D1.1 Value Creation Schemes of Electric Mobility

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Executive Summary

This document *D1.1 Value Creation Schemes of Electric Mobility* is a deliverable of SIMBe, which is a multidisciplinary research project funded by the Tekes Sustainable Community programme. For more details about SIMBe see www.simbe.fi. This document answers the question *how is the industrial electric mobility value chain formed* and provides a general picture of emerging business in electric mobility and its requirements.

In this document we intend to unravel the complexity of the progress in electric mobility by:

- Presenting an overview of the state of the art in electric mobility
- Providing industrial requirements of SIMBe partners and other stakeholders
- Drafting and analysing the emerging industrial value chain of electric mobility
- Analysing the value creation modes of the actors in the electric mobility value chain

The major findings of this document are:

- Many actors operating in the traditional mobility field want to understand the requirements of the change towards electric mobility as well as possible new entrants need to understand the developing electric mobility ecosystem.
- Many stakeholders need the experience of a systematic use of electric vehicles and end user feedback. Thus electric vehicle and charging infrastructure demonstrations and pilots are wanted.
- The industrial value chain of electric mobility is not yet ready. This means also that the related business models are not yet clearly defined. Still, there are good business opportunities for many kind of actors in the value chain in the near future.
- Who will take the integrator role in the industrial value chain is still an open question.

We recommend the following:

- An ongoing discussion on electric mobility between industry, government representatives, researchers and other stakeholders is to be launched and maintained
- Emerging business models need to be developed together with several actors in the electric mobility value chain
- Future scenarios about the ecosystem are needed to reduce uncertainty.

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BEV	Battery-Electric Vehicle
BMS	Battery Management System
E-REV	Extended-Range Electric Vehicle
EV	Electric Vehicle
ICE	Internal Combustion Engine
IEA	International Energy Agency
PHEV	Plug-in Hybrid Electric Vehicle

1. Introduction

1.1. Target group

This document is public and is targeted for those who are interested in business aspects related to electric mobility. Particularly this document is written to SIMBe participants, industry representatives in this field, ministries and government policy-makers as well as academic and other researchers.

1.2. Objectives

Objective of this document is to integrate the various stakeholders' views into a stakeholder requirements analysis. In addition objective is to define and understand the dynamics of value creation of electric mobility and furthermore, have an overview of possible business concepts. A further objective is to enable different stakeholders to understand other actors' views and expectations related to electric mobility.

1.3. Scope of this document

This document is the first deliverable of the research project SIMBe = Smart Infrastructures for Electric Mobility in Built Environments (see www.simbe.fi). Thus the scope of this document is within the scope of the project.

Main scope of the document is the business opportunities provided by electric mobility, seen from a stakeholder value perspective. Business opportunities will be recognized by analysing industrial value chain and respective value creation logics of the actors of electric mobility.

Electric mobility can be understood as wide range of means of transport propelled by an electric motor. In this document the term EV is understood as battery electric vehicle, plug-in hybrid electric vehicle and extended range electric vehicle. The scope of this document covers only vehicles which have possibility to charge their batteries from the electricity supply network.

1.4. Research questions and approach

The major research question of this document is: *how is the industrial electric mobility value chain formed*?

The following sub questions can be derived from the major question:

- What kind of actors will be needed in the industrial electric mobility value chain in order to get the business started?
- Who of the actors will take the integrator role in the electric mobility value chain?

Methods used are deep interviews of experts in this field, literature review and qualitative data gathering.

2. State of the art

The progress in the area of electric mobility is rapid and thus comprehensive state-of-the-art documents are often outdated from the outset. The SIMBe project uses wikispace service for collaboration platform where work and documents are shared. In the wikispace state-of-the-art information is collected non-stop thus this chapter is advisedly brief and only to provide a glance of the current situation.

2.1. Electric vehicles - definition

This document concentrates on electric vehicles, mostly on passenger cars and busses however some of the models can be applied with other electric vehicles. The classification of EVs divides fully electric vehicles a.k.a battery-electric vehicle (BEV) from hybrid electric vehicles (HEV) a.k.a parallel hybrid which have also an internal combustion engine (ICE). Plug-in hybrid electric vehicle (PHEV) has an ICE and a possibility to charge the battery from electricity supply network. An extended range electric vehicle (E-REV) a.k.a serial hybrid is different from a plug-in parallel hybrid in that the vehicle is always propelled by an electric motor and there is another source of power e.g. fuel cell or ICE which is used only to charge the battery and by this the range could be extended significantly. In E-REV there is in most cases a plug-in possibility for charging the battery from network as well.

In this document the term EV is understood as battery electric vehicle, plug-in hybrid electric vehicle or extended range electric vehicle. The scope of this document covers only vehicles which have possibility to charge their batteries from the electricity supply network.

It has been suggested that EVs need to have more detailed classification under these classes introduced above. Motivation for this comes from the business perspective. The battery is the most expensive element of the electric car and its size is proportional to the range. Most manufacturers introduce now EVs with 25kw-30kw batteries giving 160 km range. On the other hand customers driving needs differ a lot e.g. 80% of all daily trips are less than 20km. Thus large portion of EVs will carry expensive “spare” battery capacity. Therefore EVs could be divided according to user segments or battery size to help consumers to identify different characteristics. Different segments have different requirements and more detailed classification may help to recognise them better (Hodson & Newman, 2009) .

2.2. Electric vehicle production

Electric vehicles get a lot of attention at the moment. Situations like this have the threat of hype or a bubble. Interesting is that the demand of EVs manifolds the current supply capacity and no manufacturer has a mass production of EVs. Only Tesla Motors has a production line for an EV Tesla Roadster but the number produced in 2009 was under one thousand at a price of around 100 000 $. Several manufacturers have announced to start production in the coming years and presented EV models and production targets. Key element in EV is the battery hence the car manufacturers are partnering with battery manufacturers. These partnerships and targets are provided in table 1.

In the beginning volumes of production are modest since ramping-up EV production needs investments and car manufacturers have made massive investments for ICE vehicle production so shifting from ICE to EV will not be a light and simply crossover. In addition battery production can be a bottleneck and EV production volumes are dependent for battery production volumes for the next years. However this will possibly change quickly if big manufacturers invest in large plants e.g. battery manufacturer A123 has announced plans to build a 2 billion $ lithium iron phosphate battery production facility in Michigan that will have an annual production capacity for 500,000 electric vehicles per year by 2013. (IEA, 2009 ; Becker et al, 2009)

Table 1. Manufacturers of EVs/PHEVs and partnering battery manufacturers. Source: IEA, 2009

Car manufacturer	Battery manufacturer	Production targets (vehicles per year)
BYD Auto	BYD group	
Fiat-Chrysler	A123 Systems, Altairnano	
Ford	Johnson Controls-Saft	5 000 per year
GEM	Sanyo/Panasonic	
GM	LG Chem	
Hyundai	LG Chem, SK Energy, and SB LiMotive	500 000 by 2018
Magna Group	Magna Steyr	
Mercedes-Benz	Continental , Johnson Controls-Saft	
Mitsubishi	GS Yuasa Corporation	5 000 in 2010; 15 000 in 2011
Nissan	AESC	EV Capacity: 50 000 in 2010 in Japan 100 000 in 2012 in U.S.
REVA	Indocel Technologies	
Renault	AESC	150 000 EV/year by 2012
Subaru	AESC	
Tata	Electrovaya	
Th!nk	A123 Systems , Enerdel/Ener1	
Toyota	Panasonic EV Energy	
Volkswagen	Volkswagen and Toshiba Corporation	

Sources: Various, compiled by IEA July 2009.

2.3. Electric vehicle programs, incentives and roadmaps

There are several drivers behind the shift towards electric mobility. Many authorities have expressed benefits and different perspectives for supporting the paradigm chance. People have become more aware of environmental issues e.g. sustainability, ecological footprint and emissions. Values are changing and there is a growing demand for fair trade and organically grown production. Many governments have committed to decrease emissions substantially and particularly in traffic and transportation. Non-renewable resources are diminishing and particularly oil is politically confrontational thus electric mobility has the potential to improve energy security. When electricity used in mobility is produced sustainable this new way of providing means for transportation could solve many objectives simultaneously.

In electric mobility there are many aspects to be covered before it will be largely adopted. Realising this several countries have started programs to promote the penetration of EVs e.g. UK - OLEV, Portugal – Mobi-E, USA – Vehicle technologies program, Germany – NEMP, France - VERT, Denmark – Edison. These programs vary a lot from EV purchasing subsidy to comprehensive infrastructure and industry support strategy. Many countries have declared to be “the world’s first site for the mass use of electric automobiles" or "the European capital for electric cars" and are prepared to invest significant amount of resources.

The next step is usually to produce a roadmap how to attain these targets. International Energy Agency (IEA) produced an Electric and plug-in hybrid electric vehicles Technology Roadmap covering the OECD countries (IEA, 2009). That document motivated member countries to derive their own roadmap and several countries have already succeeded, e.g., Canada (Government of Canada, 2009), Austria (Spitzer , 2008), USA (Electrification Coalition, 2009), France (French Environment and Energy Management Agency, 2008). In Finland Minister of Transport Anu Vehviläinen has commissioned VTT to clarify needed actions for accelerating diffusion of EVs and produce a roadmap for Finland (LVM, 2010).

