-up in the automotive industry

From candidate for bankruptcy to gamechanger

Jens Clausen | Yasmin Olteanu

Impressum

Authors:

Jens Clausen (Borderstep Institute) | clausen@borderstep.de

Yasmin Olteanu (Borderstep Institute) | olteanu @borderstep.de

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1 Summary

The automotive industry in Germany has been established for decades. New suppliers have hardly played a role since Volkswagen entered the market after the Second World War. This is currently changing. Not only Tesla is building a new factory in Brandenburg for up to 2 million vehicles a year, but also some Chinese manufacturers such as Geely/Volvo and BYD are on the verge of entering the European market. Against this background, it seems necessary, particularly with regard to the topics of electromobility and digitalisation, not only to look at the diffusion of these innovations in the large car factories, but also to take a look at the niche players who are increasingly making their way into the market. Not only the speed of diffusion of individual innovations depends on the market success of the niche companies, but ultimately also questions with implications for the number of jobs and the employment situation: Which manufacturer will capture which market shares, which technologies will prevail and which supply parts will be needed in the future and - also of utmost importance - which supply parts will no longer be needed.

The Hans Böckler Foundation funds research linked to the world of work on behalf of the DGB, the Confederation of German Trade Unions. In the project "Structural Change in the Automotive Industry - Transformation of Value Creation in the Automotive Industry" we analyse the interaction between niche players and established players in the automotive industry. This study characterises Tesla as the niche player that is currently causing the most turmoil in the industry. A second study analyses the new players Waymo, BYD and Sono Motors.

Even the study of Tesla shows that the new players in the industry should not be underestimated by either the manufacturers or the unions. But first the good news for the German automotive industry: the conditions that led to the success of Tesla are so special that they are unlikely to recur in the same or even a similar constellation. Further hyper start-ups **of the same type** are therefore not to be expected in the foreseeable future. Well, there might be other types …

But Tesla brings many impulses to the industry with its activities. Cheaper and more environmentally friendly battery production and other approaches to reducing costs will intensify economic competition with the previously expensive Tesla. With ranges soon to exceed 600 km, criticism of the low ranges of electric vehicles is likely to lose momentum. Also, the reference to high costs no longer bears any weight, at the latest since the German decision to increase the purchase premium and maintain it until 2025.

And Tesla as well as Lucid Motors and Waymo are companies from Silicon Valley. At Tesla, this manifests itself in a completely new way of dealing with the digitalisation of cars. At the heart of this is a completely new hardware architecture, 'over the air updates' and automated driving functions. It is already foreseeable that this will have a considerable impact on German manufacturers. The success with which the German car industry, which does not have its roots in Silicon Valley, is following suit needs to be observed.

The trade unions will also have to develop a strategy for dealing with the transformation of the car industry towards electric propulsion and digitalisation. With the Tesla factory in Grünheide, there is a new key player in the car industry in Germany. It is doubtful whether Tesla will join the employers' association. In addition, Tesla is still in a phase of intensive growth and uses revenues primarily for the development of additional models and the establishment of new production facilities. Compared to Volkswagen, BMW or Daimler, Tesla will be a completely new type of negotiating partner for the unions. And not only the OEMs but also the suppliers are facing a variety of challenges, be it the phasing out of the production of vehicles with combustion engines or digitalisation.

2 Introduction and methodology

2.1 Introduction

The starting point for the analyses of niche companies and start-ups is to work on the importance and characteristics of start-ups in general and green start-ups in particular. Important here is Schumpeter's concept of creative destruction (Schumpeter, 1997), in which the entrepreneur is characterised as a person who swims against the current, takes risks and endures resistance, and precisely because of this persistence can be a significant factor in processes of change. Furthermore, "green start-ups", and above all the subgroup of particularly sustainability- and market-oriented entrepreneurs, with their specific goals and motivations, have an essential function in the context of building up sustainable markets (Clausen, 2004; Hockerts and Wüstenhagen, 2010; Schaltegger and Wagner, 2011) and also play a numerically significant role in today's start-up activity (Olteanu and Fichter, 2020). With regard to the origin of digitisation in Silicon Valley, specifics of digital innovations and start-ups in Silicon Valley are also important (Morris and Penido, 2014). When working on the case studies, we therefore also take into account the founders and their environment, evaluate a "green" strategy that may be geared towards sustainability and try to draw conclusions about the exemplary effects of the start-ups with regard to the automotive industry.

An important topic of entrepreneurship research is the question of raising capital, which is a challenge for start-ups in general and for green start-ups in particular (Olteanu and Fichter, 2020). Another important reason for focusing on start-ups is their high importance for the genesis and diffusion of innovations (Fichter and Clausen, 2016).

Chapter 2 begins with a brief overview of the historical development of the electric car niche from 1985 to 2020. An overview of major manufacturers and production figures is given and key events are identified.

For four selected niche manufacturers, Tesla, Waymo, BYD and Sono Motors, case studies are presented. In this brochure Tesla is focussed and in a subsequent brochure the other three start-ups will be highlighted. The case studies retrace the foundation and development of the respective manufacturer, present the founders, describe the innovation strategy and specifics of vehicle design, and characterise the sales markets and supply chains.

The analysis is carried out as a literature analysis and is supplemented by some guideline-based interviews - if available - with employee representatives.

2.2 Impact of start-ups on markets and sectors

One of the objectives of the analysis is to characterise the impact of the start-ups studied on the automotive regime[1]. The impact assessment of a start-up is subject to various specific challenges. On

[1] "Regime" is understood to mean the established socio-technical structures with their enterprises, politics, science and the customers accustomed to the established products and services (Geels, 2002; WBGU, 2011). The opposite to the regime are "niches".

the one hand, business model, products and services are often subject to short-term and radical changes (Clarke-Sather et al., 2011), which contributes to a comparatively high degree of uncertainty and volatility (Ries and Bischoff, 2012). In addition, these are relatively new market participants, for some of whom there are no or only a few historical performance data available on which to base a valuation (Judl et al., 2015; Skala, 2019). An evaluation may therefore not be able to build on the actual values, but rather consider the potential impact (Trautwein, 2020). The biggest lever for this potential impact is usually the service or product itself (Trautwein, 2020). The effect of the individual service can unfold a transformational force on the economy, environment and society through a corresponding diffusion (Clausen and Fichter, 2019).

The impact assessment in the present case studies thus focuses on performance (product or service) and includes potential ecological, social and economic sustainability in the sense of the Sustainable Development Goals (United Nations, 2018). When assessing impacts, the following differentiates between impacts on **sales markets and competitors**, impacts on the **social environment** and impacts on the **natural environment**.

The term 'effect' is defined here in terms of the theory of change as 'impact', which arises from the linear causality of input, activities, output and outcome (Clifford et al., 2014; Kurz and Kubek, 2018). In particular, this study understands 'impact' as the *intervention difference* (Brest and Born, 2013), which describes the proportion of the overall development that can be attributed to the start-up under consideration: Which market, environmental and social effects would not have occurred without this actor?

The assessment of the effects of the start-ups **on markets and competitors** will be the subject of a section in each of the following case studies. The **effects on the social environment** are examined with a focus on the issue of **working conditions** and the role of **trade unions.**

With regard to the **impact on the natural environment,** however, the impact of the innovations of *electromobility* and *digitisation* is common for all start-ups case studies. The assessment of the difference between an electric vehicle and one powered by an internal combustion engine, as well as the impact of digitisation on the environment, is therefore being investigated and evaluated across companies.

2.3 The impact of electric mobility and digitisation on the natural environment

With regard to the **assessment of the environmental relief from electric propulsion,** a war of studies has been raging for years. Again and again, studies are published that are extremely critical of the environmental impact of electric drive systems. Under the title "Electromobility and climate protection: the great miscalculation", the renowned Kiel Institute for the World Economy recently published a study of particularly poor quality (U. Schmidt, 2020), the core results of which were systematically refuted as incorrect by the Fraunhofer ISI (Wietschel, 2020). Buchal et al. (2019, p. 40) also report *"that the CO_2 emissions of electric car drives are about one tenth higher than those of the diesel engine in the favourable case and a good quarter higher in the unfavourable case"*. These authors were also sharply criticised for a lack of scientific basis (Hajek, 2019; Schwierz, 2019).

Other votes are in a clear majority. In autumn 2019, the General German Automobile Association (ADAC) reported that the most climate-friendly solution in the electricity mix at that time was the natural gas car, but sees considerable advantages for electric cars in the future scenario with green electricity (ADAC, 2019). If one takes into account that strategic decisions for the product range in 2030 should sensibly be made on the basis of the framework conditions expected in 2030, the picture becomes clearer. The Federal Environment Agency (Umweltbundesamt (publ.), 2016, p. 19) documents, for example, greenhouse gas emissions from passenger cars powered by petrol engines in 2016 of approx. 250 g CO_2/km (approx. 200 g CO_2/km in 2030), from diesel engines in 2016 of approx. 200 g CO_2/km (approx. 170 g CO_2/km in 2030), by plug-in hybrid of approx. 200 g CO_2/km (2030 approx. 120 g CO_2/km powered by renewable electricity) and by battery electric drive of approx. 200 g CO_2/km (2030 approx. 65 g CO_2/km powered by renewable electricity). The Federal Ministry for the Environment also clearly positions itself in favour of electric cars: *"Over a vehicle's lifetime, electric cars are below their fossil-fuelled counterparts in terms of CO_2 emissions. This climate benefit will increase with each year that the energy system transformation in the electricity sector progresses"* (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (BMU), 2019). The available life cycle assessment studies agree that the way electricity is provided has a major influence on the greenhouse gas emissions of battery electric cars (BEV) per km of mileage. Messagie (2017, p. 11) documents the lowest emissions at 4 gCO2/km for the Swedish electricity mix. But even with the Polish coal electricity mix, the electric car performs better than the combustion engine. The following case studies are based on the assumption that the transformation from internal combustion engine drive to electric drive has a positive impact on the environment.

In contrast, the **impact of digitisation on the environment** does not clearly lead to environmental relief. In various areas of need it has been repeatedly confirmed that although digital shared use models often change user behaviour, this does not always lead to ecological relief (Bienge et al., 2019, 2016; Gossen et al., 2019). In the context of autonomous driving, such reductions cannot be expected anyway, e.g. from the installation of driver assistance systems, i.e. the preliminary stages of autonomous driving. Even the realisation of autonomous driving itself does not certainly lead to environmental relief. On the contrary, scenarios with increased traffic volumes are also conceivable (Deloitte, 2019).

