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Get Focus on the Business of Electric Mobility

'A tool to determine the business of electric mobility in a specific region'

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Abstract

Mobility encounters a sustainable transition. There is a shift going on in which new concepts and working principles based on electric drive trains are developed. This transition towards electric mobility creates a complex market. New companies are entering the market and large companies are shifting their business towards electric mobility. Local governments struggle with how to stimulate electric mobility. In the transition towards electric mobility (local) governments play an important role. For example stimulating the business of electric mobility with legislations and subsidies. It is useful for local governments to gain insight in the unique business structure of their region in order to determine which impulse they can give to economical affairs and electric mobility.

The paper gives a detailed analysis of electric mobility in the metropolitan area of Amsterdam, a focus area for electric mobility. This analysis consists of a combination of a stakeholder analysis and a supply chain analysis. The field of electric mobility is divided in four main topics; i) electric vehicles, ii) electricity, iii) charge infrastructure, iv) (complementary) services. Within these four fields the supply chain is analyzed. Apart from the understanding of the business in Amsterdam on electric mobility, the analysis has resulted in a tool to get grip on the business in the complex field of electric mobility. The tool offers a way to categorize the stakeholders and generates an overview of the stakeholders.

In the paper a tool is presented that can be used to plot business in a specific region. The characterization is valuable for (local) governments to determine in which field a stimulation can be given to the transition towards electric mobility.

Keywords: EV (electric vehicle), mobility, market

1 Introduction

1.1 Context

In recent years activities in the field of electric mobility has increased to such extent that the perspectives for a successful market introduction of electric vehicles seem better than in earlier years (early nineties). A strong enabler is the development of a new generation battery system, but also further technological progress in the electric drive train (performance and cost) as well as urgency on policy level (requirements regarding local air quality and climate neutrality) play important stimulating roles. The extent to which electric vehicles will penetrate the market, and replace drive trains based on fossil fuels and internal combustion engines (ICE), is yet to be seen; but there is a general consensus that electric drive trains will play a part in the drive trains of vehicles and mobility systems in the future. Be it as battery electric vehicles (BEV), hybrid electric vehicles (HEV), fuel cell vehicles (FCV). Electric drive trains will also play out differently for particular applications (trucks, passenger vehicles, scooters, bikes, vessels).

The shift towards electric drive trains has an impact on the conventional supply chain. When looking at the automotive supply chain, new players have entered the chain which were not present in the conventional drive train, based on the ICE. For example battery manufacturers play an important role in the electric mobility drive train, where partnerships and joint ventures between OEMs and battery manufacturers can be found in recent years (for instance Nissan and NEC [1], Daimler and Evonik). Also suppliers of electric motors and electric drive train components have entered, although in some cases these suppliers are similar to conventional (e.g. Bosch, Siemens). On a lower level, suppliers of components for batteries (chemical industry, electronics, materials research institutes) play an important role as suppliers to battery manufacturers (although sometimes horizontally integrated). Similarly new companies in the field of fuel cells lead to new entries (e.g. Ballard, Hydrogenics).

The developments of new entries in the market and collaborations between 'old' and 'new' companies may provide indications of shifts in the supply chain, of new power structures between companies, and may indicate shifts in required competencies of companies within the complete supply chain. It may indicate how 'old' competencies may become obsolete, replaced by new competences that form the basis of competiveness of a new industry.

Naturally, it is too soon to tell whether electric mobility will lead to such shifts in power and in competencies, but it may be safe to say that certain companies will benefit from a successful electric mobility sector. In view of Porter's [2] concept of industry clusters, the electric mobility case provides an interesting case for analyzing which nations or regions may benefit from a successful EV market. Innovation policy programs have become increasingly important for nations and regions to stimulate local economy and attract innovative business. In this perspective it is important for regions and nations to get a clear picture whether the trend towards electric mobility provides opportunities to support the local economy, either by stimulating local companies with activities in electric mobility, or by attracting such companies, or by providing a stimulating market setting that attracts innovation and demonstration of electric mobility. In all cases, a solid analysis is required of developments in the e-mobility market as well as a good insight in the supply chain and stakeholders in the field of e-mobility.

This paper discusses how policy makers can be supported in analyzing the opportunities that the shift towards electric mobility provides to stimulate economic development within the region. Main research question is which analysis tools are available to map or schematize stakeholders in the field of electric mobility within the supply chain. In order to do so, this paper provides an overview of, and builds upon earlier developed supply chain models for electric drive trains, in relation to supply chains of conventional drive trains, under the assumption that the supply chain of electric drive is more complex, with more interrelationships and less organized than conventional drive train supply chains.

After discussing stakeholders and supply chain models for electric drive train, a model is proposed that allows plotting stakeholders in e-mobility in a scheme include chains for vehicles, infrastructure, electricity and services that are part of the total service package, and that provides a complex system of stakeholders involved (the so-called "e-mobility stakeholder canvas" or "canvas"). Based

on this model, the case of the region of Amsterdam is presented in which stakeholders are plotted within the stakeholder canvas, and attractive supply chain elements are identified as potential growth areas for economic development and or clusters.

2 Stakeholder mapping

There are different ways in which stakeholders related to a specific technology like electric mobility can be plotted. Mapping techniques used in stakeholder analysis usually provide an overview of relevant stakeholders [3]. Objective of stakeholder analysis is typically to get a grip on likely development scenarios for a particular action, policy or technology, by mapping supporters and opponents, identifying interests of different stakeholders, and considering partnerships and power structures of all stakeholders [4].

In this paper it is not so much the goal to assess likely development scenarios for electric mobility as well as to distinguish and map current economic activities related to electric mobility. For this purpose it is more valuable to work with a supply chain analysis. Supply chain analysis typically map the different organizations involved in moving a product or service from supplier to end user; from raw product to end product. It separates the different steps in the chain, thereby enabling plotting separate companies within the complete chain. This paper will use supply chain analysis as a basis for plotting different stakeholders in electric mobility.

