Master thesis : "New business modelling for the emerging market of electric vehicles within Europe."

Auteur : Kuyckx, Dirk
Promoteur(s) : Motullo, Marco
Faculté : HEC-Ecole de gestion de l'Université de Liège
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New business modelling for the emerging market of Electric Vehicles within Europe

Supervisor :

Professor Marco Motullo

Dissertation by

Dirk Kuyckx

President of Jury :

Professor Wilfried Niessen

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EXECUTIVE SUMMARY.

Road transportation accounts for almost one-quarter of Europe's total greenhouse gas (GHG) emissions. Cut those by 10% year on year, and Europe stands a very good chance of meeting its 2030 GHG emissions target, paving the way to a 90% reduction in transport-related GHG emissions by 2050.

E-mobility, fed by carbon-neutral and renewable energy, can get us there. Customers, whether private or corporate, can begin to understand the value of an EV over an internal combustion engine (ICE) equivalent. Supporting ecosystem will grow up alongside EV rollout. It will unlock significant commercial value for the earliest movers that participate in e-mobility and actively facilitate the customer transition to electric.(Colle Serge (EY Global Power & utilities Leader et al., 2020)

Of one thing we can be certain: the evolution towards electro mobility will be a revolution. Imagining the needs of tomorrow means taking into account multiple factors regarding energy, the environment, socio-economics, politics and technology, in a context of social transformation that stretches far beyond the automotive industry.

The study of alliances and new partnerships in the automotive industry shows that the traditional economic model of this sector is down and new business models must accompany this change of paradigm. The future mobility ecosystem that is emerging is complex and requires ambidextrous positioning. The story of electro mobility is being written day by day. The automotive industry is undergoing a profound transformation with the arrival of new types of vehicles, services, requirements and uses that break away from the traditional model of cars. The very nature of mobility is changing. (Danielle Attias, 2017)

How should a traditional automotive aftermarket supplier react to these changing events. Fear of what is to come is always a bad counselor, waiting for things to happen might result in missing the window of opportunity and some minor changes in the margin might just not be enough.

Is it worthwhile to remodel your business and how exactly, given the context, could this look like ?

INTRODUCTION

Schumacher Europe is part of Schumacher Electric, founded in 1947 in Chicago (US). With own factory sites and sales organizations on the four continents Schumacher is specialized in manufacturing and distribution of power conversion products in the automotive sector. With different research and development teams in Europe, US, and China we aim to develop and produce as much as possible in our own factory sites in Mexico and China. The smaller production sites in Belgium and Italy serve for assembly of smaller quantities for Business to Business or Private label customers in Europe. Traditionally our products are developed for fossil fuel combustion engines. We (re)charge lead acid batteries for a longer lifecycle or boost engines to start when batteries fail. We help to start or charge heavy duty engines, cars, motorcycles, train locomotives, boats, and planes. We concentrate on the development of a qualitative tool to do this. Our industry, the automotive aftermarket, however, is changing drastically and so are customer needs.

Most energy and environmental policies worldwide have set targets with the goal to shift from classic fossil fuel driven vehicles to electrified transport. The complexity of changing the human perception of transportation however goes beyond technical and economic aspects. Comprehensive analyses of political, economic, social, technical, legislative, and environmental aspects are necessary to understand dynamics in this new emerging market.(Capuder et al., 2020) If you are somehow related, professional, or private, to any aspect of the automotive market, being a consumer who wants to buy a new car, or in search of any valid alternative way of transportation, or being a professional in need of logistic services or active in the automotive industry, you are or will be confronted with the new era of electrification. Our industry is subject to the great challenge of the beginning of this century: the mobility revolution.

As a company we will have to make strategic decisions for the future. Our products for traditional combustion engine vehicles will become much less demanded and even obsolete after time. Simply changing our product portfolio to EVSE (Electric Vehicle Supply Equipment) could be an option, but probably not enough. This new emerging EV market appears to be considerably different from any existing known market we are active in today. We will have to (re)model our organization to meet new market demands if we want to succeed. Already today in this new emerging market we see new players appearing and competitors getting organized, mainly through merge and acquisition. Our actual customers of today, major retailers and aftermarket professionals, are not driving this new business. They are all more passive spectators, waiting for this market to become more mature. But will this market ever develop or move into their scope? Are they part of the future supply chain of EVSE or should we anticipate and already actively focus on new business development within new distribution channels?

To assess whether it will be worthwhile and how exactly to model our potential future business we will have to study this new market. How big is the market, how is it structured, what are the dynamics, opportunities, risks, threats?

This paper presents a hybrid methodology based on literature and active design thinking process conducted during a workshop with the leadership team. The tools used are a PESTLE Analyses, a SWOT analyses, a Value Proposition Canvas and a Business Model Canvas.

Key objectives are to visualize the EVSE (Electric Vehicle Supply Equipment) market within 3 to 5 years, to identify the key drivers of this market and to define how we should model our business to be a key player in this market, like we are today in the traditional ICE (internal Combustion Engine) aftermarket.

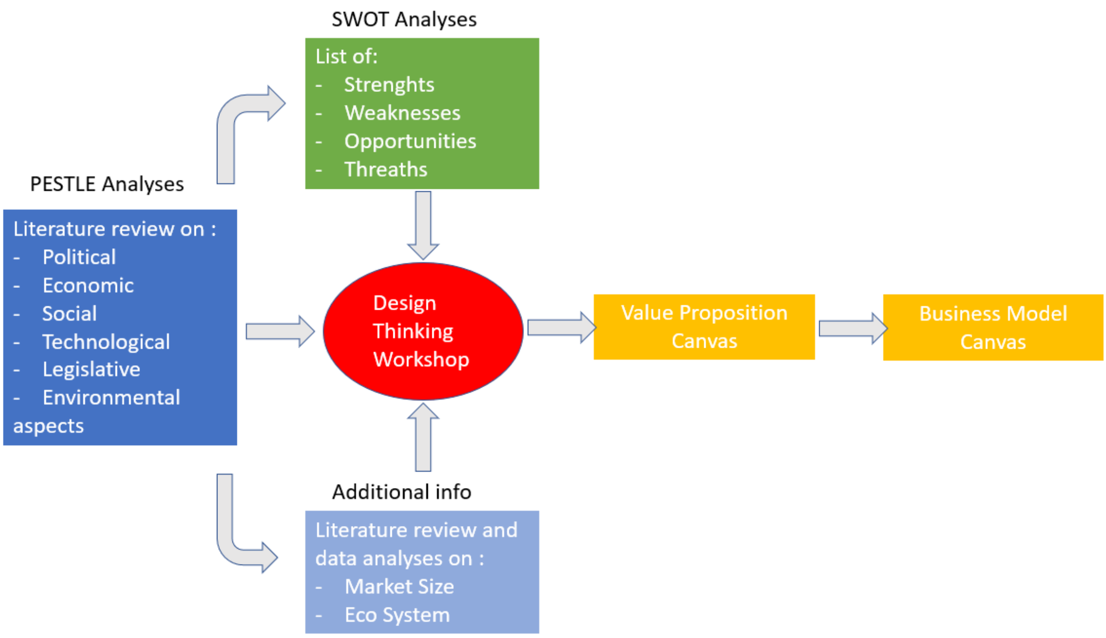


Fig1. Proposed methodology.

TABLE OF CONTENTS

1. PESTLE Analyses

1.1 Why PESTLE

A PESTLE analysis helps to understand the organization's market and business position better, plan strategically, and conduct market research in new and existing markets. It is a simple framework, easy to understand and to conduct. It facilitates a better and broader understanding of the business environment, and it encourages organizations to develop external and strategic thinking. It allows organizations to spot an opportunity and capitalize on it. PESTLE's are conducted as part of the organization's strategic planning process and is used to help shape the future direction.(*PESTLE Analysis, PESTLE Analysis Template - GroupMap*, n.d.)

Enterprises depend on long-term planning for strategic management and successful running of the business. Different firms use different analyses according to their needs and structure. Internal and external factors are highlighted in order to properly understand the complexity of the business environment and challenges. The PEST analysis is widely used among firms and focuses on the external factors instead of internal factors. It is regarded effective in long-term strategic planning and works from a macroeconomic perspective. The Political, Economic, Social and Technological factors allow firms to get a deeper understanding of the trends. (*What Is Strategic Planning: Complete Guide and Recommended Books*, n.d.)

In the methodology of this paper the PESTLE analyses was used in the explore phase of the EVSE strategy session with the Schumacher Leadership team, held in Dallas Forthworth (US) on April 22nd 2022, to determine key factors that will define how the future will look like in the Electric Vehicle market. This Pestel Analyses is based on literature study, brainstorming with the leadership team and many conversations with customers and colleagues.

1.2 Political

Together with the enforced dependency on oil suppliers and oil exporting countries, negative effects on economic growth as well as environmental degradation are expected if no effective measures are taken to increase efficiency and promote alternatives to the current mobility paradigm. Governments and politics react to the above-mentioned issues in many respects. Regulatory interventions on the international, national and local level can be identified.

What was initially seen as setting ambitious goals to increase the share of RES (renewable energy sources), increase energy efficiency and reduce carbon emissions, today calls for urgent corrections and more prompt actions. Initially Europe set a pathway to follow in 2009 requiring from its members reduction of the CO2 emissions by 20%, increasing the share of RES to 20% and improving energy efficiency by 20% by the year 2020 and continued with goals for 2030, emphasizing diversification of energy sources and reducing dependency on imported energy, particularly gas and oil.(Capuder et al., 2020)

EU institutions have formally endorsed the new emissions standards for passenger cars, heavy-duty vehicles and public transport suggesting that the Alternative Fuels Infrastructure Directive, as the key piece of legislation dealing with publicly accessible charging infrastructure, might be revised, and made even stricter.

Regulatory goals at the EU level are to be followed and adopted by national governments resulting in national strategies and incentive programs to stimulate the final users to change their habits when choosing a new vehicle. In this sense, European strategy on clean and energy efficient vehicles defines a goal of having 30% of EVs on the road by 2030.(Capuder et al., 2020)

The latest European Green Deal document with belonging Annexes is a clear indicator of where the EU governments see the future of clean technologies. The European Green Deal is a response to the challenges of the atmosphere warming up and the climate change. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use.

Accelerating the shift to sustainable smart mobility is one of eight pillars of transforming the EU’s Economy for a sustainable future. (*EUR-Lex - 52019DC0640 - EN - EUR-Lex*, n.d.)

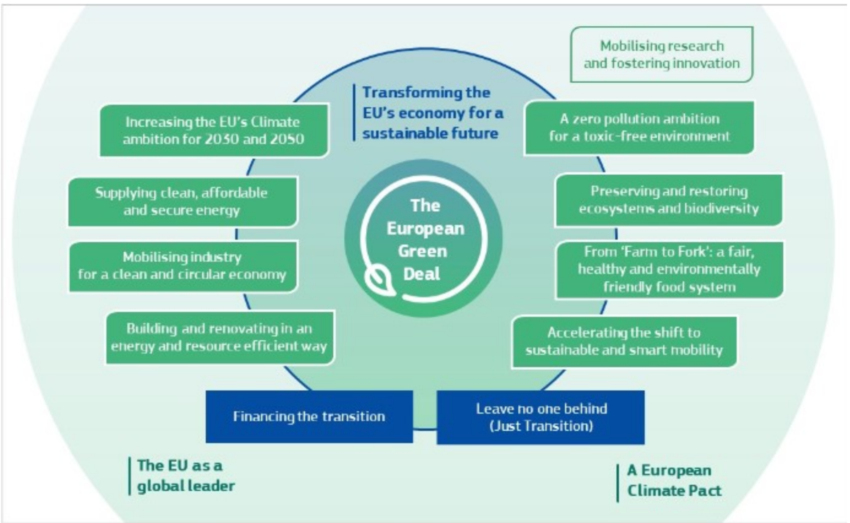


Fig3 : The European Green Deal

Article 2.1.5 states transport accounts for a quarter of the EU's greenhouse gas emissions. To achieve climate neutrality, a 90% reduction in transport emissions is needed by 2050. Achieving sustainable transport means putting users first and providing them with more affordable, accessible, healthier and cleaner alternatives to their current mobility habits. The Commission adopted a strategy for sustainable and smart mobility in 2020 that addresses this challenge and tackles all emission sources. Automated and connected multimodal mobility will play an increasing role, together with smart traffic management systems enabled by digitalization. The EU transport system and infrastructure will be made fit to support new sustainable mobility services that can reduce congestion and pollution, especially in urban areas. The Commission will help develop smart systems for traffic management and 'Mobility as a Service' solutions, through its funding instruments, such as the Connected Europe Facility. The EU should in parallel ramp-up the production and deployment of sustainable alternative transport fuels. By 2025, about 1 million public recharging and refueling stations will be needed for the 13 million zero- and low-emission vehicles expected on European roads. The Commission will support the deployment of public recharging and refueling points where persistent gaps exist, notably for long-distance travel and in less densely populated areas, and will launch as quickly as possible a new funding call to support this.