3 Overview of the development of the electric car niche 1985 to 2020

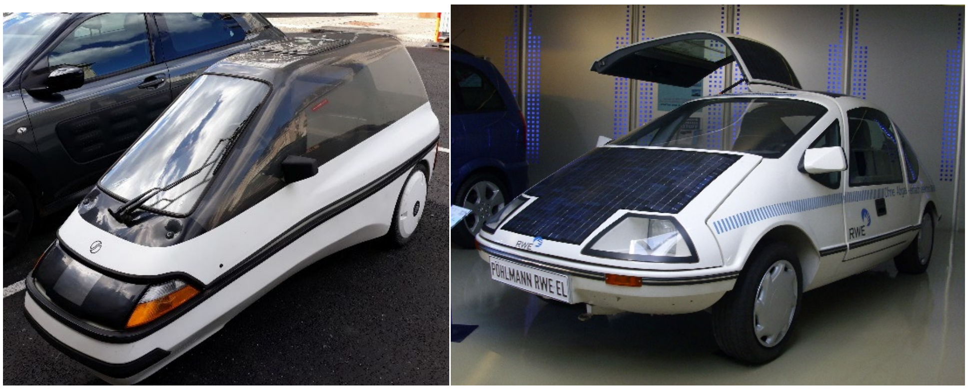
3.1 Beginnings and first providers of electric mobility

Even in the early days of automobility, electric drive was used in parallel with drives by combustion engine and steam drive. However, after the combustion engine had won this competition, it became relatively quiet for 70 years around the electric drive for the automobile. In the wake of the oil crisis and the environmental movement, activities to revive electric propulsion then began. Lemme (1988, p. 24) writes

> *"Not only because oil is becoming scarce, but also because the CO_2 content of the atmosphere is constantly increasing, which can lead to global climate change through the "greenhouse effect". If action is not taken early enough, we are threatened by the greatest environmental disaster in world history and at the same time by our dependence on the last remaining oil-producing countries. …. Not a pleasant situation."*

The utility company RWE considered how to sell the surplus night-time electricity more effectively and saw one possibility in charging batteries of electric cars at night. In 1983, RWE financed Pöhlmann KG in Kulmbach to develop the Pöhlmann EL, a sleek electric car with two engines of 7 kW each, a maximum speed of 115 km/h, charging capacity of 2 kW and a range of 60 to 80 km (Lemme, 1988, p. 29). 14 of them were built partly with PV elements before RWE ceased its activities. One of the few cars that made it into a small series was the Danish Mini EL, later City EL, of which several thousand units were sold.

Figure 1: The Danish Mini El (left) and the Pöhlmann EL (right) developed in the 1980s



Source: Clausen (left), book t (2012) on Wikimedia (right)

The Mini EL was equipped with lead-fleece batteries, was charged at a normal power outlet and achieved a range of up to 50 km with one battery charge. The consumption was significantly below 10 kWh/100 km. Since 1981 Volkswagen built some small series of the Golf Citystromer with lead gel batteries, which also had a range of about 50 km and was not sold openly. The first 'professional' electric car might have been the General Motors EV 1, first equipped with lead-acid batteries, later with NiMH batteries and a range of about 150 km. The aluminium body had an extremely good drag coefficient (C_d value) of 0.19.

Figure 2: The EV 1 from General Motors

Source: www.evnut.com

Just over 1,000 copies were built. However, global sales of electric cars remained within narrow limits for some time. In Norway, the model country for electromobility, new registrations exceeded 500 battery electric vehicles (BEV) per year for the first time only in 2008 (Figenbaum and Kolbenstvedt, 2013, p. III). The International Energy Agency (IEA) estimated the worldwide stock of battery electric vehicles in 2010 at around 20,000 vehicles (OECD / IEA, 2013, p. 10).

The activity of the producers was limited. There were some start-ups such as the Norwegian company Pivco, later Think, which was bought and sold again by Ford after a long start-up phase, went bankrupt in 2006, was rescued and finally went bankrupt in 2011. Other manufacturers such as Honda, General Motors and Volkswagen produced individual small series but never entered the mass market or even, like General Motors in 2003, went out with a bang (Paine, 2006). Until the first 'modern' electric cars appeared on the market, the Tesla Roadster in 2008, the Mitsubishi i-Miev and the Nissan Leaf in 2010, the electric car market, with the exception of the EV 1, was a niche of technically unsatisfactory short-range vehicles with long charging times.

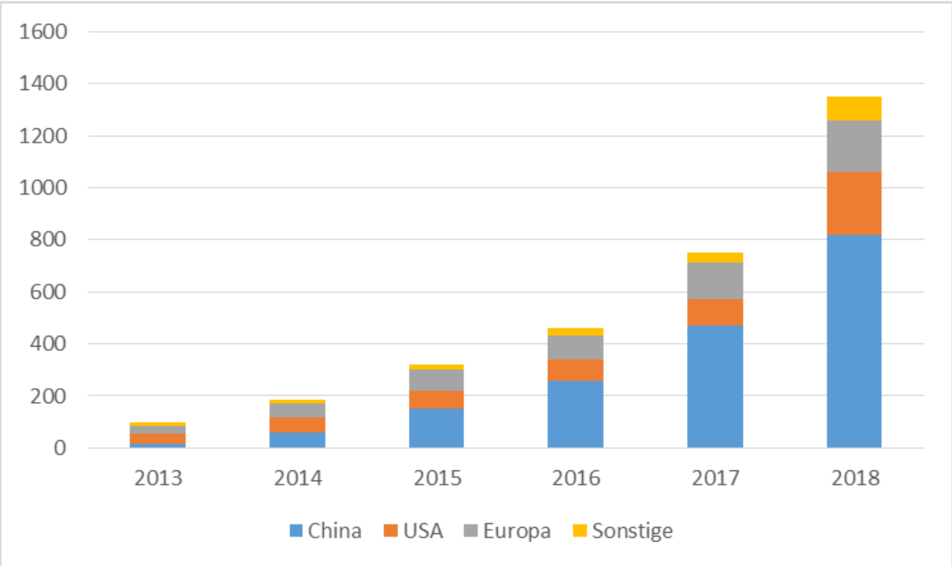
In 2009, Figenbaum and Kolbenstvedt see the trend reversal to a phase in which large manufacturers began to actively develop the market (Figenbaum and Kolbenstvedt, 2013, p. 16). But even after that, sales figures were still low. In the USA, General Motors sold 23,461 Chevy Volts[2] in 2012, Renault-Nissan 10,407 BEVs, including 9,819 Nissan Leafs, and Tesla 2,400 Model Ss (Pontes, 2013a). In Germany, Daimler AG sold 817 BEVs in the same year, including 734 SmartForTwo, Renault Nissan sold 760 vehicles, including 451 Nissan Leaf, 213 Renault Fluence and 96 Mitsubishi i-Miev. Third on the

[2] The Chevy Volt with a 16 kWh lithium-ion battery is actually too big for a plug-in hybrid and is therefore listed here as an electric car with range extender.

market was Peugeot-Citroen with 454 Citroen Zero and 263 Peugeot Ion (Kraftfahrtbundesamt, 2020).

For the following years the Global EV-Outlook of the International Energy Agency records the following distribution of the increasing BEV sales on the three large markets China, USA and Europe (International Energy Agency, 2019, p. 36).

Figure 3: Global development of the market for electric cars (BEV) 2010 to 2018



Source: Production in 1.000 cars, based on data from Global EV-Outlook (International Energy Agency, 2019, p. 36)

These markets were dominated by established manufacturers. Niche manufacturers, with the exception of Tesla, have not made it into the major markets. The Norwegian start-up Think sold almost only domestically, only in the Netherlands in 2012 a number of 6 Thinks sold could be identified in our sample (Pontes, 2013b). In the Netherlands GM was the market leader with 2,456 Opel Ampera and 284 Chevy Volt sold, followed by Renault-Nissan and Peugeot-Citroen. Tesla sold 24 roadsters in the Netherlands in 2012 (Pontes, 2013b).

If one takes the figures from Global EV-Outlook (International Energy Agency, 2019, p. 36) for the size of the world market, the following shares for the largest national markets for BEV are obtained:

Table 1: The largest national markets for BEV 2018

	Production in units	**World market share**	**Market character**	**National market leader 2018**
China	929.477	69%	National	BAIC
USA	238.823	18%	National	Tesla
Norway	42.056	3%	Import	Renault Nissan
Germany	36.062	3%	Import	Renault Nissan
France	29.216	2%	National	Renault Nissan
Japan	25.822	2%	National	Renault Nissan
Netherlands	23.574	2%	Import	Tesla
UK	13.348	1%	Import	Renault Nissan

Source: Borderstep Institute, based on figures from Pontes, José (2020)

The analysis of the leaders in the largest markets reveals four markets with national leaders (China, USA, Japan and France) and four markets with foreign leaders. Renault-Nissan was the market leader in five of the markets in 2018. In two markets, the US and the Netherlands, Tesla had ousted General Motors from the market leadership. In China, the market was spread over a larger number of national manufacturers, with BAIC being the market leader.

Of the electric mobility start-ups still active in various national markets in 2012, all but Tesla had either disappeared in 2018 or no longer played a role with extremely low production figures.

Tesla, on the other hand, has made it from a start-up to the world's most valuable car manufacturer within 17 years (Yahoo Finance, 2020) and also leads the ranking of the best-selling BEV. Cleantechnica (2020a) documents for 2019 over 300,000 sold copies of the Tesla Model 3, followed by 111,000 copies of the BAIC EU series in second place and about 70,000 Nissan Leaf in third place. BMW makes it to 8th place with almost 42,000 copies of the i3, Volkswagen with the e-Golf to 11th place.

3.2 Key events and supporting factors

The first key event on the road to electromobility were the **oil crises of 1973** and **1979**, which also led to the first research and development efforts to develop renewable energy systems (Clausen, 2019). The impending shortage of oil and thus also of petrol and diesel seems to have unsettled at least some actors in the automotive regime.

A further encouraging factor was the **environmental movement that** had been forming since the **mid-1970s**. However, the Norwegian pioneer of electromobility, Harald Røstvik, hinted that there was no consensus at all within the environmental movement on the issue of electric cars, as the preferred forms of mobility for environmentalists were public transport, cycling and walking, and the resource-intensive car was therefore often criticised (Clausen, 2017, p. 15). However, he also pointed out different positions of environmentalists from urban areas like Oslo and others from sparsely populated regions without well developed public transport.

In California, by contrast, problems with air pollution in the Los Angeles conurbation prompted another key event, the **minimum sales quota for zero-emission vehicles** adopted by the California Air Resources Board (CARB) in **1990** (California Air Resources Board, 1990, p. 22). In China, too, air quality, which is highly hazardous to health, especially in cities, together with CO2 emissions, prompted considerations to promote electric mobility (Boguang et al., 2014).