2.1 Supply chain model in a transforming industry

To what extent can this paper build on supply chain models of the existing automotive supply chain to translate to the one of electric mobility? Given the transformations in the industry and characteristics of and dynamics around electric mobility it is argued that it may need some additions and changes to capture the relevant players in the market.

Supply chain models for the traditional automotive supply typically consist of an original equipment manufacturer (car manufacturer; e.g. General Motors, Toyota), and a number of suppliers. Suppliers vary from tier 1 suppliers (closest to the OEM, e.g. Bosch, Siemens), tier 2 suppliers (supplying to tier 1), and given the complexity of the automotive supply chain also tier 3 and tier 4 suppliers [5]. In general one may say that the most value is created the closer the suppliers are to the OEM. Tier 3 and tier 4 suppliers typically provide more commodity products to the car as an end product. This is largely due to power structures in the supply chain, which generally lie with the OEM and the tier 1 suppliers.

The supply chain of electric vehicles is similar in many respects. What can be observed is that new OEMs are active in this market (Th!nk, Tesla, Fisker), that are much smaller in size than original OEMs, but have the same role in the supply chain, and source their components from the very suppliers that also provide parts to traditional OEMs. However, it can also be observed that electric vehicles require different components or is more dependent on certain components than traditional vehicles, particularly electric drive train and batteries. As a result suppliers or batteries that may have been tier 2 or 3 in the traditional supply chain, may prove to be tier 1 suppliers for electric vehicles. This process can already be observed with the continued hybridization and the partnerships OEMs and tier 1 suppliers have engaged with battery companies in recent years. Given that most value is likely to be created at tier 1 and 2 suppliers, and that the electric mobility chain is not as fine grained and complex as the conventional automotive supply chain, it is sufficient to plot the supply chain up to this level (and not include tier 3 and 4 suppliers).

Apart from the supply chain for the vehicle itself, a related supply chain concerns the provision of fuel and infrastructure. In current gasoline and diesel fueled cars, the fuel and infrastructure supply chain is largely a given; and generally treated separate from the vehicle supply chain. Fueling stations are widely available and the roles in the supply chain are clear (dominated by oil industry). This is slightly different for alternative fuel vehicles (e.g. natural gas, biofuels), where one can observe that new companies start entering the supply chain, e.g. biofuel suppliers such as Abengoa. This applies even more for electric mobility, where development of charging infrastructure requires different capabilities, expertise and energy sources. Given that this supply chain is still very much in transition, without a dominant design (e.g. slow charging, fast charging or battery swapping) and with many uncertainties about likely dominant players in this market, the e-mobility supply chain

should provide room to plot players active in this fuel and infrastructure chain.

Also there are differences in the way electric vehicles are sold to end users as compared to traditional vehicles. Typically cars are sold by dealerships related to the OEMs, mostly in combination with additional services (e.g. financing scheme, fuel pass, insurance services, maintenance scheme). For electric vehicles one can observe that electric vehicles of OEMs are still sold through dealerships, but are also brought to market through multi-brand dealers [6] These dealers are concentrated on providing electric vehicles and tend to have a portfolio of electric vehicles on sale, and provide all kinds of additional services, varying from more traditional services (financing, maintenance), to innovative services (rentals for specific usage) and project management related services (providing charging infrastructure, including installation and subsidy arrangements). Examples in the Netherlands include The New Motion, that positions itself as a mobility company, rather than as a car company. It is still to be seen whether these "multibrand dealers" owe their existence to a small market size and limited interest or resources for OEMs to control the dealerships or whether these companies are setting new standards in how vehicles are sold in the future. At this time it is relevant to observe that the supply chain for electric mobility shows differences from the traditional chain; and that new players are entering the market.
A last observation in e-mobility is that apart from electric vehicles there is e-mobility in lower power ranges (e-scooters, e-bikes) that is attracting less attention but may prove to be a growth market anyway. It makes sense to include stakeholders related to products in these low power ranges in the analysis.

2.2 Available analyses of the e-mobility chain

Several studies have studied the supply chain and stakeholders in electric mobility, to get grip on the transition in the market of electric mobility. Three models are evaluated on applicability for plotting players in the electric mobility field.
The model of Ernst &Young [7](figure 3 appendix) has the objective to find value in the emerging electric vehicle charging ecosystem. The model is based on five main "spheres", costumer sphere, utility sphere, OEM sphere, charge infrastructure sphere, thereby distinguishing the most important 'chains' in the field of electric mobility: apart from the vehicle itself, this study emphasizes the importance of infrastructure as well as provision of electricity (as separate spheres). The focus of the model mostly lies in the infrastructure and customer sphere, with valuable distinctions in the (possibly competing) types of charging stations that are emerging (regular charging, fast charging; home versus public charging). The building blocks are described in terms of functions, where in practice companies cover a range of functions; which limits the use of this model for plotting companies effectively. Furthermore the model does not give insight in the connections between the main spheres and structure.

A second model is developed by Dutch management consultancy company Squarewise [8] (figure 4 appendix). The model takes a more traditional supply chain as starting point. It places the electric vehicle central and describes two chains, one related to the vehicle itself (OEM, Tier 1 and 2) and to the energy provision on the other (including charging infrastructure). The user only interacts with the vehicle system and smart network; while in practice it may be argued that the customer may also have a contract with an energy provider, and in some cases also with the providers of infrastructure. Complementary services are an important component of electric mobility and have a central overarching position in the model of Squarewise, varying from services for payments, security, mobility concepts, maintenance and smart networks. This is a valuable addition to other supply chain models, given that the services may include new players that may be relevant to plot separately. In the model 12 companies representing the Dutch electric mobility market for an interview survey are plotted. It therefore seems to have the objective to showcase where the companies are represented in the supply chain and show their mutual relationship.
The Squarewise model is valuable with its addition of services and separating different supply chains, although it may be helpful to also separate the chains of energy and infrastructure.

