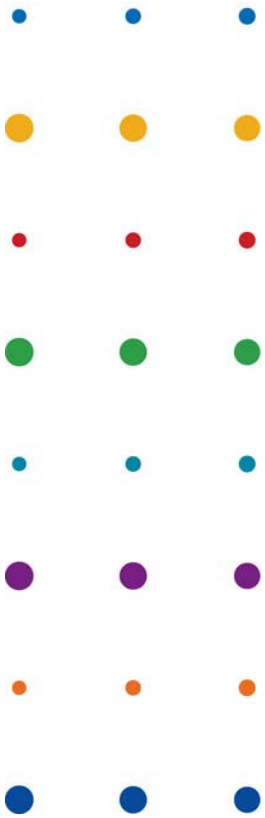
Electric Road Transport policies in Europe till 2015: opportunities, experiences and recommendations



Supervisory panel ENT19

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Final report study 1 and 2

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ERA-NET TRANSPORT (ENT)

This report presents the results of the research performed in the project Electric Road Transport policies in Europe till 2015: opportunities, experiences and recommendations..

The project has been funded by the countries Austria, Finland, the Netherlands and Norway, who set up the trans-national research call ENT19 Electric Mobility.

The initiative is organised under the umbrella of ERA-NET TRANSPORT (ENT), a network of national and regional transport research programmes.

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SUMMARY

Need for a practical roadmap offering recommendations to (local) policy-makers
The mass deployment of electric and plug-in hybrid electric vehicles (EVs and PHEVs) that rely on renewable sources of electricity has great potential to significantly reduce the emissions of greenhouse gas (GHG) by the transport sector.

The first phase of deployment of electric road transport is presently taking place. It is characterized by national action plans and 'learning by doing', frequently by means of demonstration pilots at the local level. Up to now there is little co-alignment of national policies, action plans and (local) initiatives, leading up to an ambiguous and fragmented market for electric road transport.

The aim of this project is to contribute to the co-alignment of the national and local initiatives and to encourage large scale market development of electric road transport in Europe, by:

1. Defining the potential market for electric and electric-hybrid vehicles (in particular regarding characterization), taking into account: a) the needs of relevant end-user groups in Europe; b) the current and future availability of vehicles to meet these needs; and c) conditions for integrating electric road transport in the existing transport system.
2. Providing guidelines to policy-makers on how to meet the market potential and make broad implementation of electric driving happen.

Scope and methodology
The scope of the project is limited to electric (BEV or EV) and hybrid-electric (PHEV) vehicles used for road transport. The emphasis is on passenger cars, yet vans (weighted less than 3,5 tonnes) are also included.

The primary geographical focus is on the countries involved in the joint assignment (Austria, Norway, Finland and the Netherlands), the projected time horizon is 2015, with a view on 2020. Basic principles of the research methodology were:

1. Collecting national findings by the individual partners through 1) surveys with keys stakeholders (government and front-runner companies), 2) desk-research and 3) statistics on travel demand features.
2. Integrating those to derive best practices, recommendations and opportunities for co-alignment of national policies at European scale.

Supply side of the EV market
For the time being, the EV will be a sellers market. The market can be characterized as follows:

– The emphasis is on small city vehicles at the one hand and on bigger far more expensive models.
– There is a remarkable spread in attitude of manufacturers towards electric driving.
– Some manufacturers see plug-in hybrid EV as *the* stepping stone, others bet on Battery Electric vehicles (BEVs).
– Batteries will remain costly in the next 5 to 10 years.
– (Really) fast charging is an optionm within 5-10 years.
– Wireless technology is an antidote to range anxiety.
– Smart grid and smarter connected vehicles are to revolutionize the way we use electricity.
– Battery switching may be an alluring alternative.

Market for p(H)EV still small, yet (potentially) booming

The market share of Battery Electric Vehicles (BEVs) is still very small, since the BEVs are more expensive (despite tax rebates) and have a limited range. In Norway the business case for electric cars is the most positive as a result of the biggest difference between gasoline/diesel price and electricity price and the most advantageous (fiscal) incentives. Norway has therefore by far the most electric vehicles (151 e-cars/100.000 ICE). EV drivers profit from real advantages such as faster commuting, easier access to city centres, easier parking, lower operating costs, and – in some cases – a positive image. Finland on the other hand, is having very few electric cars (1 e-car/100.000 ICE), also compared to Austria and the Netherlands (both 5 e-cars/100.000 ICE).

Interestingly though, it is clear that a large national automotive industry does not necessarily lead to a larger penetration of EV. The Netherlands and Denmark have a very small car manufacturing industry and are yet ahead of France and Germany with the number of EVs in use.

(B)EVs offer some unique selling points:

- no noise,
- no (local) emissions
- single gear

However, they still suffer from some major draw-backs (also in 5-10 years from now) that may interfere with large scale adoption of electric driving, such as:

- a substantial higher purchase price,
- limited choice of models
- and limited range (in case of BEV).

Presently, few hundred (Austria, Netherlands, Denmark) up to around 3.000 EVs (Norway, Italy) are in use in most EU-countries. Future volumes of EV are difficult to predict, due to the highly qualitative nature of this research, yet volumes up to 10.000 EVs seem to be in reach for most countries.
The actual volume is highly dependent on the implementation strategy of the automotive sector over the next years and the contribution of public authorities, charging infrastructure providers and intermediate partners such as leasing companies and providers of new service concepts.

Fleet owners are the most likely early adopters

User-group characteristics of the early adopters, that may be derived from the EV characteristics depicted above are:

- Predictable mobility pattern of the car, limited distance travelled per day (50-150 km), nighttime and intermediate periods available to recharge (at least 30 min in case of fast charging, or 4-8 hrs in case of slow charging) during the day.
- Yet intensive or daily use of the car, the more kilometers the easier the high purchase costs can be recovered (and the lower the relative environmental impact).
- Appreciation of certain comfort aspects, such as the absence of noice/stench/ gears.
- Willingness to pay higher total costs, willingness to pay the far higher initial costs.
- Willingness to compromise on choice (look and feel).
- Appreciation of the lower environmental impact (and/or the green image).

Looking at the characteristics of potential early adopters, *professional fleet owners appear to be the most likely early adopters*. (Large) fleet owners are used to large investments in the car park and to calculate with the total cost of ownership (TCO) rather than just the cost of purchase, have larger marketing budgets to spend on a favorable and green image, often have committed themselves to social corporate responsibility and – due to the larger fleet – have the possibility to organize their transport in such a way

that the EV can be fitted in despite its stricter mobility profile. Presently, by far most e-cars are company cars.
End-users should not be neglected, however. After all, they are key to reach mass deployment as they constitute the vast majority of all cars. Also end-users may appreciate the added value of the EV, being environmentally friendly, without stench and noise and single gear. In the Norway case a substantial number of end-users have procured electric vehicles which serves as an interesting example to learn from.

Early adopter groups are:

1. Public (local) authorities
2. Professional fleet owners:
   - Utility and energy companies
   - Taxi operators
   - Delivery services
   - Large companies (with focus on Corporate Social Responsibility)
3. End-users:
   - City dwellers / commuters, green conscious and flexible.

User requirements are generally limited to lower costs, more choice and larger range
Users would like EVs to fulfill the same requirements the conventional fossil fuelled cars. When asked requirements are defined in relation to the characteristics of existing BEVs:

1. First of all, a ***lower TCO*** is considered crucial. In some cases the TCO should be equal to the conventional vehicles, yet in many cases a slightly higher TCO (5%) is considered acceptable (also part of the TCO are aspects like the residual value of the battery and reliability of operation).
2. The requirement of a lower TCO is closely followed by the requirement of ***more choice of vehicles and models,*** such as mid-size passenger cars, vans and light trucks.
3. Thirdly, ***a larger range*** is asked for ***or the possibility of fast charging*** (however, a larger range is requested more often).

National and local evidence
The participating partners in this study come from the EU countries Austria, Finland and The Netherlands. In addition EEA partner Norway participated with case studies from Norway and Denmark. Finland with case studies form Finland and the UK. Together the experiences from all these countries serve as a good basis for suggesting a road map for the implementation of “Electric Road Transport” policies in Europe. It is also important to note that some of the experiences and differences between these countries should lead to important warnings against making *the* common European road map irrespective of the context of country and culture. Hence, *all* initiatives may offer interesting lessons on their own, and particularly when they are read in relation to each other.

The initiatives studied may be grouped as follows:

1. **National action plans,** that promote electric driving through strong national support, by bringing authorities and industry together and define optimal (testing) paths and EV introduction
2. **Regional or local public / private initiatives,** as a means to demonstrate promote electric driving, either driving by environmental and/or economic objectives or by looking for the best way to obtain good business cases.
3. **More general public / private initiatives,** more or less the same as their regional counterparts, but without a regional focus. Focus my vary, e.g. on the regulatory framework, involving stakeholders, infrastructure building and providing information or green energy

4. **Private initiatives, oriented at common green procurement,** by bringing together vehicle procurement of various companies in order to achieve a minimum demand level for EVs and bring down prices.
5. **Initiatives of public authorities and big companies to act as role model,** introducing EVs into their own fleet.

Lessons learned and recommendations

Important lessons to be learnt from the studied initiatives (national plans, local plans, private initiatives) for the integration of electric road transport are listed below and translated into recommendations. They should be read as interrelated and interdependent lessons about different conditions for integration of electric road transport.

1. Consistent and dependable long term policies are needed:
   a. Policies at the various policy levels (EU, national) should give a clear message about the political will to support transition to electric mobility, also as a basis for the subsequent lower policy level.at various policy levels (EU, national) to give a clear message about the political will to support transition to electric mobility.
   b. National policies are needed to involve local authorities as key stakeholders.
   c. National policies are needed to facilitate co-alignment between actors and between national authorities and to facilitate coalitions that will create a market pull for e-mobilty.
   d. To search for the optimum between market leading the way and government incentives or regulation.
   e. Policies are also needed to promote R&D, especially for advanced energy storage
   f. Clear targets will enable national action plans to be cost effective.

2. Policy measures should:
   a. Focus on high potential user-groups (early adopters)
   b. To the extent possible, policies should not favour particular technologies but promote good performance.
   c. Policy measures should aim at achieving first initial shortcomings of the electric mobility system, such as achieving first cost and full ownership (life-cycle) cost-equivalence between EVs/PHEVs and similar ICE vehicles
   d. Policy measures should be oriented at building a future-proof charging infrastructure and gain experience with smart grids.

3. Persistent communication is required to co-align the actors at large and at different levels to work in tandem towards the introduction of electric mobility:
   a. Accurate knowledge, practical evidence and demonstrations are needed to raise confidence, share experiences and create enthusiasm, to learn from more experienced initiatives or actors in order to avoid wasting time and resource on reinventing the wheel over and over again.
   b. Authorities should act as role models and ‘market shapers’ to gain real life experiences and introduce electric cars to the streetscape, that will seduce early movers.

1 INTRODUCTION

1.1 Background

The mass deployment of electric and plug-in hybrid electric vehicles (EVs and PHEVs) that rely on renewable sources of electricity has great potential to significantly reduce the emissions of greenhouse gas (GHG) by the transport sector. The IEA vision of the Electric and Plug-in Hybrid Vehicles Roadmap is to achieve by 2050 the widespread adoption and use of EVs and PHEVs, which together should represent more than 50% of annual LDV (light duty vehicle) sales worldwide. Achieving these firm ambitions requires that EV/PHEV technologies for LDVs evolve rapidly over time, with very aggressive rates of market penetration once deployment begins (see fig. 1.1). PHEVs and EVs are expected to begin to penetrate the market soon after 2010, with EVs reaching sales of 2.5 million vehicles per year by 2020 and PHEVs reaching sales of nearly 5 million by 2020. By 2030 the sales of EVs are projected to reach 9 million and PHEVs are projected to reach almost 25 million. After 2040, sales of PHEVs are expected to begin declining as EVs (and fuel cell vehicles) achieve even greater levels of market share. The ultimate target is to achieve 50 million sales of both types of vehicles annually by 2050 (Ref. [1]).