The fact that **small series of electric cars from** various **established manufacturers** from the **1980s** and **1990s have** all been **discontinued** can also be considered a key event. Driving factors behind the termination of activities, which was particularly noticeable in **2003,** were, on the one hand, the problem of powerful and affordable batteries, which the regime found almost impossible to solve, but also the lack of motivation to abandon the profitable concept of the car with combustion engine, and the corporate cultural fusion of car and combustion engine, which was not easy to overcome (Paine, 2006).

The influence of the development of **information technology** is clearer. The conviction of Tesla founders Marc Tarpenning and Martin Eberhard that the lithium-ion batteries used in their e-readers as well as in laptop computers could also power cars. That combined with the fact that the rapid scaling of mobile computers and other mobile electronic devices had led to an equally rapid scaling of the production and reduction of the costs of these batteries, led to the **lithium-ion battery** finding its way into electromobility with the founding of Tesla in **2003.** GM had also considered the use of lithium-ion batteries in the EV 1, but never realised it (Wikipedia, 2020a). Due to this clear connection between the digital economy and electromobility, it is by no means a coincidence but rather a logical consequence that Tesla was founded in Silicon Valley.

4 Tesla as gamechanger

"As of 2016, the number of American car companies that haven't gone bankrupt is a grand total of two: Ford and Tesla. Starting a car company is idiotic and an electric car company is idiocy squared" (Musk, 2016).

In an analysis of niche companies with a focus on the changes brought about by the electric drive and digitalisation, the case of Tesla Inc. is imperative. Tesla is - 17 years after its foundation - the company that produces the most battery electric cars worldwide. As a highly digitalised car with its roots in Silicon Valley, Tesla takes the installation of sophisticated computers and software updates 'over the air' for granted. At level 2 to 3, many Teslas can already drive semi-autonomously. Since the summer of 2020, Tesla has also been the most valuable car manufacturer in the world in terms of market capitalisation, although this does not fit the classic characteristics of a niche company. The production volume is still relatively low, at around 367,000 cars in 2019, compared to the world market leaders Volkswagen and Toyota (with over 10 million vehicles each).

4.1 Background and framework conditions of the foundation

The starting point for the intensive debate on the promotion of electromobility, particularly in California, was the longstanding poor air quality in cities such as Los Angeles (Collantes and Sperling, 2008, p. 1303). In 1988, the Coalition for Clean Air and the Sierra Club filed a lawsuit in which the Environmental Protection Agency (EPA), as a body of the US national government, was ordered by a federal court to draw up an air quality improvement plan in the South Coast Air Quality Management District. A ruling was granted because the district had failed to meet federal air quality standards. On 176 days in 1988, ozone levels rose above the established standard (Collantes and Sperling, 2008, p. 1303). The level of concern, not least due to documented health damage, and also the political pressure to act were correspondingly high.

In September 1990, the California Air Resources Board (CARB) adopted a minimum sales quota for zero-emission vehicles (California Air Resources Board, 1990, p. 22):

> *"While meeting the fleet average requirement, each manufacturer's sales fleet of passenger cars and light-duty trucks from 0 to 3.750 lbs LVW, shall be composed of at least 2 percent ZEVs each model year from 1998 through 2000, 5 percent ZEVs in 2001 and 2002, and 10 percent ZEVs in 2003 and subsequent model years."*

As the introduction of the three-way catalytic converter had been successfully enforced by decree some years earlier (Collantes and Sperling, 2008, p. 1311), the Californian government hoped to achieve a similar result with the introduction of electric cars. The fact that General Motors presented the electric car Impact / EV1 at the Los Angeles Auto Show on 3 January 1990 helped to demonstrate the feasibility. Through the very perceptible test fleet of the General Motors EV1, but also through other prototypes and small series, the first changes in the car fleet were then visible on the roads. Especially the EV 1 influenced the public view on electric cars. One EV 1 driver characterised it as follows: *"It's everything an American wants from a car: Cool, Fast and Sexy"* (Paine, 2006 Min. 11:20).

The GM sales team for the EV 1 won movie stars like Tom Hanks or Mel Gibson as pilot customers (Paine, 2006 Min. 22:00).

But the production of the first generation of electric cars was not profitable. As a result, GM dismissed the entire sales team in 2001 and stopped production (Paine, 2006 Min. 24:00). Two years later - on 24.3.2003 - the car manufacturers succeeded in getting the California Air Resources Board to abandon the EV mandate, among other things by promising to market fuel cell vehicles in the foreseeable future (Paine, 2006 Min. 25:00). Shortly thereafter, General Motors cancelled the leasing contracts of its EV1 fleet. The vehicles were systematically collected, centrally stored and later driven to the scrap press (Paine, 2006). At the same time Toyota drove parts of its electric RAV 4 fleet to the scrap press, Ford scrapped electric Rangers and Honda at least some brand new Honda EV+ (Paine, 2006 Min. 39:00). After protests some Ford Th!nk were exported to Norway and sold there used. A group of enthusiastic electromobilists suddenly found themselves without vehicles. In autumn 2003 they held a ritual funeral for the EV 1 that had not yet been scrapped (Paine, 2006 Min. 33:20). For the last 78 EV 1s in storage they offered GM $1.9 million. Despite the offer and the protests, the vehicles were scrapped (Paine, 2006 Min. 44:00). In his movie “Who killed the electric car?” Paine ultimately blames the car manufacturers and the myth of the rapid production of cars with zero-emission fuel cells, the oil industry, the government and reluctant consumers for the end of the electric car in 2003. In battery technology, on the other hand, he sees future potential in the lithium-ion battery, and absolves them of complicity (Paine, 2006 Min. 60:00).

In addition to these described backgrounds within the automotive industry, a development far outside the automotive industry is also important for understanding the further development in California. Due to the dotcom boom at the turn of the millennium, a lot of capital had accumulated around the Silicon Valley. A large part of the capital was in the hands of a well-connected group of IT founders, who had gained considerable wealth from the dotcom boom. Along with their capital strength, the self-confidence of these players had also grown.

This environment in Silicon Valley was a major support factor for the further development of electric cars in California, which later affected Tesla. The editor of the Silicon Valley blog 'Valleywag' formulated in 2008: *"Detroit is doing a lousy job making cars and making money. The idea, that Silicon Valley could do a better job making cars, especially electric cars, is a very powerful one"* (Paine, 2011 Min. 14:00). One element of the *"lousy job"* in Detroit, apart from the scrapping of the EV 1 fleet, was probably the fact that Bob Lutz [3], the Vice President of General Motors responsible for electric cars, was a climate change denier and was considered a clear opponent of electric cars (Paine, 2011 Min. 9:50). Lutz saw it that the American customer would base his choice of car on the price of petrol and therefore did not give electric cars, including the Chevy Volt, much of a chance (Paine, 2011 Min. 1:03:30). The first Chevrolet with electric drive, the Volt, had a range extender and was therefore not a real electric car. In the end, "Detroit" may have unconsciously challenged Silicon Valley by its handling of climate change.

[3] Bob Lutz, trained in production engineering and business administration, had previously held management positions at Ford, BMW and Chrysler.

4.2 The founding team and its environment

Marc Tarpenning and Martin Eberhard founded Tesla Motors in 2003. After training in electrical engineering and computer technology, both had worked in the electronics industry and together founded Nuova Media in 1997, which launched one of the first e-book readers on the market. In 2000 they sold the company for $197 million (Lambert, 2015). They had used lithium-ion batteries in their e-book reader; and they recognised the possibility of using the standard 18-650 cells, the size of an AA battery, to store energy in electric cars (Lawson, 2019). They were also aware of the popularity of the Toyota Prius - based on its environmental characteristics - and the willingness of the wealthy classes in California to pay for it (Lawson, 2019). They named their company after the electrical engineer Nikola Tesla.

Elon Musk came on board in 2004 as the first investor (Schefsky, 2015), motivated among other things by the described scheduled scrapping of GM's EV 1 fleet. Musk twittered in 2017 (Musk, 2017):

> *"Few people know that we started Tesla when GM forcibly recalled all electric cars from customers in 2003 & then crushed them in a junkyard."*

Musk had also become rich in the IT industry. He and his brother had first developed an online tool for newspaper companies (Zip2) in 1995 and sold it in 1999 for US $ 307m, of which Musk had received around US $ 22m (Dodds, 2015). His next venture was the development of the online payment service 'Paypal', which was sold to Ebay for US $ 1.5 billion in 2002. Musk received a stake of approximately US $ 165 million (Dodds, 2015). After Musk used part of this money to establish the private space company Space Exploration Technologies Corporation (SpaceX), he also joined Tesla (Dodds, 2015; Guldner, 2015).

The origin of the founders as well as the environment of Silicon Valley is reflected in the high degree of digitalisation of the Teslas. There is no tachometer, hardly any switches and levers; especially with the Model 3, almost all operation takes place via the touch screen. This may take some getting used to for car drivers, but it allows for maintenance and updates.

Tesla found numerous interested parties for the initially very expensive roadster, but demanded disproportionately high down payments and in some cases increased the prices even after the order was placed, without many customers dropping out (Paine, 2011 Min. 56:40). One of the reasons for this active support from the first customers might be the vision that Silicon Valley could produce better cars. Aybaly et al. point out that the first customers for the luxury products Roadster and Model S also came from the ranks of Silicon Valley's influential digital economy innovators (Aybaly et al., 2017). For a long time, however, Tesla's economic success was uncertain, and at times even the blog "Tesla Death Watch" existed (Paine, 2011 Min. 55:45).

After the Tesla Roadster was delivered from 2008 (53 kWh, 350 km), initially in small quantities, the first competitors were the Chevy Volt (16 kWh, 60 km) equipped with range extender and the Nissan Leaf (24 kWh, 160 km) from 2010. The then Nissan boss Carlos Ghosn emphasised the difference to

Tesla, that the Leaf was affordable and therefore mass marketable (Paine, 2011 Min. 28:00). The cultural environment also included a group of entrepreneurs, characterised by Paine as an underground movement, who converted conventional vehicles to electric drive (Paine, 2011 Min. 19:00).