2.3 Towards an e-mobility supply chain model

Based on observations in the market for electric mobility and the available stakeholder related models in e-mobility, it is concluded that no model fits the objectives of this study, namely supporting

policymakers in making effective innovation policy for e-mobility by providing an effective overview of local e-mobility related stakeholders. The models however do provide valuable elements for making a plot for the e-mobility supply chain, which will be presented and discussed in the following section.

3 Electric Mobility Supply Chain Model

3.1 Elements for the E-mobility supply chain model

Based on observations in the e-mobility sector as on models analyzed in chapter 2, an effective method to plot relevant stakeholders in the field of electric mobility would have to fit the following requirements:

- The most relevant supply chains should be differentiated, most likely vehicle, infrastructure, electric energy and services.
- The user is placed in a position that it interacts with each of the differentiated chains
- There is room for overall/overarching companies, that may play an enabling role for developing a strong position in the electric mobility market (e.g. technical universities, research institutions)
- In the canvas a distinction can be made between high and low power/drive trains that allows identifying expertise and competencies built up in a broader scope (not only electric cars)
- In the infrastructure section a distinction can be made between the type of charging, e.g. high power, normal, battery swap (given that no dominant design has been chosen here)
- Simple layout, in one overview the different type of companies can be determined

3.2 Canvas layout and explanation

Figure (1) shows the *stakeholder canvas* for mapping the stakeholders in the supply chain positions. The main elements for this model include (i) division in 4 chains (including service), (ii) division of chains in 3 steps, (iii) distinction in 3 types of users, (iv) addition of complementary organizations. These will be explained in the following paragraph.

3.2.1 Four chains

The proposed canvas in this paper focuses on the four main components of electric mobility: (i) the electric vehicle, (ii) charging infrastructure, (iii) electricity and (iv)services. By dividing the canvas in these four main supply chain the complex field of electric mobility can be overviewed, to differentiate the four components that must be available for end users to make a successful transition towards electric mobility.

And thus the electric vehicle chain consists of companies with a main focus on development, manufacturing or marketing and sales of the electric vehicle; whereas other companies better fit in the supply chain of infrastructure (charging stations) or electricity. Naturally there are overlaps: some companies have a role in more than 1 supply chain. In these cases the most prominent focus of these companies will be taken as a basis for placing these companies in the canvas.

The most discussion concerns the supply chain of "(complementary) services". These services are related to important elements of a successful rollout of electric vehicles and providing end users with a good end solution. Given that infrastructure, payment schemes, and security are less well organized for electric mobility, one can see different companies developing services on these topics, reasons to take them along as separate supply chain. Based on analysis of the electric mobility market and the earlier mentioned model of Squarewise, complementary services are related to (but not limited to) services regarding (i) information provision for electric mobility (charge status, maintenance), (ii) placement of charging points, (iii) payment schemes, (iv) security and (v) mobility services.