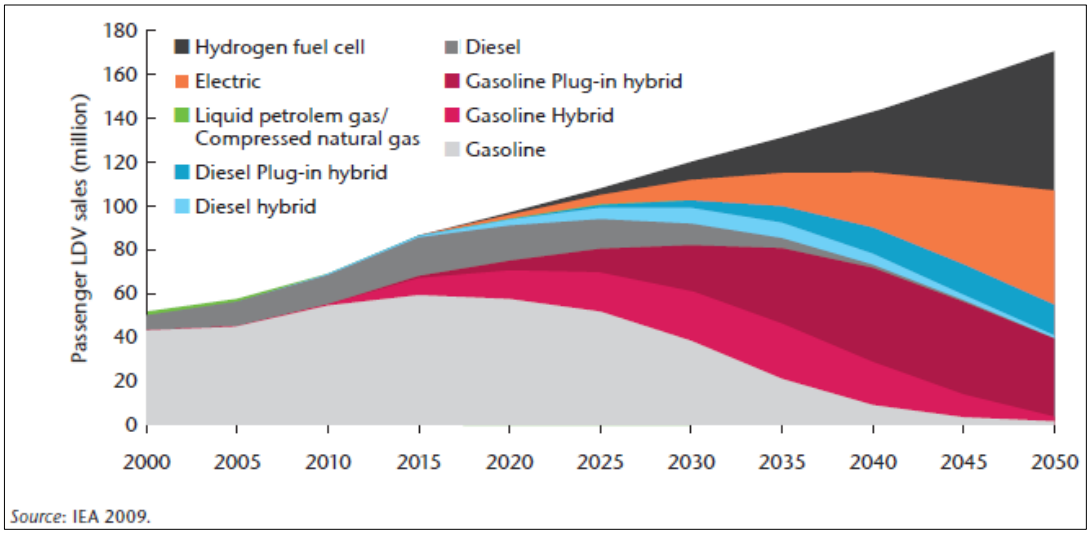

FIG 1.1: Annual light-duty vehicle sales by technology type, BLUE Map scenario.

To cover the development of the EV/PHEV market worldwide up to 2030 and to attain widespread adoption and use of EVs and PHEVs worldwide by 2050, government involvement and strong policy support are considered essential. IEA recommends several lines of policy that align with global targets to stabilize GHG concentrations, including:

National governments leading strategic planning efforts by working with “early adopter” metropolitan areas, targeting fleet markets and supporting education programs and demonstration projects via government-industry partnerships.

Coordinated strategies to support the market introduction of electric-drive vehicles. Electric-drive vehicles are unlikely to succeed in the next five to ten years without strong policy support, especially in two areas: making vehicles cost competitive with today’s internal combustion engine (ICE) vehicles (for example by using fiscal instruments) and ensuring adequate recharging infrastructure and electricity supply are in place.

Improving industry understanding of consumer needs and behaviours. Currently, the profile of car buyers in most countries is not well known. The industry needs to gain a better understanding of “early adopters” and mainstream consumers to overcome market barriers and increase the demand for electric-drive vehicles. Fostering low-cost infrastructure to facilitate PHEV and EV introduction. Other valuable areas to explore include innovative electricity recharging systems (e.g. battery swapping centres), grid powering from batteries, smart metering and implications for drivers and utilities.

The IEA outlines additional recommendations that must be considered in order to successfully meet the technology milestones and strategic goals. These recommendations include the following:
Use a comprehensive mix of policies that provide a clear framework to at least 2015 to give stakeholders a clear view.
Engage in international collaboration efforts to help lower costs and accelerate EV/PHEV technology diffusion. Key areas for information sharing and collaboration include e.g. policy development and experience in implementing different approaches.

1.2 Objectives of the study

In 2010 the interest in electric mobility is increasing rapidly, both with manufacturers and with the authorities: electric driving is recognized as offering a major potential for reducing local air pollution, GHG emissions, noise levels and oil dependency. The very first phase of deployment of electric road transport has just started and is characterized by national action plans and ‘learning by doing’, frequently by means of demonstration pilots at the local level.

The transition towards *large-scale implementation of electric mobility* however is complex, since many aspects and actors (with their interests) are involved and need to be tuned to support each other. We may group those in four categories of stakeholders and issues, which are interrelated:
Technology, such as manufacturers, suppliers, maintenance: batteries (charging time, efficiency, recycling), renewable energy, road safety, etc.
Use and behaviour, such as individuals (commuters, consumers at large), fleet owners (public and private, urban distribution companies) and operators (car leasing companies, taxi companies, dedicated public transport, car sharing agencies, car rental companies, etc.): functional requirements (driving range, safety, reliability, flexibility, comfort, size), costs (purchase versus use), etc.
Governance and business models applied by public & private parties (local and national level): PPP, fiscal incentives and regulation and conditions, consumer subsidies, R&D outlays, demonstration projects, user arrangements, etc.
Public space and infrastructure provided by public & private parties: electricity network (smart grid), charging facilities (pay and pole standards, induction, battery changing stations), spatial integration, parking facilities etc.

The first phase of deployment of electric road transport is presently taking place. It is characterized by national action plans and ‘learning by doing’, frequently by means of demonstration pilots at the local level. Up to now there is little co-alignment of national policies, action plans and (local) initiatives, leading to an ambiguous and fragmented market for electric road transport. To achieve the firm ambitions that are laid down in the IEA roadmap, the eagerness of frontrunners should be channelled and used to convince the (late) majority to join the transition towards electric mobility. The aim of this project is to contribute to the co-alignment of the national and local initiatives and to encourage large scale market development of electric road transport in Europe, by:

1. Defining the potential market for electric and electric-hybrid vehicles (in particular regarding characterization), taking into account: a) the needs of relevant end-user groups in Europe; b) the current and future availability of vehicles to meet these needs; and c) conditions for integrating electric road transport in the existing transport system.
2. Providing a practical roadmap, offering guidelines to policy-makers on how to meet the market potential and make broad implementation of electric driving happen.

Objective 1 has been addressed in study 1, whereas objective 2 is the subject of study 2.

1.3 Scope: geography, vehicles and time frame

The scope of the project is limited to electric (BEV or EV) and hybrid-electric (PHEV) vehicles used for road transport. The emphasis is on passenger cars, yet vans (with a weight less than 3.5 tonnes) are also included. Motorcycles and mopeds are included if the occasion rises. The primary geographical focus is on the countries involved in the joint assignment (Austria, Norway, Finland and The Netherlands). In addition to these countries various countries with a domestic car industry such as France, Germany, the UK and Italy have been (briefly) investigated. Denmark, with it's ambitious action plan on electric mobility, has also been investigated. The study focuses on the short term. The projected time schedule is 3-5 years (2015) for the market potential as well as policy measures to encourage electric driving with a view on 2020.

1.4 Research methodology

Basic principles of the research methodology are the following:

1. National findings have been gathered by the individual partners, simultaneously for the involved and other countries as well as for study 1 and 2.
2. Desk research of existing reports (projects, action plans, policies, handbooks) and statistics on travel demand features have been carried out also for the other countries involved.

Since electric road transport is still in its infancy and much knowledge and experiences have not been reported on, additional information has been gathered for the involved countries. To gain in–depth information, especially regarding enablers, barriers and the implementation process (study 2), at least 20 relevant stakeholders (front runners, national associations and policy makers) were interviewed, either in person or by telephone. The information has been integrated to draw conclusions and recommendations on the European level.

1.5 Target groups of the report

The primary target group for this report is policy-makers (EU, national, regional/local level).
Special attention was paid to their networks and sources of information. Other target groups
are:
Private sector; i.e. the automotive industry, mobility providers, lease companies, energy suppliers and their umbrella organizations.
Academic community (incl. other EU-projects regarding sustainable transport).
Civil society (NGOs), such as environmental organizations.

References

[1] Technology Roadmap Electric and Plug-in Hybrid Electric Vehicles, IEA 2009.

STUDY 1

2 ADOPTION MODEL OF ELECTRIC MOBILITY

2.1 Introduction

In this chapter an adoption model for electric mobility is presented, using the famous Rogers' adoption model for the diffusion of innovations. The model shows which stages should be passed to reach eventually large scale deployment of electric cars. Also, this chapter will address the present situation regarding electric driving in the participating countries to see where we stand today.

2.2 Adoption model of electric road transport

For our analysis of the market adoption of electric vehicles, we choose to use Rogers' adoption model, which shows the diffusion of innovations among different categories of user-groups over time. The model, first published by Rogers, has become the standard in all scientific textbooks on marketing and the diffusion of innovations. Rogers claims that all new innovations and ideas are adopted by consumers according to a particular pattern:
innovators → approx. 2.5% of the relevant market
early Adopters → approx. 13.5% of the relevant market
early Majority → approx. 34% of the relevant market
late Majority → approx. 34% of the relevant market
laggards → approx. 16% of the relevant market

The model is based on what is known as the Bell Curve, which follows a standard distribution. In practice, the curve can take many different shapes. All innovations introduced to the market today far from follow the same curve. Some products may have a very short introductory period before they hit the mass market. Many products and services are currently designed to be so "niche-oriented" that they never hit a mass market.

Nonetheless, this curve seems suitable for use in describing the attempt to introduce a new technological platform in the car market. Firstly, because the intention of the electric car is precisely to break into the mass market. And secondly, because the car market is a conservative market where most consumers think and act more traditionally than they do in other product and service areas [2].

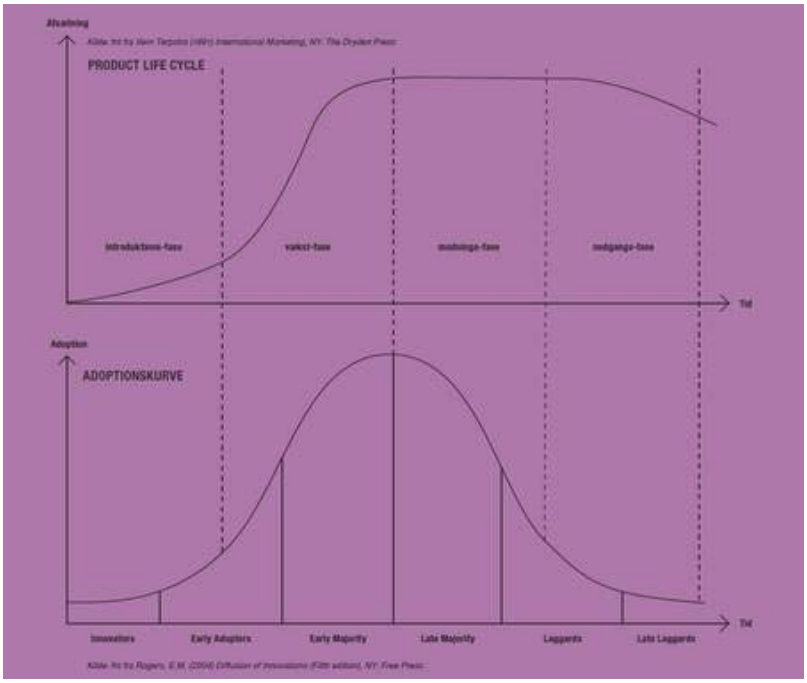

FIG 2.1 Rogers' adoption model (www.etrans.dk).