A former EV 1 driver and Tesla retail investor summarises (Dickey, 2020):

> *"I bought stock early on at $19 per share. I thought it would just be a donation to one more company that I wanted to see succeed. When I reached $2,000 profit on that $2,000 total investment I sold, thinking that I was really lucky to double my money. Had I held onto that stock, today it would be worth over $200,000! Anyway, the general feeling at the time was that this was just one more company that was going to make a few prototypes and then fade away while we waited for the big companies to start making real EVs. Tesla was promising size, design, performance and insane charge rates that nobody could possibly achieve. Of course just a few years later they over-delivered by a factor of about 100 percent on all promises. When they made the roadster, many people made disparaging remarks about how it was just one more company making toys for rich people. But then the subsequent car (Model S) offered a leap forward in performance, range, capacity, features... with a reduced sticker price. Then the Model 3 came out at the average price of a new car sold in the US, and as we can all see, Tesla now has a huge lead in the segment. The cries of 'toys for rich people' are no longer heard."*

4.3 Investors and participations

Elon Musk participated in the first round of financing for Tesla in 2004 (Clausen and Perleberg, 2017) with $ 6.5 million out of a total of $ 7.5 million. The venture capital firms 'Compass Technology Partners' and 'SDL Ventures', both from Silicon Valley, also participated in this first financing round. In 2006 Musk lent Tesla $ 13m in February and $ 40m in May. In this second round of financing, 'Valor Equity Partners' was the first investor not based in Silicon Valley. In the third round of financing, several prominent Valley founders participated, including Google founders Sergey Brin and Larry Page and former Ebay president Jeff Skoll. Other venture capital funds also joined in, including 'The Bay Area Equity Fund' managed by JP Morgan (Wikipedia, 2020b). Troubled times began for Tesla. Staff were made redundant several times in order to reduce the cash burn rate. By January 2009, Tesla had raised a total of $ 187 million in capital and delivered 147 cars. Musk himself had invested $ 70 million.

Then, on 19 May 2009, Daimler AG acquired a 10 percent stake in Tesla and is said to have paid $ 50 million for it (Clausen and Perleberg, 2017). The Japanese manufacturer Toyota also took a stake of $ 50 million (Clausen and Perleberg, 2017; Spiegel Online, 2010). The investors were also strategic partners: Tesla supplied the batteries for the electric Smart. Together with Toyota, Tesla wanted to build electric cars. But already in July 2009 Daimler announced that Aabar Investments from Abu Dhabi had taken over 40 percent of the share.

Following the 2008 financial crisis, the US government launched a $ 25 billion loan programme to 'save' the troubled car industry. Tesla borrowed $ 465 million from this programme in the form of a soft loan (Schefsky, 2015; Todd et al., 2013). From this loan, $ 365 million was used to complete the Model S and the remaining $ 100 million to build a powertrain manufacturing plant (Tesla Powertrain Plant in Palo Alto) (Badkar, 2013; Todd et al., 2013, p. 38).

On 29 June 2010 Tesla went public with an initial public offering of $3.40 per share[4]. In the 10 years since then, the price of the Tesla share has risen from $ 3.09 on 2.7.2010 to $ 79.20 on 3.1.2020 to currently over $ 300 in September 2020.

Figure 4: Development of the Tesla share price 2010 to 2020

Source: Google Finance (2020) of 28.11.2020

As a result of Daimler's participation, Tesla received a first order in 2012 for the full development of an electric powertrain system for a Mercedes vehicle (Badkar, 2013). In 2014, however, Daimler sold its remaining shares. The relationship between Toyota and Tesla also ended in 2014 due to small sales of Toyota's electric version of the RAV 4 SUV, for which Tesla produced the battery (Voigt et al., 2017, p. 194).

In May 2013, Tesla raised $ 1.02 billion, of which $ 660 million from bonds, in order to repay, among other things, the loans from the Ministry of Energy that it had received in 2009. In February 2014,

[4] For the purpose of comparability, all previous share prices of Tesla were divided by a factor of 5 on the basis of the share split of 1.9.2020. An exception is the quote from Darell Dickey.

Tesla raised a further $ 2 billion in capital from a convertible bond issue to build the first Giga Factory. And in August 2015, Tesla realised $ 738 million by selling stock options to build the X model (Crunchbase, 2020).

In 2016 Tesla Inc. acquired the Solar City Corporation for $ 2.6 billion. Since its foundation in 2006 (by cousins of Elon Musk), Solar City had become the largest supplier of photovoltaic roof systems in the USA (Crunchbase, 2020).

In May 2016 a further $ 1.46 billion from equity issues was added to finance the production of Model 3 (Crunchbase, 2020).

In the course of the production start-up of Model 3, Tesla took over the German plant manufacturer Grohmann Engineering (Handelsblatt Online, 2016; Richarz, 2017) and one year later the Minnesota-based company Perbix (Lambert, 2017) also specialised in automation. At the beginning of 2019, Tesla bought Maxwell Technologies, a specialist for super capacitors (Rathi, 2019). Rathi believes the reason for this is Maxwell's expertise in dry electrodes, which can be used to significantly improve the properties of batteries (Rathi, 2019). In autumn 2019 Tesla took over the Californian AI start-up Deepscale, presumably to strengthen his team in the field of autonomous driving (t3n digital pioneers, 2019).

To date, Tesla has mobilised over $ 20 billion in equity capital in a total of 35 financing rounds (Crunchbase, 2020). On 1 July 2020, Tesla reached a market capitalisation of $ 206 billion, exceeding Toyota's $ 202 billion and becoming the most valuable car manufacturer in the world (by market capitalisation).

From July 2019 to June 2020, Tesla recorded four profitable quarters in a row for the first time, which qualifies the company for inclusion in the S&P 500 today (Wikipedia, 2020b).

During the early years, the financing of Tesla was a Silicon Valley project. Since the IPO in 2010 at the latest, Tesla has been financing itself on the international capital market. Even in seemingly hopeless situations, such as shortly before the start of production of the Model 3 in 2016, the charismatic Elon Musk succeeded time and again in raising enormous amounts of equity capital.

It is interesting to note that from 2010 to 2014, two of the world's largest car companies, Toyota and Daimler, held shares in Tesla. Both companies were interested in cooperating in the production of electric drive trains. However, as in both cases the sales of the vehicles were not crowned with success, both cooperations broke up again and the participations were terminated.

Ultimately, the current investment structure is relatively ordinary. The Investopedia information service lists the current top 5 shareholders (Reiff, 2020):

- Elon Musk with 21.0 percent of the shares,
- Susquehanna Securities with 6.6 percent of the shares,
- Baillie Gifford & Co. with 6.5 percent of the shares,
- Capital World Investors with 5.8 percent of the shares,

- Citadel Securities LLC with 4.3 percent of the shares.

All but Elon Musk are investment companies. The five together hold 44.2 percent of the shares. The shares held by Musk alone were worth over $ 100 billion in November 2020.

4.4 Strategy and objectives

On the website "About Tesla" the headline is: *"Tesla's mission is to accelerate the world's transition to sustainable energy"* (Tesla, Inc., 2020). The mission of the company described Musk in the Tesla Blog in 2013 (Musk, 2013): "*To accelerate the advent of sustainable transport by bringing compelling mass market electric cars to market as soon as possible".*

Tesla's character as a start-up as well as the strategy of the early years becomes very clear in a blog post by Elon Musk on the 'secret master plan'. Tesla already used a blog for public communication in 2006 (Musk, 2006):

> *"Background: My day job is running a space transportation company called SpaceX, but on the side I am the chairman of Tesla Motors and help formulate the business and product strategy with Martin and the rest of the team. I have also been Tesla Motor's primary funding source from when the company was just three people and a business plan.*
>
> *As you know, the initial product of Tesla Motors is a high performance electric sports car called the Tesla Roadster. However, some readers may not be aware of the fact that our long term plan is to build a wide range of models, including affordably priced family cars. This is because the overarching purpose of Tesla Motors (and the reason I am funding the company) is to help expedite the move from a mine-and-burn hydrocarbon economy towards a solar electric economy, which I believe to be the primary, but not exclusive, sustainable solution.*
>
> *Critical to making that happen is an electric car without compromises, which is why the Tesla Roadster is designed to beat a gasoline sports car like a Porsche or Ferrari in a head to head showdown. Then, over and above that fact, it has twice the energy efficiency of a Prius. Even so, some may question whether this actually does any good for the world. Are we really in need of another high performance sports car? Will it actually make a difference to global carbon emissions?*
>
> *Well, the answers are no and not much. However, that misses the point, unless you understand the secret master plan alluded to above. Almost any new technology initially has high unit cost before it can be optimized and this is no less true for electric cars. The strategy of Tesla is to enter at the high end of the market, where customers are prepared to pay a premium, and then drive down market as fast as possible to higher unit volume and lower prices with each successive model.*
>
> *Without giving away too much, I can say that the second model will be a sporty four door family car at roughly half the $89k price point of the Tesla Roadster and the third model will be even more affordable. In keeping with a fast growing technology company, all free cash*

> *flow is plowed back into R&D to drive down the costs and bring the follow-on products to market as fast as possible. When someone buys the Tesla Roadster sports car, they are actually helping pay for development of the low cost family car."*

Musk explains below the ecological advantages of the all-electric Tesla Roadster compared to cars with natural gas, fuel cell and hybrid drive. And he makes it clear that the regenerative power supply of Tesla is also being considered (Musk, 2006):

> *"I should mention that Tesla Motors will be co-marketing sustainable energy products from other companies along with the car. For example, among other choices, we will be offering a modestly sized and priced solar panel from SolarCity, a photovoltaics company (where I am also the principal financier). This system can be installed on your roof in an out of the way location, because of its small size, or set up as a carport and will generate about 50 miles per day of electricity.*
>
> *If you travel less than 350 miles per week, you will therefore be "energy positive" with respect to your personal transportation. This is a step beyond conserving or even nullifying your use of energy for transport - you will actually be putting more energy back into the system than you consume in transportation!* **So, in short, the master plan is:**
>
> > *Build sports car*
> >
> > *Use that money to build an affordable car*
> >
> > *Use* that *money to build an even more affordable car*
> >
> > *While doing above, also provide zero emission electric power generation options*
>
> *Don't tell anyone."*

The website "About Tesla" continues with the energy and growth strategy (Tesla, Inc., 2020):

> *"To create an entire sustainable energy ecosystem, Tesla also manufactures a unique set of energy solutions, Powerwall, Powerpack and Solar Roof, enabling homeowners, businesses, and utilities to manage renewable energy generation, storage, and consumption. Supporting Tesla's automotive and energy products is Gigafactory 1 - a facility designed to significantly reduce battery cell costs. By bringing cell production in-house, Tesla manufactures batteries at the volumes required to meet production goals, while creating thousands of jobs."*

The start of sales of the first high-volume product Tesla S made it necessary to expand the strategy. About energy-efficient, because electric, driving and the appropriate generation of green electricity on the roof at home, the question arose where the vehicles with their high range could be charged on the road. The few charging options available before 2012 offered only limited power, making hours of charging necessary. Tesla therefore set up a slowly growing network of superchargers from mid 2012. By 2020 this network had grown to 1,971 supercharger stations worldwide with 17,467 superchargers. The characteristically designed charging stations turned the offer to buy a car into a promise of mobility, especially in the first years when free charging at the Superchargers was included in the purchase price of the cars. By 2015, Tesla customers would be able to drive long distances without any problems. At a time when customers of other manufacturers of electric cars had to deal with charging capacities of 11 to 22 kW and could thus charge electricity for 70 to 150 km in one hour, the Tesla S already had a charging current of 115 kW, which enabled an additional range of almost 300 km in 30 minutes.