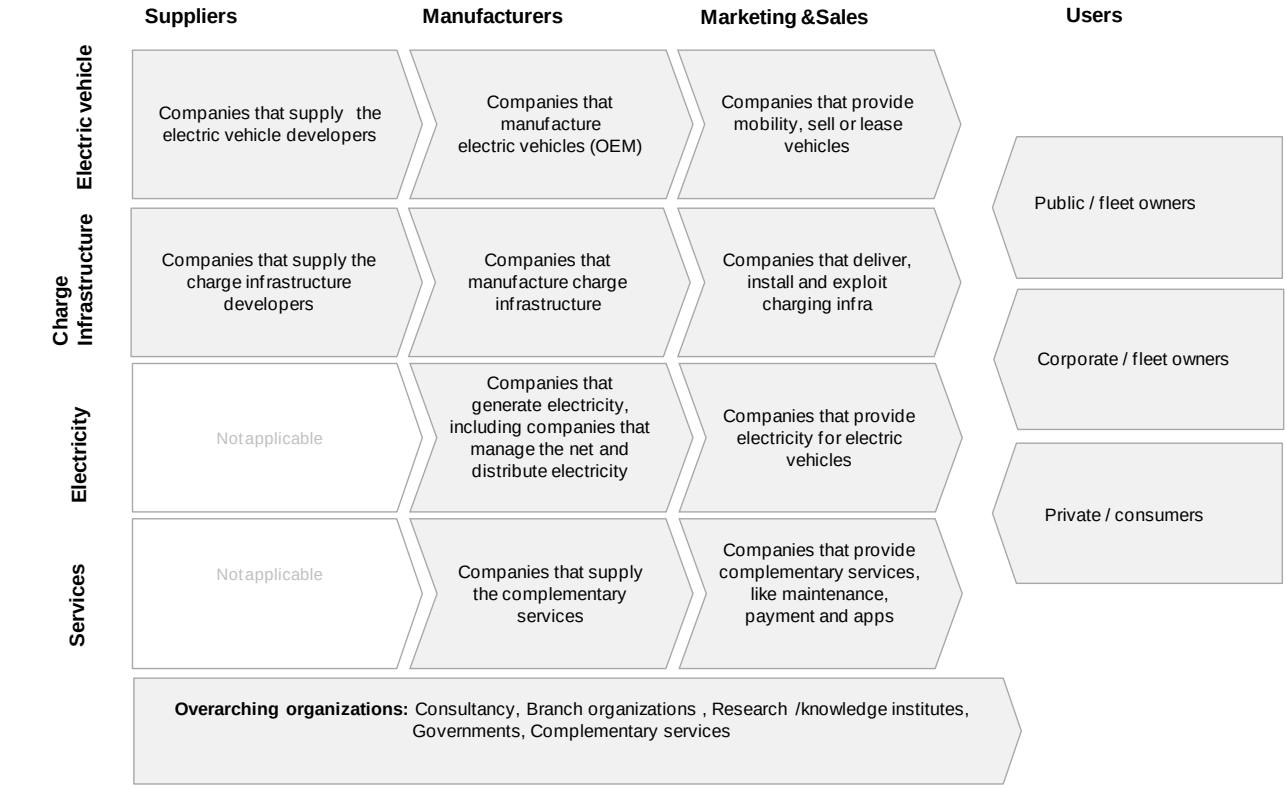

Figure 1: The canvas layout for mapping stakeholders of electric mobility

3.2.2 Supply chain divided in three chain steps

In the canvas the supply chain is split up in three chain steps: (i) suppliers, (ii) manufacturers (Original Equipment Manufacturers) and (iii) companies related to marketing & sales. Given the limited role that companies further in the supply chain usually have (tier 2, 3 companies) in electric mobility, the supply was limited to include tier 1 suppliers. In case a tier 2 supplier company is evaluated as having an impact on the field of electric mobility it is worth mentioning in the supplier block (as tier 1).

In the figure a description of activities per step is given to clarify differences between the steps. This distinction allows plotting a company that supplies electric motors to OEMs, but also a company that may be leading in the development of innovative charging stations. There are companies focusing on the marketing and sales of products that are not active in the development and/or manufacturing of vehicles or charging infrastructure.

Note that suppliers to utilities and service providers are not included; largely due to the fact that their business is not likely to be affected by, or have a large influence on the success of e-mobility in a certain region.

3.2.3 Overarching organizations

In addition there are several overarching organizations, they may influence one or more of the supply chain steps. These overarching organizations are integrated in the model, given that they may provide an additional stimulus for e-mobility in a region; e.g. through a strong knowledge network of universities or large knowledge institutes. Overarching companies that are considered include research institutes, universities, consultancy, branch organizations and government.

3.2.4 Three types of end users

The end users of the products of electric mobility is split in three groups: First, public fleet owners, such as governments or governmental organizations with their own car fleet. These car fleet owners are often leading in experimental projects for research on electric mobility. Second, corporate car fleet owners with their own car fleet which are using electric mobility products. These companies either lease their car fleet or have their own. Within this subcategory a difference can be made between vehicles intended for cargo drive, like taxis, delivery vans, these vehicles make a

great deal of kilometers. There are also corporate vehicles mostly used for commuters. The third and last category are private users, that use their car for private use.

The distinction between the three categories is included, as end users may play an important role in a successful regional stimulation of electric mobility, and end users may differ in their role in enabling electric mobility to grow fast. For instance, a strong interest of corporate clients to purchase or lease electric vehicles can play an important role to attract companies in the complete supply chain. Note also that corporate clients most likely have different charging needs (private or semipublic) than private clients (public), and may be able to afford different charging solutions (inductive, fast charging for public fleet owners).

3.3 How to plot companies

3.3.1 Data Collection

To place the companies in the correct blocks requires understanding of the supply chains and knowledge about the activities of companies. This can be done by carrying out a survey, by analyzing company websites, company profiles posted at electric mobility branch organizations, evaluating innovative electric mobility projects (and the roles of different partners) complemented with interviews and congress visits. It is important to get a good understanding of the activities of the companies that are engaged related to electric mobility in the specific region, before they can be placed in the canvas. The scope of the survey is also important for the companies that can be placed in the canvas, for instance how to define the region (which companies are included and which are not). The company names can be placed in the box according to their activity.

3.3.2 Placing the companies

Some companies operate in multiple boxes. The company concerned will then be placed in the most dominant activity. A company that is clearly active in multiple boxes the company can be placed in several boxes.
In case a company is adding economic activity to the region it is worth mentioning in the canvas. This applies for instance for foreign companies like Car2go. The company is originally German (as a daughter company of Daimler) but has started a big demonstration program in the Netherlands and as such has several employees stationed in the proximity, and is therefore adding some new economic activity for the region. The same accounts for large international electricity suppliers. RWE, Vattenfall, their daughter enterprises are generating economical activities in The Netherlands but also learning from the Dutch electric mobility market.
It can be debated whether these companies should be included in the canvas; for this paper whether several new employees of a foreign company are stationed in the region of analysis is considered as sufficient to be included. Not only from an economic point of view, but also given that this may attract further activities of other companies.

4 Case | Metropolitan area of Amsterdam

4.1 The case

In this paper the *stakeholder canvas* is filled in and measured with the data of the metropolitan region of Amsterdam. Amsterdam presents itself as a frontrunner in the field of e-mobility [9] and is international leading [10]. Urged by air quality problems and ambitions to reduce carbon by 40% in 2025 (ref to 1990) it has had a stimulating policy to develop the market of e-mobility in the region of Amsterdam. In recent years its policy has consisted of a combination of amongst others infrastructure (subsidizing the roll out of hundreds of public charging stations), market measures (subsidy of purchase of electric vehicles, free parking) and demonstration and awareness programs. It has made the municipality of Amsterdam one of the frontrunners in electric mobility in Europe with more than 400 charging stations, more than 300 e-vehicles, a roll out of Car2Go vehicles and demonstration site for introducing the Nissan Leaf as well as testing of battery swapping stations and fast charge stations [11].

With the stimulation program, new companies related to e-mobility were started within the region, while national and international companies set up local offices to be close to the market “where it happens”. The region is interested to make a new step, and leverage the positive market conditions to attract e-mobility business to the region and investigate the opportunities to develop an economic cluster around e-mobility. The question arises in which line of business and which point in the supply chain the municipality may

play a (leading) role, both nationally as internationally. This requires an analysis of stakeholders and the shifting supply chain around electric mobility. To find out which companies in the region are active in the field of e-mobility and what their activities are, an overview is presented.