2.4. Electric vehicle penetration forecasts

It is quite challenging to predict the future but estimations of EV penetration are needed to understand the order of magnitude. When the number of EVs is remarkable it could be too late to make the adjustments to the electricity supply network and to offer needed services they need to be developed in advance. Therefore business enterprises are most interested to know how the situation is evolving.

Electric mobility is considered a disruptive business and it deploys many industries thus it challenges analysts and executives. In several countries it is also subsidized from the government side which makes it more complicated to predict how the business around electric mobility will evolve in the near future. Theoretical models of innovation adoption are naturally used in this area but the complexity of electric mobility complicates the use of generic theories e.g. Rogers diffusion of innovation (Rogers, 2003) which is one of the leading model of innovation adoption. Figure 1 shows how innovations often diffuse presumed the innovation takes off and becomes generally used.

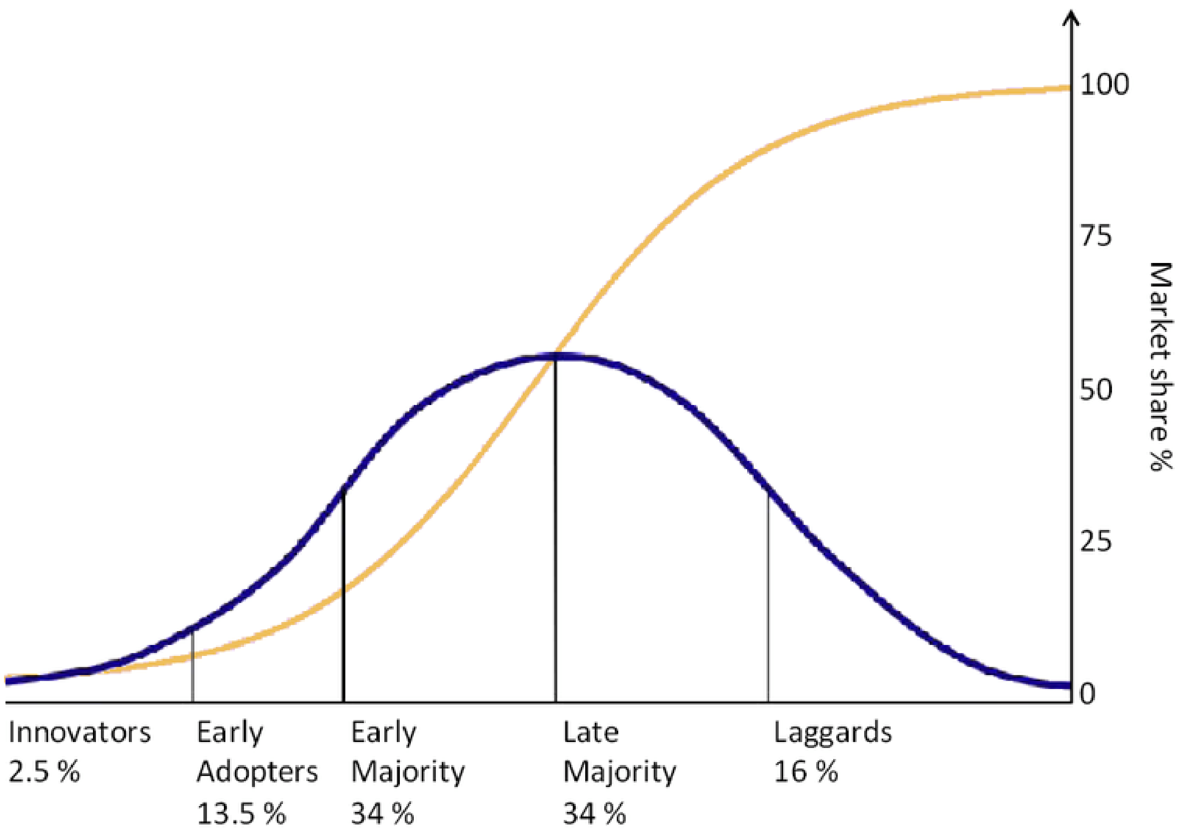


Figure 1. Diffusion of innovation. Source: Rogers, 2003

Most of the EV diffusion forecasts share the same view: EVs will penetrate significantly latest 2020. Table 2 provides a list of announced national EV and PHEV sales targets.

Table 2. Announced national EV and PHEV sales targets. Source: IEA, 2009

Country	Target	Announcement / Report Date	Source
Australia	2012: first cars on road 2018: mass adoption 2050: up to 65% stock	04 Jun 2009	Project Better Place Energy White Paper (referencing Garnault Report)
Australia	2020: 20% production	10 Jun 2009	Mitsubishi Australia
Canada	2018: 500 000	Jun 2008	Government of Canada's Canadian Electric Vehicle Technology Roadmap
China	2011: 500 000 annual production	1 Apr 2009	"government officials and Chinese auto executives", per *The New York Times*
China	540 000 by 2015	8 Jul 2009	Pike Research
China	2008: 21 000 000 electric bike stock	27 Apr 2009	*The Economist*
China	2030: 20% to 30% market share	Oct 2008	McKinsey & Co.
Denmark	2020: 200 000		ENS Denmark
France	2020: 2 000 000	Oct 2009	Jean-Louis Borloo, Minister of Ecology
Germany	2020: 1 000 000	Nov 2008	Nationale Strategiekonferenz Elektromobilität
Ireland	2020: 350 000	28 Apr 2009	Houses of the Oireachtas
Ireland	2020: 250 000 2030: 40% market share	26 Nov 2008	Minister for Energy Eamon Ryan and Minister for Transport Noel Dempsey
Israel	2011: 40 000 EVs 2012: 40 000 to 100 000 EVs annually	9 Sep 2008	Project Better Place
Japan	2020: 50% market share next-generated vehicles	Jul–Aug 2008	Prime Minister Yasuo Fukuda
Netherlands	2015: 10 000 stock in Amsterdam 2040: 100% stock in Amsterdam (~200 000)	28 May 2009	Marijke Vos, Amsterdam councilmember
New Zealand	2020: 5% market share 2040: 60% market share	11 Oct 2007	Prime Minister Helen Clark
Spain	2010: 2 000	24 Feb 2009	Instituto para la Diversificación y Ahorro de la Energía
Spain	2014: 1 000 000	31 Jul 2009	Industry Minister Miguel Sebastian

Country	Target	Announcement / Report Date	Source
Sweden	2020: 600 000	May 2009	Nordic Energy Perspectives
Switzerland	2020: 145 000	Jul 2009	Alpiq Consulting
United Kingdom	2020: 1 200 000 stock EVs + 350 000 stock PHEVs 2030: 3 300 000 stock EVs + 7 900 000 stock PHEVs	Oct 2008	Department for Transport, "High Range" scenario
United States	2015: 1 000 000 PHEV stock	Jan 2009	President Barack Obama
United States	610 000 by 2015	8 Jul 2009	Pike Research
Worldwide	2015: 1 700 000	8 Jul 2009	Pike Research
Worldwide	2030: 5% to 10% market share	Oct 2008	McKinsey & Co.
Worldwide	2020: 10% market share	26 Jun 2009	Carlos Ghosn, President, Renault
Europe	2015: 250 000 EVs	4 Jul 2008	Frost & Sullivan
Europe	2015: 480 000 EVs	8 May 2009	Frost & Sullivan
Nordic countries	2020: 1 300 000	May 2009	Nordic Energy Perspectives

Source: Individual Country Roadmaps and Announced Targets, as listed in the references.

2.5. Value chains

Value chain analysis in academic discussion was started by Michael Porter in his book “Competitive advantage: creating and sustaining superior performance” (1985). Porter defined value chain analysis to cover the activities within and around the organisation which are linked to the analysis of the organisation competitiveness. Figure 2 illustrates the generic value chain by Porter.

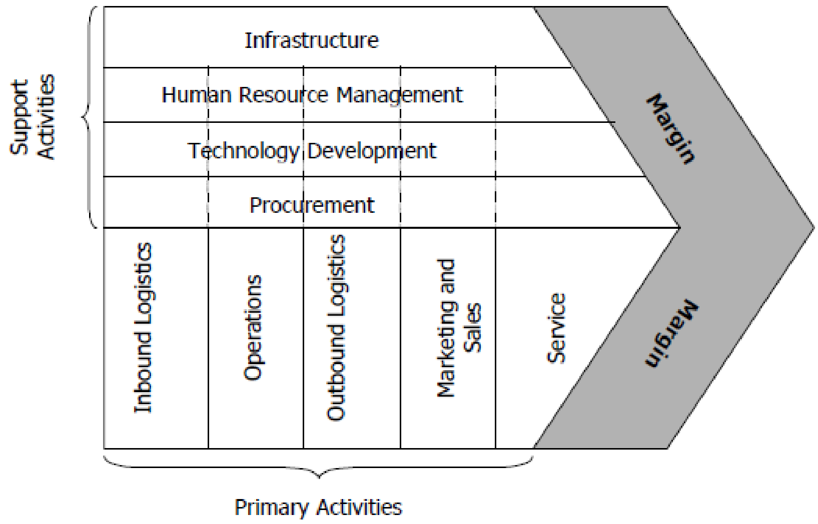


Figure 2. Porter’s 1985 generic value chain

In the figure 2 the term *Margin* represents the profit an organisation produces when managing all the activities in the value chain. If an organisation is capable for adding value in the process the end result is more valuable than the sum of the activities and there is profit for the organisation (Porter, 1985) .