Tesla's strategy thus differed significantly from the strategy of classic car manufacturers in that, in addition to the mobility solution, it aimed to contribute to a more electric and thus more sustainable world. The company's mission was to solve all the challenges that stood in the way of this transformation. And since electric cars require a different - electrical - supply infrastructure than combustion engines, Tesla had always been concerned from the early years on with the question of where the electricity comes from, where it is stored and how it can be made available to electric motorists on the move. Other car manufacturers saw the supply of fuel as a task outside their business, which had been done for the combustion engine by the oil companies and for electric cars by the power companies or the state.

Thomas and Maine (2019, p. 661) try to prove that Tesla does not pursue a disruptive strategy. Their argument is that Tesla does not, like Kia for example, first enter a less profitable market segment with low-priced vehicles and only then attack the large manufacturers in the luxury segment with its high margins. They overlook the fact that Tesla entered the segment of luxury **electric** cars, which is equally considered to be completely unattractive from an economic point of view, and thus, similar to other disruptive innovators, made a typical entry into a market segment that was not given much attention because of its low margins. In addition, Thomas and Maine (2019, p. 660ff) explain that Tesla not only has technical differences to the market-leading products due to new competences in electric drive and digitalisation, but also redefines the relationship to the customer through 'over the air updates' as well as the company's own charging infrastructure and car dealerships, thus pursuing a strategy of system innovation beyond technical innovations (Nill, 2009, p. 88).

Aybaly et al. (2017, p. 545) also see Tesla as a prime example of the marketing of luxury goods, explicitly referring to the various groups of adopters identified by Rogers (Rogers, 2003). Aybaly et al (2017, p. 545) state

> *"The 'Theory of the diffusion of innovations' is precisely the concept that a successful innovator needs to keep in mind, in order to create a desire for the brand and maximize his/her chances for success; and Tesla has not only understood this but, by taking advantage of its inevitable luxury association with a 'pioneering and exclusive brand', it has put this theory in practice."*

On 20 July 2016 Elon Musk publicly announced his 'Master Plan, Part Deux' on the Tesla Blog. His short summary reiterates the link between power generation and the construction of electric cars for all market segments, including pick-up trucks, trucks and city buses (Musk, 2016):

> *"Create stunning solar roofs with seamlessly integrated battery storage.*
>
> *Expand the electric vehicle product line to address all major segments.*

Develop a self-driving capability that is 10X safer than manual via massive fleet learning.

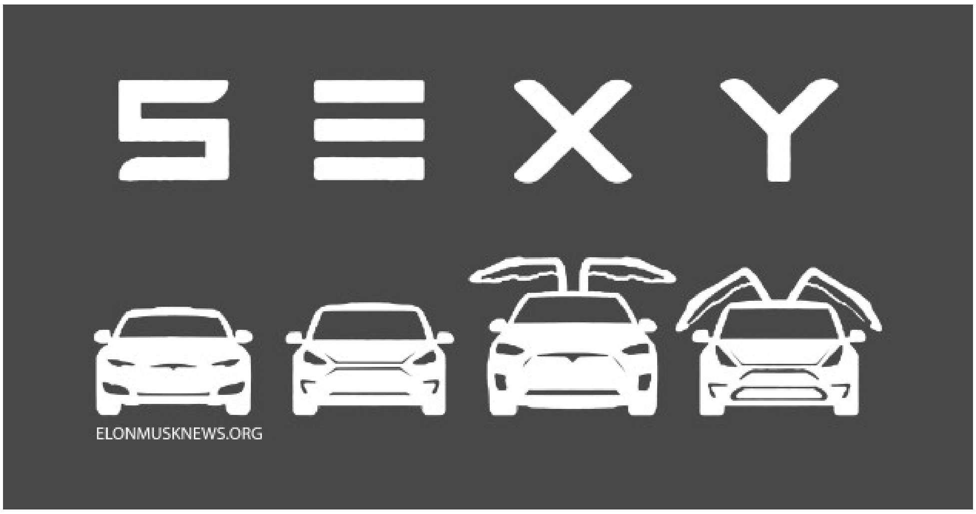
Enable your car to make money for you when you aren't using it."

In addition to 'cool' electric cars at low prices, digitalisation and autonomous driving are moving to the centre of Tesla's strategy. Already today Tesla states that the autopilot, in the situations in which it can be used, is about 7 times safer than a human driver in terms of accident frequency per kilometre driven (Tesla, 2019, p. 24). However, it is not yet clear when a car that can drive autonomously in all situations can be expected (Litman, 2020; Roos and Siegmann, 2020). Whether and when the fourth point, which implies that every Tesla can drive as a taxi autonomously on behalf of its owner, can be implemented is still unclear.

4.5 Products and production figures

Tesla's first product in 2008 was a small convertible, the Roadster, which already had a 53 kWh battery. Between February 2008 and December 2012, Tesla delivered about 2,450 roadsters worldwide (Wikipedia, 2020c). Production of the Model S began in mid-2012, the first Tesla X were delivered in mid-2015 and production of the Model 3 started in mid-2017. The latest Model Y was delivered from March 2020, initially in the USA.

Figure 5: Tesla plays with the model names



Source: elonmusknews.com

Tesla is constantly working on changes and improvements to secure its lead over competitors through technology.

The batteries are the central component of an electric car and determine many characteristics that are important for competition, such as price, range and charging speed, but also some sustainability aspects (Clausen, 2018). Tesla is currently working on enlarging the battery format to 46 mm diameter and 80 mm, new materials for anodes and new cobalt-free cathodes, and more efficient manufacturing. Furthermore, the battery cells are to be installed directly into the load-bearing parts of the frame in the future (Tesla, 2020). In parallel, Tesla is developing lithium iron phosphate batteries (LFP) in cooperation with the battery manufacturer CATL. LFP batteries also do not use cobalt and could make a battery price of less than 100 dollars per kWh possible (Morris, 2020). Through changes in cathode technology, Tesla aims to increase the number of possible charge cycles from 1,000 to 1,500 to around 4,000. With weekly charging, this would correspond to a service life of about 75 years (Morris, 2020) and would enable a mileage of over 1 million km (BBC, 2020). Costs are to be further reduced by a significant increase in production capacities - Tesla speaks of "Terrafactory" instead of "Gigafactory".

But Tesla also optimises in line with the wishes of other ecological target groups. After animal welfare activists have voiced their criticism of leather upholstery at a shareholders' meeting, a vegan version of the interior of Model X was offered with synthetic leather instead of real leather (ecomento, 2016).

While, for example, expensive carbon parts are installed in the BMW i3 to reduce weight, the body and chassis of the Tesla Model S are largely made of aluminium, partly reinforced by steel components (ecomento, 2016). For cost reasons, the body of the Tesla 3 was designed with considerably more steel. And to minimise energy consumption, all Tesla models have excellent drag coefficients.

As a highly digitalised car with its roots in Silicon Valley, a Tesla also requires software updates 'over the air' and the installation of sophisticated computers. In Japan "Nikkei Business Publications" had a Tesla 3 completely dismantled and analysed (Lambert, 2020a). The most striking feature was the integrated central control unit of Tesla, a "full self-driving computer". According to Tesla, the computer can carry out 144 trillion operations per second, process 2,300 images per second and all this at low power consumption. According to Tesla, the hardware 3, which has been fitted as standard since April 2019 and which includes a large number of sensors in addition to the central computer, will make it possible to gradually implement fully autonomous driving with the vehicles equipped in this way through further software updates.

Even though Tesla still lags far behind Waymo and others in the development of autonomous driving (Navigant Research, 2019), the computer already installed as standard, including the sensor technology, could prove to be a core element of competitiveness, because additional software for autonomous driving can be installed 'over the air' as long as only the built-in hardware is powerful enough to run the software.

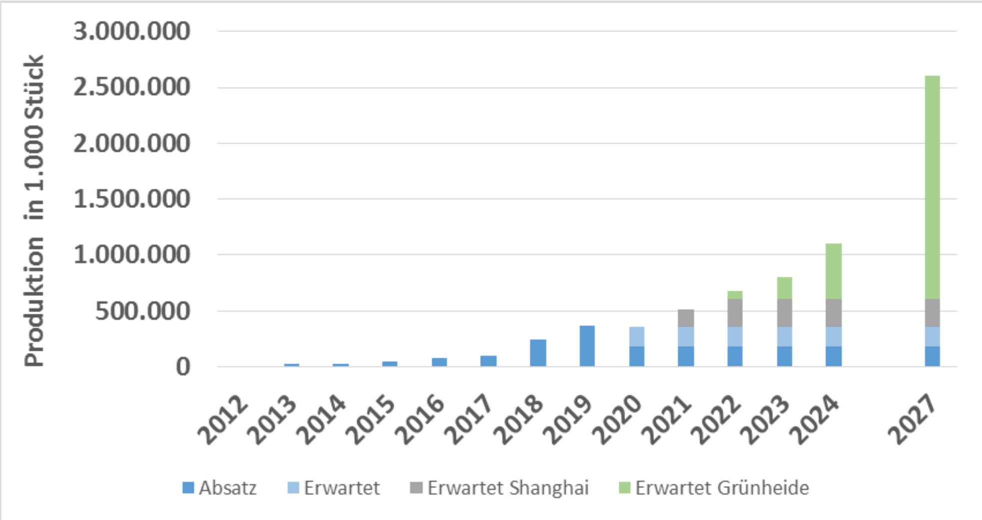
Over the air-updates' means that Tesla is constantly installing new functions, the usefulness of which is certainly debatable in detail, but which in any case continue to change the Tesla even after purchase. For example, on 26.9.2019, Software 10 made the following functions newly available or improved (Tesla Team, 2019):

- Tesla Cinema
- Karaoke
- Restaurants & Destinations
- Music & Podcasts

- Tesla Arcade
- Security & Convenience
- Smart summon (for all customers with the Full-Self-Driving option)

Through the constant further development of parts, production technology as well as hardware and software, Tesla is preparing itself to produce even larger quantities of cars.

***Figure 6:* Past and expected future development of Tesla production figures**



Source: Zachary (2020), Teslamag (2020), Pfalz-Post (2020), Lambert (Lambert, 2020b)

Tesla vehicles were previously produced in Fremont, California. Two gigafactories are currently under construction: one in Shanghai, where assembly of the Model 3 has already started, and one near Berlin. Together they will increase Tesla's production capacity to over 2.5 million vehicles per year.