The economic crisis started in 2008 and led to an increasing interest in small and fuel-economic cars. Remarkably, the share of hybrid electric vehicles (HEVs) in total car sales continued to grow in many countries. This trend is expected to continue because of the following reasons:
HEV cars are more fuel-efficient than ICE cars, especially in urban traffic.
More hybrid models will become available on the market.
Higher production volumes may lead to lower HEV costs and prices.
Incentives for energy-efficient and low CO_2 emitting cars, such as tax reductions and entry rules for urban areas.

The growth of the sales share of HEVs is expected to continue in established markets (today a 2-3% share in new vehicle sales) as well as in markets where hybrid sales are in their infancy. It is assumed that a steady number of new models will be introduced over the next ten years, with eventual targeted sales for each model of 100,000 units per year. However, it is also expected that this sales rate will take time to achieve. Although most vehicles manufacturers ("Original Equipment Manufacturers", or OEMs) are planning to bring new hybrid models on the market in the coming years, it is expected that total HEV sales will be limited because of limited supply. New EV and PHEV models will be introduced at low production volumes as manufacturers gain experience and test out new designs. Especially the production volume of batteries might be a bottleneck.

Early adopter consumers are expected to play a key role in sales, and sales per model are expected to be fairly low as most consumers will wait to see how the technologies and market develop. As a result, it is assumed that from 2015 to 2020, the existing number of models and sales per model will increase fairly dramatically as companies move toward full commercialization (IEA). With EVs reaching sales of 2.5 million vehicles per year by 2020 and PHEVs reaching sales of nearly 5 million by 2020 (projected time schedule in the BLUE maps), we are by then about to enter the phase of early majority (between 2020 and 2025).

In other words, the challenge for the coming years is to make the Great Leap Forward from innovators to early adopters and successfully pass through the phase of early adoption. Early adopters have - similar to innovators - more financial lucidity and have close contact to scientific resources and other parties that are involved or related to the innovations. However, they are:
More discrete in adoption choices than innovators. Realize judicious choice of adoption will help them maintain a central communication position (Rogers 1962 5th Eds., p. 283 [1]). *Meaning they are more critical of the performances of electric cars.*
They have the highest degree of opinion leadership among the other adopter categories. *Meaning they are crucial to convince the early majority to get acquainted with the innovation.* More on this in chapter 5.6.1.

2.3 Electric mobility at present

Where do we stand regarding electric mobility in the year 2010? The table below shows a number of key characteristics regarding the penetration of E-driving in the countries that are part of our study.

The figures are just indicative, as data sources differ between countries, and the market of electric mobility is highly dynamic. All in all, we can conclude that the market of pure EVs is still very small. EVs are a success in a number of market niches where they offer a clear advantage for the users.

In Norway the business case for electric cars is the most rewarding caused by the biggest difference between fuel price and electricity prices and the most advantageous (fiscal) incentives. Norway has therefore by far the most electric vehicles (151 e-cars/100.000 ICE). EV drivers profit from real advantages such as faster commuting, easier access to city centres, easier parking, lower operating costs, and – in some cases – a positive image. Finland on the other hand, has very few electric cars (1 e-car/100.000 ICE), also compared to Austria and The Netherlands (both 5 e-cars/100.000 ICE).

Since the electric car is still very much confined to market niches, no clear relationship between urbanisation degree and car distance can be detected. Interestingly though, it is very apparent that a large automotive sector does not necessarily lead to a larger penetration of EV. The Netherlands and Denmark have a very small car manufacturing industry and are yet ahead of France and Germany with the number of EVs in use.

Even if the EV market may still be modest, it is due time to start taking into consideration e.g. the aspects of recharging systems in construction and building regulations. In order to give equal possibilities for all motorists to use EVs, public charging infrastructure is needed. Again, figures are indicative and probably out-of-date already. It is obvious however, that Norway is very active concerning public electric charging.
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Characteristics 2010	Netherlands	Austria	Norway	Finland	Italy	France	Denmark	UK	Germany
Fleet of passenger cars (x 1 mln)	7,6	4,6	2,2	2,9	34,4	32,3	2,1	28,4	41,7
-> of which are leased (x 1.000)	460 (6%)	440 (10%)	n.a.	175 (6%)	-	-	-	-	1.7 (4%)
Fleet of vans (x 1 mln)	0.9	0.3	0.4	0.3	-	-	-	-	-
Urbanisation degree (% of population living in urban areas)	82%	67%	79%, but only 32% live in cities with more than 100 000 inhabitants	68%	68%	76%	85%	90%	88%
Mean car trip (km)	17 km	32 km	21	19 km	33	36	-	-	35
Annual car kilometers (km)	13.700 km	13.500 km	13.400 km	17.000 km			-	-	12.600 km
Electricity costs of 15.000 km in EV (euro)	€ 500	€ 306	€ 104	€ 223	€ 467	€ 244	-	€ 267	€ 425
Petrol costs of 15.000 km in conventional car (1 l gasoline on 10 km)	€ 2.400	€ 1.800	€ 2.550	€ 2.200	€ 1.950	€ 2.025	-	-	€ 2.100
Electric cars in total (#)	395	223	3.400	17	2.700	1.400	400	-	1.600
Electric passenger cars per 100.000 conventional passenger cars	5	5	151	1	8	4	19	-	3
Charging points, public and private (#)	400	532	2.666	50	670 (under construction)	178 (Paris and suburbs)	45 (only public)	400	875
Direct employment in auto and parts production (x 1.000 employees)	24,5	32	-	8,3	196	304	6,3	213	773

FIG. 2.2: EV market characteristics of countries involved in the study [3].

References

[1] Rogers, The Diffusion of Innovations, 1962.
[2] www.etrans.dk.
[3] Various national statistics provided by national partners.
[4] Outlook for Hybrid and Electric Vehicles, 2009, IEA.

3 AUTOMOBILE INDUSTRY PERSPECTIVE ON ELECTRIC MOBILITY

3.1 Introduction

The upcoming market of electric vehicles coincides with a worldwide economic crisis. Also the traditional car manufacturing companies as well as the energy sector have been hit by the crisis. It may well turn out that the introduction of the first OEM electric vehicles actually forms the first sign that the dawn of a new era has arrived.

Today's EVs and the infrastructure needed to support them may seem far out compared with conventional cars that run on gasoline, but they are within reasonable thinking compared with what is on the drawing boards. Automakers are pushing the definition of the motor vehicle as they contemplate a future with densely populated cities that are inhospitable to today's cars and trucks. Current EVs struggle to achieve higher performance and greater range than the current 150 km or so, to compete credibly with combustion engine cars.

The concept of electric connected vehicles is in the pipeline. There are three macro trends that drive development of such vehicles from now until 2050: increased urbanization, an aging population and the switch to electric power from fossil fuels. Those trends imply that for automakers to remain relevant, they will have to offer much smaller, more manoeuvrable and more "intelligent" vehicles. Not to mention safety and environmental aspects.

Switching from gasoline to battery power reduces tailpipe emissions but does nothing to reduce accidents per se, optimize traffic flow or make it easier to find parking space. To do all that, networking and downsizing are necessary too. Going 'clean' and switching to EVs does not save us from the gridlock. The streets and roads in the metropolitan areas, the megacities if you will, cannot build traffic capacity fast enough to keep up with growing vehicle ownership; take London and Stockholm as warning examples. Going electric isn't just altruistic; it is to make sure automotive manufacturers will have a product to sell to tomorrow's city-dwellers.

However, not all car manufacturers are equally convinced that a break-through of electric driving lies ahead. Often there is some reluctance to embrace the new technologies. In a sense this logically follows from the fact that the investments made in the present installed production base, and newly developed advanced fuel efficient combustion engines must first bring profits before new major investments can be made. Also there is a remarkable regional spread in attitude. The car majors in Japan are starting mass production, in China there is rapid growth of the EV market and the Lithium ion battery market as well. In Europe and America most companies are either gearing up to finish EV product development or are forming strategic alliances to arrive at the market sooner. Start-up companies, that are enthusiastically trying to bring innovations to the market and that in fact initiated the EV production, have a hard time growing/ surviving in the present economic climate. Finally, it is important to note that for the time being, the EV market will be a Sellers Market. For the next three to five years, there will likely be less OEM supply than market demand. Some small companies specializing in conversion (from conventional to electric, or from hybrid to plug-in hybrid) will probably profit from this situation.

3.2 Examples of recent and up-coming market introductions

Many car manufacturers are busy developing products for the new market for electric driving. Some have products ready for the market already, others are a little hesitant.

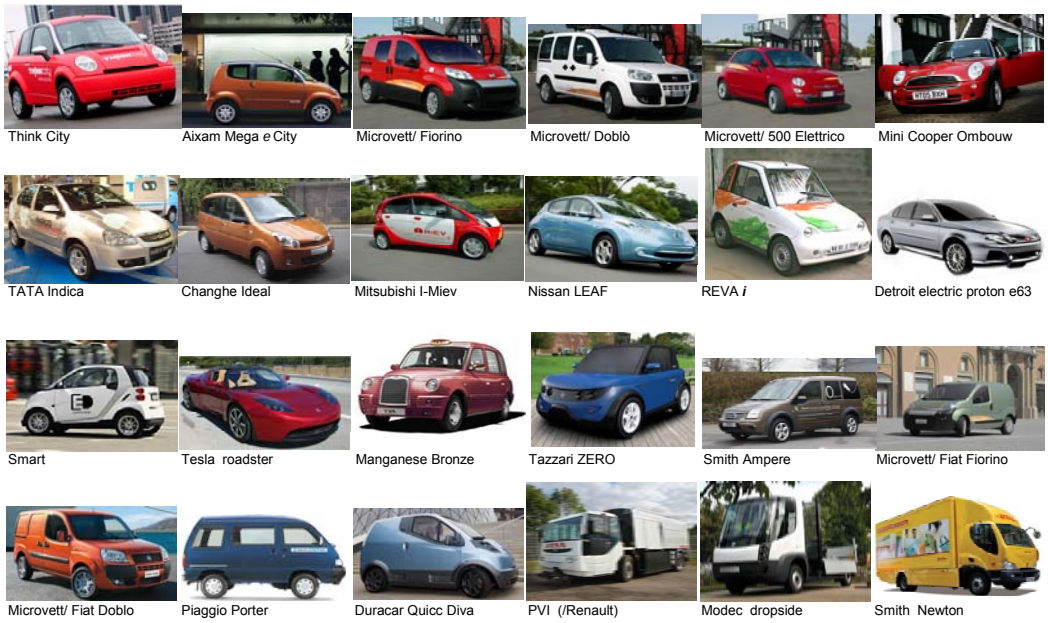

FIG 3.1: A collection of electric vehicles that either are already available on the European market, or that were announced to be introduced within 2011.

The Mitsubishi Motors and PSA coalition

PSA Peugeot Citroën paid 300 G¥ (2.7 G€) to Mitsubishi Motors to forge an alliance (designed to rescue the Japanese company from financial calamity) and at the same time create a European powerhouse for EV. The Mitsubishi iMiev, introduced on the market in 2009 (Japan) will also become available as Citroen or Peugeot. Strategic considerations led PSA to team up with Mitsubishi. Projected production volume for the family of iMiev-like cars: in 2009 1400 were sold, 8500 in 2010. Approximately 18,000 in the fiscal year 2011/12, and for 2013 a sales target of more than 30,000 has been communicated.

FIG 3.2: From left to the right: the Mitsubishi i-Miev, the Peugeot ion and Citroen C zero. One car in three brand versions.