The concept of value chain is widely used in business management in various contexts and it has been applied to many perspectives. Porter’s traditional value chain analysis has evolved to more advanced value chain techniques, e.g. Loebbecke (2001) uses a product’s industrial value chain for locating the strategic roles of different stakeholders. But the basic idea behind Porter’s value chain analysis has not changed. The key thought in value chain analysis is how the elements in the chain and the management of the linkages between the chain elements add value for the entity.

Furthermore the value chain of the firm is a part of the value system which describes the larger stream of activities from suppliers to buyers. Figure 3 shows the value system. The linkages between the down stream and the up stream can provide new opportunities for the firm to enhance it’s competitive advantage. And respectively these interactions between them can affect a company’s value chain.

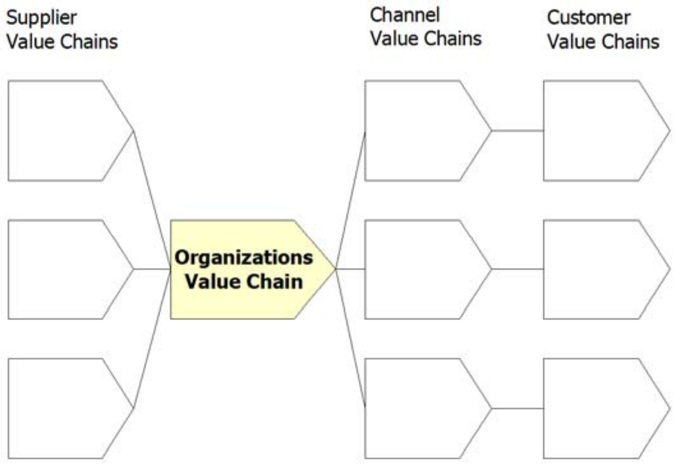


Figure 3. Porter's 1985 value system

The value chains of different companies within an industry vary from one another. Also the value chains of different industries vary a lot based on the particular characteristics of the industries. That is why the industry value chains play an important role when analysing firms' competitive advantages in the whole value system. So in fact, the differences in value chains among the different industry players provide the source of competitive advantages between them.

In this document in chapter 4 we use the generic industrial value chain approach to unravel the complexity in electric mobility of all the actors and their value adding activities that terminates with the customer.

3. Requirements on SIMBe

3.1. Consumer requirements

In the end the introduction of EVs depends on consumers. It is a shared view that it is essential to collect consumer information to overcome market barriers and increase the demand for EVs. That is one of the key findings in IEAs technology roadmap for electric and plug-in hybrid electric vehicles. Wide use of EVs will require an improved understanding of consumer needs and behaviour. As it will all start with *innovators* and *early adopters* hence the industry needs to gain a better understanding of these groups' requirements. (IEA, 2009)

3.1.1. End user surveys

A global end user study including market research and an online survey of 1850 consumers was conducted in five countries, including Germany, France, Italy, the United States and Canada in February 2010. The respondents ranged in age from 18 to 61 years and over, and were a near split between male (52 %) and female (48 %) consumers. (Accenture, 2010)

Survey questions and answers for all the countries represented are provided in table 3. One of the interesting findings is that in the beginning the adoption of EVs relies strongly on the users which are not too demanding on performance or price compared to ICE cars. The majority are ready to wait until EVs are able to compete against ICE vehicles in every aspect. Then again it is interesting that already 57% of respondents in Italy stated that 'everyone should own a hybrid or electric car' although the EV is a relatively new concept to the majority. For technical requirements it is interesting to recognize that 50% to 73% of respondents want re-charging to take less than 20 minutes which is still far from the present capabilities.

Table 3. Global Auto Consumer Survey. Source: Accenture, 2010

Survey Question	Germany % of Respondents	France % of Respondents	Italy % of Respondents	U.S./Canada % of Respondents
More likely to buy a hybrid or electric vehicle that is better than a fuel-only car in every way	74%	55%	46%	65%
Rate the fuel efficiency of a hybrid or electric car very good to excellent, but rate ride, performance, style and maintenance as good	59%	64%	45%	74%
More likely to buy a hybrid or electric vehicle in the next two years	29%	51%	62%	31%
More likely to purchase a hybrid in the next two years	67%	63%	71%	70%
More likely to buy an electric car in the next two years	17%	22%	19%	5%
Everyone should own a hybrid or electric car	21%	39%	57%	26%
Would pay nothing more for a hybrid or electric car compared to a fuel-only vehicle	45%	52%	46%	56%
Desire a payback time for a hybrid or electric car purchase to be five years or less	64%	83%	73%	82%
Assuming a hybrid or electric vehicle could run on an electric charge for 200 miles, want the driving distance between re-charging points to be every 11 to 50 miles	55%	44%	52%	20%
Want re-charging to take less than 20 minutes	72%	73%	69%	50%

The City of New York conducted a market research study in partnership with McKinsey (2010). Objectives were to determine potential early adopters of EVs, to identify size and characteristics of EV consumer segments as well as to recommend possible steps the City and other stakeholders could take to enable EV adoption. The study included four phases. First there was a series of 40-minute interviews with consumers indentified through an informal network. Second a “quick” quantitative survey was designed to establish a basic fact base regarding current driving and parking patterns in New York City. The survey involved a final sample of over 1,600 drivers. Third the qualitative research began with interviews of individuals and couples. The research team conducted multi-hour discussions with consumers and two full-day workshops with more than 20 attendees each, comprising consumers and industry experts. Phase 4 was a full-length survey where 1,384 consumers were asked to complete a 45-minute survey. (McKinsey, 2010)

One of the key findings of the study is the identification of EV buyer segments. Figure 4 shows these segments and on the right side of the figure there is a key characteristic for *early adopters*. In table 4 there are presented central differences between *early adopters* and other segments.