4.2 Analysis

Before the canvas is filled a survey a preliminary survey for the Amsterdam case is done, based on analyzing various sources (literature, research programs/alliances, project, Ecomobiel fair [12], analysis of industry associations, chamber of commerce). Key companies, companies that came out dominant in the desktop research, are often interviewed to check the data. The overview (figure 2) shows the electric mobility companies in the Amsterdam region. When looking at the positions of companies in the complete canvas, it becomes clear where the region of Amsterdam has a great deal of activities, and which type of companies are missing.

4.2.1 Mobility providers

First, the existence of companies that act as electric mobility providers is striking. These companies promote electric mobility, sell and exploit electric vehicles, offer charge opportunities, and in some cases provide additional services. Most known in the Amsterdam region are The New Motion and Mr. Green. These companies have taken the lead in the transition towards electric mobility, in collaboration with companies that manage the grid (in the Amsterdam region Alliander), utilities (Nuon daughter under Vattenfall) and local governments. These companies provide electric mobility solutions, rather than providing the vehicle alone. Due to the lack of infrastructure and the hurdles for customers to organize both the vehicle, infrastructure and the electricity and/or services, companies like the The New Motion provide a one stop shop for customers. Some of the companies that operate as multibrand dealers also develop products for the charge infrastructure to tackle the chicken/egg dilemma of electric vehicles versus charging points. These companies often provide different

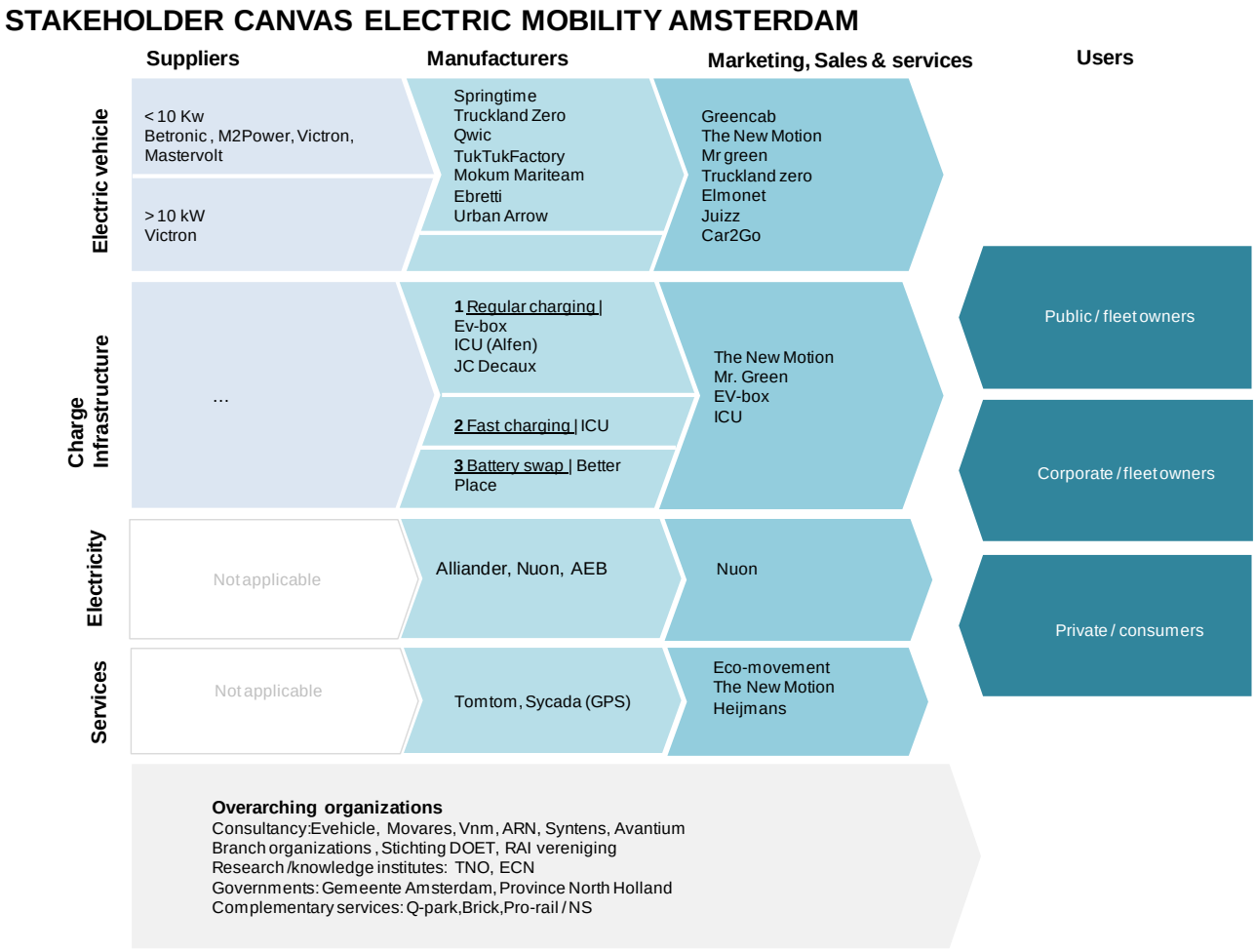

Figure 2: The overview of the stakeholders reflect the various Dutch companies engaged in the field of electric transport in the metropolitan region of Amsterdam.

brands of electric vehicles, and as such function as multibrand dealers. This may be partly due to the fact that electric mobility is a niche market that cannot legitimate a sales channel for every electric vehicle type: a combined sales channel for all electric vehicles seems to make sense.

The question is whether these electric mobility companies will also play a role in case electric mobility is scaled up, or whether these companies will be overrun by large OEMs (or other large companies, for instance utilities) in providing mobility services. It is likely that in case the market for electric mobility is scaled up, it will become sufficiently attractive for traditional OEMs to take a more active role. Most mobility providers are importing products from abroad and reselling them to the Dutch market, like Segways, Nissan Leafs, Chinese e-scooters and Th!nk cars.