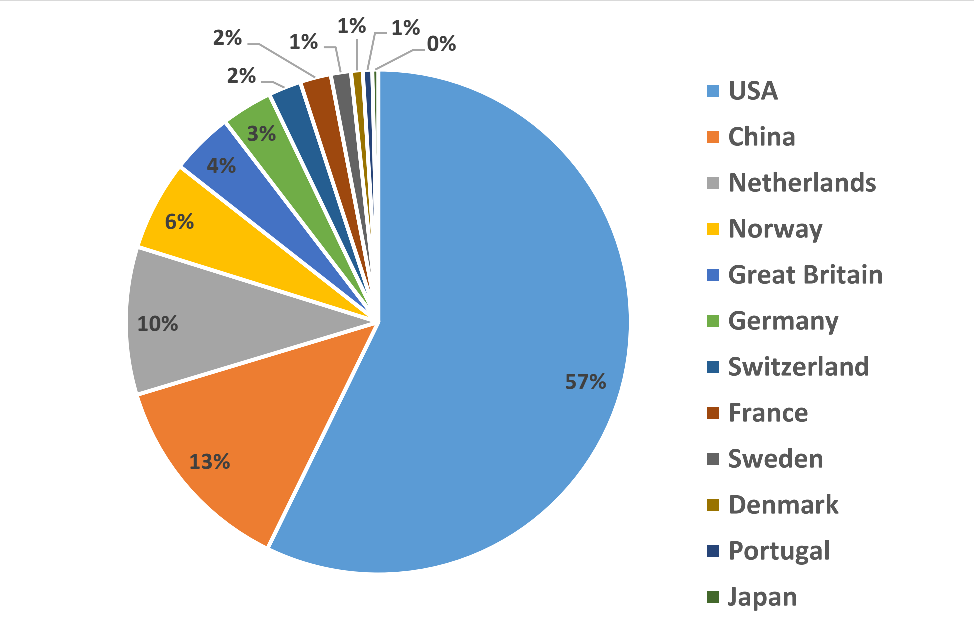
In recent years, approx. 40,000 vehicles each of the S and X model series have been sold annually. This has not changed even after the market launch of Model 3, of which approx. 300,000 units were produced and sold in 2019 (Zachary, 2020). Production figures for Model Y are not yet known.

Tesla's strategy was initially to target the environmentally conscious hybrid car owner customer group in the USA. These were often customers in the sports and luxury car segments at the same time, and seemed particularly interesting as a customer group, as these households often had more than one vehicle (Valentine-Urbschat and Valentine-Urbschat, 2014). Market entry in the high-priced luxury segment was intended to create the financial basis for subsequently developing cheaper cars with usually lower margins and then reaching the mass market with more affordable electric cars (Voigt et al., 2017, p. 189). With Model 3 Tesla has taken a big step forward on this strategy, and Model Y, which is also rather small, also aims at mass markets. So far Tesla has consistently pursued its strategy and has not deviated from its focus on all-electric cars with a high degree of digitalisation.

4.6 Sales and procurement markets

Based on figures from Cleantechnica (2020b), the UK Department for Transport (2020), Dawson (2020) and the South China Morning Post (2020) Tesla's sales can be broken down by country:

Figure 7: Tesla sales 2019 by country

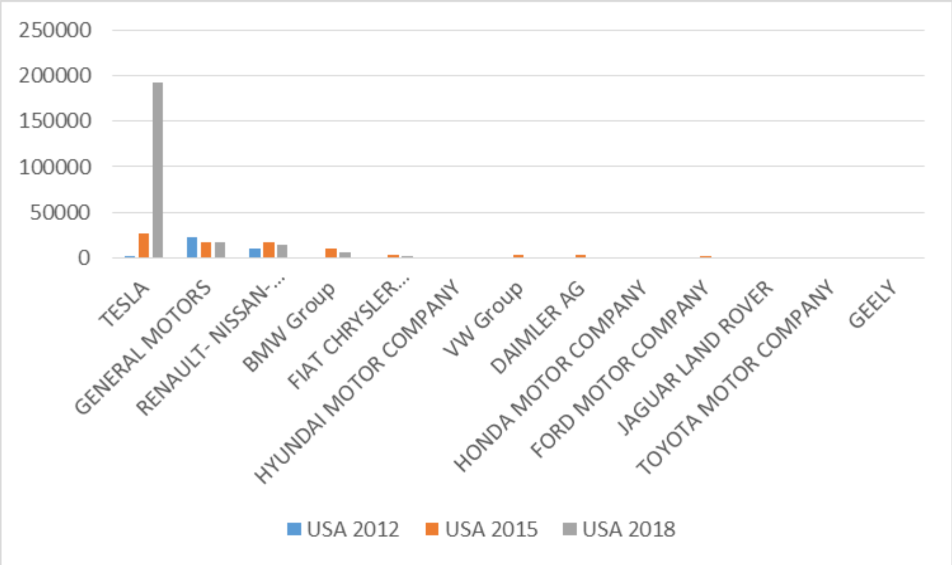


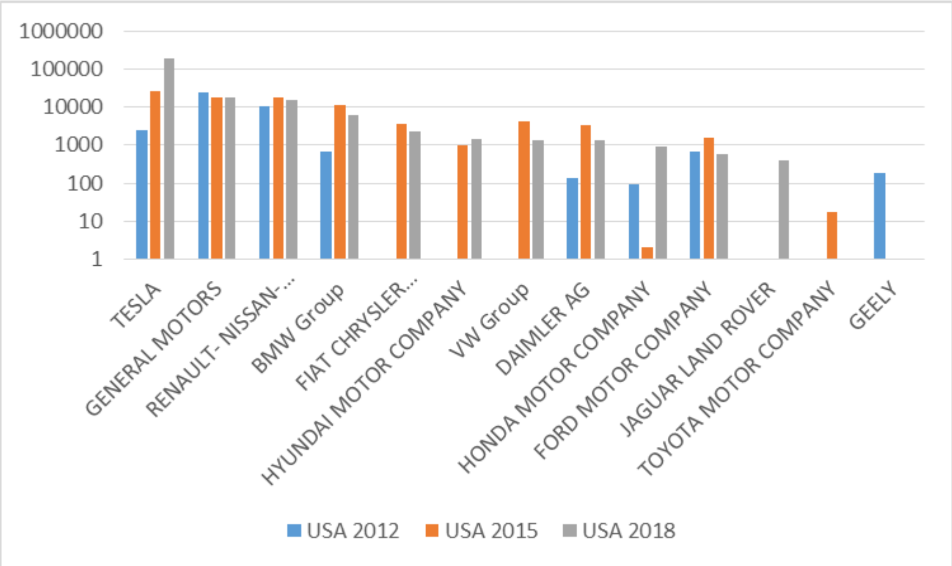
Source: EV Sales Blogspot (Pontes, 2020)

Approximately 89 percent of Tesla production was sold in the countries listed here. The highest market shares in the market for battery electric vehicles in 2018 will be achieved by Tesla in the USA (approx. 80 percent), the Netherlands (approx. 35 percent), the United Kingdom (approx. 25 percent) and Norway (approx. 20 percent). In China, Germany, France and Japan, Tesla achieves market shares of between 3 percent and 5 percent in the BEV segment.

In the USA, sales figures have risen from 38,048 BEV in 2012 to 86,457 in 2015 and 238,823 in 2018 (Pontes, 2019, 2016, 2013a). The market shares have changed significantly in favour of Tesla over the years.

Figure 8: Sales figures by manufacturer in the US market for electric cars 2012 to 2018 (upper figure linearly scaled, lower logarithmically)





Source: Borderstep Institute, based on figures from Pontes, José (2020)

None of the other manufacturers, apart from Tesla, have continuously growing sales figures. Either between 2012 and 2015 or between 2015 and 2018, sales figures decreased for all manufacturers except Tesla. The dominance of Tesla is absolute.

Like many other companies, Tesla tends to keep a low profile with regard to its suppliers. Investopedia estimates that more than two dozen suppliers supply parts for the Model S (Maverick, 2019). Tesla makes the basic electrical components of the car itself - the electric motor, battery pack and charging electronics - but other parts come from suppliers in the US, Europe and Asia. Investopedia documents a list of 8 possible main suppliers and the respective components supplied (Maverick, 2019):

Table 2: Main suppliers or partners of Tesla

Parts	**Suppliers**	**Company head-quarters**
Batteries	Partnership with Panasonic (to-day additionally LG Chem and CATL)	Japan, Korea China
Windscreens	AGC Automotive	Japan
Brakes	Brembo	Italy
Seating systems	Fisher Dynamics	USA
Dashboard	Inteva Products	USA
Battery Cooler	Modine Manufacturing Co	USA
Vibration and noise reducing prod-ucts, thermoplastic lightweight com-ponents	Sika	Switzerland
Tailgate gas spring	Stabilus	Germany / Lux-embourg
Power steering	ZF Steering Systems	Germany

Source: Borderstep

As these suppliers are all large suppliers with sometimes hundreds of locations, it is difficult to trace where the parts Tesla needs are actually manufactured. The only suppliers or partners exclusively for the electric drive train are the battery manufacturers.

4.7 Aspects of the organisation of the company

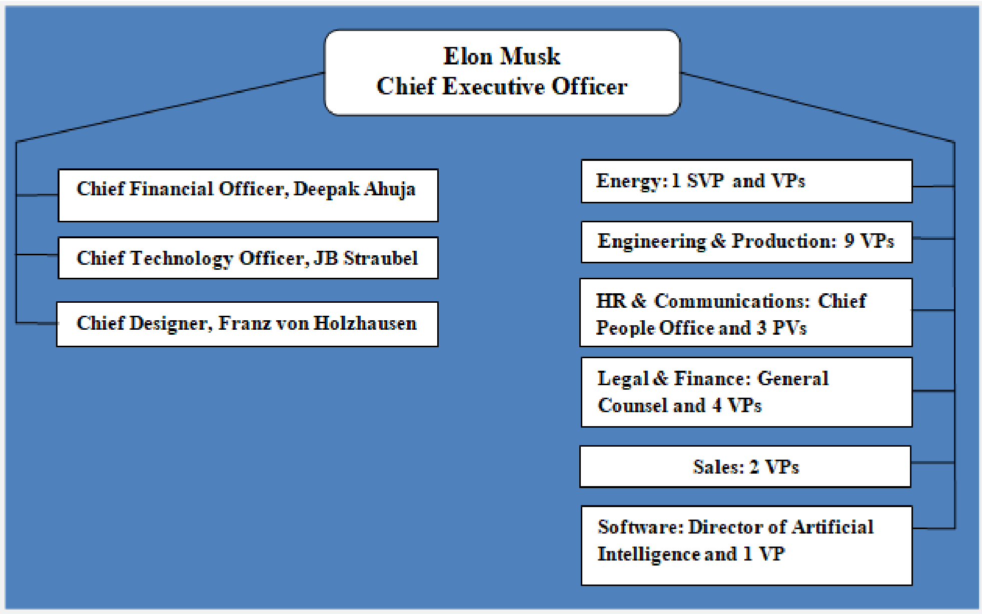
The theory of organisational ecology by Michael Hannan and John Freeman (1977) emerged in the mid-1970s. It regards organisations as resistant to change and assumes that they have only very limited abilities to adapt to changing environmental conditions. From an organisational ecological perspective, changes at sector level are therefore not so much caused by active change in existing organisations, but rather by the process of founding new organisations and the demise of others.