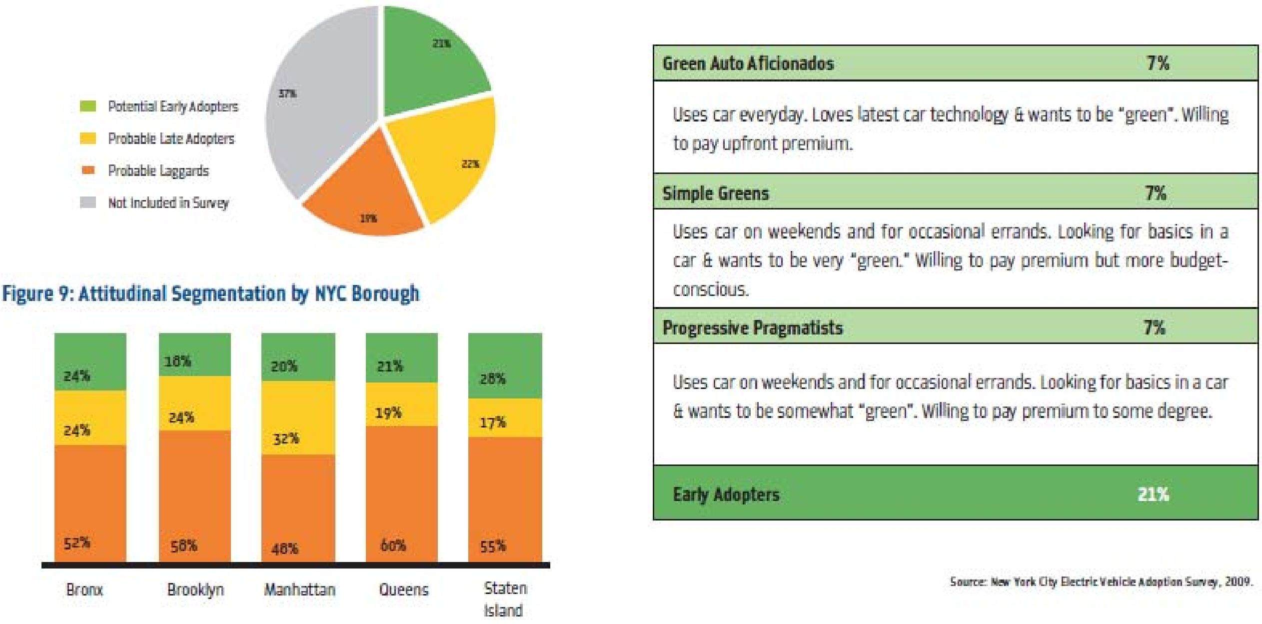
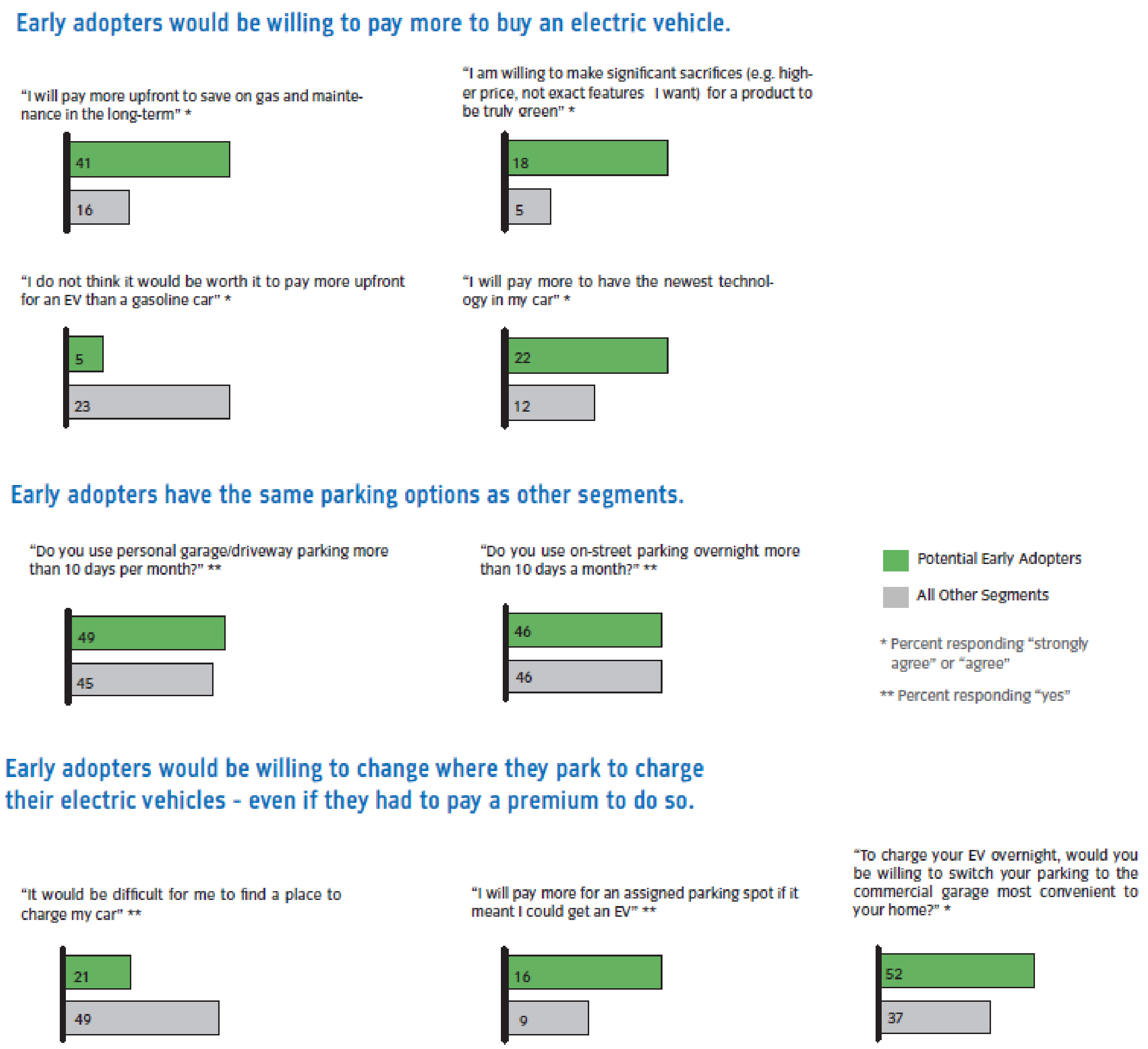


Figure 4. Attitudinal segmentation of NYC EV buyers and key characteristics for *early adopter* segments. Source: McKinsey, 2010

Table 4. Survey responses – *early adopters* vs. other segments. Source: McKinsey, 2010



3.1.2. SIMBe end user study

In SIMBe it is planned to conduct a market research study in partnership with the Consumer Economics unit of the Department of Economics and Management in University of Helsinki. The purpose of the market research is to produce knowledge about potential end users and for developing EV charging infrastructure. The study will be composed of two parts: qualitative and quantitative. The idea of the qualitative part is to get information about the current travelling habits of potential end users and the cultural discourses (that is culturally typical and commonly shared conceptions) about electric vehicles. The material collection will be carried out through deep interview techniques and the data consists of 15-20 interviews.

The second, quantitative study, will be partly grounded on the results of qualitative research and it will be directed to the citizens of Helsinki metropolitan area. Through the questionnaire techniques it is possible to find out e.g. who are the early adopters of electric cars, where and how they live, how much they are willing to pay for these vehicles and how they want to charge the batteries and pay for it. It is also possible to investigate the attitudes, values and knowledge level of people of Helsinki metropolitan area about electric vehicles. The purpose of this information is to help companies and Transportation and Traffic Planning Division of Helsinki to establish the infrastructure for electric vehicles and also direct marketing campaigns to the early adopters.

3.2. Individual SIMBe participant requirements

3.2.1. Helsingin Energia

As one of the largest energy companies in Finland, Helsingin Energia supplies electric energy to about 400,000 customers in Finland and covers more than 90 percent of the heat demand of the capital city with district heat. Helsingin Energia produces and sells district cooling, which is considerably expanding in Helsinki.

Among the services provided by Helsingin Energia are the design, projecting and maintenance of energy production and distribution systems. Helsingin Energia is also responsible for the outdoor lighting systems in Helsinki. Helsingin Energia has developed solutions for electric public transport with Helsinki City Transport and VR within hundred years and now electric private traffic is about to increase.

Requirements for SIMBe are:

- Possibilities to provide services in electric mobility for public and private traffic solutions
- Business Concepts for EV Charging from Helsingin Energia point of view
- The Need: timing and location for EV charge points in Helsinki
- Semi-massive electric vehicle and charging infrastructure pilot
- Smart grids and the significance of EV batteries for balancing wind power fluctuation

3.2.2. Nokia Siemens Networks Oy

Nokia Siemens Networks Oy is a leading global enabler of telecommunications services. With its focus on innovation and sustainability, the company provides a complete portfolio of mobile, fixed and converged network technology, as well as professional services including consultancy and systems integration, deployment, maintenance and managed services. It is one of the largest telecommunications hardware, software and professional services companies in the world. Operating in 150 countries, its headquarters are in Espoo, Finland.

Requirements for SIMBe are:

- Investigate utilization and integration of existing infrastructures, business models and networks of players. Key focus on cross disciplinary / multi-utility nature of eMobility
- Investigate the role of telecommunication technologies / enablers in successful development of eMobility
- Investigate the role of telecommunication sector entities / value networks in successful development of eMobility
- Disseminate/inform learning from mobile communication service business (e.g. value networks, business models, factors for adoption, market development)
- How service control, billing & management of EV electricity charging can be accomplished by using principles common in the telecommunication sector.
    - Study of EV service control & billing requirements, features & interfaces
    - EV management requirements, features & interfaces

- o Architectural concepts to apply common telecom service control, billing & management principles in EV electricity charging based on Phase 1 results
- o As a real option with consortium partners validation of architectural concepts with a limited number of vehicles or vehicle prototypes connected to telecom service control, billing & management systems

3.2.3. HOK-Elanto

Helsinki Co-operative Society Elanto (HOK-Elanto) provides benefits and services for residents of the Greater Helsinki area. Own business operations are supplemented by other S-Group as well as dozens of partners from various business fields. The co-op member's benefit, competent personnel, ability to change, responsibility and profitability are the basic values which steer operation.

HOK-Elanto is part of the S-Group, and as the largest regional co-operative, it is owned by over 500,000 customer-owners. The HOK-Elanto co-operative has an annual turnover of 1.6 billion euro, and it employs 6,000 employees. HOK-Elanto operates in the Greater Helsinki area with 300 stores, and holds market leadership in retail grocery trade. Moreover, HOK-Elanto is one of the largest restaurant operators in the Nordic countries.

Requirements for SIMBe are:

- Possibilities to provide services in the field of electric mobility
- Business Concepts for EV Charging
- Guidelines for charging concepts utilizing existing fuel station network
- The Need: timing and location for EV charge points
- Electric vehicle and charging infrastructure pilot

3.2.4. Suomen Pysäköintiyhdistys Ry (SPY Ry) – Finnish Parking association

The Finnish Parking Association unites parking operators, designers and equipment vendors, such as BK Group Oy, several cities', Pysäköintitalo Oy, Länsi-Pasilan Autopaikat Oy, Vaasan Toripysäköinti Oy, Europark Oy, Finnpark Oy and Q-Park Finland Oy.