4.2.2 Low power range suppliers and OEMs

In the region of Amsterdam there are almost no OEMs for regular electric vehicles (with a power >10kW). Probably this has to do with the fact that the Amsterdam region is not strong in the automotive sector, both regarding developers as well as in suppliers of automotive parts. For example, this sector is much stronger in the region of Eindhoven and Arnhem with more activity in the field of >10kW vehicle and component development.
Strikingly enough, there are quite a number of vehicle manufactures in the low power range (<10kW), for instance QWIC (developer of e-scooters and e-bikes), TukTukFactory (developer of three-wheeled electric recreation/taxi vehicles), Urban Arrow (developer electric cargo bikes) and Springtime (developer of small one person electric vehicles). Typical products in this market include electric boats, electric scooters, e-bikes and other low powered vehicles.
Parties who are in this supply market around low power e-mobility are also situated in the region of Amsterdam, Betronic, Mastervolt and Victron (e.g. measurement and control, management and controls, etc), M2Power (battery systems). For the region the cluster around low power electric vehicles systems may provide an attractive focal point for further stimulation; although the canvas does not provide information on relative strength of this cluster compared to other regions or countries.

4.2.3 Charge infrastructure

The block for the charging infrastructure manufacturers is divided in three categories too, quick charging, regular charging and battery swap.

Developers of charge infrastructure solutions are well represented in the region of Amsterdam. The companies that are involved in the manufacturing and development of the charge infrastructure are ICU, EV-box and The New Motion. These companies are likely to look for advantages of the strong stimulation program in the region of Amsterdam to develop and sell charging infrastructure.

Furthermore, Better Place is active in the region of Amsterdam, for instance by installing a battery swap station in Amsterdam and looking for opportunities to expand in the region. Lastly, companies like ICU Alfen and ABB (former Epyon; more in the region of Eindhoven, not in the canvas but worth mentioning) are international leading in the field of fast charging, with several activities carried out in the region of Amsterdam.

In the charge infrastructure manufacturers block there are different companies that initially delivered different products. Alfen for instance, a supplier for net managers is shifting towards the production of charging points with the company ICU, whereas (French) JC Decaux is a company focused on integrating charging points in street furniture. The New Motion develops the LoLo, a charging point so they can deliver a total package, electric vehicle, charge infrastructure and services.

The amount of charge infrastructure developers is remarkable. An explanation could be that due to the policy of the local government the demand for charging points has grown. Companies have been stimulated to develop charge solutions for electric vehicles. The companies in the charge infrastructure development are relatively small and creating a product in a transition market. Their products develop quickly and are depending on international standards and protocols. The companies are pioneering and filling in the demand for charge infrastructure in public and private parking spaces. The requirements for private, public or semi-public are different. This results in a range of charge infrastructure products and companies. How these companies will position in an international perspective remains the question, given the strong position of German,

Asian en American companies to set the standards for charging stations.

4.2.4 Electricity and grid

The electricity is produced in the region of Amsterdam mainly by NUON and the net is managed by Alliander. Both companies are stationed in the area of Amsterdam, although the headquarters of Alliander are situated in Arnhem. The presence of a net manager and electricity suppliers are not unique for the region of Amsterdam. Because Amsterdam is a focus area for electric mobility, these companies can use the city as a demonstration site for research of the impact on the electricity supply and net capacity. Alliander plays an important role in the placement of charge infrastructure.
A trend is decentralized power generation, companies and private users are generating their own electrical power. This trend can be stimulating for the link towards electric mobility. The companies concerned in this business are not considered in this paper, given the scope on electric mobility. But synergies do seem to exist between e-mobility and decentralized energy provision, and may be interesting to further to investigate concerning their role in stimulating e-mobility in the region.

4.2.5 Overarching organizations

Overarching organizations that not have a particular place in the supply chain may still play a role in successful development of electric mobility in a region; and may also developer skills or expertise that may become an export product. The municipality has an interest to develop a fruitful cluster of companies; such overarching companies may be valuable for this objective.
Most notably in this respect or knowledge institutes or universities as a locus for specialized knowledge. Although the region of Amsterdam has several universities, only a limited number have a focus on electric mobility. For instance technical universities lack; only the university of applied sciences of Amsterdam, source of this paper, is focusing on technical development of electric drive trains.
A second stakeholder is the local government itself, which is very active in stimulating the business of e-mobility in the region, through a combination of subsidies, infrastructure provision, demonstration projects and incentive systems (parking privileges).
Furthermore, two branch organizations are worth mentioning. First Stichting DOET is a foundation and a collection of small and medium sized companies active in the field of electric mobility, that has chose the region of Amsterdam as their home basis, given , the a large number of activities on e-mobility in this region. Second the RAI Association represents all major automotive OEMs; and also has a section on electric mobility. Both play a supporting role to stimulate the development and uptake of electric mobility; but do not invest as such in its development. Lastly, a large number of consultancies and project development bureaus can be distinguished, active in the market. Although these organizations may play a catalyzing role in setting up e-mobility projects, these companies are less inclined to invest in electric mobility, and therefore cannot form the backbone of an industrial cluster.

4.2.6 Marketing & sales

A large number of companies are not involved in the development of physical products on e-mobility, but play a role in the sales of electric vehicles in the market. Examples are The New Motion, Mister Green, Eco-movement. It is striking that it is not about pure sales of electric vehicles, but most companies have a range of services for the e-vehicles to offer, ranging from maintenance to development. And thus these companies are developing new business models around electric mobility products. New business models are more focused on availability of products rather than owning products.

The companies in the marketing and sales are small and expanding. Whether these companies have a structural potency for success remains to be seen and depends on what larger companies, focusing on a big market, will do. Larger companies are either struggling, or awaiting for the electric mobility market to really take off. For larger companies it can be hard to make a change in the business model. The large companies in the marketing and sales, like lease companies, are questioning how to make the transition towards electric mobility profitable.