At European level different regulatory goals and directives are put in place. Some examples :

- DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

- The Energy Efficiency Directive (EED)(*Energy Efficiency Directive*, n.d.)
- The Renewable Energy Directive (RED)(*Renewable Energy Directive*, n.d.)
- Directive 2014/94/EU on the deployment of alternative fuels infrastructure (*EUR-Lex - 32014L0094 - EN - EUR-Lex*, n.d.)
- The energy Performance of the Buildings Directive (EPBD) (*DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the Energy Performance of Buildings (Recast) (Text with EEA Relevance)*, n.d.)

One of the most ambitious strategies today is that of Denmark aiming at becoming completely fossil fuel independent by 2050, predicting that EVs will have an important role in achieving this goal. The idea of having a zero emissions transportation by 2050 can also be found in the UK strategy which claims a support of 1 billion £ by 2020 will be made available to achieve this. Even without going into details of other countries transportation strategies, one can notice a pattern: in order to achieve goals of reducing CO2 emissions and dependence on oil, coal and gas, the transportation sector needs to be more efficient and electrification followed by decarbonization of the power sector is seen as the most promising way of doing this. (Capuder et al., 2020)

More than 20 countries have electrification targets or ICE bans for cars, and 8 countries plus the European Union have announced net-zero pledges. (Energy Agency, 2021)

The era of the petrol and diesel engine is coming to an end in Europe. Recently, the European climate ministers agreed that from 2035 the combustion engine may no longer be produced in Europe. All new cars must be electric from then on.

1.3 Economic

The volatility of crude oil prices and the advances in alternative fuel technologies have started generating new ideas on more ecological, cheaper, and efficient personal vehicles. One way of reducing the negative impact of personal vehicles is the production of more efficient engines. However, this can only reduce the problem to a certain point. In fact, recent research has shown that only 6 out of 28 newly produced more efficient vehicles in the US justify higher initial investment costs through fuel savings. When this is put in the context of occasional significant drop in oil prices, such as the one in 2015 and 2016, it is clear that the highly efficient internal combustion engines are not the proper means to reduce the global and local emissions. A similar obstacle of higher initial investment cost emerges when purchasing an EV. If a buyer decides on making this investment, the next questions is: is the lifetime cost of an EV, often expressed as the total cost of ownership (TCO), competitive with a conventional vehicle (CV) since EV fuel and maintenance costs are lower in comparison to a CV. However, calculating TCO includes detailed sensitivity analysis of the current and the future greenhouse gas emission taxes (of electricity and petroleum), different subsidies (for both EV and fossil fuels), and uncertainties of the future electricity and petroleum prices. As mentioned, the most relevant factor for the buyer is the initial price of EV, which is mostly dictated by the high costs of batteries. Significant efforts and investment are made into the development of batteries aiming to reduce their cost and increase energy density. The predictions of battery technology development suggest that in 2020 their cost will be 50% lower, while the mass of battery packs of the same energy content will be reduced by 30% . (Capuder et al., 2020) Knowledge in PEV technology is growing rapidly, thanks to the substantial collaborative R&D programs currently in place that increasingly include support to manufacturing scale-up and the development of regional supply chains. Initiatives exist to share best practices in PEV public policies internationally.(Contestabile et al., 2020)

Another issue are doubtful savings on fuel and maintenance, as the future prices of electricity and petroleum are subject to a number of uncertainties. Although it is ungrateful to forecast these prices in a long run, the concepts where EVs operate in coordination with RES (Renewable Energy Sources) are recognized to offer benefits to both the EV owners and the power system regardless on the electricity prices. Studies about the total cost of EV ownership analyzed multiple uncertain economic factors for different countries and the results indicate that PHEVs and EVs could be financially more attractive option by 2025, with estimates that prices of EVs will be in the range of CV before 2030.. (Capuder et al., 2020)

Future electrification of transportation needs to be carried out following the principles of Smart Grid integration, where the new EV consumption becomes flexible and controllable. By doing this, the EV owners would benefit from lower electricity prices for charging, since the services of making EVs available for providing support and enabling secure supply of electricity would be awarded by the electric system operators. The idea of EV owners helping the system by agreeing to also inject surplus of electricity from their vehicles back into the grid in times of need with a proper remuneration (this is called vehicle to grid or V2G concept) turns the EV fleet into a large distributed storage, changing the power system paradigm. (Capuder et al., 2020)

Fleet is the quick win that will make the biggest and fastest contribution to the decarbonization of road transport. At 63 million vehicles, fleet accounts for 20% of the total European vehicle parc, travels more than 40% of total vehicle kilometers and contributes half of total emissions from road transport. Fleet electrification is being hurried along by the CO2 emission standards. Added to that are 300+ low- and zero-emission zones to keep polluting vehicles out of cities. For logistics and last-mile delivery companies, there is a choice: electrify or pay a penalty.(Colle Serge (EY Global Power & utilities Leader et al., 2020)

Numerous stakeholders are emerging that can be mobilized to work on the same project, i.e. the electro mobility economy. In addition to the usual, directly concerned stakeholders, newcomers include rental companies, public transport operators, and energy providers that, alongside IT companies, are the emerging players in the game. They participate in drawing up these new business models and in other forms of cooperation that have dominated up until now.(Danielle Attias, 2017)

The idea of “reversibility between producers and consumers” is also interesting. This situation occurs for example when the owner of an electric car produces his or her own electricity to drive and may sell it to a third party to make a profit.(Danielle Attias, 2017)

1.4 Sociological

The very nature of mobility is changing. User behavior is shifting; social symbol connected to vehicle prestige and journey priorities are not the same. The aspiration attached to private cars is also in the process of changing. New services (car-sharing, car-pooling, self-service cars) are making a significant contribution to the emerge of a new ecosystem.(Danielle Attias, 2017)

As technologies develop, the biggest obstacle to their societal acceptance is overcoming people's skepticism on the usefulness and practicality of the product. If a product is a substitute for an existing product, it should be characterized with additional features or benefits compared to the old one. Customers will not choose the new product giving up on their comfort. In this respect, some analyses have shown that substituting classical petroleum fueled cars with EVs would not impact the users' comfort in majority of cases, while a minor change in behavior, such as more frequent charging or minor adaptation in their common driving patterns, would make EVs an acceptable alternative for driving. However, when potential users are asked about their expectations from EVs, they emphasize larger driving range, lower initial cost compared to CVs and shorter charging time. (Capuder et al., 2020)

More and more private households are becoming electricity prosumers, both consuming and producing electricity. This is supported by government programs in many countries that involve citizens in the actual implementation of energy transitions. Also in the context of mobility transitions, citizens are becoming an important success factor for the phaseout of petrol and diesel cars. With the rise in renewable energy technologies and EVs, as well as the ongoing digitization of more and more areas of production and everyday life, concerns are increasingly being raised about the negative side effects and downsides of these developments. The growing use of critical materials in the respective technologies is one major point of criticism and concern. It is obvious that the kind of goods and services people consume and the ways in which they are disposed of have significant socio-ecological consequences. Concerns about the unsustainability of consumption patterns have particularly been raised in the context of discussions around sustainable development. In the context of ongoing mobility and energy transitions, consumers are regarded and mobilized by different stakeholders (policy-makers, business actors, NGOs, etc.) as central actors in the "greening" of energy and mobility systems. Furthermore, goods such as PV (photo voltaic or solar panel) systems or EVs and their diffusion among wider parts of society are discursively presented as imperatives for the success of sustainability transitions. Although many of the critical materials used in renewable energy technologies are not scarce, sustainability issues arise from the way they are currently mined. Common consequences and issues associated with the mining of critical materials are loss of farmland, air pollution, contamination of water supplies, highly energy-intensive and water-intensive extraction processes, as well as serious health risks for mining workers. Thus, while EVs and PV systems are supposed to support the "greening" of lifestyles in Western countries, the costs of producing the necessary raw materials are externalized to other countries.(Sonnberger, 2020)

The acquisition of EVs and PV systems particularly addresses the utilitarian, positional, and expressive functions of consumption. The adopters of EVs and PV systems expect financial gains, positive environmental effects, and also—at least in the case of EVs—gains in status. As a motive, "environmental protection" can thereby refer to both the utilitarian and the expressive functions of these goods. EVs and PV systems can be acquired with the aim of contributing to environmental protection (utilitarian function) and expressing one's "green" identity (expressive function). Demonstrating one's status is an important motive for the adoption of EVs, since cars in general are one of the most powerful status symbols in modern societies. (Sonnberger, 2020)

Self driving, autonomous cars are the final step of an underlying trend in vehicle automation. But the autonomous car creates a radical break with other mobility modes and lifestyles because it can be thought as shared car. Imagine the residents of a neighborhood jointly using this mobile object on four wheels, sharing it, and inventing new uses together and thus forming a new social link. However, many obstacles remain to be overcome, social, legal, and financial issues to name a few, and need to be considered by carmakers. The latter are facing the arrival of new players like Google and Uber, players who are ready to create disruptive business models. (Danielle Attias, 2017)

New requirements and usage of customers, who from one generation to the next, confer cars with a different role and social status. Generation Y, which emerged over ten years ago, has introduced new societal values, including a very different relationship to mobility. This generation designates 25-35 year-olds, also known as "digital natives" and "Generation Why", who grew up within the internet ecosystem and have built a new generational identity through social networks. These young people, the successors of generation X, live in a system of constant communication dominated by new usage types; they expect to use objects and products for free or almost nothing, enjoy open access to knowledge technologies, and in particular, consider that ownership can be shared or exchanged and is not a symbol of social success. (Danielle Attias, 2017)

Privately owned cars are currently used only 2.6% of the time for driving; 0.8% are spent to look for a parking spot; 0.5% for sitting in congestion; the rest of the time; approximately 96%, the typical car is parked. (Danielle Attias, 2017)

1.5 Technological

A significant step towards higher fuel economy was the introduction of hybrid electric vehicles (HEVs) that combine a conventional internal combustion engine with an electric engine. Introduction of plug-in hybrid electric vehicles (PHEVs) was the next important step in making a transition towards electrifying the transportation sector. PHEVs have an option to charge their batteries at home by connecting to an electric wall socket, but these batteries do not make the core of the PHEV driving range, as most of it comes from the gasoline engine. The final step away from the internal combustion engines is the introduction of battery EVs that use only chemical energy stored in rechargeable battery packs.(Capuder et al., 2020)

Two types of batteries are currently being used in PHEVs, nickel cadmium (NiCd) and lithium-ion (Li-ion) batteries, but majority of EV use Li-ion batteries. The initial uptake of NiCd was due to the higher number of deep discharge cycles (up to 80%), while Li-ion can be discharged only up to 50% for the same number of life cycles. On the other hand, NiMH batteries offer inferior energy and power densities which reflects on the vehicle dynamic performance. Since driving range is currently seen as one of the main obstacles for EV acceptance, the batteries currently being developed are aimed to have higher energy density. At the same time, future batteries need to have higher power ratings to enable faster charging, they need to be more affordable and should be significantly lighter. Most of these challenges are conflicting and significant research and manufacturing investments are needed in this area to reach the goals set for the upcoming years.(Capuder et al., 2020)

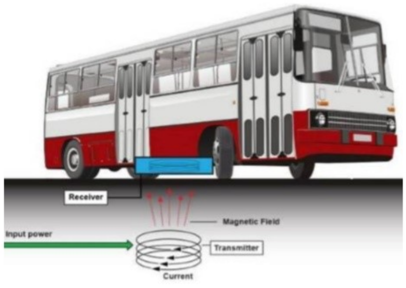
Another technical issue EVs are facing is battery degradation. Namely, the Li-ion battery capacity reduces over time as a result of cycling. This capacity reduction depends on the number of charging/discharging cycles and the depth of discharge of those cycles. As the battery capacity degrades, the EV driving range reduces, thus diminishing the comfort of an EV owner. The reduction in battery capacity has a negative impact on the EV ownership economy as well, especially since the battery pack is the costliest part of any EV. The battery pack is considered ready for retirement once its capacity falls to 80% of the original capacity.(Capuder et al., 2020)

EV charging system consists of charger control unit, charging cable and vehicle control unit. There are three ways of charging the battery of the EV (Electric Vehicle) viz. conductive charging, inductive charging and replacing the battery.(*Difference between Conductive Charging vs Inductive Charging*, n.d.)