Requirements for SIMBe are:

- Preparation for customer needs, to enable them to use electric mobility
- Up to what point in time can our existing infrastructure handle the electric charging needs?
- Do we need to switch to high power (fast) charge?
- How much investment is needed, and when?
- How strong will be the demand, at which stage?
- How to calculate trucks and their electricity needs?
- Can we sell electricity as a business model, and if so, how?

3.2.5. European Batteries Oy

European Batteries Oy (EB) is an independent battery systems provider, founded in 2003. It produces large lithium-ion battery systems with a focus on energy, industrial and vehicle sectors. The business concept offers a seamless service for its customers and their products' full life cycle. EB provides battery systems from solution development to production, engineering and testing to maintenance.

EB's target is to provide large energy storage solutions for the most demanding stationary, industrial and vehicle market applications. The aim is to deliver previously unattainable level of energy, safety and life cycle to the EB batteries.

Requirements for SIMBe are:

- Study and understand the market for electric vehicles
- Provide comprehensive and ready to use energy storage to the customer
- Strengthen the cooperation with other value chain members e.g. battery's capability to communicate to the grid.

3.2.6. Ensto Finland Oy

Ensto is an international industrial group and family business specializing in the development, manufacture and marketing of electrical systems and supplies. Playing an essential role in the distribution and energy efficient use of electrical power, Ensto's systems and products are present in domestic electrical installations, public premises and businesses.

Operating in 19 countries, Ensto employs approximately 1,250 staff in Europe and Asia. The company's net sales amount to approximately EUR 170 million.

Requirements for SIMBe are:

- To figure out the essential issues relevant for the international business of electric mobility
- Comparison of the politic situation of electric mobility in different countries
- Surveying of the future political issues for electric mobility and proposals for implementations
- Lobbying the political decision makers on different levels. Interacting in seminars and publications
- Collaborative business with other SIMBe partners
- Commercial based charging infrastructure pilots leading to profitable charging business

Ensto aims at developing safe, easy-to-use, durable and serviceable charging solutions with stylish design and functionality to fulfill various customer needs. Solutions are being designed to range from slow charging all the way up to higher charging powers and to timely comply with relevant standardization. Ensto is working in a partnership mode to ensure best total service to our customers.

3.2.7. Puronovo Oy

Puronovo Oy stands for proven technology for clean urban environment. PuroNovo has set the new standard for reliable energy swap for industrial automation. With PuroNovo's solution Warehouse automation (AGV) electric energy supply can be fully automated and battery life is optimized. Now this revolution is coming to help clean up our common urban environment. Electric buses are now on their way to streets around the world and Puronovo offers proven solution for their energy swapping, fast and reliable. With the Puronovo solution bus operators can run their electric bus fleets with ease. Puronovo takes care of the green energy!

Requirements for SIMBe are:

- Influencing decision makers to support e-industry to take off
- Participate in definition of standards needed
- Be part of an e-cluster

3.2.8. o2 Media Oy

o2 Media Oy is ecological – their concept idea is to offer a new low-emission vehicle for people living and travelling in Finland's most populated areas. Thus drivers do not necessarily have to own a car anymore, because they can rent a car for a very low price whenever they need it. o2 Media Oy is renewing their fleet of cars all the time as well as seeking for even more ecological options; in the future they want to provide their customers electric cars.

o2 Media Oy have compensated their already low carbon dioxide emissions with the Neutral Drive service supported by WWF.

Requirements for SIMBe are:

- Gathering information about the available EV infrastructure over time
- Clarify the tax policies and other regulations
- Promoting their car rental model to likely stakeholders
- Broaden business model with appreciating car renting as electric vehicle test drive facility and have retail as well

3.2.9. Oliivi Autot Oy

Oliivi Club is a modern car sharing company. In Oliivi Club you can have a car to use on demand without the need of owning a car. You can also support car electrification by reserving an converted electric vehicle for a day. Oliivi Autot Oy is working together with eCars Now! It is also possible to offer your own car for Club members to use and make a profit.

Requirements for SIMBe are:

- Networking and collaborative business with other SIMBe partners
- Promoting their car sharing model to likely stakeholders
- Specify and focus own business model and strengthen status with investors
- Business concepts for EVs

3.2.10. eCars Now!

SIMBe and eCars Now! share the same primary goal to significantly accelerate the introduction of sustainable electric mobility in Finland. eCars Now! aims for mass introduction, which improves earning models – for both new and kit-fitted e-cars. eCars Now! established an extensive community of e-car trendsetters and "early adaptors" – these clients are potential users for industrial SIMBe partners.

Requirements for SIMBe are:

- Working models of economically viable public charging for electric vehicles
- Especially (fast) charging and other possible forms of extra energy on highways is the key bottleneck for EVs. These bottlenecks and possible bottlenecks inside cities must be identified
- Solutions shall be searched in a whole-systems approach.

3.2.11. Helsingin Kaupunki – Helsingin kaupunkisuunnitteluvirasto

The City Planning Board renders most of the decisions concerning designs prepared by the Transportation and Traffic Planning Division. The Traffic Planning Director makes decisions in special cases concerning traffic arrangements of minor importance and provides municipalities with recommendations regarding the installation of traffic control devices on privately owned roads.

Transportation and traffic planning, a part of land-use planning, includes all modes of transportation: public transport, vehicular traffic, parking, as well as cycling and pedestrian networks. In Helsinki's planning one of the top priorities is to promote the fluency and service level of public transport. Improving traffic safety is also a central objective in all planning.

Requirements for SIMBe are:

- Understand the "Big picture" of electric mobility
- Understand the need, timing and location for EV charge points
- Cooperation with stakeholders developing charging infrastructure

3.3. Joint requirements of SIMBe participants

SIMBe participants' requirements differ both in width as well as in the level of detail. This supposedly reflects the situation generally. Many stakeholders have been working with this field internally for a long time without being noticed, and at the same time newcomers are entering the industry. The resulting uncertainty in the ecosystem is reflected in the requirements for high level understanding

Requirements	Participants
• Study and understand the market for electric vehicles • Clarify the tax policies and other regulations • Understand the "Big picture" of electric mobility • Find the possibilities to provide services in the field of electric mobility • Gather information about the available EV infrastructure over time	Helsingin Kaupunki, European Batteries Oy, o2 Media, Oliivi Autot Oy, HOK-Elanto, Helsingin Energia, Suomen Pysäköintiyhdistys Ry

More concrete requirements where target is to carry business closer to reality and promote the adoption of EVs such as:

Requirements	Participants
• Understand the need, timing and location for EV charging infrastructure • Semi-massive electric vehicle and charging infrastructure pilot (e.g. as a SIMBe spin-off based on 100 to 1000 vehicles) • Lobbying the political decision makers on different levels • Interacting in seminars and publications	Helsingin Kaupunki, Nokia Siemens Networks Oy, eCars Now!, European Batteries Oy, o2 Media, Oliivi Autot Oy, Ensto Finland Oy, HOK-Elanto, Helsingin Energia, Suomen Pysäköintiyhdistys Ry

In addition several participants require more detailed information how to proceed and refine opportunities into lucrative business:

Requirements	Participants
• Understand the business concepts for EV charging and other services • Investigate utilization and integration of existing infrastructures • Create business models and networks of players • Investigate innovation opportunities with a key focus on the cross disciplinary/multi-utility nature of e-mobility • Create collaborative business with other SIMBe partners	Helsingin Kaupunki, Nokia Siemens Networks Oy, o2 media, Oliivi Autot Oy, Ensto Finland Oy, HOK-Elanto, Helsingin Energia

3.4. Requirements of other stakeholders

The overall aim of SIMBe is to significantly accelerate the introduction of sustainable electric mobility in Finland. To achieve this SIMBe makes an attempt to have a societal impact and interacts with policymakers and government representatives. Objective is to identify legislation areas which need to change to adopt the new energy-transportation paradigm and outline possible changes. Furthermore enhance policymakers' comprehension on needed measure of support for accelerating penetration of EVs.

In SIMBe there has been ongoing communication between government representatives as well as active participating in workshops and seminars and public debate (Pirhonen & Malinen, 2010). SIMBe has started also dissemination for improving public awareness of electric mobility (see www.SIMBe.fi and Kronqvist, 2010). The feedback at the present moment from these discussions and workshops and public statements is somewhat inconsistent. Targets of traffic emissions reduction would benefit directly from deployment of EVs, trade balance and energy security would benefit from declining oil import as well as new industry and services would create jobs. Government representatives support EVs in speeches, e.g. former Prime Minister Matti Vanhanen stated, that he "wants to have EVs rolling out to the finish roads as soon as possible" (Mainio, 2008). At the same time quite little sponsoring or active operative support is given. It appears that ministries are still in the phase of investigation and clarification and concrete actions are to be defined, still.

One example is the discussion around a possible national EV and charging infrastructure demonstration. Many stakeholders have expressed their demand of government support or in the extreme form a responsibility to co-ordinate collective semi-massive pilot. Government representatives are in favour but have not yet taken an active role to facilitate. Still, stakeholders in this field were motivated to present to the government a "so good and well planned scheme which can not be refused" (Peltonen, 2010). In parallel, a new Tekes programme dedicated to EVs and their systems (working title, Tekes 2010) has been announced to commence soon.