4.2.7 New Companies

New companies are entering the automotive supply chain due to the impact of electric mobility. New companies could be set up from a larger enterprise as investor or be a start up with an innovative business model. The new companies have in common that they see opportunities in the field of

electric mobility and fill the gap created by the implementation of electric mobility in the automotive supply chain. Most of the new companies are operating in the promotion of electric mobility, marketing and sales or service blocks in the supply chains.

4.3 Electric mobility stakeholders in the metropolitan region of Amsterdam

Based on the analysis it can be concluded that the metropolitan region of Amsterdam can be characterized as an area where many activities in the field of electric mobility take place. The canvas provides a good overview where activities are strongly developed; but also point to the fields of expertise that are not well represented in the region. Roughly three fields of expertise are strongly developed in the region, and may provide a growth segment that may be deployed and stimulated further: (i) low powered vehicles, (ii) charge infrastructure and (iii) new business models around electric mobility.

First, a large number of developers of (components for) low powered vehicles are active in the region. These companies have the technological knowledge and innovative skills to create new mobility concepts, ranging from e-scooters, e-bikes, new 2- and 3-wheel solutions and e-boats. The city of Amsterdam is crowded, with a high urgency to reduce emissions, and there is market for agile and small vehicles the city of Amsterdam is represented by a great deal of bikes. A mix of public transportation, bikes and new low powered electric vehicle concepts for public and cargo, can support Amsterdam to shift from cars to alternative (zero emission) mobility concepts.

Second, charge infrastructure manufacturers are well represented in the region. The widespread deployment of charging infrastructure by the municipality are likely to have stimulated companies to develop own charging infrastructure. Aspects such as standardization of loading protocols, identification, business models and payment raise many questions and are discussed internationally. The new developed standards give new opportunities to the business of charge infrastructure.

Third, Amsterdam is a city of entrepreneurs and traders. This seems to translate to a large number of companies active in marketing & sales of electric mobility, thereby developing of and building op expertise on business models and new services that may become the new standard in electric mobility Vehicle sharing, maintenance services, combined vehicle and infra packages, availability instead of owning as unique selling point can become dominant in the automotive marketing and sales. With these concepts a number of companies are gaining experience; and may support Amsterdam to become a frontrunner in the large scale rollout of electric mobility. Note that these concepts will still have to prove itself. But the region of Amsterdam with its large scale demonstration opportunities (or living lab) provides the perfect testing ground for these new models. This living lab for electric mobility may attract innovative companies to pitch and try out their e-mobility products and business models.

These three potential growth areas are the most likely starting points for supporting a cluster of companies in the field of electric mobility for the local government of Amsterdam. Further research to the possibilities in the three fields should be done, to get more understanding on the importance and growth potential of these sectors, as well as establish the national and international position of the current companies in these expertise fields.

Less opportunities for the region lie in the field development or manufacturing of (components of) electric vehicles: expertise in this field is too limited in the region. Furthermore, provision of electricity or grid services is not differentiating enough vis a vis other regions. Lastly, complementary services in the field of payment systems, privacy systems, information services and installation technology (charging infrastructure) prove to be less prevalent in the region, and do not seem an anchor point of growth in the region.

5 Conclusion & Recommendations

5.1 Conclusion

This paper presents a tool for plotting companies and organizations active in the field of electric mobility for a particular region. It thereby may support local authorities to set priorities regarding attracting or developing a cluster of economic activities to the region.

Using the region of Amsterdam as a case to plot economic activities in electric mobility in the region, it can concluded that the tool provides perspective as a plotting tool that enables getting a good overview which different companies and organizations are active in the sector of electric mobility. . Furthermore, the tool is helpful in separating suppliers, developers and sales-oriented companies, clarifying the roles and main activities of different companies in the field of electric mobility. In general the tool gives a quick overview where most economic activities are taking place in the complete supply chains, thereby giving direction for policy makers where priorities may be set for economic policy. The proposed tool also provides opportunities to provide regular updates, and thereby function as a monitoring device for policy makers. Given the complexity and dynamics in the electric mobility supply chain, the tool helps make sense of and provide grip on the shift observed in the market.

The model also allows differentiating between low and high power applications as well as different types of charging solutions. However in case too many companies are involved, it may make sense to make two separate canvasses for each of the power ranges.

The tool currently does not consider power positions within the industry. This step should be included for economic policy setting; certain supply chain steps may be well represented by companies, but these companies may not have a strong power position within the supply chain. For instance, marketing and sales companies are dependent on the suppliers of electric vehicles, and have limited differentiating power to other sales companies, while export value of the knowledge built up at these companies is likely to be low.

Apart from power distribution between the different supply chain steps, the tool only provides an absolute analysis of companies in the region, without considering the relative competitiveness of these companies in a national or international context. Both these factors (power position of each supply chain step, and relative competitiveness) should complement the plotting tool in order to develop a realistic economic policy to stimulate clusters around electric mobility in a specific region. It may also be useful to plot relationships between companies as a way to see which direction technology is taking.

Also, it is important to establish the scope of the region, when filling in the canvas. It is possible to use the canvas for different regions, and although the scheme is developed for the local level of a metropolitan area, the focus of the area can be increased – as long as the number of companies to be plotted is not too large. In that sense a multilayer model, or plotting activities per supply chain may be more valuable.

The filled in canvas is a snapshot in time. Therefore the canvas should be handled as an indicator and a living document and as such can be used as a monitoring device. The canvas changes according how the market shifts and the stakeholders do their business.

5.3 Recommendations for further research

The model will benefit from having a standardized approach of data collection and further definition how companies active in different supply chain steps are to be plotted in the canvas. Also a color coding may add value as a way to clarify strong supply chain steps.