Boeker (1988, p. 36) emphasises that, in addition to the company's environment, the people who set the tone in the start-up phase are also of great importance for the start-up strategy and the developing corporate culture. He particularly emphasises the influence that the entrepreneur has on the strategy of the company and stresses the influence, experience, background and opinions of the founders. *"One of this study`s most significant implications is that organizations are set on a course at founding from which change may be costly or difficult. ...Only very strong external or internal events are likely to motivate change from previously established patterns. ... The founding of the organization provides an opportunity for entrepreneurs to embed their own assumptions about the tasks and the means to accomplish in the newly created organization"* (Boeker, 1988, p. 51). It is therefore plausible to assume that the organisation of a comparatively young company with roots in

Silicon Valley is fundamentally different from the organisation of a more than 100-year-old "company veteran" such as Daimler.

Tesla is a unique company in many respects and its organisational culture seems to be special compared to German car companies. For example, Tesla has no publicly known management structure, there is no organisation chart and no public list of managers available (Hull and Pogkas, 2018). Dudovskij (2018) characterises Tesla's organisational structure as divisional. It includes a number of departments such as Energy, Engineering and Production, Human Resources and Communications, Legal and Finance, Sales and Software. *"Each division is headed by several vice presidents, with the exception of the software division, which is headed by a vice president and an artificial intelligence director"* (Dudovskij, 2018). Overall, the organisation seems to be strongly focused on the central person Musk.

Figure 9: Tesla organisational structure



Source: Dudovskiy (2018)

Zetlin refers to an organisation chart leaked in 2018 which makes it clear that 29 executives report directly to Elon Musk and concludes that he is still unable to delegate (Zetlin, 2018). Zetlin continues (2018):

> *"But Tesla's lack of transparency about its leadership team other than Musk is pretty weird. One insider told "The Information" that Tesla's management team has few meetings and its members are rarely all in the same place. If true, that's weird as well. Meantime, Musk is known for often communicating directly with employees who would be far below him in the hierarchy if there was one. It all points to something we all already know about Musk: He's bad at delegating."*

Overall, the picture of Tesla's organisational structure remains unclear. At best, only one fact becomes clear: without Elon Musk nothing works. It is therefore not surprising that Musk in particular is mentioned in the risk report of the annual report: *"In particular, we are highly dependent on the services of Elon Musk, our Chief Executive Officer"* (Tesla, Inc., 2020). With regard to the speed of innovation at Tesla, it can be deduced that at least ideas from Elon Musk are implemented at a considerable speed. Now, the management of a company by a founder like Elon Musk is nothing special for start-ups and occurs frequently. What is very unusual, however, is that such a management structure centred on a single person is still practised in a company with annual sales of $30 billion.

However, the "entrepreneurial spirit", which is carefully cultivated by Musk, may have led to Tesla being much more willing to take risks than its competitors even after years of successful growth. In Grünheide near Berlin, the company is currently building a factory in record time and - at its own risk - is not waiting for all permits (Donath 2020). For classically organised German automobile companies, such a thing is hardly conceivable.

4.8 Working conditions and trade unions

Elon Musk is described as an unconditionally ambitious and extremely demanding boss, whose demands for commitment and speed also entail a not inconsiderable wear and tear on personnel (Feloni, 2014; Guldner, 2015). It is therefore no wonder that the original founders Eberhardt and Tarpenning left the company in 2007 and 2008 respectively. An Internet search for the words "Elon Musk" and "Trade Union" has uncovered countless sites that report on how he obstructs trade union activities and disregards labour laws. The clash between Elon Musk's management style and a German medium-sized company taken over by Tesla is described in Automotive Technology as follows (Richarz, 2017):

> *"While, for example, more than half of Grohmann's employees are members of the trade union (IG Metall), Elon Musk, who is disreputable as a slave labourer, does not like unions at all and finds employee representatives superfluous. It was only last October that he reduced the forced overtime hours at his US plant. Previously, working hours of twelve hours a day six days a week had been the norm. An e-mail from him to an employee who was absent at a Tesla company event because he wanted to be present at the birth of his child is vouched for. "This is no excuse, I am extremely disappointed," wrote Musk. "You need to clarify where your priorities lie." Moreover, wages there are just as much below the industry average as at Grohmann in Prüm. In the Eifel region, according to Michael Ebenau, trade union secretary of the IG-Metall district management in Frankfurt, 70 to 75 percent of collectively agreed wages are paid. "*

With a view to the ongoing factory construction in Grünheide near Berlin, "Die Zeit" examines the prospects for workers: *"Tesla workers in the USA are not unionised. On top of that, they are paid an hourly wage of initially 19 dollars, which is well below the average for car manufacturers in the USA"*, it says (Schade, 2019). But Musk is a fan of Berlin as a German start-up centre with coworking spaces, innovation hubs and networking events. *"Thus, development professionals at Tesla can expect a dis-*

tinct start-up culture - with probably all the fun gadgets, the stylish offices, pot plants and table tennis tables, but also the self-exploitation often assumed in young companies" (Schade, 2019). But in Germany the Works Constitution Act (Betriebsverfassungsgesetz) applies. There is a right to form a works council, and in view of the planned 10,000 employees, this will hardly be avoidable.

In his entrepreneurial role, the workhorse Musk is perceived as assertive and credible and realises seemingly impossible plans (Clausen and Perleberg, 2017, p. 14). At the time of the production start-up of Model 3, described by Musk as "production hell", he twittered at 3 a.m. from the roof of the new hall where he and his team roasted marshmallows and drank beer. A behaviour that for a German CEO demonstrates a level of closeness to the team that is hard to imagine.

Tesla customer Jason Calacanis expresses Musk's unimaginable power as follows: "People said he'd never get the rocket in space. He did that. People said the Roadster would never get delivered. He did that. People said he'd never get a hundred of them done. He's got two hundred done." (Paine, 2011 Min. 1:11:25). The challenge for Germany and its trade unions will be to integrate the innovative power of an entrepreneur like Musk and the new jobs he creates into a cooperative culture of co-determination in such a way that the innovative momentum is maintained, but basic workers' rights are safeguarded. Because only if successful cooperation is achieved Tesla will realise its recently announced plans to expand Grünheide to an annual production of 2 million cars per year (Teslamag, 2020) and perhaps create some of the jobs that IG Metall laments the loss of in the automotive industry and its suppliers.

4.9 Unique selling points

The question of why Tesla is successful, unlike the many other and often more unsuccessful start-ups in the automotive industry, is easy to ask and difficult to answer. But at least some factors can be identified:

A key factor is without doubt the person of Elon Musk with his entrepreneurial identity, drive and ability to deal with conflict. He embodies the archetype of the entrepreneur and addresses a depth-psychologically effective prototype that is easy for the human brain to decode and store (Hartwell et al., 2012). The archetype of the entrepreneur is regarded as demanding, self-confident, performance-oriented and determined. These qualities are unconsciously projected onto the Tesla brand. The Boston Consulting Group also sees Elon Musk and his media-effective appearance as a key success factor of the "Tesla phenomenon" (Andersen et al., 2016), especially since Musk's presence in the media also saves expensive marketing activities.

The second factor is found in the company's origins in the IT industry in Silicon Valley (Andersen et al., 2016). Without being tied to the centuries-old traditions of the automotive industry with its strict division of labour between oil companies, suppliers, car manufacturers and garages, Tesla became a highly vertically integrated group that controls the entire value chain, from solar cells, batteries and cars to the sales organisation and superchargers. The pragmatic, albeit at first sight contradictory, approach of manufacturing all critical components in-house in order to increase speed has proven itself over time. The Tesla mobility promise made possible by the Superchargers could be a key factor in the success of the company's first 10 years. Tesla achieves a maximum degree of differentiation from the competition through this complex range of services (Porter, 1985).

The Tesla cars are *"fast, cool and sexy"* (Paine, 2006 Min. 11:20) and feature high performance engines and a design typical of the brand. The self-esteem of first mover customers is served by owning an elegant, innovative and environmentally friendly product. Due to Tesla's clear mission to provide mobility for a world of renewable energy, owning a Tesla may also give the feeling of contributing to climate protection and places the owners in the exquisite group of electric car owners. In the value pyramid according to Almquist, Senior and Bloch, Tesla serves the highest levels of "active change" and "social influence" (Almquist et al., 2016).

A third factor lies in a stream of technical innovations. Tesla was the first manufacturer to rely on the lithium-ion battery, markets various driver assistance systems as autopilots with great public appeal, installs the extremely powerful and updatable "Hardware 3" instead of various individual electronic components and is currently trying to make a leap forward again with innovative and more environmentally friendly battery concepts. Tesla also wants to set new standards in body production and manufacture large parts of the vehicle frame using die-cast aluminium (Günnel, 2020). The American news channel CNBC subsequently does not only explore Tesla's unique selling points, but turns the question around: "Which Automakers Can Seriously Challenge Tesla?" (CNBC, 2020).

4.10 Effect on markets and competitors

One element of Musk's innovative momentum is that Tesla announced in June 2014 that it would release all patents and provide free licenses (Musk, 2014). With regard to the competitive situation, Elon Musk explained the decision in the Tesla blog as follows:

> *"Our true competition is not the small trickle of non-Tesla electric cars being produced, but rather the enormous flood of gasoline cars pouring out of the world's factories every day. [...] Technology leadership is not defined by patents, which history has repeatedly shown to be small protection indeed against a determined competitor, but rather by the ability of a company to attract and motivate the world's most talented engineers. We believe that applying the open source philosophy to our patents will strengthen rather than diminish Tesla's position in this regard." (Musk, 2014).*

Tesla and Musk undoubtedly offer opportunities for structural change in the sense of climate change, for the creation of jobs in electric mobility and for the transfer of knowledge to other companies.

But Tesla's influence on the global automotive industry is huge, regardless of free licenses. From 2008 until today, the cars built by Tesla have been the benchmarks of what can be achieved electrically on four wheels. They have shown the world that electric driving is cool and sexy and offers more possibilities every year. The unusually large batteries compared to early competitors, the ability to drive semi-autonomously, the promise of mobility realised by the supercharger system: All these set standards against which car manufacturers worldwide will have to be measured for years to come.