3.5. Summary of requirements

The following is a synthesis on a certain level of abstraction. This does not mean that the more detailed requirements as of section 3.3 are dismissed. They are valid.

The climate around electric mobility is temperate or somewhat cautious. The majority of stakeholders are still waiting for more evidence before being convinced that electric mobility will eventually take off. Consumers' general attitude towards electric mobility is positive but considerate and the majority is most likely waiting for electric vehicles to be superior to traditional ICE vehicles in every aspect before adopting them. This could change in the near future when knowledge and experience increase thus end user studies are needed to predict the diffusion.

The industry has studied and prepared for a possible adoption of electric mobility but on the other hand has now understood the need to clarify all the possibilities and risks related to mobility electrification. Many actors operating in the traditional mobility field want to understand the requirements of the change towards electric mobility as well as possible new entrants need to understand the developing electric mobility ecosystem. Still, future scenarios about the ecosystem are needed to reduce uncertainty.

Many stakeholders need the experience of a systematic use of electric vehicles and end user feedback. Thus electric vehicle and charging infrastructure demonstrations and pilots are wanted. Electric mobility is considered a disruptive industry which increases the demand for organized pilots to gather information and to push the industry forward.

Government and policy makers want to work with the industry and other stakeholders to understand the need for actions and their role.

4. Electric mobility value chain

The objective of this value chain is to provide a framework to identify needed actors and their role in making the chain sound.. Diffusion of EVs is directly depended on the services and other applications related to EVs. Consumers will not adopt electric mobility unless the complex entity of using EVs is offered well-designed. This is not possible without extensive supply of needed elements and collaborative business between chain elements. All the parts of value chain need to be covered, in other words the chain needs to be sound or there will not be business.

The generic industrial eMobility value chain is provided in figure 5. It is possible to divide the value chain elements in more detailed level because each element contains sub levels e.g. the element *vehicle supplier* contains sub levels, players and subcontractors however here only *battery supplier* is separated on its own since it is pivotal for the development of electric mobility.

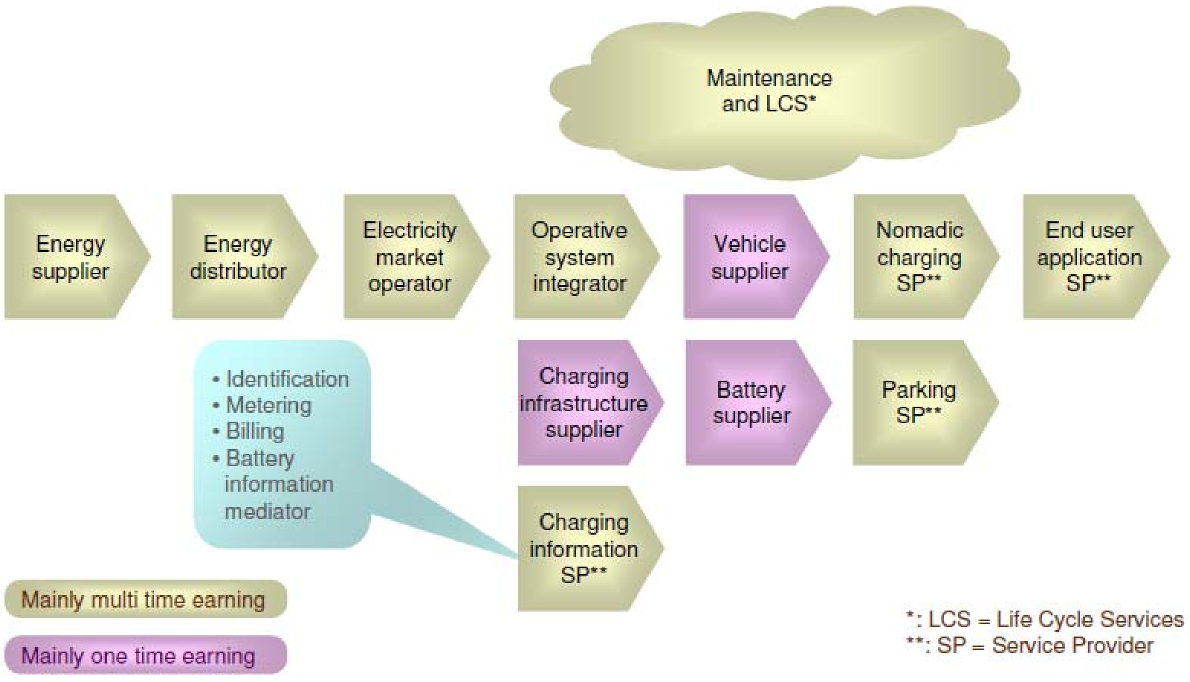
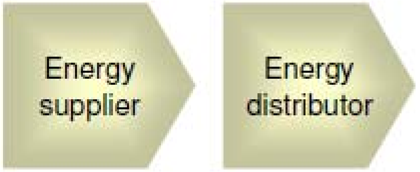


Figure 5. Generic industrial e-mobility value chain

4.1. Value chain actors and their roles in the chain

In the following we describe the actors in detail.



Electricity production and distribution is separated in Finland by legislation. Consumers can not choose the distribution company, it is determined by the location. The distribution company is a neutral party and operates strictly under legislation. In addition to distribution tariffs consumers pay electricity tax, strategic stockpile fee of the state and value-added tax. Distribution tariffs depend on power requirements and voltage. Consumers are free to choose their electricity supplier.

They also pay their bills separately to the chosen electricity supplier and to their local electricity distributor.

Electricity market operator

In the charging event the electricity supplier provides energy on demand and the customer pays the agreed price. Still, there might be a third party needed, in between car and grid, to manage the information, billing and electricity price variation (which depends on ratio of supply and demand). This third party, the electricity market operator is not yet obligatory when billing is part of other services e.g. parking fee or complementary of the service provider. In the future when charging volumes are higher, an operator between customers and electricity market will probably be needed.

Operative system integrator

The operative system integrator is needed for example when a local administrator decides to provide charging poles in a street car park. The operative system integrator would be an expert for taking care of all the necessary arrangements and practicalities as well as helping to co-ordinate. For instance the electricity distribution network and cabling needs to be sufficient and charging pole installations need to be done understanding the network requirements. Charging information service is needed and battery management systems need to function with it as well as with electricity supply.

Charging infrastructure supplier

Electric vehicles are dependent on electricity and battery charging is needed nearly daily thus adequate charging infrastructure is essential. Either home or work place charging or nomadic charging requires compatible and easy to use charging poles. Development of charging poles for EVs is quite fast and the poles are no longer simple, on the contrary there are sophisticated and smart poles coming to the market. The charging time needed is proportional to the power capacity. Standard household electricity gives 230 volts and up to 16 amps and takes 8-10 hours to completely recharge an empty battery. Faster charge stations are under development and for example a taxi pilot in Tokyo is testing 30 minutes rapid charge provided by Aker Wade Power Technologies working with Better Place battery swapping station (Better Place, 2010).

Charging information SP**

For making EV charging safe and convenient there needs to be information transfer between the battery, car and electricity network via the charging pole. Battery management system needs to control the charging and for optimising charging these systems communicate with each other. The information service provider enables the charging event to happen smoothly and effectively. Information mediated possibly includes identification of the car or the driver, metering the amount of energy as well as potential billing information of the energy charged.

Vehicle supplier

Electric vehicle production is at the outset and only electric bicycles and electric scooters are available in mass production. Lack of electric cars has led to emergence of eCars Now! which provides open source blueprints of the electric conversion kits to convert a traditional ICE car to an electric car. Moreover some manufacturers have made electric car conversions for demonstration purposes. This shift from ICE towards electrically powered vehicles is the biggest change in auto industry in the last 50 years. After a period of ambivalence all the manufacturers have published their first plans and future models of EVs.

Battery supplier

Battery manufacturers for EVs are operating both independent as well as partnering with EV manufacturers as shown in table 1. Accessibility to batteries could be salient for EV manufacturers. One example is the electric bicycle: European brands are offering better quality and performance in every aspect of a traditional bicycle but the batteries are not the latest technology. At the same time inferior Far East produced electric bicycles use the superior LiFePO4-lithium battery technology. The market lacks a model which would have everything state-of-the-art.

The battery is the most defining part of an EV and the recent improvement in Lithium batteries is one of the key reasons for making EVs possible. Lithium batteries require an advanced battery management system (BMS) because of the unsteady essence of lithium which needs to be monitored and controlled constantly (when driving, charging, pre-heating and in grid “feed-in” mode). Battery manufacturers develop their own BMS and offer maintenance and life cycle services but there are also companies who exclusively provide extensive battery management e.g. Lithium Balance A/S. While the battery lifespan in EV use is approximately 6-8 years, a battery can have a ‘second life’ e.g. in power plant after EV use.

Nomadic charging SP**

The term nomadic charging is often used to describe charging away from home or workplace. The existing (fuel) filling station network is one possible EV charging service provider in the future as well as supermarkets with large parking lots.