The first PHEVs typically will have dedicated, on-board, unidirectional chargers that will have conductive connections to the charging stations or wall outlets and will be charged using either dc or ac. The terms charger and charging station cause terminology confusion. To prevent misunderstandings, a more descriptive term of electric vehicle supply equipment (EVSE) is used instead of charging station. The charger is the power conversion equipment that connects the battery to the grid or another power source, while EVSE refers to external equipment between the grid or other power source and the vehicle. EVSE might include conductors, connectors, attachment plugs, microprocessors, energy measurement devices, transformers, etc. The two main standards from SAE describe the requirements for conductive and inductive coupled chargers and the charging levels.(Kisacikoglu et al., 2012)

Conductive charging uses direct contact between an EV connector and a charge inlet. The cable can be fed from a standard electrical outlet or charging station. There are two methods employed in EV charging stations using conductive method, AC chargers and DC chargers. AC charging is carried out using AC chargers. This is further categorized into various levels based on features namely level-1, level-2 and level-3. Level 1 allows the EV to be connected to most common grounded electrical receptacle. It is known as Home charging. In this method, the vehicle is connected with the on board charger which is capable of accepting energy from an existing AC supply network. Level 2 method utilizes dedicated AC. EVSE is used either at private or public locations. In this method, the vehicle is connected with an on board charger which is capable of accepting energy from alternating current. It is known as fast AC charging. It uses either 7.4 KW (32A single phase) or 22 KW (three phase) level. It is used at home, workplace and public charging facilities. DC charging is carried out using a DC charger. It utilizes dedicated DC EV supply equipment to provide energy from appropriate off board charger to the EV in either private or public locations. It is known as fast DC charging. It is used up to 50KW i.e. battery can be charged in 20 minutes from empty to 80% full.

Inductive charging uses an electromagnetic (EM) field to transfer energy between two objects.



Energy is transmitted through inductive coupling to an electrical device. This energy is used to charge batteries. Inductive chargers are used with an induction coil to create an alternating EM field from the charging base. The portable device such as cars or trucks use a second induction coil to receive the EM field. These EM fields are converted back into electric current in order to charge the battery of EV. (*Difference between Conductive Charging vs Inductive Charging*, n.d.)

EVSE devices offer a range of methods for authenticating a charging session. These methods include using Radio Frequency Identification (RFID) tags, smart phone Near Field Communication (NFC), or credit card chip/swipes. These methods link the EV operator (i.e., owner or driver) or their account information to the charging session for billing and tracking purposes. Many DCFCs now also include touch screen front panels that allow the driver to determine the cost of electricity and vehicle status (charging rate, state of charge, etc.). Some EVSE vendors also include the ability to display custom messages or run advertisements on their EVSE devices. Plug-and-charge functionality that is developed in ISO 15118-20 will allow the vehicle to automatically authenticate over the charging cable.(Johnson et al., 2022)

Modern EVSE connects to one or more internet services. These connections typically exchange telemetry data and extend control to EVSE vendor or third-party cloud environments. Cloud-to-cloud communications then enable billing operations and grid operators to interact with EVSE equipment. (Johnson et al., 2022)

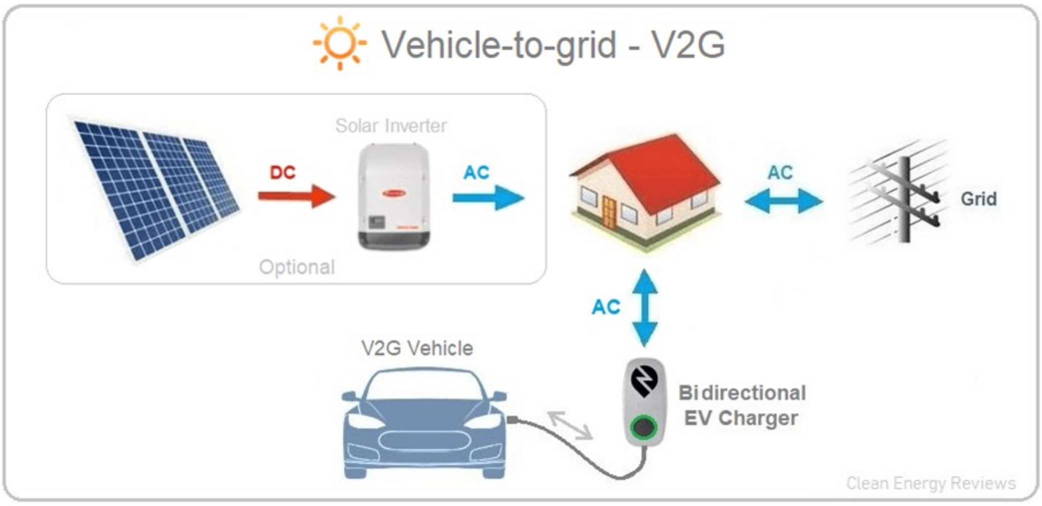
Open Charge Point Protocol (OCPP); Open Smart Charging Protocol (OSCP); IEEE 2030.5; OpenADR; Message Queue Telemetry Transport (MQTT); and Building Automation Control network (BACnet) are also in use by EVSE devices on the market. OCPP is widespread and used to connect EVSE to third-party EVSE monitoring and control networks. OCPP is currently on Version 2.0.1, but Version 1.6 is widely used in the field. (Johnson et al., 2022)

Workplace charging of electric vehicles (EVs) from photovoltaic (PV) panels installed on an office building can provide several benefits. This includes the local production and use of PV energy for charging the EV and making use of dynamic tariffs from the grid to schedule the energy exchange with the grid. The long parking time at the workplace provides the chance for the EV to support the grid via vehicle-to-grid technology, the use of a single EV charger for charging several EVs by multiplexing and the offer of ancillary services to the grid for up and down regulation. Further, distribution network constraints can be considered to limit the power and prevent the overloading of the grid.(Mouli et al., 2019)

The optimal way to charge EVs is to schedule the charging by taking into consideration the EV user preferences, local renewable generation, distribution network and energy prices from the market. This is called smart charging and is accomplished by using an Energy Management System (EMS) to schedule the EV based charging on a multitude of inputs. (Mouli et al., 2019)

Battery chargers of EVs are categorized into on-board and off-board charging systems that can provide the unidirectional and bidirectional power flows. The charging system with the capability of unidirectional power flow has the benefits such as minimum hardware, simplification of interconnection complications, and lesser battery degradation issue. The other charging system with bidirectional power flow has several features including the stabilization of power, vehicle-to-grid (V2G) technology, and sufficient and controlled conversion of power. (Habib et al., 2018)

Electric vehicles with bidirectional chargers provide a distinct benefit as means of a technology acknowledged as V2G. When batteries of EVs are not in use but still connected to a network, they can provide energy to a power grid at its highest demand of load and therefore enhance the efficiency of grids; this refers to V2G technology. Vehicle-to-grid technology is based on control and management process of EV loads with the help of communication linkage between vehicle and utilities or aggregators. Vehicle-to-grid (V2G), V2V, and V2H are significant applications of EVs corresponding to bidirectional power flow. The batteries of EVs and power network of a home exchange power between each other in case for V2H concept. The amount of energy stored in EV battery will sever as a back-up source for home appliances and RES installed in home. The V2V concept can be implemented by building a local community of EVs where changing and discharging of EV battery energy are possible among vehicles.(Habib et al., 2018)



1.6 Legal

Incentivizing sustainable low-carbon technologies is recognized and accepted as a way of making them commercially competitive with the traditional ones. In case of RES, these incentives had different forms in different countries, but have slowly converged into a few most common ones, i.e. green certificates, market premium and feed-in tariffs. Similar incentives and privileges for EV owners are being promoted to accelerate the uptake of EVs. In general, subsidies stimulating EVs can be divided in two main categories: direct subsidies (one-time bonus) and fiscal incentives, such as reduced taxes.

A few examples of new & upcoming EU legislation :

EU Taxonomy : The EU taxonomy is a classification system, establishing a list of environmentally sustainable economic activities. The EU taxonomy is an important enabler to scale up sustainable investments and to implement the European Green Deal. This new EU classification system means that industry operators need to extensively report how they have reduced, prevented, and managed emissions in order to have access to financing.

The Energy Efficiency Directive (EED) : Current energy efficiency improvements are intended to reduce at least 32.5% of the EU's overall energy consumption by 2030. This non-binding target can be reached by hastening the shift to more efficient, electric vehicles, and increasing the efficiency of the existing vehicle population.

In practice, multiple countries have already taken concrete steps to fasten the transition towards e-mobility with national zero-emission mobility targets or introducing scrappage schemes and rewards for old cars. The directive has already been implemented in member countries and can and should be supported with ambitious transport policies that support the EU's 2030 energy efficiency target.

The Renewable Energy Directive (RED) : By today, a majority of European Union member countries have not yet incentivized the use of electricity as a fuel in the same way they do with for instance biofuels. Yet, electricity is the cleanest alternative to oil.

The refreshed Renewable Energy Directive, RED, offers a chance to move away from crop-based biofuels such as palm oil to cleaner fuels. The creation of a credit system would help in increasing the rise of renewable fuels since renewable electricity requires a separate infrastructure to be introduced to the market.

The Energy Performance of the Buildings Directive (EPBD) : The revised Energy Performance of the Buildings Directive is a must-know for all real estate sector actors. Depending on the purpose of the building, EPBD obligates new buildings and buildings undergoing major renovations to either install charging stations or ensure the installation of ducting infrastructure in parking spaces.

The Commission has also proposed a smartness requirement for the charging points: meaning, that the chargers should be capable of reacting on signals from the grid. In the long term, smart charging stations are a cost-efficient choice for both real estate owners and consumers.

Market Design Directive and Regulation : encourages member states to introduce smart metering systems in using electricity.

Incentives are currently being offered around Europe, including purchase subsidies, tax bonuses, charging incentives and more. An overview :

Electric vehicle incentives
across Europe

KEY	Vehicle incentive	No vehicle incentive

COUNTRY	PURCHASE SUBSIDIES	REGISTRATION TAX BENEFITS	OWNERSHIP TAX BENEFITS	COMPANY TAX BENEFITS	VAT BENEFITS	OTHER FINANCIAL BENEFITS	LOCAL INCENTIVES	INFRASTRUCTURE INCENTIVES	SCORE
FRANCE	Up to €6,000, plus up to €5,000 scrappage bonus.	Exempt from registration tax, with some further regional discounts too.	No road tax.	Reduced TVS tax of €20 per year.	VAT 100% recoverable on electricity.		Up to two hours free parking in some municipalities.	30% tax credit on installation of personal chargers.	7
NORWAY		Exempt from registration tax.	Pay the minimum road tax rate.	Reduced tax.	Exempt from VAT.	Various incentives decided at a local level such as reduced tolls and free parking.	Various incentives such as free parking, reduced tolls, use of bus lanes and free ferry crossings.	Public funding to ensure a charging station every 50km on main roads. New car parks must allocate at least 6% to electric cars.	7
GERMANY	Up to €4,000 (on vehicles up to a value of €60,000).		Exempt from road tax for first ten years.	Tax on electric company cars is offset by €500 per kWh.		Those who charge their vehicle at their workplace are exempt from claiming this as a cash benefit on their income tax.	Free parking, reserved parking spots and use of bus lanes.	Various subsidies worth around €300 million to install around 15,000 charging points.	6
ICELAND		Exempt from registration tax.	Exempt from road tax.		Exempt from VAT.	Exempt from import excise duties.	Free parking up to two hours in Reykjavik and Akureyri.	Grants amounting to 200 million kronur to triple the number of charging stations in the country.	6
IRELAND	Up to €5,000.	Relief of up to €5,000 on purchase tax.	Pay the minimum road tax rate.	Companies can write off 100% of the purchase value of qualifying energy efficient equipment against their profit in the year of purchase.			Free on-street parking while charging in some local authorities. Free charging at normal and high power public recharging points.	Free installation for first 2,000 domestic charging points.	6