Furthermore, the model may be enhanced by adding a value perspective, thereby getting a clearer insight in the most valuable and attractive chains to focus on for policy makers – or in other words, the dominant companies or supply chain blocks that drive the electric mobility sector. This requires a future valuation method for evaluating the potential value of individual chain steps given limited information and lack of dominant designs in the field of electric mobility at this moment.

6 Figure Appendix

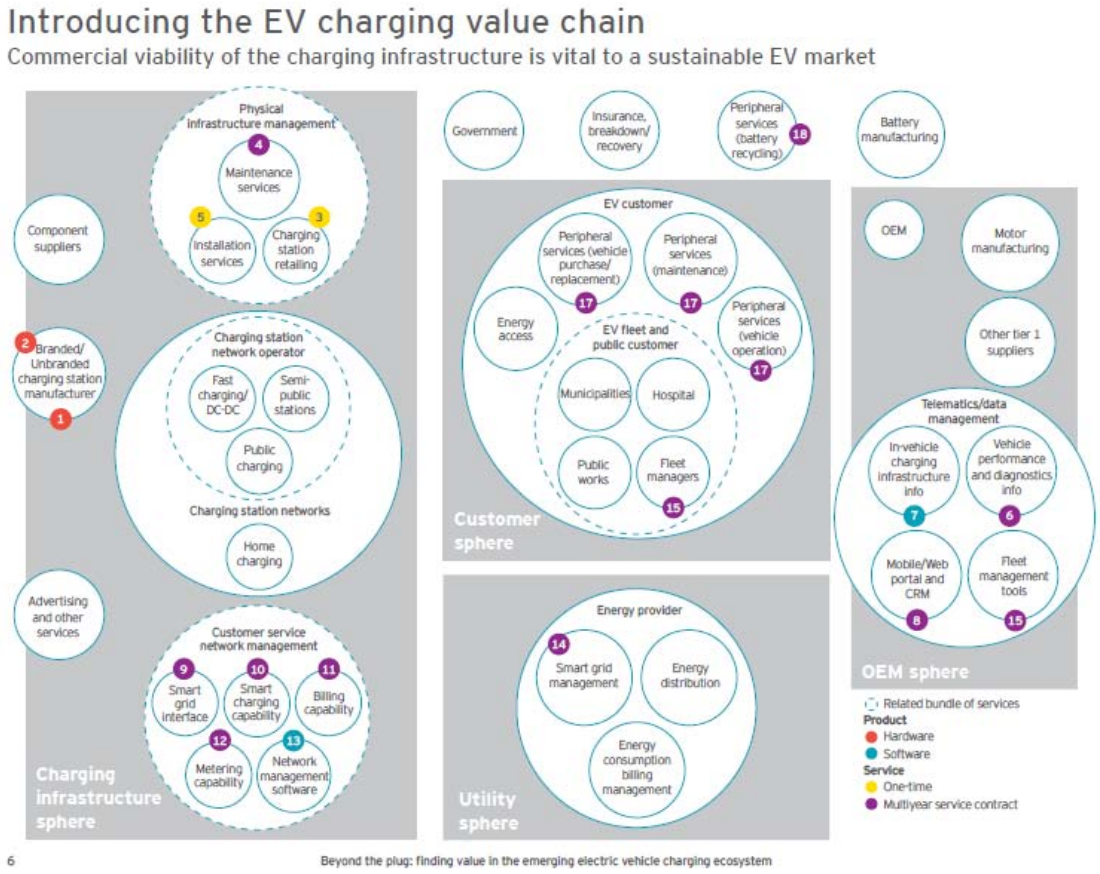

Figure (3) the EV charging value chain of Ernst & Young [7]

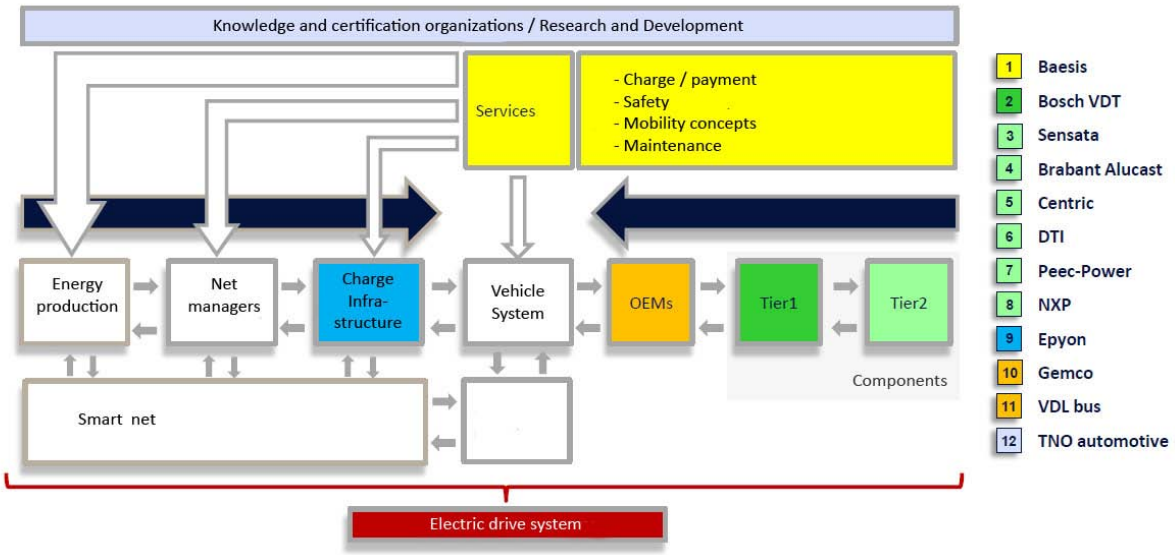

Figure (4) the EV charging value chain of Squarewise [8]

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