Renault Nissan entered the market with the Nissan Leaf in fall 2010, with a sticker price about the same in most countries as a similar gasoline powered car (after tax credits). Considering the size of the Li-ion battery (24 kWh) this price point is remarkable. EV Battery Capacity is worth approximately 1 € / kWh in today's market. Also with the announced ZE (zero emission) models from Renault, Renault Nissan is clearly aiming at rapid development of a mass market. Also the communicated production volumes seem to indicate this: until 2012 they have a production capacity of 50,000 in Japan. In 2012 plants in Smyrna (USA) and Flins (F) increase capacity with 150,000 and ~50,000 (variable, may increase), while the Sunderland (GB) plant will add further 50,000 in maximum production capacity in 2013. In the course of 2011 the Renault Kangoo ZE will be introduced and, at he beginning of 2012, also the family car Renault Fluence ZE. Specifically the Kangoo is interesting because as of this date, very few electric delivery vans are available. The Kangoo ZE van may be relatively small; still it will be an important new offering.

FIG 3.3: From left to the right: the Nissan Leaf that was released on the European markets in 2010, the Renault Kangoo ZE (zero emission) light delivery van and the Renault Fluence ZE, to be introduced in 2012.

TESLA motors has sold over 1,200 roadsters (July 2010). Tesla has been in financial trouble but is now linked to Daimler (supplying batteries for a series of Smart city cars) as well as Toyota. Mainstream product Tesla model S is expected on the market in the fall of 2012.

FIG 3.4: Tesla models Roadster (in front) and S (white, in the back).

Daimler Benz will introduce electric versions of the Mercedes A and VITO model in the course of 2011. For the Vito delivery van some 2000 vans will probably be sold in 2011. For the A class the picture is less clear at the moment, but as the A class was originally designed to become electric (with a battery compartment designed-in under the passenger cabin), this will be a very interesting product.

FIG 3.5: The new products that Daimler Benz is launching. Remarkable detail: the models are designated E-cell and not electric. A hint at an F-cell (for Fuel cell) version in the future?

Valmet Automotive has been a contract manufacturer for several car producers for several decades. It has a special role in Finland which does not have its own car makers. The tough competition in the field of contract manufacturing prepared Valmet Automotive to the decision to start manufacturing electric vehicles. Now their repertoire covers the Think City full electric passenger car and the Garia electric golf car. They also are in contact with the US car company Fisker on starting the production of Karma hybrid vehicles. It is too early to say how this development affects the company's future, but it is an example on how a minor actor with agile attitude may act on EVs as a new market possibility.

FIG 3.6: The full range of Valmet Automotive customer projects with Fisker Karma, Garia ("neighborhood") EV and Th!nk City at the Geneva Auto Show.

Apart from the car companies mentioned explicitly above, there are of course many more. Most of the established car makers have electric vehicles in development, quite a few of which are almost ready for the market. Companies like Volvo, Ford, VAG (Volkswagen), BMW and Fiat are all promising electric vehicles in the coming 2 to 3 years. However, for the time being, introduction dates, projected production numbers and / or the markets for which these products will be available are either unknown or unclear due to changes in plans and postponements (technically or economically driven). It is therefore quite difficult to assess what impact these companies will have on the European Electric Vehicle market up to 2016. Rather than guessing, it is perhaps better for now to consider the market activities of all these car manufacturers as uncertain.

3.3 Type of vehicles

The OEM electric and plug-in vehicles that are available already or are announced to be introduced soon all fall in the category of small to medium sized passenger cars. In the coming couple of years also some light commercial vehicles can be expected. Amongst others, Ford, Nissan and Volkswagen have communicated about such models, without giving expected introduction dates though. In general it is

expected that the majority of new electric vehicles will be modest in size and weight (irrespective of being a sedan or commercial vehicle) because this keeps the requirements on expensive battery capacity acceptable. A big, heavy truck on today's EV technology would need such a gigantic, costly battery pack that for most purposes it would hardly ever be a realistic solution.

Plug-in Hybrid EV, the stepping stone

Some car companies are betting on hybridization as a stepping stone toward electrification of automobiles. The hybrids that can also charge form the electricity grid (so called plug-in hybrids or Extended Range EV) may be interesting offerings on the market in the coming years. Toyota for example (pioneer with the hybrid Prius) will come with a plug-in version of the Prius, although this appears to be a learning experiment for now with only 600 vehicles until 2013. The Toyota Group has launched also Toyota Auris HSD and Lexus CT200h hybrid vehicles based on the proven Prius technology.

FIG 3.7: A wide range of Toyota Group PHEVs: form left top Prius, Auris and Lexus CT200h.

The Chinese company Build your dreams (BYD) has the products ready (figure below), but apparently sales are less than projected with approximately 200 F3DMs sold in 2009 instead of the targeted 3000. Still this company may well profit from the powerful development of the Chinese market.

FIG 3.8: F3DM.

Finally also General Motors must be mentioned who will introduce the Opel Ampera (Chevrolet Volt) on the market. There have been changes in production schemes and market targets so that the production volumes to be expected are unclear yet.

In this decade the plug-in hybrid can be the logical choice for drivers who want to use electric drive as much as possible, but regularly drive further than the electric range would allow. After the batteries are empty, the internal combustion engine comes in and extends the range. Whether the PHEV will be a stepping stone for one decade or so only, or will stay as a long term alternative remains to be seen. If oil

becomes really expensive, it seems more likely that fuel cell electric vehicles will take over for longer ranges. If oil prices should drop however, e.g. due to large energy supply from new, sustainable sources, the PHEV may remain a highly competitive option for many decades. This scenario seems not very likely though. Nevertheless the IEA expects PHEVs to stay in the market well beyond 2050 (see figure 1.1).

FIG 3.9: Opel Ampera, to be introduced on the market in 2012 with approximately 64 km all-electric range.

3.4 The automotive perspective on charging

With regard to charging possibilities there are some insights that most automobile manufacturers share, which will definitely influence the developments in the market the coming 5 to 10 years.
Some attention points with regard to charging scenarios are:

Batteries will remain costly in the next 5-10 years. Including battery management system, safety provisions (e.g. crash safe enclosure) and integrated charger the overall costs reach some 600 tot 1000 € per kWh capacity [1]. In the coming ten years this number will come down some 50%. Research of Roland Berger predicts the same cost developments, as illustrated by the figure 3.10. The figure shows that the battery price of a midsize EV are expected to decrease from € 16,500 to € 7,500, whereas the battery price of a PHEV is expected to decrease € 14,000 to € 7,000 (battery in PHEV is smaller).

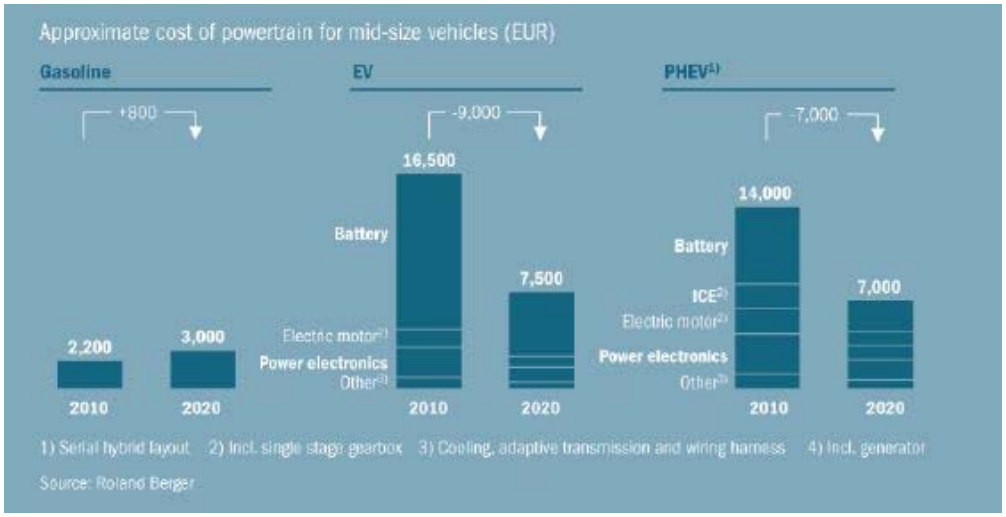

FIG 3.10: Cost developments of gasoline car, EV and PHEV [5].

There are signals from the car manufacturing industry that costs are coming down a lot faster than expected so far [2]. Going by this new information, the costs for electric drive train components might come down considerably faster than expected even a year ago, so that in ten years time costs could have decreased to just 20% of the present level. The costs of a medium sized battery pack (20 kWh capacity, good for approximately 120 km electric range) will therefore be sizeable for the coming years. However, if indeed costs will be decreasing at the rate mentioned, a hybrid or electric car can become an instantly attractive proposition. At present (with present oil, materials, dollar and car price levels) an electric or plug-in hybrid needs in the order of 5 to 10 years before the owner breaks even compared to purchasing and using a (otherwise comparable) conventional car. At a lower purchasing cost of the electric vehicle (and no introduction of extra taxes on electricity) as predicted by the report [2], this break even point may be reached much sooner. Also the power electronics for battery chargers is costly (for now). Typically the costs of the battery charger are some € 600 per kW charging power [3]. There is no natural drive among the manufacturers to make a fast charger a standard component in a middle class automobile ('fast' charging implies a power of 10 to 50 kW charging per hour or an electric range of ~60 to 350 km). Possibly a fast charger will be offered as an option (for a considerable up-price though). Perhaps it will some day be viable to use the inverter (which generates AC drive current -for an AC motor of course-) as the battery charger. That piece of power electronics is already on board after all. Such a dual function inverter / charger is still highly experimental, but the concept is very promising for the future. In this decade the 'standard' integrated battery chargers will quite likely remain small (cost effective) and will have typical charging powers of 2 tot 3 kW (good for ~12 to ~20 km max. range per hour charging).

(Really) fast charging is a viable option within 5-10 years. When using a powerful external charger, the costs of a sturdy direct current power supply do not weigh on the electric vehicle (which has to live with expensive batteries anyway). Furthermore the electronics are not exposed to the adverse circumstances onboard a car (e.g. vibrations or heat). Present battery technology does not allow charging with powers above 100 kW. But development is quick, and with the introduction of iMiev and Leaf respectively, fast charging with 50 kW DC has arrived already. These cars use a so-called TEPCO connector which is likely to become the de facto worldwide standard for DC charging. The recently introduced Mitsubishi iMiev illustrates how the OEMs (at least the Japanese) see charging of EV: there is a small slow charger on board (maximum 7 hours on 230V AC for 160 km electric range), or the possibility to charge DC: an external (!) 50 kW charger supplies DC to fill 80% of the battery capacity (good for some 125 km) in 30 minutes. Now, of course, 30 minutes is faster than several hours, but it is not really fast. For charging times to come down to a couple of minutes for a full charge, the charging power would have to go up to hundreds of kW. As mentioned before, this is no viable option with the present battery technology. Specific power of modern Li-ion batteries is increasing so fast though, that much faster charging will very likely be possible in the near future. In five years time maximum charging power may have increased to some 100 kW (the maximum for the present TEPCO plug). In case active cooling of the battery pack during charging was to be introduced, this power might even rise further to a few hundreds of kWhs.