MALTA	Up to €7,000 when trading in an older vehicle.	Exempt from registration tax.	Only pay a 'symbolic' contribution of €10 per year.	The deduction from a company's chargeable income 150% instead of 125% for electric vehicles.			Use of priority lanes in Valetta. No congestion charge in Valetta.	Grant of €2,000 for companies to install charging points, up to five charging points per company. Subsidies also available for residential chargers.	6
PORTUGAL	Up to €2,250.	Reduced tax based on CO_2 emissions.	Reduced tax based on CO_2 emissions.	Exempt from company car tax.	Reduced VAT.		Free parking in Lisbon. Local utility companies give one year discount to EV owners.		6
UNITED KINGDOM	Up to £3,500.	Exempt from registration tax (for vehicles valued up to £40,000).	Exempt from road tax (for vehicles valued up to £40,000).	Reduced company car tax rates. Tax benefits for companies installing charging infrastructure.			Exempt from London congestion charge. Other incentives such as free parking decided at local level.	Grant of up to £500 for installation of charging points.	6
AUSTRIA	Up to €3,000 (on vehicles up to a value of €50,000).	Exempt from registration tax.	Exempt from road tax.	0% company tax or VAT on privately used company cars.			Free parking in major cities.		5
BELGIUM	Up to €4,000 (Flanders only).	Exempt in Flanders, minimum rate of €61.50 in Brussels and Wallonia.	Exempt in Flanders, minimum rate of €77.35 in Brussels and Wallonie.	120% deductive from company tax (100% from 2020 onwards).		75% of charging costs can be deducted from income tax.			5
DENMARK		Charged 40% of normal registration tax.	Pay minimum road tax rate.	Companies that provide EV charging can receive a rebate of 1 DKK per kilowatt-hour.		Exempt from parking fees up to 5,000 DKK.		Tax exemption for commercial charging and favourable tariffs for electric buses.	5
SPAIN	Up to €5,500.	Exempt from registration tax.	Reduction or exemption from road tax based on local councils.				Toll exemption on regional highways. Free parking in some cities. Access to HOV lanes.	Subsidies for private and public charging points.	5
HUNGARY		Exempt from registration tax.	Exempt from road tax.	Exempt from company car tax.		Parking benefits such as free parking while charging.			4
LATVIA		Exempt from registration tax.	Exempt from road tax.	Reduced company car tax.			Free parking in Riga and Liepaja Bus lane use.		4
ROMANIA	Up to €9,500.	Exempt from environmental tax.	Exempt from road tax.					Refunds of up to €2,500 for charging stations.	4

SWEDEN	Up to SEK 60,000.		Exempt from road tax for first five years.	Reduced income tax.				SEK 700 million allocated to improve charging infrastructure.	4
FINLAND	€2,000 (on vehicles up to a value of €50,000).	Reduced to 5%.	Pay the minimum road tax rate.						3
GREECE		Exempt from registration tax.	Exempt from road tax (up to 1,929cc).			Exempt from luxury car tax and luxury living tax.			3
ITALY	Up to €4,000 with a further €2,000 scrappage bonus.		Exempt from road tax for first five years, paid at 75% after this period in many regions.					Credit for charging infrastructure in non-residential buildings over $500m^2$.	3
LUXEMBOURG	Up to €5,000.		Reduced road tax.	Reduced tax based on CO_2 emissions.					3
NETHERLANDS		Exempt from registration tax.	Exempt from road tax.	Minimum rate paid on income tax for electric company cars. Investments in clean energy are also deductible from corporate and income taxes.					3
SLOVAKIA	Up to €8,000.	Exempt from registration tax.					Parking discount in some cities.		3
SLOVENIA	Up to €7,500.	Pay the minimum registration tax.	Exempt from road tax.						3
BULGARIA			Exempt from road tax.		30% reduction on product tax.				2
CYPRUS		Exempt from registration tax.	Exempt from road tax.						2

(*Electric Vehicle Incentives in Europe | Comparethemarket.Com*, n.d.)

What's not included in this summary are some specific requirements for implementation. For example to benefit from private tax deduction in Belgium, your EV charger needs to be "smart" and connected to a "Green energy" grid.

"Smart homes, smart villages, and smart cities can place the consumer at the center of the energy system. As local and renewable energy sources will decarbonize the energy usage, smart grids are needed to balance the system.

Smartness in charging unravels the possibility that electric vehicles have in providing stability and flexibility to the grid. With MDD and smart charging systems, consumers have a right to use, generate, store, and even sell energy without redundant charges.(*Here's How EU Legislation Accelerates the EV Revolution*, n.d.)

Cybersecurity researchers have recently identified several vulnerabilities that exist in EVSE devices, communications to electric vehicles (EVs), and upstream services, such as EVSE vendor cloud services, third party systems, and grid operators. The potential impact of attacks on these systems stretches from localized, relatively minor effects to long-term national disruptions. EVSE must communicate with cloud services, EVs and their battery management systems, and much more. For example, EV chargers may be integrated into distributed smart grid EV charging, or interconnected with Building Automation Systems (BAS) or Building Energy Management Systems (BEMS). The breadth and complexity of EVSE connections create a large cybersecurity profile and raise concerns that bad cyber actors could use insecure chargers as an unauthorized access point to abuse charging equipment, vehicles, buildings, or grid resources. EVs, for example, interface with dealerships, mobile phones, navigation, mapping, telemetry, entertainment, vehicle-based web browsers, other vehicles, driver assist systems, over-the-air software updates, and more, using an array of protocols, including Bluetooth, GSM Mobile, and Wi-Fi. Autonomous-driving electric vehicles add further cybersecurity complexity. Researchers have highlighted the manipulation of onboard, safety-critical electronic control units (ECUs) to interfere with braking, steering, engine and battery controls. Vehicle data are also at risk, including telematics, tracking, customer, dealer and insurance data. EVSE interfaces with highly connected EVs and vendor systems, charger owners, and grid operator systems. (Johnson et al., 2022)

1.7 Environment

Global warming and the increase of greenhouse gas (GHG) emissions are some of the most fundamental challenges of the 21st century. Especially the transport sector with a growing number of vehicles worldwide has to make a contribution to reduce GHG emissions radically. Furthermore, the scarcity of conventional energy resources, in particular crude oil, requires new energy carriers in the transport sector. Electric vehicles (EVs) such as battery (BEV), plug-in hybrid (PHEV) or range extended EVs (REEVs) are a means to this problem since they are more energy efficient than conventional cars and produce less GHG emissions when renewable energy is used. (Plötz et al., 2014)

The transport sector is one of the main contributors to anthropogenic climate change worldwide, accounting for 23% of global energy-related greenhouse gas (GHG) emissions. The number is similar in the European Union (EU). Besides global GHG emissions, ICE vehicles also cause noise and local air pollution, creating adverse health effects especially in urban environments. (Lévay et al., 2017)

By offering their battery capacity to help balance in the RES (Renewable Energy Sources) dominant power system, EVs become a crucial new source in enabling the transition to a low carbon energy system. Other sustainable transportation technologies, such as hydrogen or biofuel, do not have these capabilities. When focusing on a single winning technology, the existing research suggest that electrification makes most sense.(Capuder et al., 2020)

Lithium-ion batteries make up to 30% of the EV cost and in Europe EV batteries are subject to recycling regulations, imposing carmakers the recycling of at least half the battery weight which might be costly for batteries that weight usually more than 200 kg. Given this context, the battery end-of-life recovery impact is assessed in order to determine whether it will be a cost or profit source for automakers.(Danielle Attias, 2017) The recycling process of dead Li-ion batteries can increase the pollutants in the groundwater because only very few organizations are capable to perform the complete recycling process of these batteries. Therefore, facilities should be provided by the government for appropriate and fully manageable recycling of Li-ion batteries to ensure the clean and safe environment.(Habib et al., 2018)

To evaluate the environmental impact performance of EVs in comparison with conventional ICE vehicles, a term “well-to-wheels” is introduced that take into account the lifetime emission including exhaust pipe emission and material and energy utilized to power the vehicle.

Minimum well-to-wheels emissions are suggested by various research studies for EVs. The environmental impacts of EVs based on life cycle evaluation strategy, which incorporates the well-to-wheels stages and electricity production mix suggests that EVs are the vehicles with least intensity of carbon gas emission. (Habib et al., 2018)

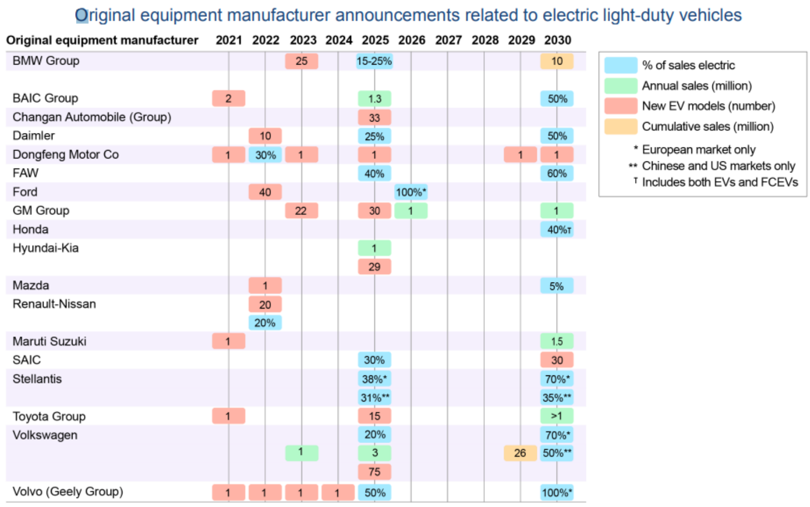
The rise in massive EV penetration introduces a significant additional charging demand, which can generate certain undesirable impacts on the power system. This situation specifies that the power grid is facing an increase in load profile during peak hours, over loading of power system components, transmission losses, voltage deviations, phase unbalance, harmonics, and system stability issues, which endanger the power quality and reliability of the power system. (Habib et al., 2018)

Our world is facing a problem of limited availability of easily accessible materials and energy and a problem of disposal on a more general level. A circular economy could decouple growth from resource constraints, avoid waste pollution, and preserve and enhance natural capital. Copying biological cycles, technical cycles have to collect, maintain, prolong, reuse, redistribute, refurbish, remanufacture and recycle products and parts to minimize systematic leakage and negative externalities.(Danielle Attias, 2017)

2. The Market (Size and Structure)

Passenger Cars are consumer products and ultimately the success of Plug-in Electric Vehicle (PEV) requires individual consumers to decide to adopt them. The decision to buy a PEV is more complex than that of a regular car as these vehicles combine a symbolic meaning that is still emerging and evolving with the need for behavioural adaptations such as dealing with range limitations and charging (fueling up) habits.(Contestabile et al., 2020) The pace of adaptation can differ from region to region and from many different parameters. Over the last few years, the market for PEVs has truly taken off. Driven by strong government incentives. The global PEV market has been growing at a rate of at least 40% per year. According to figures from the 2019 edition of the Global EV Outlook published by the International Energy Agency, in 2018 the global PEV fleet has exceeded 5.1 million cars, up two million from 2017 and with new PEV car registrations having almost doubled in a year. In addition to incentivizing adoption, governments continue to support PEV Research & Development (R&D) and increasingly also manufacturing, all of which has led to substantial technological learning and scale economies. In particular, lithium-ion batteries for PEVs have become more reliable, their energy density has improved, and their price fallen faster than many experts had anticipated. As a result, some experts are now predicting that PEVs will become cost-competitive in the coming decade. Moreover, industry is increasingly getting behind PEVs, with electricity providers becoming more interested in the flexible load that these vehicles can offer to manage intermittent renewable power and automotive original equipment manufacturers (OEMs) becoming committed to a transition from internal combustion engines to electric powertrains. This gives great hope that PEVs, together with greening of the grid, will provide a two-punch solution to reduce urban air pollution and meet radical carbon reduction goals.(Contestabile et al., 2020)

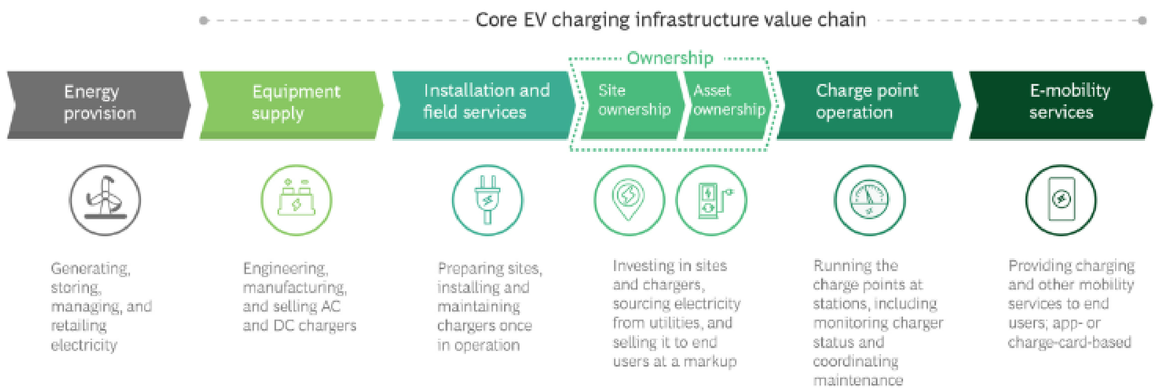
OEMs are expected to embrace electric mobility more widely in the 2020s. Notably 18 of the 20 largest OEMs (in terms of vehicles sold in 2020), which combined accounted for almost 90% of all worldwide new car registrations in 2020, have announced intentions to increase the number of available models and boost production of electric light duty vehicles (LDVs). A number of manufacturers have raised the bar to go beyond previous announcements related to EVs with an outlook beyond 2025. More than ten of the largest OEMs worldwide have declared electrification targets for 2030 and beyond.. Significantly, some OEMs plan to reconfigure their product lines to produce only electric vehicles. In the first-trimester of 2021 these announcements included: Volvo will only sell electric cars from 2030; Ford will only electric car sales in Europe from 2030; General Motors plans to offer only electric LDVs by 2035; Volkswagen aims for 70% electric car sales in Europe, and 50% in China and the United States by 2030; and Stellantis aims for 70% electric cars sales in Europe and 35% in the United States. Overall, the announcements by the OEMs translate to estimated cumulative sales of electric LDVs of 55-73 million by 2025.(Energy Agency, 2021)



Until recently, the understanding of consumer decisions to adopt and use PEVs could only be based on the study of participants to small-scale PEV field trials and of buyers and users of conventional internal combustion engine vehicles. Now that PEVs have entered the everyday lives of millions of car users and that a growing number of PEV models are being offered on the market by automotive OEMs, this has radically changed. Important insights can now be generated directly from the study of actual PEV buyers and users, as well as rejecters, and this can inform governments seeking to continue to support the transition towards electric mobility as well as automotive OEMs developing new PEV models.