The strategy of building automobiles with ever greater benefits and at the same time consistently working on reducing the costs of core components such as the battery starts precisely where consumers need to be packed: On the price-performance ratio of products for whose use the accustomed behaviour (of driving) can be maintained (Clausen and Fichter, 2019). In the Impact Report 2019, Tesla (2019, p. 21) shows that Model 3 has successfully achieved price parity with key competitor models from Mercedes, BMW and Audi, and that the goal of price competitiveness has been achieved. Tesla also shows that due to the higher range, Tesla models are more often not only the electric second car for short distances (Valentine-Urbschat and Valentine-Urbschat, 2014) but are also deployed and used as first cars (Tesla, 2019, p. 22).

One component of habitual behaviour must nevertheless change: Car drivers have to build up confidence in the range and learn to charge the vehicles. And this is where a series of public self-experiments can be observed in the summer of 2020, demonstrating to the general public that electric cars are also suitable for long distances. The author of this article reports on a trip in the Renault ZOE through Denmark (Clausen, 2020), the well-known scientists Volker Quaschning on a holiday trip to Switzerland in the Tesla 3 (Quaschning, 2020) and Herbert Diess, CEO of Volkswagen, has set off with his daughter for Italy with the VW ID3 to make a public appearance.

A small piece of technology, Hardware 3, which has been in series production since April 2019, could have a further impact on the industry. Hardware 3, unlike other vehicles, gives the Tesla the ability to change virtually all functions through updates. In all vehicles equipped with Hardware 3, Tesla thus also sells the hope of future fully autonomous driving. According to Japanese analysts, Hardware 3 could cause lasting disruption to the car industry. Engineers at a Japanese car manufacturer remarked "We cannot do it." (Lambert, 2020a). However, the Nikkei analysts did not expect other manufacturers to install such a powerful central computer unit. According to Lambert (2020a) these car manufacturers feared that computers like Tesla's could make the spare parts supply chains that have been maintained for decades redundant. Such systems would drastically reduce the number of electronic control units in cars. According to Microsoft, up to 100 electronic control units are installed in modern cars (Britz, 2017). This would be a matter of life and death for suppliers who rely on these components, as well as for their employees.

However, the Nikkei assumption that the central hardware will not be copied was not correct at the time it was expressed. Volkswagen had already founded the organisation Car-software.org in 2019, with the aim of regaining sovereignty over software in cars (Bliesener, 2020). While 10 percent of the software used so far came from Volkswagen itself, this figure is to rise to 60 percent in the future (Volkswagen, 2019). In addition, a small number of In Car Application Servers (ICAS) will be used as hardware for the electric Volkswagen ID 3 in the future, offering central data processing as well as the possibility of 'over the air update' (Continental AG, 2019). The supplier Continental has already designed the ICAS hardware for the increased life cycle requirements in electric vehicles. The devices will replace 70 to 100 control units previously in the vehicle (Boschinger, 2019). With the introduction of a central IT architecture in 2020, Volkswagen is thus the closest follower of Tesla in Germany (Bliesener, 2020). Daimler is cooperating with graphics specialist NVIDIA on the same issue and plans to introduce an updatable solution for all Mercedes-Benz model series in 2024 (Daimler, 2020). The hardware will also be the basis for automated driving functions (Daimler, 2020).

In September 2020 Volkswagen began to make the media band wagon behind Musk usable for itself. After the latter had made a press tour of the construction site in Grünheide, his jet landed in Braunschweig with just as much media attention; and Elon Musk drove an ID 3 over the airport together with Herbert Diess for a test drive (S. Schmidt, 2020). Diess apparently also recognised that it can be quite helpful for Volkswagen that, in addition to Volkswagen, Tesla as another large manufacturer of electric cars is also producing in Germany. "Tesla brings pioneering automotive technology to Germany: electric driving, cell production, connectivity, autonomous driving and software expertise. Tesla will stimulate competition in Germany and significantly accelerate the transformation of our established industry. Good for the region and good for Volkswagen AG," Diess wrote on Linkedin (S. Schmidt, 2020).

Following Tesla's Annual General Meeting on 22.9.2020, Elon Musk recently presented a number of developments in battery technology aimed at making cars cheaper and more powerful in the future (Tesla, 2020). The Annual General Meeting was held in the car park of the factory in Fremont, and social distancing was achieved through a kind of drive-in cinema. The applause of the audience, all of whom had driven up in Teslas, was by honking. A larger audience found itself online. The livestream of the event already had 1,760,728 hits 12 hours after the start of the meeting.

Figure 10: Audience of the Tesla Shareholder Meeting 2020/ Battery Day

Source: Tesla (2020)

Tesla is planning a series of changes around the battery as the central component of electric cars in the next 2 to 3 years. For example, enlarging the battery format to 46 mm in diameter and 80 mm in length will reduce the specific costs per kWh of battery capacity alone by 14 percent. New materials for anodes and new cobalt-free cathodes will enable further cost reductions of 17 percent. In addition, the production process is made significantly more efficient and accelerated, so that it requires considerably less space per GWh of batteries produced, and this optimisation also reduces the battery costs per kWh by 18 percent. In future, no "battery packs" will be installed in the car, but the individual battery cells will be installed directly in the load-bearing parts of the frame. This saves mass, Musk speaks of 10 percent less weight, requires considerably fewer parts and reduces costs by a further 7 percent. In total, these changes result in 56 percent lower battery costs per kWh and 69 percent lower costs for expanding battery production per GWh, which helps Tesla to scale up. The target for 2030 is to increase Tesla battery production to a volume of 3 TWh per year. In addition, Tesla is currently developing new lithium mines in Nevada that will operate without permanent damage to the landscape, is developing a highly environmentally friendly lithium refining process, and will in the future also recycle the batteries in its own facilities. No statements were made about an expected long-term guarantee. On the other hand, Musk announced a new small model for 2023 for $25,000 net, which is almost exactly €25,000 incl. 19 percent VAT in Germany (Tesla, 2020).

While big companies, Musk says, tend to slow down, Tesla needs to speed up instead, in view of climate change. As part of the strategy to combat climate change, it is therefore also important that Tesla, as Musk claims, produces the cheapest solar cells in the world, plans to expand battery production significantly and aims to build 20 million vehicles annually (Tesla, 2020). This would mean that Tesla would then produce as many cars as Volkswagen and Toyota together today.

5 Conclusion

First the good news for the German automotive industry: the conditions that led to the success of Tesla are so special that they will hardly ever occur again in the same or even a similar constellation. Further hyper start-ups **of the same type** are therefore not to be expected in the foreseeable future. Well, there might be other types …

Nevertheless, there are other impulses that the start-up scene has in store. For example, the American start-up Lucid measured the range of its vehicle according to the measuring methods of the Environmental Protection Agency (EPA) with one battery charge of 517 miles (832 km). A C_d value of 0.21 is specified for the luxurious and probably very expensive Lucid Air model (Baldwin, 2020). The model was presented to the public on 9.9.2020. Production is scheduled to start in early 2021. Lucid is backed by a 1.3 billion investment of the Public Investment Fund of Saudi Arabia (O'Kane, 2020).

Both Sono Motors in Germany and the Dutch company Lightyear are working on vehicles that are equipped with solar cells and thus gain a range of up to 30 km per day in the summer months without being connected to the grid at all.

The criticism of the low range of electric vehicles is therefore likely to lose force. Even the reference to high costs is no longer relevant, at the latest since the German decision to increase the purchase premium and maintain it until 2025.

Tesla as well as Lucid Motors and Waymo are companies from Silicon Valley. At Tesla, this manifests itself in a completely new way of dealing with the digitalisation of cars. The focus is on a completely new hardware architecture, 'over the air updates' and automated driving functions. It is already foreseeable that this will have a considerable impact on German manufacturers. The success with which the German car industry, which does not have its roots in Silicon Valley, is following suit needs to be observed.

The trade unions will also have to develop a strategy for dealing with the transformation of the car industry towards electric propulsion and digitalisation. With the Tesla factory in Grünheide, there is a key new player in the car industry in Germany. It is doubtful whether Tesla will join the employers' association. In addition, Tesla is still in a phase of intensive growth and uses revenues primarily for the development of additional models and the establishment of new production facilities. Compared to Volkswagen, BMW or Daimler, Tesla will be a completely new type of negotiating partner for the unions. And not only OEMs but also suppliers are facing a variety of challenges, whether due to the phasing out of production of internal combustion engine vehicles or to digitalisation.

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Authors

Dr. rer. pol. Jens Clausen is co-founder of the Borderstep Institute. A graduate engineer in mechanical engineering, he heads the Borderstep Hannover office as a senior researcher. His work focuses on start-up, innovation and transformation research. His particular scientific interest is in the fields of heat, electromobility and digitalisation.

After his studies, Dipl. Ing. Jens Clausen worked as a development engineer and application technician for Continental AG. From 1991 until the foundation of the Borderstep Institute in 2005, he worked as a senior researcher at the Institute for Ecological Economy Research in the research field "Ecological Corporate Policy" in Berlin and Hanover. From 1993 to 2000 Jens Clausen was a member of the DIN NAGUS working committee "Environmental Management Systems".

In 2004 he received his doctorate from the Institute for Institutional and Social Economy at the University of Bremen. Since 2006 he has been a reviewer for various start-up competitions and since 2019 he has been coordinating the regional group of Scientists4Future in the Hannover region.

Dr. rer. pol. Yasmin Olteanu is a researcher at the Borderstep Institute. Her research focus is Sustainable Entrepreneurship. Within the project "Strengthening Green Start-ups as a Transformation Engine" she stimulates a stronger perception of the importance and challenges of green economy start-ups and the optimisation of relevant funding instruments. In the "Sustainability4ALL" project, Yasmin Olteanu is developing target group-specific content and formats to support start-ups and their ecosystems in integrating sustainability aspects. She also deals with the impact measurement of start-ups and relevant funding programmes.

Prior to joining Borderstep, she gained extensive international experience at the intersection of financial, social and environmental corporate objectives as a trainer and manager in Sub-Saharan Africa (LFS Financial Systems, SOLARKIOSK), and as an investment officer in Peru (Triple Jump Fund Management).

Yasmin Olteanu received her doctorate at the Free University of Berlin. She completed her diploma and subsequent master's studies at the Berlin School of Economics and Law, the Università degli Studi di Bergamo (Italy) and the Universidade Estadual de Campinas (Brazil).

The automotive industry in Germany has been established for decades. New suppliers have hardly played a role since Volkswagen entered the market after the Second World War. This is currently changing. Not only Tesla is building a new factory in Brandenburg for up to 2 million vehicles a year, but also some Chinese manufacturers such as Geely/Volvo and BYD are on the verge of entering the European market. Against this background, it seems necessary, particularly with regard to the topics of electromobility and digitalisation, not only to observe the diffusion of these innovations in the large car factories, but also to take a look at the niche players who are increasingly making their way into the market.