Wireless Technology as an Antidote to Range Anxiety: if we look carefully at the problem, it is not the range that is causing the problem. Most of us have a pretty much pre-defined mileage that we do every day, give or take a few kilometers. However, the uncertainty of the possibility that you could run out of fuel mid way without seeing it coming and the possibility of being stuck in the middle of nowhere was the real cause. In other words, lack of information was the actual issue. EV telematics can give you real time information on the amount of charge that you have available on your battery and the distance that you will be able to cover with it. This real time information is the first half of the solution, which is complemented beautifully by charging Point of Interest (POI) to get rid of range anxiety. Also, the Real-Time Traffic Information presented to you is relevant. It does not assume ideal conditions like empty roads or well built roads. It is connected to a satellite-based navigation system and will calculate the distance you can cover,

based on real time traffic. So there will be no mental calculations needed on the part of the driver and no ambiguity. The connected vehicle will do all the thinking and guide the driver to the best route, based on current information. This will help solve the problem of traffic too! Needless to say, telematics could turn out to be a life saver. Most modern Eva's will have telematics systems built into them and offer navigation systems as a subscription. So, the vehicle will automatically tell you when it is running out of fuel. It will also tell you the nearest charging station and how to get there. Once you enter your current location and destination, the system will automatically plan its fuel requirements and communicate this to you on a real time basis.

***Smart Grid and Smarter Connected Vehicles*.** Smart grid is set to revolutionize the way we use electricity. Based on real time information, it will make sure that people have more incentives to use electricity in off peak hours. EV telematics is taking this into consideration in its bid to ensure future success. Since charging a car uses electricity equivalent to a whole house, EV manufacturers are seeing a forthcoming problem and are working on avoiding it. If EVs gain mass acceptance, a lot more electricity may be required at peak hours and the price of electricity might increase, reducing the financial advantage. Information on when to charge is crucial. Connected vehicles will have tools to analyze the smart grid and tell you when to charge your vehicles to ensure cost efficiency. In fact programs are being built to ensure that the vehicles automatically charge themselves when they see a good enough price.
As a user, you will have complete flexibility with regard to your schedule. You can just pre-program your weekday and weekend schedule and plug the car in the garage and leave it. When you come the next day, you will find your car fully charged and in optimal working condition, in terms of temperature, heat, etc. You could even control the vehicle with your smart phone, since both the smart phone and the car will be connected to the same server.

Alluring alternative: Battery switching. The concept of battery switching can be a very powerful and alluring solution to rapid charging of electric vehicles. With the present state of battery technology it is no option to recharge -lets say- 15 kWh of battery capacity in 2 minutes (with a charging power of 15*60/2= 450 kW !). By simply exchanging the empty battery by a fully charged one this can –in principle- be done. The Israeli/American company 'Better Place' advocates this solution and is involved in field tests to demonstrate the principle: one is a public trial in the French district "les Yvelines" with approximately one hundred Renault and Nissan electric vehicles (sedans and light commercial vehicles), and another one was with a small number of battery switch taxis in Tokyo. However, the battery-switch concept has disadvantages as well:
Strictly standardized battery pack (dimensions, voltage etc.).
Robotised equipment to safely and accurately handle the battery pack (> 100 kg).
Need for a (however limited) number of extra batteries on stock at the switch station.

These disadvantages are quite serious and so far only Better Place and Renault have embarked on the concept of battery switching.
Yet, it also has the potential to help decrease battery ownership costs for EV consumers via innovative business models where swapping charges cover both electricity and battery "capital" costs on an incremental basis. Even for home recharging-oriented systems, the cost of batteries could be bundled into the daily costs of recharging, allowing consumers to pay for batteries over time. Decoupling battery costs from vehicle purchase costs could enable EVs to be sold at more competitive prices – but doing so may be closely linked to the development of infrastructure and the associated business models adopted.

3.5 Overview

A simple, purely indicative overview of the various car types to expect on the market with their various advantages as well as disadvantages and expected developments is given in the table on the following page.

Type of EV	General	Plus (user)	Minus (user)	Availability (now / in 5 yrs)
Small BEV (e.g. Smart For two electric)	Typically 100 km of all electric range. May influence city air quality in case of substantial market share.	Good acceleration and regeneration at braking. (Far) lower maintenance costs, fuel costs.	Relatively heavy and costly driveline (for now!) Most of the time slow recharging	+/++
Large BEV (e.g. Tesla S or BYD e6)	Can have decent range >200 km. Professional use in cities may substantially reduce air pollution. Some could be used as a taxi for example.	Good acceleration and regeneration at braking. Spacious. (Far) lower maintenance costs, fuel costs.	Heavy, relatively costly as well (for now!) Most of the time slow recharging	0/+
Light commercial EV (e.g. Renault Kangoo)	Typically 100-150 km of all electric range. Professional use in cities may substantially reduce air pollution. Ideal for inner city parcel delivery and the like (with many starts/stops).	Good acceleration and regeneration at braking. (Far) lower maintenance costs, fuel costs.	Heavy, relatively costly as well (for now!). Most of the time slow recharging (for now!), may limit usefulness. Mostly small vans, larger vans (>7.5 t) will be exceptional.	-/+
PHEV (e.g. Toyota Prius Plug-in)	Entry point for general public. Plugged but feels 'familiar', especially for users of hybrid cars!	Car like what people are used to, and still most of the time electric. Less fuel costs, yet more than BEV. Fast and available recharging of gasoline.	Two drive lines. Benefit of small cost efficient battery is offset by additional cost of conventional driveline.	0/++
E-REV (e.g. Opel Ampera)	Comparable to PHEV, but more BEV 'feel' and expected to be cleaner.	As PHEV, but ICE can be tuned more precisely to needs. Less fuel costs, yet more than BEV. Fast and available recharging of gasoline.	As PHEV.	0/++

FIG. 3.11: Summary of availability, advantages and disadvantages of EV, now and over 5 years.

At present, available electric cars are mostly small BEVs. The business case for electric driving in the context of inner city use with limited range is the best suited and will continue to be the best in the coming years. However, larger BEVs are being developed that offer a longer electric range, very suitable for commercial inner city/regional use. The same applies to light commercial vehicles, although it is expected that it will take more time to reach a substantial and varied supply of light vans, since the market of vans is highly competitive and suffers from small profit margins. The PHEV is considered to be the entry point for the general public, since they offer the 'feeling' of a conventional car and the advantages of electric driving. Manufacturers are expected to act on this by supplying ample and various PHEVs.

The vision of advanced power train, electrification of vehicles, and a communication connection between vehicles and the infrastructure is moving closer to reality. However, many elements must come together for the benefits of the alternative power train and connected vehicles to be realized. What are the enablers and barriers to a full-scale implementation and deployment of these vehicles? Overcoming logistical, technical, political, and workforce related barriers is required to make these advanced technologies viable in the marketplace. Full-scale deployment of disruptive, new green technologies (those that require a fundamental change in propulsion and/or fueling) requires a business model designed to cover costs, generate a reasonable profit margin, and also provide the product at an affordable and competitive cost to consumers. For a new vehicle to come to the market in the traditional path from an established OEM, a number of factors must be considered long before development and engineering are to begin. These include, chiefly, an analysis of potential return on investment (ROI), along with market trend surveys, market size forecasts, potential number of sales, future fuel costs, future consumer preferences, and technology availability and its cost. In an open marketplace, these factors are difficult to estimate without a little uncertainty, leaving final decisions to rely more or less on intuition. Given a situation where the public sector is encouraging the mass adoption of a product or technology for a perceived public benefit, analyses of future trends and intuition provide even less comfort. The reason for this is that public sector involvement - usually in the form of subsidies and incentives - tends to be a short term remedy to address a skewed market which is not providing, or driving consumers to, a preferred outcome.

Nevertheless, it is widely expected that in five years from now most car manufacturers will have introduced one or more electric car models. Quite likely some of the manufacturers will try to become dominant in a new era of the automobile market and others just want to gain some experience for when the EV market will eventually really take off. The latter manufacturer may opt to offer cars with internal combustion engines for as long as they can. The emergence of fundamentally different technology in a certain market is nearly always a point in time when some new players come in (could Tesla be named as an example?) and others are too slow to adapt (trust on their old strengths for too long) and perhaps vanish in the transition to the new technology. With production volumes that are small compared to the considerable interest that has surfaced, it is likely that at least for several years, there will be a market for converted electric vehicles (from conventional to electric).

Case study: Evidence form the UK EV industry

In the UK there is a growing community, with companies offering capabilities to deliver vehicle technology from a single battery pack to a whole vehicle. Broadly speaking the UK EV industry has capabilities in energy storage, design engineering, and vehicle design and manufacture. In common with the wider UK motor industry, the UK EV industry offers significant strength in the design engineering area.

Energy Storage: The UK has a strong research capability with significant clusters of capability and new industry in Scotland, Yorkshire and South East of England. This reflects a sound scientific base focused on conducting polymers and ceramic materials. A handful of companies are involved in understanding the provision of electrical energy storage for automotive drive. Whilst this market should expect to expand with

an increase in EV sales, it is clear from discussions with the industry that core battery cell manufacturers are unlikely to relocate from the current production locations (mostly the Far East). Therefore, a developed UK capability would focus on the technical effort required to take battery cells or super-capacitors into battery packs with functional battery management systems ready for vehicle integration.

Design Engineering: A strength area in the UK automotive industry, design engineering is also a focus in the UK EV industry. Organisations such as Zytek, Lotus and Ricardo have proven histories in the development of systems for electric and hybrid EVs. Focused on the early development stages, these companies also gain from knowledge transfer through collaborative work with leading UK universities to develop new technology solutions. A few of these design engineering companies are capable of producing vehicles, where volumes start at single prototypes and can go up to small series. These types of project typically incorporate new technology into an existing carrier vehicle, as demonstrated by the smart EV. Additionally these businesses have the capability to produce bespoke components for these vehicles, such as motors or controllers. However, in occupying the design engineering space in the supply chain, it is unlikely that these companies would directly undertake the volume production either of systems or of components. More probable is the development of technology solutions for other volume manufacturers, or licensing third party manufacture. Transferable skills from traditional internal combustion engine design and development have helped provide this foundation in the UK EV industry. For example, engine control unit and gearboxes development skills are similar across the vehicle space.

Vehicle Manufacturers*:* Several low volume manufacturers or assemblers are present in the UK. The UK hosts companies manufacturing cars and public transport vehicles. With all these businesses the boundaries between manufacturing and assembly vary depending on the method of operation. Some organisations manufacture the chassis and running gear and others utilise a rolling chassis/body from an external supplier (typically an automotive OEM). The common themes are the fitting of an electric drive system and an energy storage device (typically a battery pack).
The EV manufacturing environment differs from traditional vehicle manufacture, where OEMs typically also manufacturer the whole power train (engine and gearbox). An EV manufacturer can act more as an assembler, potentially accessing the majority of the power train and energy storage components as externally supplied parts.

Imported Vehicles: The UK has a number of organisations importing complete EVs into the UK for sale. Whilst these organisations have no direct input to the UK EV supply chain (imported vehicles are typically manufactured in the EU or India), a considerable wealth of knowledge about the in-service capabilities of EVs resides within these organisations.

Business opportunities: A variety of interested parties has been consulted to assure the industry view of the risks and opportunities connected to the mass uptake of electric cars. The findings have in general been positive and lead the expectation that new opportunities can be created from this.

The findings can be summarised as follows.
Increased electrification of transport is predicted. The technology for this is still in its infancy, and will evolve rapidly over the next 20 years. The UK is home to a large resource of R&D capability in its universities, the automotive and motor sport engineering sectors, and in electronics, aerospace, civil engineering and defense industries. There is a need to bring together the collective skills to focus on the next generation of EV technology and the infrastructure it requires.

This in itself will encourage the supply industry to undertake research in the UK and will bring work and added value from abroad to our universities and engineering companies.

As a first step, technology around the world should be benchmarked to identify and quantify gaps and opportunities.