This new emerging market of EV clearly requires a different approach as the traditional automotive (after)market we know. Different technologies, different requirements from different channels, different competences, etc., all this lead to a different value chain that has emerged. (Fig 4) It includes:

* Equipment Supply. Engineering, manufacturing, and selling AC and DC chargers.
* Installation and Field Services. Preparing sites and installing the chargers, routinely checking them, making repairs, and providing cleaning services.
* Site Ownership and Asset Ownership. Investing in sites and chargers, sourcing electricity from utilities, and selling it to end users at a markup.
* Charge Point Operation. Running the charge points at stations. This entails connecting chargers to e-mobility service providers (e-MSPs), monitoring charger status, and coordinating maintenance. While charge point operation is a value-chain step, the term "charge point operator" or "CPO" is commonly used to refer to the pioneers that operate and lease or own EV charge points and charge point establishments—companies such as Allego, Fastned, and IONITY—the EV equivalent of the gas station.
* E-Mobility Services. Providing charging and other mobility services to end users. These app- or charge-card-based services include service maps, payment mechanisms, and roaming services, in which the end user can charge at different charging networks with one charging card.



Source: BCG analysis.

Fig 4 : The EV charging Value Chain

At this early stage, the marketplace is not yet fully organized. Companies from different areas and sectors of the EV market are getting in on the action, with different approaches and business models that address different segments of the value chain. The picture is much like that of an anthill, in which the participants are scurrying about to test opportunities.

Patterns are emerging, though—and from them we have distilled seven core strategic plays in the EV charging value chain. Some market participants will specialize in one link in the chain, while others will provide an integrated offering to establish their independence and secure bigger margins. At this point, most business models remain unprofitable; that's a reflection of low charger utilization. Participants must therefore weigh the benefits of seeking first-mover advantage against those of waiting for an economically lucrative moment to enter the market.

The seven strategic plays include five vertical specialists—the hardware systems specialist, the installer, the site and/or asset owner, the software platform player, and the aggregator—and two integrators, the turnkey provider and the end-to-end integrator. (*Winning the Battle in the EV Charging Ecosystem - ProQuest*, n.d.)

Suppliers have the goods and the client connections, but they must guard vigilantly against commoditization and the threat from low-cost, high-tech Chinese competitors. Doing so means aiming for quality in manufacturing as well as efficiency, removing cost wherever possible. Equipment suppliers are developing software which would be compatible with the hardware of other suppliers, but their results are not perceived as being as hardware-agnostic as that of third-party developers.

Equipment suppliers must also focus on developing smart solutions—cloud-connected technologies that allow a station owner to monitor and control charge-point use remotely, thereby ensuring efficient energy consumption. In this way, they can continue to enhance their customer value proposition. (*Winning the Battle in the EV Charging Ecosystem - ProQuest*, n.d.)

The current auto-industry's value chain structure and internal rivalry between OEMs will evolve towards a play of competing mobility eco-systems with new parties and with even the customer as a mobility partner. The customer and the satisfaction of her/his mobility needs will move in the focus of interest (customer centricity) and generate the necessity of a holistic approach in which products and services are bundled and offered to consumers as a system.(Danielle Attias, 2017)

The global EV Charging Station market is segmented based on Vehicle Type, Charging Station, Charging Level, Application, Battery Swapping Type and region. Based on the Charging Level the market is further classified based on AC Level 1, AC Level 2 and DC. Based on the Application, the market is further classified based on-Residential, Public and Commercial. Based on region, the market is segmented into North America, Europe, Asia Pacific, Rest of World, United States, China and Japan.("Global EV Charging Station Market 2021," 2021)

The total global EV charger market is estimated at little more than 52 billion USD by 2026 with an estimated annual growth rate of more than 30%. Europe is the second biggest market, estimated at 17 billion USD with the highest CAGR by 2026. ("Global EV Charging Station Market 2021," 2021)

Global EV Charging Station Revenue (USD Million), By Region							
	2021	2022	2023	2024	2025	2026	CAGR % (2021-2026)
North America	2804,92	3929,41	4709,63	5315,76	5742,90	5985,99	21,44%
Europe	4747,50	7264,08	9570,97	11966,80	14454,19	17035,84	34,27%
Asia Pacific	7910,84	11968,97	15593,75	19279,27	23026,33	26835,69	32,77%
Rest	571,41	893,26	1202,44	1536,02	1895,49	2282,46	37,18%
Total	16034,68	24055,74	31076,81	38097,87	45118,93	52140,00	31,65%

Fig 5 : Global EV charging station Revenue by region. Source HTF Market Intelligence

Remarkable, but inherent to emerging markets, is that this growth is exponential. Europe and Asia are for Electric Vehicles to be considered as having passed the early adaptor phase and entered a more mature stage. The adoption rates of BEV's as a share of new passenger vehicles sales in some European countries has entered the "early majority" and soon already the "late majority" phase in comparison to the US or the rest of the world where BEV are only addressing the "early adopters".

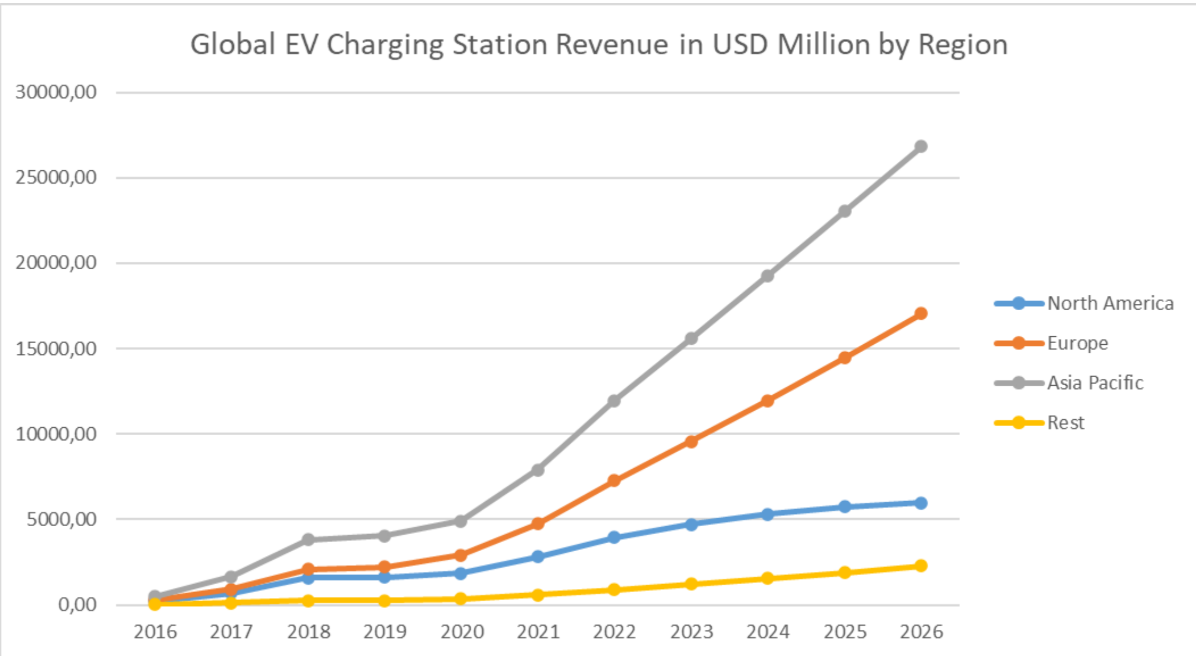


Fig 6 : Europe EV charging station Revenue exponential curve. Source HTF Market Intelligence

In terms of technology the biggest portion of the total European market is within AC level 2 chargers, valued at about 12 billion USD by 2026, followed by DC chargers for the public market at about almost 5 billion USD in the same period. AC level 1 chargers is very small and without any growth as the market gets bigger. (“Global EV Charging Station Market 2021,” 2021)

Europe EV Charging Station Revenue (USD Million) By Charging Level, (2021-2026)						
	2021	2022	2023	2024	2025	2026
AC Level 1	111,05	145,07	158,23	156,52	138,91	104,36
AC Level 2	3.307,10	5.071,79	6.697,83	8.393,70	10.161,72	12.004,24
DC	1.329,33	2.047,22	2.714,90	3.416,57	4.153,55	4.927,23
Total	4.747,50	7.264,08	9.570,97	11.966,80	14.454,19	17.035,84

Fig 7 : Europe EV charging station Revenue by Charging Level. Source HTF Market Intelligence

Finally in terms of business type both “Residential” and “Public” are of approximately equal value, +/- 6.7 Billion USD, where the commercial is less than half of this size by 2026.

Europe EV Charging Station Revenue (USD Million) By Business Type, (2021-2026)						
	2021	2022	2023	2024	2025	2026
Residential	1.791,55	2.761,13	3.663,95	4.613,24	5.610,55	6.657,45
Public	1.952,09	2.962,98	3.872,71	4.803,40	5.755,41	6.729,11
Commercial	1.003,85	1.539,97	2.034,30	2.550,14	3.088,22	3.649,27
Total	4.747,50	7.264,08	9.570,97	11.966,80	14.454,19	17.035,84

Fig 8 : Europe EV charging station Revenue by Business Type. Source HTF Market Intelligence

Private Charging for Electric Light-duty vehicles will dominate in numbers and capacity. EVs require access to charging points, but the type and location of chargers are not exclusively the choice of EV owners. Technological change, government policy, city planning and power utilities all play a role in EV charging infrastructure. The location, distribution and types of electric vehicle supply equipment (EVSE) depend on EV stocks, travel patterns, transport modes and urbanisation trends. These and other factors vary across regions and time.

• Home charging is most readily available for EV owners residing in detached or semi-detached housing, or with access to a garage or a parking structure.

• Workplaces can partially accommodate the demand for EV charging. Its availability depends on a combination of employer-based initiatives and regional or national policies.

• Publicly accessible chargers are needed where home and workplace charging are unavailable or insufficient to meet needs (such as for long-distance travel).

The estimated number of private LDV (light-duty-vehicle) chargers in 2020 is 9.5 million, of which 7 million are at residences and the remainder at workplaces. This represents 40 gigawatts (GW) of installed capacity at residences and over 15 GW of installed capacity at workplaces. Private chargers for electric LDVs rise to 105 million by 2030 in the Stated Policies Scenario, with 80 million chargers at residences and 25 million at workplaces. This accounts for 670 GW in total installled charging capacity and provides 235 terawatt-hours (TWh) of electricity in 2030. In the Sustainable Development Scenario, the number of home chargers is more than 140 million (80% higher than in the Stated Policies Scenario) and those at workplace number almost 50 million in 2030. Combined, the installed capacity is 1.2 TW, over 80% higher than in the Stated Policies Scenario, and provides 400 TWh of electricity in 2030. Private chargers account for 90% of all chargers in both scenarios in 2030, but for only 70% of installed capacity due to the lower power rating (or charging rate) compared to fast chargers. Private chargers meet about 70% of the energy demand in both scenarios, reflecting the lower power rating.