Parking SP**

During a large part of the day cars are parked and this gives opportunity to charge the battery without inconvenience. Today, distinct car parks and parking garages offer slow charging during parking and in the future this service will most likely grow.

Electric vehicles are better suited to city centre traffic than traditional ICE vehicles as EVs move without local emissions and exhaust gas. Therefore EVs would be ideal for car sharing clubs and car renting vehicles used in the centre. Also, hotels will be certainly willing to utilize the opportunity to provide for their customers EVs for city usage. EVs will be suitable for collecting traffic in context with railway stations for commuter traffic as well as long distance traffic.

Maintenance and life cycle services refer to all upkeep under many elements. This could be provided by the original supplier of the product e.g. charging pole or separately e.g. car repair shop, as well as centralized e.g. metal recycling. This element will be covered with each related element.

4.2. SIMBe project partners in the e-mobility value chain

Figure 6 locates SIMBe partners in the generic industrial e-mobility value chain. The objective of this example is to help to comprehend the logic in the value chain.

One example for an operative system integrator is Better Place which has taken the role of integrator in e.g. Japan, Australia and Israel.

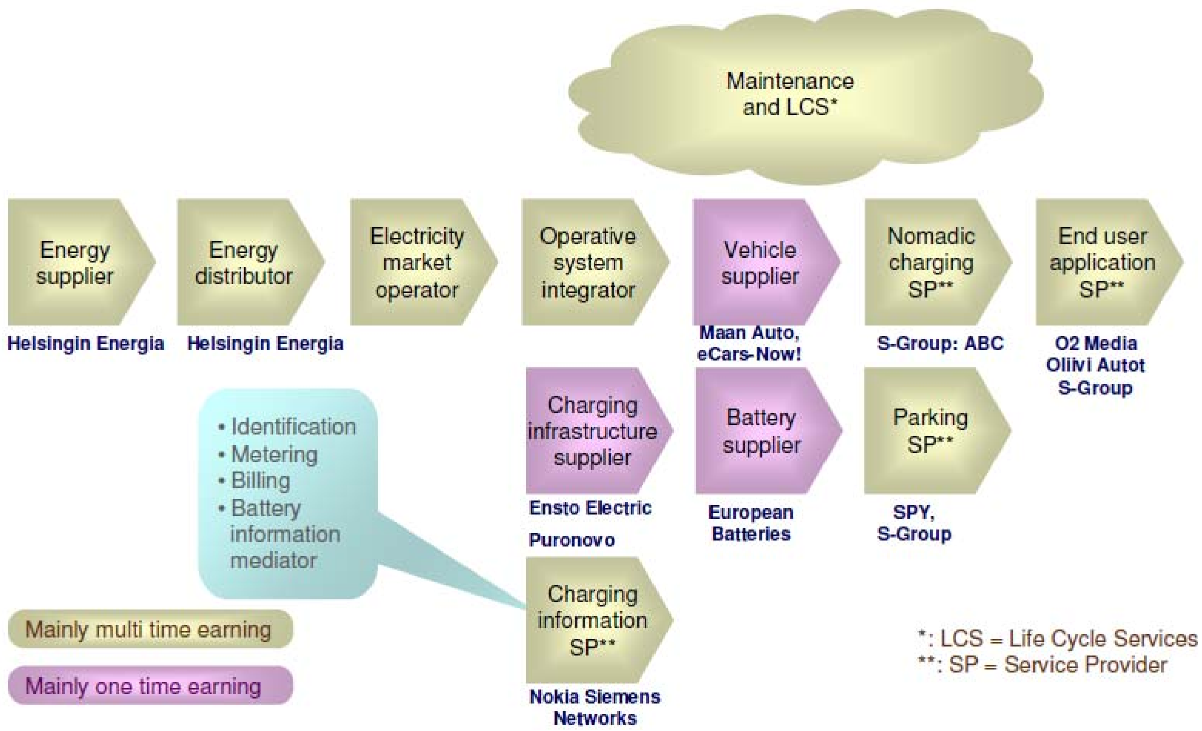
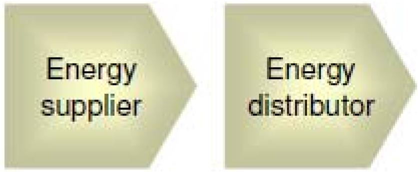


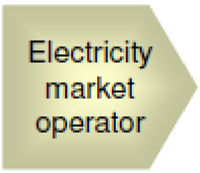
Figure 6. SIMBe project partners in the e-mobility value chain

4.3. Value creation models for value chain actors

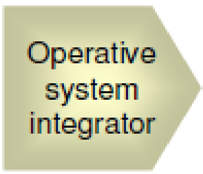
This chapter concentrates on value creation. Objective is to review how the actors in value chain can add value through taking on their roles in the chain.



Electricity production by e.g. wind has a timing problem i.e. there is not enough consumption when electricity is generated. EV batteries could help to solve this problem by providing energy storage when the EV is plugged into the distribution network. This requires a significant amount of EVs before this notably impacting the energy production framework. At the same time if EVs become general, the electricity distribution network may encounter load challenges and thus the development towards a smart grid is needed. This smart grid will offer a good environment for EVs to operate. The smart grid can involve EV batteries to play an important role in storing off-peak production and feeding electricity back to the grid when need. This Vehicle-to-Grid feature is a remarkable development for the grid as it will integrate the EV batteries to it. The development towards the smart grid will add value for the electric mobility value chain by making the EV more important in the electricity distribution framework. In addition this progress increases the role of the battery and possibly even amortizes partially the high purchasing costs for an EV as the users can sell the electricity back to the grid from the battery.



When the number of EVs in use is substantial the charging of batteries need to take place in off-peak times of electricity consumption. For motivating consumers to act that way there need to be value for them. The electricity market operator could provide real time price information which varies depending on demand. Besides that the price needs to be sufficiently high, the well-timed (ideally off-peak) charging needs to be convenient enough for consumers to adapt. The electricity market operator will add value to the e-mobility value chain by providing the information needed as well as controlling the charging timing as request. This will also serve the interest of electricity producers and distributor. The same added value applies for battery feed-in to the grid.



The operative system integrator may play a central role in connecting value chain actors' interfaces smoothly. Besides conducting the operative tasks of charging infrastructure installation there is a need to ensure that the value chain for charging the EV is sound. The operative system integrator also adds value in supporting other value chain actors' functions. From maintenance and life cycle services perspective it is important that there is a responsible and active player taking care of operative actions e.g. software and hardware updates.

Charging infrastructure supplier

Development of charging infrastructure is dependent on development of physical charging poles and stations. Charging infrastructure manufacturers will add relevant value to the electric mobility value chain by providing physical means to make the charging viable. Charging infrastructure manufacturers need to work closely with other value chain actors e.g. charging information service provider, energy supplier and distributor as well as vehicle and battery supplier. Particularly when the electricity distribution network will develop towards smart grid the EV charging infrastructure needs to respond to smart grid requirements. Intelligent charging infrastructure is in key position for supporting EVs for creating value in the electricity production and distribution framework.

Charging information SP**

The plain and slow EV battery charging does not need much sophisticated technology or information exchange between the vehicle and electricity distribution network. However immediately when the charging is more advanced the amount of mediated information grows. Especially when charging is to be well-timed regarding electricity supply and demand ratio, information is needed in real time. Interaction between the battery, charging station, electricity distribution network and electricity producer is dependent on the information service provider. The charging information SP will add value for the e-mobility value chain by making this communication smooth between different operators. The development of the smart grid necessarily requires intelligent information exchange between electricity producers, distributors as well as consumers or their electric vehicles.

In the following we quote how this role is seen to evolve in the future by the company Siemens IT Solutions, quoted from Li, 2010.

Begin quote:

> ***“Electric Ecosystems – Innovations for Mobility***
>
> […] *New trends in energy sector (energy production and utilities) include:*
>
> - *The need to reduce dependency on oil resources, focusing on innovative energy productions as well as encouraging saving energy*
> - *Increasing environmental awareness and regulations support CO2 free solutions*
> - *Private energy suppliers are emerging, forced to take part in the energy market*
> - *Stakeholders from different domains not used to work together are forcing integrated solutions to empower their business*
>
> *An innovative example shows that a combination of heterogeneous solutions is necessary to meet actual challenges. In Siemen’s vision of “Electric Ecosystem”, energy utilities, car makers and ecar service providers are working together in new and innovative business scenarios.*
>
> *A vision of mobility is emerging in which vehicles not only deliver clean transportation, but also store excess energy from renewable sources. New driver systems, battery, billing, and smart grid technologies are setting the stage for tomorrow's energy and transportation ecosystem.*
> *What are the visions that will become reality soon? Some examples are emerging from our research:*
>
> - *Cars that Generate Income*
> - *Battery Alliance*
> - *Selling Miles instead of Cars*

- *Outstanding Well-to-Wheel Efficiency*
- *High-Speed Electric*
- *Cars Join the Grid*
- *Mobile Power Plants*

Activities both inside and outside the car in such an Electric Ecosystem need to be addressed in this integrated approach with a lot of services, including:

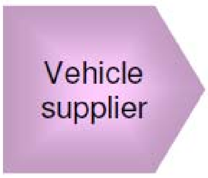
- *Energy management (e.g. utility mgmt, charging equipment)*
- *Mobility management (e.g. telematics, navigation/routing, driver information system, battery asset management)*
- *IT & System management (e.g. operations centers, ERP, master data management, identity infrastructure, messaging infrastructure, communication).*

We note that nearly all relevant ICT topics are addressed within the existing SIS business:

- *Grid Asset management*
- *Meter-2-Bill – Metering & Billing*
- *Payment*
- *Fleet mgmt.*
- *Car2X communication*
- *Telematic solutions*
- *In Car solutions*
- *Identity mgmt. and authentication*
- *Portal and collaboration services*
- *IT Backbone (Cloud)*
- *…*

The challenge therefore is not about inventing new ICT, but to integrate existing technologies and make them interoperable in the Electric Ecosystem involving different stakeholders - from energy providers to consumers as well as service providers."