There is insufficient battery manufacturing capacity around the world, and a number of the bigger automotive companies have established strategic alliances with battery manufacturers to safeguard their supplies and accelerate production. Li-Ion chemistry was originally developed in the UK and there is a key role to play in the ongoing advancement of the technology. It is unlikely that volume manufacture of cells would be viable here, but there are opportunities for battery assembly, motor development and manufacture, and control systems algorithms and technology.

The UK automotive industry leads the world in specialist manufacture, and as has been stated earlier, EV power facilitates and encourages niche low volume production. A number of small companies are already active in this field; with support and encouragement they can start to build the UK's EV industry.

The UK automotive industry comprises a complex supply chain of small, medium and large suppliers, culminating at the VM with final assembly of the complete vehicle. The introduction of EVs and PHEVs into the UK market will primarily be substitution rather than additional. Therefore if the manufacture of these vehicles does not take place in the UK, total vehicle manufacture in the UK will be reduced from today's volumes. Some of the VMs that currently manufacture in the UK consider that the volumes they build here are marginal; a reduction on these volumes could change the business case and lead to a complete model range being moved overseas. This will impact not only the immediate workforce, but also the whole automotive supply chain.

HEV products will become more widespread after 2010, with PHEVs being introduced by VMs in 2014/5. The introduction of PHEVs will dramatically reduce demand for HEVs. Also in 2014, pure EVs will start to come to market in volume, initially as small commuter vehicles.

In the timescale of this study it is likely that electric power will emerge as a solution for vehicles operating over predetermined duty cycles of less than 150km. ICEs, using liquid fuels and possibly hydrogen in the future, will continue to be used in higher power demand applications – freight and (hybrid) premium passenger cars. The UK automotive industry has significant interests in ICEs, both in design and research, and in manufacture. The UK currently manufactures over three million ICEs per annum.

Legislation has been a key driver in the development of low emission technology. Many of the manufacturers consulted for this study have indicated a preference that any government intervention should be based on emission levels and should not prescribe technology. Legislation should be EU wide, and provide long term visibility to lead the progress of development and ensure that industry has time to develop satisfactory solutions.

Local delivery vehicles and minibuses have duty cycles that comprise frequent stop/start operation. This is ideally suited to EV operation. Manufactured in very low volumes, the investment for these vehicles is small by comparison with the major VMs, but all of the companies in this market struggle to finance product development and to source components economically. Demand in this market currently exceeds supply, and with encouragement, this sector has the potential to grow significantly and is an ideal first niche for wider EV adoption.

EV battery charging will out of necessity take place at a number of disparate locations – home, work, public car parks, on-street. To optimize energy draw from the grid and enable the vehicle user to select the most cost efficient charging, smart metering will need to be widely available. This will enable the network to

predict off peak requirements and to recognize and bill individual users. Charging points are, as yet in a very early stage of their development, and there are very few companies producing them. They will not only need to be designed and manufactured in high volume, but they will also need to be installed, networked and maintained. This has the potential to become a core UK capability which could be exported.

EVs will be manufactured and marketed not only by the traditional vehicle companies but also by entrepreneurs from other industries. The new companies, unencumbered with existing automotive practice and tradition, will change not only the way cars are manufactured but also the modes of ownership. All EV manufacturers are struggling to find ways to mitigate the high cost of the battery. New models of ownership may emerge, such as that seen in the mobile phone industry, whereby a driver would pay a small or zero fee for their vehicle, but be charged the amount of miles driven. The practicality of such schemes which marry a number of disciplines requires careful investigation and they present a clear case for future pilot studies.

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4 RELEVANT USER-GROUPS

4.1 Introduction

In this chapter we will return to Roger's adoption curve, as introduced in chapter 2. Firstly, we will elaborate on the 'innovativeness' of the electric car compared to the conventional car. Following the key characteristics of the electric car, we will derive the key characteristics of potential user groups that are likely to adopt the electric car initially, the so-called early adopters.

4.2 The innovativeness of the electric car

There is a willingness to change petrol to current electric driving: it is new, it is in the media and it is green. All this complies very well with the early innovator. However, in order to successfully establish electric mobility as a mass market product, the vehicle must fulfill the customer's requirements of a (conventional) car to some extent, on aspects like:
car features, such as speed, comfort, size, safe, variety of choice
costs of driving
range and/or charging facilities
image; after all customers act on perception, not necessarily on actual facts
AND/OR: offer important added value compared to a conventional car. Naturally, the appreciation of these aspects differs between types of user (groups).

Otherwise, EVs will stay a niche market due to:
limited functionality of the vehicle, and consequently
only suited to very specific and limited target groups, consequently
small volume, consequently
low economies of scales (batteries) and high margins, consequently
very expensive, etc.

The following table offers a brief overview of the comparison between the conventional (gasoline) car and the EV, in the year 2010 and 2015.

Characteristic	Electric vehicles 2010	Electric vehicles 2015	Assessment (compared to conventional car)
Emissions	In case of green electricity, emissions (CHG, NOx, particles) are near zero.		++
Speed	Most electric cars have a generally accepted maximum speed of 120-150 km/hr.		0
Comfort	No stench, no noise, and single gear! Good acceleration and regeneration at breaking.		++
Size/luggage room	Presently, in converted/modified cars, the pack of batteries may reduce available luggage room.	New models that have been designed to drive electric, will not suffer from loss of luggage room.	0
Types and variety	Very limited choice, mostly city cars.	The choice of electric cars is rapidly growing. Before 2015 a choice of OEM cars will be available within each segment: city cars, compact cars, sport cars, utility cars. However, the choice will still be limited compared to conventional cars.	-
Safety	Safety issues are largely dealt with by the international standard ISO/TS 16949.	International standards are expected to be accepted.	0
Purchase costs	Purchase costs for mid-size EV are about € 15.000 higher.	Even in the most optimistic scenario, purchase costs will be about € 7.000 higher (for BEV as well as PHEV).	-(-)
Energy costs	Factor 5-10 lower than gasoline in most countries.	Ratio expected to improve in 5 years.	++
Maintenance	Maintenance costs of EV are lower due to fewer moving parts (availability of repair services may be complicated though).		+
Range	A medium size battery pack (20 kWh capacity) is good for 120 km electric range.	Large BEVs are being developed (>200 km range), as are various types of PHEVs. In any event, the EV driver needs to refuel (i.e. recharge) more often than the conventional driver.	-(0)
Recharging time	Present batteries do not comply well with fast charging. It takes about 6-8 hrs to fully reload in case of slow charging.	New batteries can be charged fast or slow, depending on the user wishes. Fast charging is expected to take <30 min.	-(0)
Image	On the positive side green and progressive, yet less muscular and up till now rather limited choice.	With a rising sense of urgency concerning the environment and more and varied supply of EV, the image of EV is expected to become more and more favorable.	+

FIG. 4.1: Qualitative and indicative assessment of EV characteristics now and within 5 years (TNO and DHV).

Legenda: ++ = much better; + = better; 0 = no difference; - = worse; -- much worse

As the table shows EVs offer some unique selling points such as no noise, no emissions, single gear, but still suffer from some major draw-backs (also in 5-10 years from now) that may interfere with large scale adoption of electric driving, such as a substantial higher purchase price, limited choice of vehicles and limited range (in case of BEV).

4.3 User-groups characteristics and relevant user-groups

As the Roger Model has indicated, the innovators and early adopters' requirements need to be identified to reach eventually the early majority and late majority. User-group characteristics of the early adopters that may be deduced from the EV characteristics depicted above are:

Predictable mobility pattern of the car with limited range/day (50-150 km depending of range of the car) or time to recharge (at least 30 min in case of fast charging, or 4-8 hrs in case of slow charging) during the day.

Yet intensive or daily use of the car, the more kilometers the easier the high purchase costs can be recovered (and the lower the relative environmental impact).

Appreciation of certain comfort aspects, such as the absence of noise/stench/gears.

Willingness to pay higher total costs, willingness to pay the far higher initial costs.

Willingness to compromise on choice (look and feel).

Appreciation of the lower environmental impact (or rather the green image!).

Looking at these characteristics, *professional fleet owners appear to be the most likely early adopters*. (Large) fleet owners are used to large investments in the car park and to calculate with the total cost of ownership (TCO) rather than just the cost of purchase, have larger marketing budgets to spend on a favorable and green image, often have committed themselves to social corporate responsibility and – due to the larger fleet – have the possibility to organize their transport in such was that the EV can be fitted in despite its stricter mobility profile.

End-users should not be neglected, however. After all, they are key to reach mass deployment as they constitute the vast majority of all cars. Also end-users may be appreciative of the added value of the EV, being environmentally friendly, without stench and noise and dingle gear. In the Norway case a substantial number of end-users have been starting to procure electric vehicles which serves as an interesting example to learn from.

5 ANALYSIS OF USER-GROUPS

5.1 Introduction

In the previous chapter two types of early adopters have been identified: fleet owners and the *(premium) end-user*. Within the segment of fleet owners the following subgroups have been selected through expert judgment of the project partners:
The highest potential is ascribed to *public authorities* and *energy and utility companies.*
Next to these types of fleet owners, *delivery services* and *taxi companies* are considered high potential groups.

All user-groups, including the end-user, have been researched regarding their attitude and behavior regarding electric driving on aspects such as:
Present car (fleet), including EVs (if applicable).
Reason (to start) procuring EVs.
Conditions to start procuring EVs/extend the number of EVs.

5.2 Research methodology

The empirical analysis of relevant user-group is based on interviews (either by phone or in person) with companies/persons belonging to the various user-groups. Each user-group has been researched:
In at least 2 countries to gain insight in the national / local context.
For each country among at least 2 respondents that have already electric vehicles in use, and at least among 1 random respondent that is not using any electric vehicles.

The spread of investigated user groups among the countries that are part of the study is shown in the following table.

Country	Energy companies	Public authorities	Delivery services	Taxi companies	(Premium) end-user
Austria	x	x	x	X	
Denmark	x	x			x
Finland	x	x	x	X	
Netherlands	x	x	x	X	
Norway	x	x			x
Importance (as assessed by the project group)	5	5	3	3	2

FIG. 5.1: Distribution of the interviews among user-groups and countries (x= relevant for that country, at present).

In the following section the main conclusions per user-group will be presented. Appendix 1 shows a complete overview of the interview results.

5.3 Public authorities

Naturally, the government is more inclined to invest in EV as they serve public objectives concerning the environment. Moreover, it is often said that for the market for electric mobility to take off, governments (national / regional / local) should act as a launching customer. They have the responsibility to lead the way and have the power because of the size of its car fleet. The government can assure the minimum threshold can be reached in order to justify the installation of e.g. electric chargers.

The potential for green public procurement was first highlighted in the European Union in 2003 in the Commission Communication on integrated product policy. In 2004, Directives 2004/17/EC and 2004/18/EC, which constitute the European framework for the procurement of public contracts, clarified how purchasers can integrate an environmental dimension into the tendering process. The Commission handbook "Buying green!" that was adopted in August 2004 aims to further clarify how these new rules can be used to conclude green public contracts. The new European Union strategy for sustainable development, adopted by the Council in June 2006, set a target that by 2010 the average level of green public procurement in the EU should be the same as the 2006 level of the best performing Member States in this area.

The *Dutch* government owns about 38.000 light vehicles (<3.5 ton), which accounts for 6-7.000 new sales per year. In order to promote sustainable business, the Dutch government has defined minimum requirements for sustainable public procurement for the own organisation. The governments' passenger cars have, among others, minimum requirements regarding energy labels (A or B); weight; particulate filters; fuel consumption indicator and tyres. On a more general note the Dutch government stimulates Cradle to Cradle and has set strict governance targets for itself with respect to CO_2 and the climate. Many parts of the government however have imposed themselves with much stricter requirements. The municipality of Amsterdam for example has decided to procure only EV. For the procurement of a non-EV formal consent is needed from the administration.