There are 14 million slow public chargers and 2.3 million public fast chargers by 2030 in the Stated Policies Scenario. This accounts for 100 GW of public slow charging installed capacity and over 205 GW of public fast installed capacity. Publicly accessible chargers provide 95 TWh of electricity in 2030. In the Sustainable Development Scenario, there are more than 20 million public slow chargers and almost 4 million public fast chargers installed by 2030 corresponding to installed capacities of 150 GW and 360 GW respectively. These provide 155 TWh of electricity in 2030. (Energy Agency, 2021)

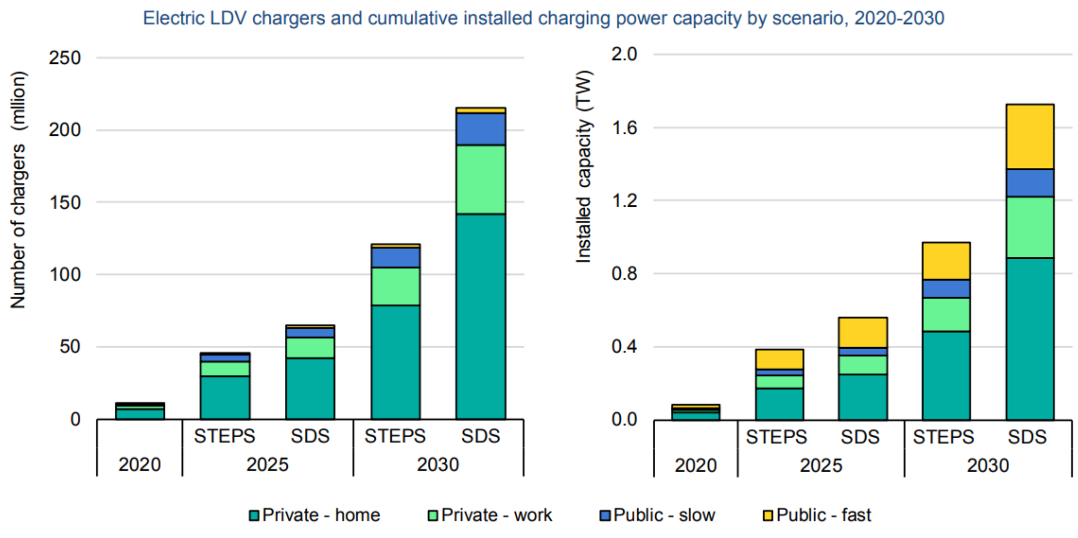


Fig 9 : Private charging for electric LDV will dominate in numbers and capacity (IEA analyses developed with the Mobility Model)

Online research shows that our main competitors are all mainly focusing on the Level 2 AC charging market and within the widest possible scope. They all address to Private Home, Private work, and Public-slow charging. This seems to be quite normal for the more mature market like Europe is. Different government regulations, technical requirements and standardizations within Europe lead to MVP's (Minimum Viable Product) that require high technical standards with a certain flexibility. Most competitors use EV-charger base units that allow to add or leave out certain specifications. This agility in terms of specifications enables through upgrading or downgrading to address to different customer segments with all different requirements.

Technical requirements

up to 350Kw		LEVEL 3
Network	CCS2/ Tesla connector	
Cloud service		
200-450V		
IP55		
OCCP1.6		
32A		
22-44Kw 3 ph	Roaming / reporting / billing	LEVEL 2
IP55	IK10	
DLM	RFID	
Iso 15118 (V2G)/ plug & charge	3G/4G	
Smart/ connected/OCCP1.6	Eco system	
up to 22KW	Wifi/Bluetooth/RFID	
Iso 15118 (V2G)	IK10	LEVEL 2
Smart/ connected/OCCP1.6		
DLM		
Autostart		LEVEL 1 - 2

Revenue streams	Main competitors	Origin	Channel	Customer segments
margin	ABB		Direct	Governments
maintenance	Tesla	US 2003	public tender	Public investors
leasing/rental fee			Energy/fuel companies	Communities
subscription fee	Ionity (BMW group)	GE 2017		energy companies
Charging as a service				private real estate
				leasing company
margin	Alfen	Nl 2008	Electric Mobility service Providors	OEM/PL
maintenance	Wallbox	SP 2015	Direct business	Large companies/ Last mile del / Taxi
subscription fee	Gewiss	IT 2018	Distributors	Fleet managers
leasing/rental fee	Charge point	US 2007	construction builders	Mobility sharing systems
	EV box	Nl 2010	Tech home	
	Ctek (chargestorm)	SW 2018	Electricians	
rental fee				Family/multiple EV owner
subscription fee				parking lot private cons/comp
Charge fee				
Margin on sales	SEC		Retail / DIY / online	private EV user (single)

Fig.10 : Online research on competition/Channels/Technical requirements

The EV charger market is complex and in constant change. High technical requirements in different domain's, from hardware to software integration, compatibility issues, general standards, different and changing regulations, a very specific value chain without a single proven "best of practice" business model require exclusive focus. All major players in this market are either new start-ups, M&A's or dedicated separate business units within existing organizations that have been active for already several years. Specific knowledge and know-how need to be acquired or developed to address to this market. A permanent focus on new trends, regulations, requirements, technical aspects, firmware updates, partnerships with or integration of different verticals and/or integrators is mandatory. Addressing to different channels and different customer segments require a different approach and sometimes high technical skills. Generating revenue through different (new) revenue streams require agile business models or integrated services.

3. The ECO system : EV charger part of the energy management system.

Traditional vehicles were always a stand-alone object with often a specific social connotation attached to it. Cars were used to bridge distances, to impress or to show a certain social standard. In short, traditional vehicles are and were merely utensils. This is about to change with EV.

With focus on renewable energy and the scarceness and increasing prices of the available energy together with the digitalization a new eco system is evolving. Where EV's were initially perceived as a possible threat to the energy system because building electrical systems and utility grids were not designed to accommodate the magnitude and acceleration of electrical load increases. The EV is no longer a standalone object but became a part of the personal energy management system of private homes

EVs have the capability of controllable charging and discharging, meaning they can balance out the intermittency of RES and provide flexibility by moving their individual charging requirements in time and by offering their battery capacity to help balance in the RES dominant power system (Capuder et al., 2020).

Electric vehicle energy management systems (EVEMS) represent an opportunity to maximize usage efficiency of existing electrical infrastructure and avoid prohibitive costs inherent with capacity upgrades.

The future smart grid, alternatively known as the internet of energy (IoE) is expected to be more decentralized and disaggregated, which could fundamentally shift the way power has traditionally been generated, transmitted, or distributed. A significant amount of the future power demand will be generated from renewables, and some loads will be mobile, such as electric vehicle (EV), electric boat, and electric ship. The current development of electric vehicles' bidirectional energy transfer through vehicle-to-grid (V2G), and their expected penetration in the IoE, introduces a promising feasibility to exchange energy between vehicle and grid. This bidirectional energy transfer could potentially bring a benefit in emission reduction and optimal renewable energy integration.(Mahmud et al., 2018)

The potential of smart charging is not limited to its use at home. When parked during the day, smart charging can be aligned with renewable energy production. Like this, charging can be aligned with moments of excess resulting from solar or wind energy. Similarly, the charging could be interrupted temporarily when there is a risk for an imbalance between supply and demand. When the vehicle is able to allow bi-directional exchange with the grid, an entire new range of possibilities for supporting the grid opens up. The EV can function as a power backup for buildings, contribute to local congestion management, optimize consumption on building or neighborhood level and maximize the use of renewable energy sources. (*EU Smart Cities Information System*, n.d.)

The EV charger, as soul connection between EV and energy system, will play a crucial role in the conversion of energy.

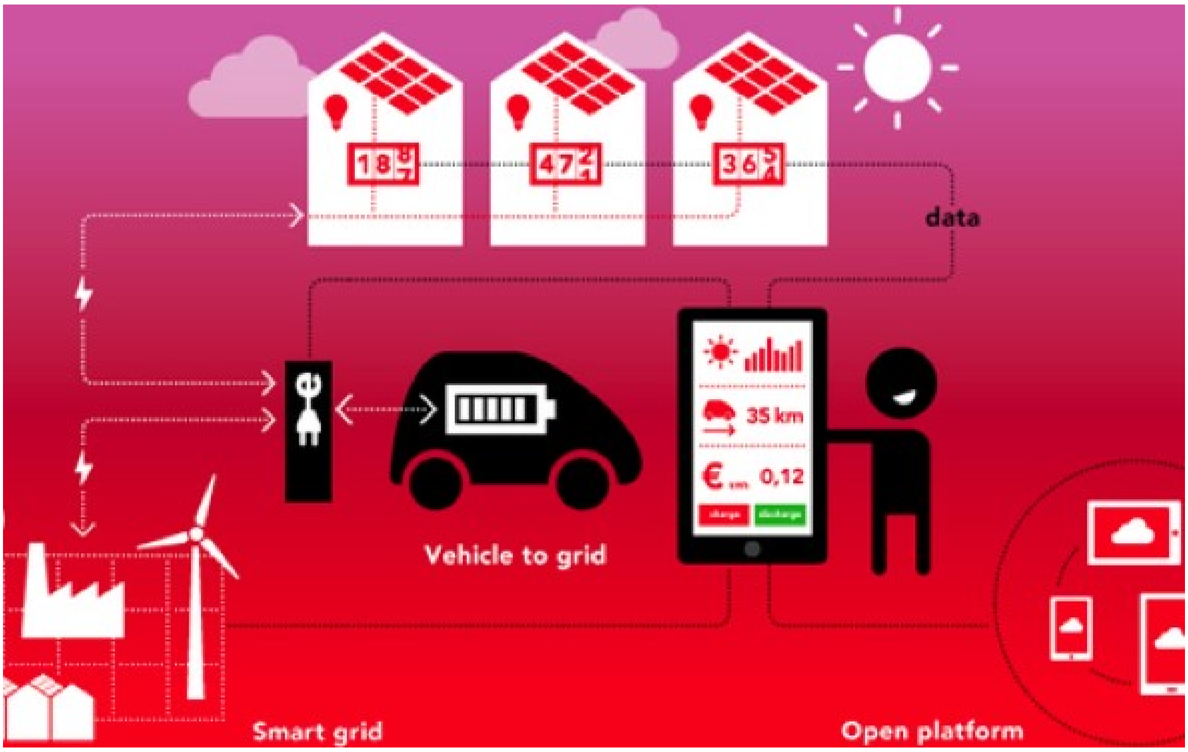


Fig 11: project: Smart Grids and Vehicle to Grid

4. SWOT analyses

I will not focus on the SWOT analyses of the EV (charger) market, these analyses are sufficiently available online and in literature. This analysis will look at Strengths, Weaknesses, Opportunities, and Threats as a technique to use for assessing these aspects for Schumacher Electric in our business for EVSE.

SWOT Analysis is a tool that can help Schumacher to analyze what our company does best now, and to devise a successful strategy for the future. SWOT can also uncover areas of the business that are holding us back, or that our competitors could exploit if we don't protect ourselves.

This SWOT analysis examines both internal and external factors – that is, what's going on inside and outside our organization. So, some of these factors will be within our control and some will not.

STRENGHTS	WEAKNESSES
Experience in Equipment supply for Automotive Aftermarket	Lack of experience in EV. No specialists in the field
Specialist in Power Conversion since 1947	No integrated Business Model (only cover 1 of 5 verticles)
Own production facilities, engineers, R&D	No experiece in other industries besides Automotive Aftermarket
We own retail channel in Automotive Aftermarket	Production capacity limits
Customer database	No integrated software development/Lack of digital skills
OEM, PL, DL experience & customers	Go To market time for In House Production
M&A strategy through PE	Not yet profitable / ROI period ?
Global Player / Local Agility / Brand Identity	Internal KPI's
Quality focus	Market Focus
	Staff shortage
	Financial Limits

OPPORTUNITIES	THREATS
Hughe Potential new market	Uncertain market evolution
New Business Models/synergies/partnerships	Other possible ICE alternatives
Emerging additional related business opportunities	Traditional products becoming obsolete
Battery Testers and diagnostic appliances	Political instability
Batteries second life applications	Window Of Opportunity miss. Late to market
CAAS (Charging as a service)	Capital drain
New additional revenue streams	Changing Standards and Legislation
Gouvernment support and incentive programms	Cheap (Chinese) products
ECO System	Product liability/Claims/ security/Privacy
M&A	Choice of partners/ Vendors / War for talent
(Future) expansion in other verticles	Scaling up time in exponential market
Economy of Scale	

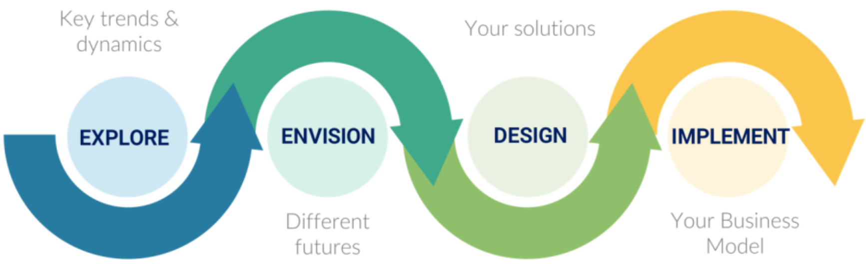
5. Strategic Intelligence and Design

On April 22nd 2022 I organized a EVSE strategy session around strategic intelligence, Design and Innovation with our leadership team in Dallas Forthworth (USA). Theme of this session was : “The company that kills you doesn’t look anything like you ! “

In the traditional industry we are active in today and have been since 1947 we tend to look at our competitors to benchmark our performances and marketing mix. Doing the same in the new emerging market of EVSE might be a big mistake. We might find ourselves blind for what is really happening or being too slow or too late to react. With products and services that might become obsolete over time we could jeopardize our future and fail to deliver on our commitment to our equity sponsors.