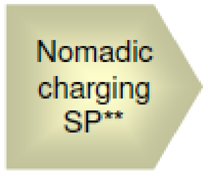
End quote.



Motivations for purchasing electric vehicles differ with potential consumers and end user studies will provide more information on this issue. Vehicle suppliers need to make sure they can deliver these wanted attributes. The electric vehicle has properties which have advantage compared to a traditional ICE vehicle, e.g. no local emissions or exhaust gas, less maintenance needs and lower "fuel" price. There is also a possibility for consumers to attain self-sufficiency producing energy by themselves by, e.g., solar panel or wind turbine. EVs could also provide value in a more abstract level by supporting the whole nation's energy self-sufficiency and energy security. EVs will probably be playing a key part in future smart grid and decentralize energy productions schemes. Smart housing and future energy solutions will integrate car batteries to households or to entire electricity networks, hence EV manufacturers need to work close to various stakeholders to deploy the EVs huge potential of creating value.

Electric vehicle battery manufacturers have a possibility to play a more central role in the electric mobility value chain than only to supply batteries. Besides the technological requirements and value of battery management system the battery manufacturers will probably offer more holistic solutions for storing energy. As electricity distribution networks will evolve towards smart grid and the decentralized electricity production, including wind and solar power, grows intelligent energy storages are needed. EV batteries need to be sophisticated to smoothly integrate into the smart grid. Intelligent EV batteries will add value for the future electricity market and electricity distribution network developments.

Because the batteries are the most expensive components in the electric vehicles, new financing solutions will be needed in order to make the prices of EVs more attractive for consumers. Leasing of batteries is one possible approach. Thus leasing companies may play a role in the value chain as well.



The existing fuel station network could be a future EV charging service provider, complemented by, e.g., supermarkets, shopping centres and other public areas with large garages and/or parking lots. The monetising clue is the “full battery, here and now” requirement, which allows asking for a considerably higher fee per kWh than in usual home or work place charging.

Already today selected car parks and parking garages, also in Finland, offer slow charging during parking. In the future this can be extended in volumes and also in speed (of charging). Ultimately a parking service provider can become nomadic charging service provider.

EVs are most suitable for urban traffic due to their inexistent exhaust emissions. Thus EVs are ideal for urban car sharing clubs and car rental agencies. Also hotels and further real estate and utility providers can certainly realise the opportunity to provide EVs to their urban customers. EVs will be suitable for collecting traffic in context with railway stations for commuter traffic as well as long distance traffic. Thus a whole gamut of business opportunities through e-mobility is opening up. Note that the market will gradually become end-user driven – they ask for clean mobility, including smart mobility, and they are most likely ready to pay for it.

Maintenance and life cycle services are usually integrated in various chain links. These services could be provided by the original supplier of the product (e.g. charging device/pole) or separately (e.g. car repair shop), as well as centralized (e.g. battery recycling).

4.4. Overview of future business concepts

The business related to electric mobility is in infant stage. Many of the roles and models described in the chapters 4.1 and 4.3 are still under development and could be defined as future business concepts as well. The purpose of this chapter is to look even further into the future and outline briefly some of the possibilities in the electric mobility business concepts. This theme will be discussed deeper in the next (internal) SIMBe deliverable D1.2.

Taking into account the nature of a battery and electricity propelled vehicle, the resulting cost logic could embrace much more options compared to a conventional ICE vehicle. Vehicle leasing could be extended to cover the whole usage. Instead of only leasing the vehicle, the customer would pay by kilometre. Electricity producer and distribution company would be part of the leasing agreement as well as battery supplier and maintenance and life cycle service provider. Thus the high purchase price of the electric car could be divided between many actors in the agreement. This is similar to mobile phone sales where customers are used to pay by call duration and get the device without extra purchasing costs.

The charging of the vehicle is a nearly daily operation and if done in a smart and sustainable way it requires cooperation of many actors. When the number of electric vehicles is substantial the charging must be done well planned or the electricity system may not be able to handle the load. Besides this challenge, charging also opens new business opportunities. For charging to be smart it needs to be well-timed and take into account the current electricity production situation and this requires improvement in the electricity distribution network communications. On the other hand there is a strong development going on for making the smart grid a reality, even without EVs. Therefore the whole electric vehicle charging can be safely considered as just one element of the future smart grid.

Understanding electric vehicles as part of the electricity framework the new business concepts need to be developed in collaboration with the smart grid. For the end user the charging of the electric vehicle need to be convenient, safe and straightforward as well as the paying for the electricity needs to be simple. Both charging event and transaction development should be in collaboration with the smart grid. For instance automatic electric vehicle identification, roaming and billing automations and smart charging timing are needed for making charging convenient. From this perspective the future charging business concepts are closely to related to the development of the smart grid.

In Finland the starting point for developing the infrastructure for slow charging of EVs is good due to the large number of existing car heating plugs. The situation is different when considering the fast charging infrastructure and related operation models. The local energy requirements are far more challenging for fast charging. New innovative solutions can solve the energy requirements for local charging points by utilizing i.e. battery swapping solutions and related energy rack scenarios. This opens also new business models for value chain actors.

The question of who takes the integration role in the value chain is open and different possibilities will be evaluated in the near future. In some countries a battery switching actor (Better Place) has taken this role and is extending its business. We expect other integrator solutions as well as new innovative approaches to emerge in the mid term.

5. Conclusion

There is a high momentum in electric mobility and the possible shift from ICE to battery and electric motor is perhaps the biggest technological change in the transportation history. Recharging the vehicles, electricity billing and other services will create a rich industry value chain around electric mobility. There are many challenges but also opportunities to establish smart business models and add value to this ecosystem.

This ecosystem is slowly commencing. Electric cars are soon entering the market which will increase the demand for service providers to act faster. End user surveys and studies give guidelines but only real use of EVs can provide the relevant customer requirements through actual experiences. Many actors in the industrial value chain are ready to act but want to wait for more certainty before making investments. After the chicken-egg problem is passed the development could be faster than expected. Still, the current uncertainty needs to be addressed – there are literally too many roads to take. Some of them ending in write-off investments. Therefore to accelerate the adoption of EVs several countries have decided to give subsidies to reduce individuals' and companies' risks.

The major findings of this document are:

- Many actors operating in the traditional mobility field want to understand the requirements of the change towards electric mobility as well as possible new entrants need to understand the developing electric mobility ecosystem.
- Many stakeholders need the experience of a systematic use of electric vehicles and end user feedback. Thus electric vehicle and charging infrastructure demonstrations and pilots are wanted.
- The industrial value chain of electric mobility is not yet ready. This means also that the related business models are not yet clearly defined. Still, there are good business opportunities for many kind of actors in the value chain in the near future.
- Who will take the integrator role in the industrial value chain is still an open question.

We recommend the following:

- An ongoing discussion on electric mobility between industry, government representatives, researchers and other stakeholders is to be launched and maintained
- Emerging business models need to be developed together with several actors in the electric mobility value chain
- Future scenarios about the ecosystem are needed to reduce uncertainty.

6. Discussion

6.1. Limitations

The progress in electric mobility is rapid and there is a high risk of **state-of-the-art** information to be outdated. The **requirements**, however, based on our current knowledge, are complete. As said before the **value chain** is not yet ready to be implemented and continuous follow up of the progress is needed.

Another limitation comes from the nature of emerging business models. Even if interviewed organisations expose key developments, the situation is constantly evolving. For example, liaisons between large companies, or standardization, or government actions could change the conditions for efficient business models.

6.2. Further Research

The current analysis results are rather industrial driven. Thus, as outlined in chapter 3.1.2, an end user study is needed as a complement. The consequential continuation of requirements analysis and value chain modelling will be more detailed studies of business concepts for electric mobility in built environments.

Regarding technologies, the following is needed:

- research on new technology driven concepts of combined EV and sustainable communities
- a blueprint for charging in the greater Helsinki area is needed, as well as
- deeper understanding of charging and feed-in options of EVs

The SIMBe project will perform this research in its work packages 1-4. See also www.simbe.fi

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