The *Finnish* government has been developing public procurement practices for some years. Even though the new law does not set specific target levels for energy efficiency, it points out this as one recommended quality criterion. On the other hand, ministries and other public bodies, especially the largest cities, have set their own goals. The Ministry of Trade recommended environmental qualifications already in 2000 and the Ministry of Environment in 2004. The city of Helsinki released its recommendations in 2008 and the city of Tampere in 2010 in its climate policy. None of these, though, is strictly maintained. After the European Directive 2009/33/EC, the Electric Vehicle Working Group of the Ministry of Employment and the Economy has asked for more responsibility on preventing climate change when it comes to public procurement. The *City of Tampere* is committed to reduce vehicle emissions. The number of EVs is what is measured, but also the reduction of pollution is important. However, it is difficult to measure the pollution reduction resulting from the use of EVs. Tampere is targeted to be a pioneer and example to other cities in Finland. The cars owned by the city are parked for rather long periods of time, so slow charging is quite sufficient. The city fleet is rather large, so if an EV would not be fully charged at the moment a vehicle is needed that would not be a problem. The objective of the city is to reduce the average CO_2 emission level of the vehicles that constitute its fleet under 120 g/km in the future. Tampere is putting effort in changing the attitude among the city officials. The progress in the city organization is slow. There should be an acceptable need for EVs though; nothing is bought just because of interesting technology. It is recognized that the policies will effect on buying of EVs. Purchase price and taxes play an important role. Parking privileges or other privileges have not been subject of discussion.

Several *Danish* municipalities have already started EV projects. In 2009 the Municipality of Copenhagen bought 15 EVs to be used in the fire department and department for environmental technology. Arhus Municipality wants to buy EVs for their own use and also to encourage local families and enterprises to buy EVs.

In *Austria*, public fleets are a very high potential user group for EVs. There are more than 2,350 municipalities, which have all kinds of vehicles in use – from service-bicycles to cars and trucks, used in passenger transportation, at the building yard or for waste management. There is a high potential in a lot of operational areas where EVs could be used.

Norwegian fleet owners hold a potential of yearly *new sales* of about 6,000 cars in the Norwegian public sector, and the increase can be large and rapid as current user needs to a large extent are served by today's vehicular functional specifications. Norway is not part of the EU, but through the EEA Norwegian authorities follow many of the same procurement regulations as the member states. Information and recommendations about green procurement is provided, but not mandatory. Hence, there are no demands as of 2011 that environmental concerns must be included in the public procurement of cars. Nevertheless, EVs are given "added value" due to exemption from both tax and VAT on new cars, reduction in yearly road tax, free parking and admittance on toll roads and free ferry rides. In addition the EVs may use bus lanes. The public sector is stimulated towards buying EVs because of a higher travelling allowance/refund for EVs than for conventional cars and company taxation for car ownership is halved for EVs compared to conventional cars.

We can conclude that the public sector of the countries involved is indeed a significant possible early adopter. Their fleets make up a reasonable amount of the total car fleets and the government advocates clean vehicles.

5.3.1 Interview results

12 out of 13 municipalities are considering to start procuring or to extend the number of EV within the year. Main reason to start electric driving is less/no emissions (in general), although reduction of noise is mentioned in 2 specific cases, as is a general concern for the environment. Also improving the image and marketing of the municipality was mentioned.
The cities that employ EVs (9) have typically 1-4 EVs, with an occasional outlier of more than 10. Makes vary (though mostly Th!nks), but they have the following characteristics in common:
Merely small city cars.
Typically drive less than 80 km/day, within the maximum range.
Take more than 4 hrs to recharge (only one public authority has access to fast charging).
Are used daily.
In most cases (7 out of 9) EVs and conventional vehicles are interchangeable in the operational use.

Main conditions to start procuring or extend the number of EVs are:
The TCO, compared to the conventional alternative, should substantially decrease.
A larger range, compared to present EVs.
More choice of EVs and models (vans and light trucks).

5.4 Energy and utility companies

Energy and utility companies, likewise the public authorities, have an intrinsic motive to encourage electric driving. For one thing, electric driving will increase demand for energy significantly. Electric cars could increase demand for electricity in 2020 by nearly 3% compared to 2006 levels, according to a study by CE Delft, a Dutch consultancy firm for Transport and Environment. But what will the increase of electricity demand impose on the electricity grid? Many energy companies have therefore started experiments with electric driving to gain experience regarding the optimal use of the electricity grid.

The *Helsinki Energy* (Helen) company owned by the city of Helsinki stated that the Finnish electricity grid can handle the forecasted electricity demand for the next 20 years, and by then smart grids will be in use. Information provision and marketing are part of the upgrading process. Availability of green electricity is not a problem; there are several sources for it. However, there is a minor threat that the current EV/PHEV hype does not last, but the early adaptors are prepared for some setbacks. Charging infrastructure has developed as planned, but the availability of different types of vehicles has developed slower than was anticipated. The change in public and political opinions has been a success. In the future free charging as part of the demonstration phase will end, as the business models and real demand develop. Supply of EVs will not be a problem anymore, but more production volume is needed to lower the prices. Development of batteries and electronics seem to go on. One thing mentioned is whether the vehicles are suitable to arctic conditions.

5.4.1 Interview results

All energy companies that employ EVs (6) have 1-6 EVs in use, with the exception of one Austrian energy company that employs about 40 EVs. By far the most cars are small city cars of various brands, yet mostly Th!nks. Besides, all of these companies are considering extending the number of EVs within a few years.
The main reason to start procuring / extending the number of EVs – that is shared by all companies - is improving the image and marketing of the company (pushing use of electricity). Next to this, overall concern for the environment and corporate social responsibility was pointed out as well as experimenting with new mobility concepts.
Generally speaking, the operational use of EVs is more or less the same or considered adequate and the comfort is praised. In no case fast charging is available.

Various conditions for extending the use of EV are pointed out, and for each company in a different order of importance:
More choice of EV and models (mid-size, van, 4WD).
TCO, compared to conventional alternative is at least equal.
Availability of fast charging spots.
Larger range, more speed and reliability compared to present EV (especially for maintenance cars).

5.5 Delivery services

City distribution services and postal services are potential early adopters in several countries, in particular in those areas with high rates of urbanisation and a high population density. For example in The Netherlands, city distribution has been quite problematic. The cities are congested, delivery time windows are limited, often restricted to early morning times, and restrictions regarding emission levels are in place.

A relatively new trend is that 'the last mile' is being outsourced. Transporters deliver their goods to a location just outside the city centre. One truck takes care of the last mile to deliver the goods to various shops. As a result only one or a smaller number of trucks need to enter the city, avoiding multiple truck deliveries to the same shop. City distribution may be an excellent sector for stimulating EVs in inner cities, not only in The Netherlands. It may well fit the efficiency goals of the logistics operations of long haul transportation companies and of the retailer's goals and their green image alike. In a practical matter it is also an excellent candidate given the short (city centre) distances to be driven by the EVs (vans and trucks).

5.5.1 Interview results

The delivery companies that employ EVs, typically have 1-2 vans and / or light trucks and consider extending the number of EVs within a few years. The companies that have presently no EVs, are considering electric driving. Main reasons to start procuring / extending the number of EV are less / no emissions (CO_2, particulate matters and NOx). Also image, marketing and corporate social responsibility are important issues (as a marketing strategy to attract more and new customers). Also in the case of delivery services, EVs are considered interchangeable with conventional vehicles. Since they have multiple vehicles that are used for just inner city transport, it just took some changes in the logistics. In one case the occasional use of fast charging is mentioned, otherwise only slow charging is used.

Main conditions to start procuring or extend the number of EV are:
TCO, compared to conventional alternative should decrease substantially.
More choice of EV and models, such as light trucks.
Reliability of the car incl. maintenance.
Larger range.

5.6 Taxi companies

Taxi transport is characterized by many inner-city kilometers and short trips. Moreover, introduction of electric cars for taxi operators, car sharing and rental companies can have a wide effect on the public. Experiencing electric driving these ways could have a positive effect on customers towards new car technology by seeing it or driving it. Taxi cabs and rental / shared cars could present the customers the advantages of electric driving.

In The Netherlands an initiative called Green Cab has recently be launched. A consortium - a.o. between a taxi operator, an electricity provider, the municipality of Utrecht, and a car manufacturer - will introduce electric cabs in Utrecht that will charge customers the same as other cabs. Another Dutch pilot called gCab introduced the electric cab in April 2009 in The Hague [1]. Generally, the taxi sector as well as the Dutch government believes strongly in switching to EVs. To give an example of the market size: in Austria there are more than 15,100 taxi cabs. In the Netherlands there are 45,000 taxi cabs.

In Finland some taxi companies and individual driver-owners currently have HEVs in commercial operation. However, the total number of these is less than ten nation-wide. In the taxi industry the main driver for EV/HEV/PHEV are economical benefits. After that come the green values. The price of fossil fuels will rise in the future. EVs must be reliable, and batteries must cover about 500 km continuous driving. Taxis are driving in weekend all the time, so there are now possibilities to recharge batteries during weekends; unless there would be fast charging facility for the weekends, normally slow charging should be

enough. The average annual mileage for a taxi cab is about 80,000 km. For the taxi industry today long term decisions of government in various vehicle related taxes are the most important. Tax reductions and other incentives should stay stable for several years in order to bring stability for the business and not change annually.
Purchase of EVs will be realized when EVs are economically competitive and trusted. Expectations for the future are that there will be enough big family car size EVs available. The services and maintenance should be also easily available and in several places.

5.6.1 Interview results

Results seem highly similar to delivery services due to communalities such as:
Largely inner-city transport.
Transport is core business, consequently the employee spends much time in his car and the car should meet many conditions (look and feel, size, reliability, heating, etc).
Highly competitive with small profit margins.
Much impact on the environment and much exposure to the public. In all cases EVs have been subsidised by the government.

An interesting finding: some respondents within delivery services as well as taxi companies praised spontaneously the comfort aspects of the electric vehicles, such as absence of noise, stench and the good acceleration.

5.6.2 End-user

Based on an extensive study by Etrans[1], private motorists are described as so different that they can be divided into seven categories that differ in terms of values and behaviour, everyday routines, lifestyle etc. The seven different types of motorists are categorised according to their transportation needs, environmental profile, perception of cars, etc.

1 Qualitative in depth anthropological research of 50 different car users by Etran (2009). Evenly distributed on private households and enterprises they followed 24 users of conventional cars, 24 users of EVs and 2 non- users [2].