New business models will appear to conquer this new market with a complex value chain. New businesses, spin-offs, surprising partnerships or even customers becoming competitors (e.g. OEM’s integrating the value chain). To survive and grow we will have to go beyond our current scope.

The intention of this strategic session was to explore key trends & dynamics, to envision different futures, to design solutions and to implement a (new) business model.



The deliverables for this strategic session were, considered the limited time frame, a Value Proposition Canvas and a Business Model Canvas.

5.1 Focal Issue Definition

We started the session with a discussion on the focal issue. What will be the subject of our analyses and what is the time horizon we want to explore? We decided to focus on how the Electric Vehicle Charger market could look like in 3 to 5 years.

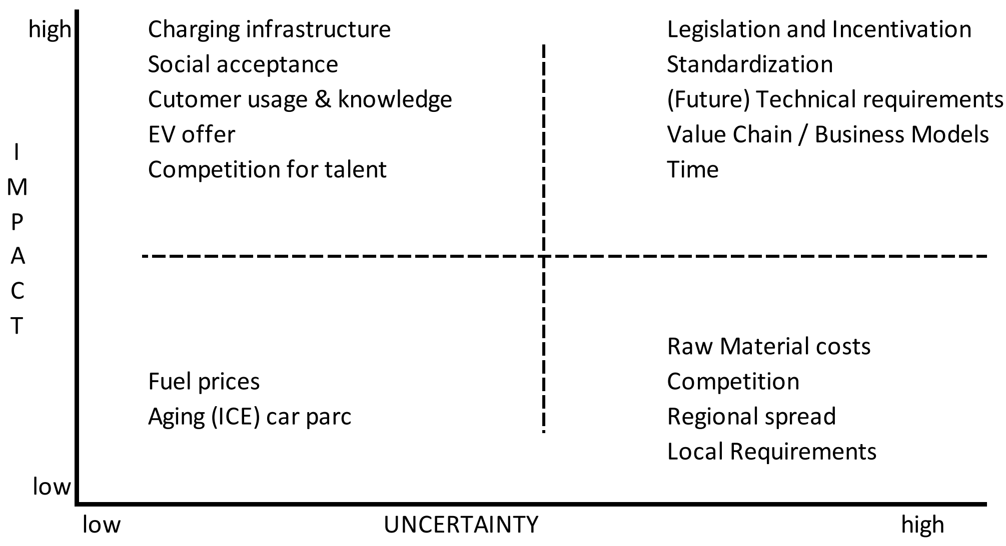
5.2 Identification of Key drivers

Moving into the Explore phase we first set the rules for creative Brainstorming:

- Create confidence: since the leadership team has been working together for some time as a team by the principles of Lencioni's 5 disfunctions of Trust, Conflict, Commitment, Accountability and Results this rule didn't need any further attention.
- Quantity goes before Quality: Important to understand and acknowledge was that every thought or idea did not need to much (over)thinking, rather the number of idea's counted as valid contribution to the session. The more, the better.
- No criticism of ideas: no comments on any ideas or thoughts, no criticism, no laughter, no verbal nor nonverbal opinions expression.

In sessions of each time 5 minutes, we all individually noted key thoughts on post-its. Always 1 aspect per post-it on the 6 different elements of a PESTLE analyses. (Political, Economic, Sociological, Technological, Legal, and environmental). The ideas were collected by subject and arranged by themes. Then most important drivers were grouped by negative or positive influences and interdependencies. Finally, we looked at all our identified key drivers and ranked them by the degree of impact they have on our focal issue and their degree of uncertainty.

IMPACT / UNCERTAINTIE MATRIX

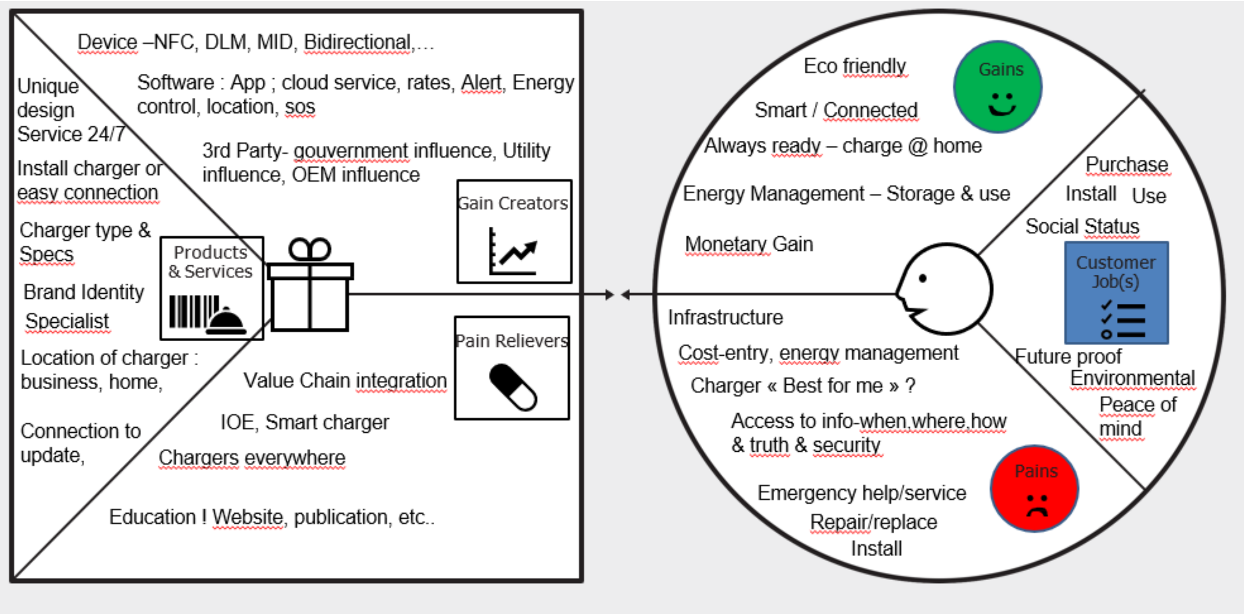


5.3 The Value Proposition Canvas

The Value Proposition Canvas is considered as an important part of the Business Model Canvas. Value Proposition Canvas zooms in on one of the most important parts of the Business Model Canvas, namely the Value Proposition a product or service has for the customer. The Value Proposition Canvas helps to systematically understand what customers want to enable a product/service offer perfectly aligned to customers needs. In designing new business models companies often make the mistake to focus to much on internal factors and forget to look external to their customer. Good, creative ideas are easy to achieve, but the focus and goal should be creating added value to the customer. The Value Proposition Canvas is composed of two parts : the Customer profile and the Value map.

With the Customer profile you describe the jobs the customers try to get done. You highlight your customer pains, which annoy customers while trying to get a job done. Gains describe how customers measure a job well done. Gains are positive outcomes that customers hope to achieve, concrete results and benefits.

With the Value Map you list the products and services your value proposition builds on. You describe in which way these products services are pain relievers making their lives easier and you outline in which way they are gain creators, how they produce and maximize outcomes and benefit customers expect or desire.



Jobs can be Functional, Social or Emotional. As major customer Jobs the leadership team indicated:

- the Purchase, Installation and Use of the EV charger.
- The EV answering to a certain social status, the EV charger should preferably also serve this purpose. The appliance might after all be very visible installed in a garage or outside on the driveway or parking lot.
- With so much evolution still to be expected in the EV industry with new technology, standardization and regulations the need for a "Future Proof" appliance is mandatory.
- EV's are often bought out of environmental considerations. EV chargers should preferably also fulfill the Ecologic aspect of purchase intention.
- And finally, the Consumer wants peace of mind. In this emerging market so many offers are available, so many different propositions and so many new (unknown) brands appear.

Customers Pains for EV chargers consequently often are:

- The need for information. Which charger is best for me? Where do I find the wright trustful information, how do I find information and how do I use or install my charger? Can I get help, or can my device be installed, serviced or repaired? How about infrastructure? What do I have and what do I need? In short, the biggest Pain for customers today is "Advise and help".

Finally, Customer Gains are:

- ECO friendliness of the EV charger as part of your home energy management system and your interface between storage and use as "Prosumer" in the new eco system
- Adding a Smart Connected device to your daily life that helps you manage your energy consumption,
- Enabling you to always be ready to leave, fully charged and prepared to hit the road
- Giving you a monetary gain.

A Value Map for Schumacher Electric would have to contain:

- Products and services that have a unique design. An impeccable 24/7 service for home installation or help by installing. An easy to install and easy to connect device that perfectly fits technical requirements for use and infrastructure. A strong brand that is known for its quality and sustainability, a specialist in his field of expertise. A “SMART” devise as part of the Internet of Energy, always connected to update new firmware, latest technology and requirements. A Multi Usage devise for Home or Office, for private use or business use.

- A device that is the interface to your energy system. That creates Gains through easy charging, Dynamic Load Management and agile charging at the best moment and at the best energy price. A bidirectional gate for optimal “Prosumption” with software applications to monitor consumption, billing and connecting.
- As Pain Reliever, with a unique combination and experience as manufacturer and sales & marketing organization Schumacher Electric will maximize the Value Chain integration and availability of EV chargers in the biggest possible variety of (sales) channels. Our expertise in technical products will guarantee training, education, and optimal clear and trustworthy information to ease customers and user’s minds.

5.4 Business Model Canvas

The business model canvas is a strategic management tool that lets you visualize and assess your business idea or concept. It's a one-page document containing nine boxes that represent different fundamental elements of a business. The right side of the canvas focuses on the customer or the market (external factors that are not under your control) while the left side of the canvas focuses on the business (internal factors that are mostly under your control). In the middle, you get the value propositions that represent the exchange of value between your business and your customers. There are nine building blocks in the business model canvas and they are customer value proposition, customer segments, channels, customer relationships, revenue streams, key resources, key partners, key activities, and cost structure. Our leadership team defined each of the building blocks during the strategic session:

Key Partners
Existing Customers
Vendors
System integrators
Software Developer
DST/SPT & Schumex
Strategic Alliances
Joint Ventures
M&A
Coopetition
Call Center

Key Activities
Production
R&D
Distribution
Sales
Training/education/service
After Sales
Business Development
Relationship Management

Key Resources
(Hire or Acquire)
Employees/Specialist/
Know How
Dedicated Business Unit
Capital, Cash, Credit line
Patents, Intellectual property, Copyright, brand
Production capacity
Equipment / Molds / tooling / testing/ labo /production

Value Propositions
Global leading manufacturer and distributor of Unique Design, future proof, ergonomic and easy to use EV level 2 chargers, with state-of-the-art hardware, software, and meeting all third-party requirements, coupled with installation and integration capabilities, training, education and 24/7/365 service.

Recognized brand associated with quality, competitive pricing and sustainability.

Customer Relationships
D to C
B to B
B to C
(Exclusive) Partnerships
Hotline 24/7
Website/social Media/ Youtube

Channels
Retail distribution
Third-Party installers
Home Tech
Home construction
OEM/PL/DL
Online
Communities
Public Investors
Own sales force

Customer Segments
(LEVEL 2 AC)

Private User
- Single Family Home
- Multi Family Home

Professional User
- Employees at Work
- Fleets

Public Users

Cost Structure
Capital, Cash, Credit lines for :
- additional resources and activities
- Research & Development / Marketing
- Market research
- New Hirings
- New equipment / Molds / tooling / testing/ labo /production
- M&A / Joint Ventures

Revenue Streams
Margin on sales
Maintenance/ installation fee
Leasing/rental/ usage fee
Subscription fee
Advertising

The main takeaways of the Business Model Canvas by the leadership team are:

- We will focus on Level 2 AC charging with the widest possible scope of customer segments in Private, Commercial and Public segments. We will not (at first) move into fast DC charging for the Public Market.
- We will go to the market with our Value Proposition of being a Global leading manufacturer and distributor of Unique Design, future proof, ergonomic and easy to

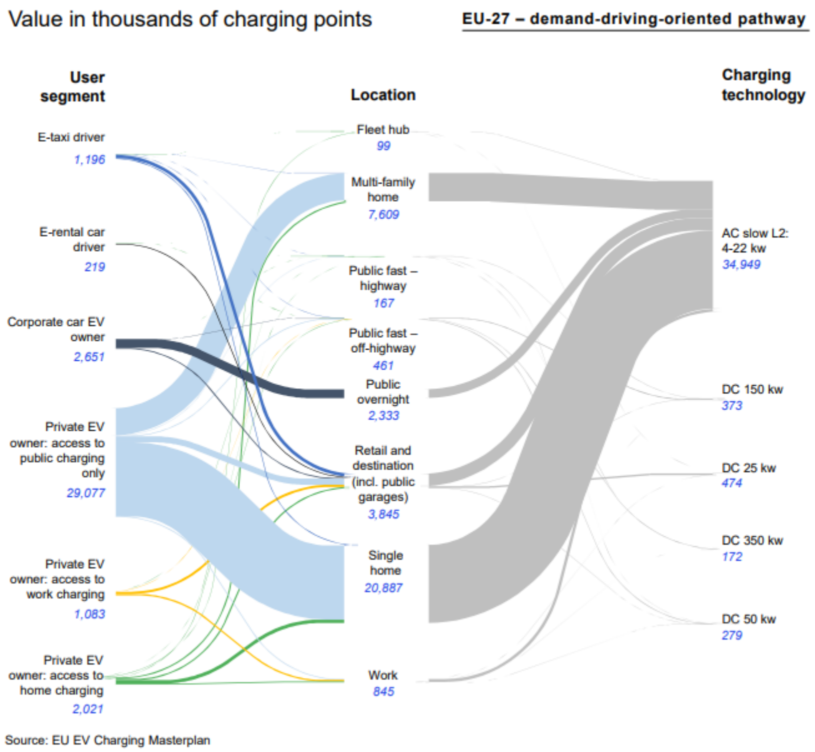
use EV level 2 chargers, with state-of-the-art hardware, software, and meeting all third-party requirements, coupled with installation and integration capabilities, training, education and 24/7/365 service. We operate with a Recognized brand associated with quality, competitive pricing and sustainability.

- To reach our potential customers we will use retail distribution, partly through our existing customer portfolio, but also through new retail channels that will emerge or add EV chargers to their product portfolio. We will further concentrate on new business development with third-party installers, Home-tech companies, Construction builders, OEM, Private label and Distribution label business through our own dedicated sales force, that also will be our direct contact to public investors or communities for the Public Level2 AC charger's segment.
- We will relate to our customers through Direct to Customer, Business to Business, Business to Consumer and partnerships. We will expand our service to our customers through a 24/7 hotline, our website, social media (LinkedInn, Instagram, Twitter, Facebook, YouTube.)
- We have production plants in China and Mexico for traditional chargers and jump starters. These plants can be used to produce EV chargers as well. We will have to partner up though with other vendors, system integrators, software development companies and service companies like e.g. a call center because we lack some experience, know how or competences and/or are short on employees, engineers and workers to absorb additional research & development, servicing and production. We might even consider a joint venture or coopetition or even a possible merge or acquisition to focus on the EVSE market.
- For our key activities we concentrate on what we know how to do and are good at with a proven track record: Production, R&D, Distribution, Sales, Business development, training and education, after sales and relationship management.
- We will need some additional resources: hire or acquire employees, specialists and know how. Creating a dedicated business unit for EVSE would probably be the best option since this market is complex and somehow different from our other activities and markets we manage. We might have to acquire some patents, Intellectual property or copyrights, but we can use our own brand identity to leverage on.
- In terms of costs we will need more capital, cash or credit lines for additional investments, market research, key resources and marketing.

6. Recommendation

Entering this new market is very difficult, and impossible without proper focus and know-how. All current competitors have been active in this market since several years and enjoy the advantage of having experienced the evolution, building up knowledge and specific competences.

An interesting graph taken from the European EV Charging Infrastructure Masterplan March 2022 shows that, considered all different user segments, the level 2 AC chargers up to 22Kwh cover a significant portion.(*European EV Charging Infrastructure Masterplan*, 2022)



To have the best and most optimal return on investment my recommendation would be to focus on Level 2 AC charging only and leave Fast DC charging for the time being unexploited.

Innovation is multi-dimensional and concerns changes in the company's in-house organization and its ecosystem.

I would recommend a Multi-Layer approach:

- Leverage on our experience in the automotive aftermarket and our R&D, distribution, sales, and production competences. Use what we have and what we know. We can use our experience in building battery chargers to develop a basic EV charger, we can have our own unique design and use our sales and marketing skills to market our products in channels and customers we cover today. If we look at the specific requirements and the complexity of this new market, however, this will not be sufficient, or it would take us to much precious time. We would risk missing the window of opportunity or the exponential growth phase that would speed up ROI or we would never catch up with new developments.

- If we take a good look at the Business Model Canvas as described above, the best solution to take this market is to create a dedicated, separate new EVSE business unit within our organization. We will need specialists that know and follow this market meticulous. Dedicated technical Engineers and Software developers for R&D, dedicated Sales Engineers for new business development, to zoom in on the different market evolutions, requirements and opportunities, and dedicated Marketing Specialists to optimize and adapt our marketing mix to the variety of customer segments we will be addressing to. We will have to hire or acquire knowhow and competences.
- We need to be in this market as soon as possible, we have a lot of catching up to do. Only by being active in this market we will gather field experience and attention. It is however not an option to be in this market with only a basic offer to start with. We are specialists in what we do today and recognized for our variety and quality of products and services. We cannot afford not meeting up to those same standards in another new market. This could damage our brand image and identity. There is only one option: if we go in, we go to win.
- The best and fastest go to market could be through M&A, joint Venture or Coopetition. Partnering up with a company that already acquired knowledge and experience in the EVSE market and bridge to our experience in the traditional Automotive Aftermarket and OEM business.

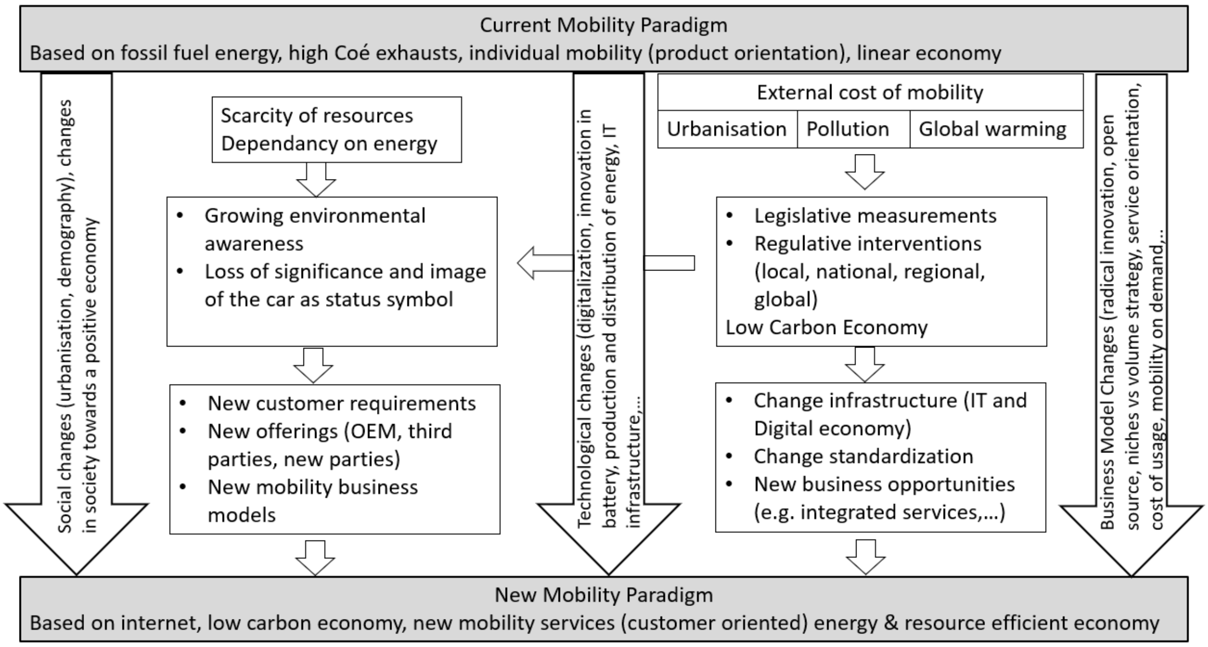
A final recommendation would be to start looking at opportunities in future EVSE market. We can be the innovator as we are in our traditional market:

- EV's today are new to the market and require little maintenance. Within some years from now however, first generation EV's will be replaced. This will create another new market of second hand used EV cars. A crucial element of any EV is the battery capacity and quality. Every potential used EV buyer would like to know what power the batteries still generate, how long they will last and how much mileage they can provide. Everyone would like his batteries tested. This is a huge market for testing- and diagnostic EV battery equipment which we could develop and market.

- At the end of their lifetime for use in EV’s the Lithium batteries are not completely out of power. Several new applications could be thought of to re-use these Lithium batteries. An example would be a Power Storage Unit for private use made of re-used Lithium batteries.
- A major concern of EV drivers is the mileage they can make. Often there is still a lot of stress to get to a destination with sometimes little power left in the batteries and no charging point in the near distance. A tool that could add a few miles after a total power shut down, or an application that could contact near EV drivers to spare some miles of energy from their batteries could take away a lot of stress.
- Charging as a Service could become the new thing. You can imagine, as the number of EV drivers grow, parking lots of stores, shopping malls, hotels, restaurants etc. will have a lot of EV’s on them. As a service, charging their EV could be offered for free or at a reduction rate related to the spendings of these customers. An integrated system of EV chargers to rent, lease or buy connected to a customer profile and a Smart interface with the store could do the job.
- Just looking at the concerns and daily problems of (potential) EV drivers could generate new ideas for products and services. If we are in this market, we could learn from it and create new business opportunities.

7. Conclusion

The current mobility paradigm will reach environmental, economic and social limits thus provoking a change in political frameworks, and, together with technological progress, driving the change to a more sustainable mobility.



Drivers of the new mobility paradigm. Source The Automobile Revolution (Danielle Attias) Springer

Existing business models have not yet proven any profitability in this new emerging market, but without the necessary investments in tooling, knowh-how, skills etc. the fast-closing window of opportunity will be gone and it might be too late to enjoy the exponential growth. It's now or never. This is not just another product line to add to a product portfolio. This is a new business with specific requirements that needs dedicated, specialized attention and focus.

New players and shapers in the value chain (using economies of scale, economies of scope, network and lock-in effects but without profits) are arising with mobility services and challenge traditional automotive (after) market players. Through customer centric approach the new shapers can seize customer's interests and contact, and thus capture more value; customers will even be part of the value chain and become prosumer, being either consumer or producer.

The EV story is written today. It's all about "Power Conversion", and Schumacher Electric is a specialist in this domain and highly recognized for it by the market. This exponential market can be considered as our biggest new business opportunity for future years to come. It seems but natural Schumacher should be part of it.

List of abbreviations (alphabetical order)

AC	Alternating Current
CPO	Charge Point Operator
CV	Conventional Vehicle
DC	Direct Current
DCFC	Direct Current Fast Charger
EM	Electro Magnetic
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GHG	Green House Gas
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
IOE	Internet Of Energy
LDV	Light Duty Vehicle
M&A	Merge and Acquisiion
MSP	Mobility Service Provider
MVP	Minimum Viable Product
NFC	Near Field Communication
OCPP	Open Source Point Protocol
OEM	Original Equipment Manufacturers
PEV	Plug-In Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PV	Photo Voltaic (solar panel)
R&D	Research and Development
RES	Renewable Energy Sources
RFID	Radio Frequency Identification
SAE	Society of Automatic Engineers
TCO	Total Cost of Ownership
V2G	Vehicle To Grid
V2H	Vehicle to Home
V2V	Vehicle To Vehicle

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