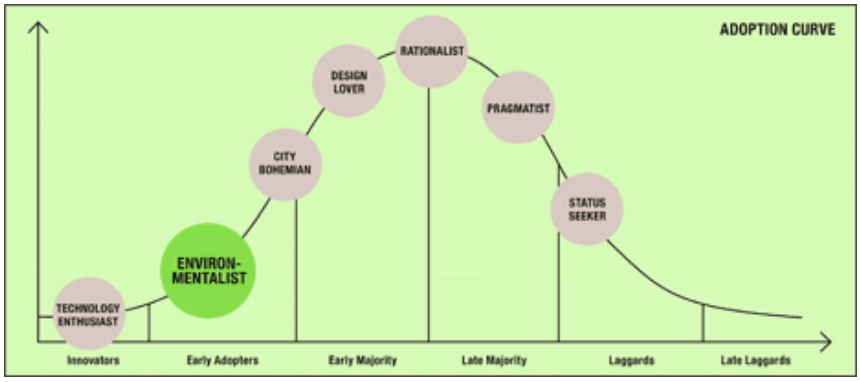

FIG 5.2: **Adoption Curve (Illustration: Etrans, Report 1, p. 68, based freely on Rogers, E.M. (2004) Diffusion of innovations (Fifth edition), NY: Free Press).**

The seven steps of the adoption curve are briefly described in figure 5.3.

phase	market share	short description	purchase motive	values	car use	characteristic	leads for electric driving policies
innovators	2.50%	technology enthusiast	hobby/toy	technology adept, freedom, visibility	irrelevant	often male	little (autonomous decision)
early adopters	13.50%	environmentalist (ca 5%)	evironmental issues	moral obligation, visibility	irrelevant	often higher education	willingness to compromise on price, range, looks and comfort
		city bohemian (ca 8.5%)	trendy/rebellion project	freedom, flexibility, spontaneity, smart and eco, visibility	mostly inner-city	often first car owners, starters, living in the city	willingness to compromise on price, looks and range
early majority	34%	design lover	look and image of the vehicle	visibility, aesthetic expression	?	?	willingness to compromise on price and range
late majority	34%	pragmatist / rationalist	everyday transport	economy, comfort, function, safety	extensive and everywhere	often business motorists	P(H)EV must compete wih conventional vehicle
laggards	16%	status seeker	status and exclusivity	independence, status and achievement, materialistic	irrelevant	conservative	

FIG 5.3: Short description of the subsequent phases of the adoption curve.

To reach the late majority and the laggards the P(H)EV will need to compete with the conventional car regarding price, range, comfort and looks. As illustrated by the previous chapter this is not going to happen within the first decade. On the other hand the innovators and to some extent the environmentalists are inclined to compromise on the many draw-backs of the P(H)EV out of sheer interest (hobby) or a hart-felt moral obligation. From the government or automotive perspective, these groups don't need any persuasion (innovators) or can rather easily be convinced to switch to electric driving (environmentalist). However, these groups are only a minor part of the end-users. City bohemians and design lovers comprise a far larger part of the end-users and capturing these groups will eventually make large scale implementation of EV happen. These groups are less inclined to compromise. On the other hand, they are characterised by a mobility pattern that goes well with the EV (city bohemians) or they might like the innovative image and look (design lovers) of the car, which provides clues for policy measures and marketing.

5.6.3 Interview results

End-users have been researched in Denmark and Norway. EV users (4) all have small city cars and use the EV for inner city transport and the surrounding area within the range of the car. In three cases the car is an actual replacement for a conventional vehicle, though smaller. All vehicles are mostly charged at home and the company. Whereas in Denmark the reasons for procuring are mostly environmental

considerations and less noise and stench, in Norway the EV has been primarily procured for cost savings (incl. parking fee, road toll, etc.).
Non EV-users both state that the main reason for not buying an EV is lack of choice (they both prefer a mid-size car with more luggage room). In the Danish case the respondent also requires more charging possibilities (slow and fast) and / or larger range. Decrease of costs was not mentioned by either respondent.

Relatively high purchase costs have been mentioned as the most important barrier for a higher share of HEV and EVs in the current vehicle fleet. To date, owners of HEVs did not purchase these vehicles based on financial savings. A green image or just being different were more important driving forces. For a larger market share of hybrids to materialize, financial savings will play a much larger role in purchase decisions than today. The reselling price on the used car market, which to date is largely unknown, may play an important role in the total costs and savings of operating a HEV. When more hybrid car models will be offered on the market, total production numbers will go up and consequently production costs and purchase price may be expected to come down.

5.7 Comparison of user groups

With respect to the EVs that are presently in use, we have come up with the following general findings (see also attachment A).

EVs in use
EVs in use are mostly small city cars, corresponding with the current supply of EVs, with an occasional van, light truck, mid-size passenger car or sports car, with range of 75-150 km.
The majority of organizations employ a very limited number (1-5) of EVs, to get acquainted with the concept of electric driving.
The vast majority of companies own the car (in contrast to leasing); since they think leasing would be more expensive.
The vast majority uses slow charging. Batteries are charged at the company and/or at own premises as fast charging is still very sporadic.
In some cases the EV is an additional vehicle, bust most of the time replaces a conventional (ICE) car.
In the vast majority of cases the procurement of EVs has been subsidized by the (local) government, on top of tax benefits.

The selected user-groups also appear to have many characteristics in common that result in comparable user requirements to EVs. There are some slight, yet interesting differences between the user-groups as depicted in the table below (see also attachment A).

User-group	Motive	Demand for EV (1-5 years)	EV specifications	Price	Range+ charging	Policy recommendations	Else
Public authorities	Less emissions Improving image and marketing.	**++**	Vans Light trucks.	TCO should decrease, some higher costs are admissible.	Larger range + fast charging.	Green procurement should be maintained, as well as fiscal policies. **Demonstration projects.**	***Pay attention, because EV is silent!*** Comfort of EV is praised.
Utility companies	Part of marketing strategy.	+	Vans Utility vehicles Winter comfort (heating) should improve.	TCO should decrease, some higher costs are admissible. Guarantee of residual value of car.	Larger range + fast charging	Grants and fiscal policies to lower the price of EV.	EV works well with companies that have chosen to employ EV.
Delivery services	Less emissions marketing strategy ***and potential cost savings (through more customers).***	+	Vans Light trucks. Reliability of operation.	TCO should be equal to conventional cars or be offset by more customers. Guarantee of residual value of car.	Larger range = fast charging.	***Local privileges in addition to national policies: extended delivery times, environmental zones, driving on bus lanes/tram tracks.***	EV works well with companies that have chosen to employ EV.
Taxi companies	Marketing strategy ***and potential cost savings (through more customers).***	0/+, very much dependent on the way of operation (type of cars, trips).	More choice of EVs and models. Reliability of operation. Winter comfort (heating) should improve.	TCO should be equal to conventional cars or be offset by more customers. Guarantee of residual value of car.	Larger range + fast charging.	Grants an fiscal policies to lower the price of EV.	Comfort is praised by drivers as well as passengers.

End-users	Environmental concerns (Dk en No). ***Cost savings and times savings (No).***	0/+, depending on the adaptation curve.	More choice and more size (passengers, luggage). Reliability of operation.	***Costs are not mentioned in interviews.***	Larger range + fast charging.	***Local privileges in addition to national policies: free parking, driving on bus lane, access to restricted areas.***	***Local service providers are considered essential.*** ***EV should be more promoted, i.e. with respect to comfort.***

FIG 5.4: User-groups and their opinion on the procurement of EV.

5.7.1 Similarities

Environmental concerns play an important role in each user-group's motive to start procuring or to extend the number of EV.

Demand for EV is expected to increase in each and every user group. Partly due to expected developments regarding present barriers to procure, partly because the EV has proven or is expected to fit a (small) part of the mobility need.

Each user group mentions the importance of more choice of EVs and models. Heavier E-vehicles (mostly vans) are much wanted. Also the importance of reliability of operation is stressed several times, next to winter heating which takes a lot of power and – consequently – limits the range of the vehicle quite badly (as experienced by a couple of organizations that employ EV).

In general the user-groups are very persistent that TCO should decrease - although public authorities and utility companies are willing to pay extra for the EV (compared to a conventional alternative).

All user-groups agree that larger range and fast charging of the EV is necessary to procure or extend the number of EV. For almost each organization that already employs EV, available slow charging complies with the mobility pattern, and satisfies their needs.

Policy recommendations by each user group tend to direct at fiscal policies and/or grants that lower the purchase prices or TCO of EV.

Organizations that employ EV, report in many cases a) high satisfaction with the comfort of EV and b) little logistic reorganization needed to fit in a (small) fraction of EV in to the total fleet.

5.7.2 Differences

Interestingly, in the case of delivery services and taxi companies the potential of extra customers is included in the business case for the EV.
Also the business case for end users in Norway seems to work out quite well. For example, the total costs of the Fiat e500 exceed the total cost of the conventional Fiat 500 or VW Polo by far, despite lower maintenance and fuel costs, lower road tax, free parking and free access to toll roads. If the same conventional car is compared to a cheaper EV like Think City, however, the life expectancy of the battery still makes the EV a somewhat more expensive alternative (NOK 4.000 a year), but when free parking and toll roads are added to the equation the average EV owner can actually save NOK 5000 (Euro 640) a year compared to driving a conventional VW Polo. In addition the EVs may use bus lanes.

It is expected that public authorities demand for EV will rise most eminently, since they are subject to public procurement regulation, whereas the other user groups are completely free in their choice of a car.

In the interviews, the high costs of EV have barely been addressed by the end users. Recent (global!) research, however, shows that price is the number one concern of consumers. The majority of consumers (65%) would not pay more for an EV than they would for a regular gasoline one [3], while out of consumers polled by Kelly's Blue Book [6], 91% thought EVs remain too expensive to purchase. Of those who accepted the price differential, consumers were split in the polls on how much more they would be willing to pay:

- 51% said they would not be willing to pay more than $5,000 above the average price of a standard vehicle [3].
- 40%, say they would pay up to 20% more for such a vehicle [5].
- 58% said they would like to buy an EV but would wait for the price to fall first [4].

Local privileges have been mentioned by delivery services as well as the end-users, to encourage electric driving. Privileges also apply to taxi companies, although not mentioned during the interviews, and may have quite a large impact on the willingness to convert to electric driving, as the Norwegian business case (see above) shows.

More promotion of the EV is suggested by a number of interviewees, such as more exposure and commercials, more emphasis on the advantages (no stench, no noise, single gear, etc.) and demonstration projects to give potential buyers of EV a taste of electric driving. Finally, the importance of local repair service providers is stressed by the end users.

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6 MARKET POTENTIAL OF ELECTRIC VEHICLES

6.1 Introduction

In this final chapter, the main conclusions of the previous chapters will be presented. First we give a short summary of the (expected) user requirements and demand for EVs, followed by a description of the (expected) supply of electric vehicles over the next five years. We will conclude with a short overview of the market potential.

6.2 Electric vehicles demand in 2015

(Potential) demand for electric vehicles has been researched among five user groups:
1. Public authorities.
2. Taxi operators.
3. Utility and energy companies.
4. Delivery services.
5. End-users.

Up till now, EVs in use are mostly small city cars, corresponding with the current supply of EVs, with an occasional van, light truck, mid-size passenger car or sports car, with a range of 75-150 km. The majority of organizations employ a very limited number (1-5) EVs, to get acquainted with the concept of electric driving.

Primary reason to procure EVs is environmental concern, either for its impact on emissions (local authorities) or social corporate responsibility, image and marketing. The latter is specifically mentioned by utility companies (to raise attention for electric driving) and delivery services (to be preferred by customers for being a sustainable transportation company).

Requirements of future EVs to be procured are:
4. First of all, a ***lower TCO*** is considered crucial. In some cases the TCO should be equal to the conventional vehicles, yet in many cases a slightly higher TCO (5%) is accepted (also part of the TCO are aspects like the residual value of the battery and reliability of operation).
5. The requirement of a lower TCO is closely followed by the requirement of ***more choice of vehicles and models,*** such as mid-size passenger cars, vans and light trucks.
6. Thirdly, ***a larger range*** is asked for ***or the possibility of fast charging*** (however, a larger range is requested more often).

Finally, the importance of communication and demonstrations should be stressed. The market of electric driving is new and highly dynamic. Despite some apparent draw-backs, EVs offer unique selling points such as less noise and great driving abilities, often reported by respondents that have started driving EVs. Moreover, respondents report a lack of reliable information on the real costs and benefits of EV and/or the opportunity to get acquainted with EV by means of demonstrations and temporary trial.

6.3 Supply of electric vehicles in 2015

At present (with present oil, materials, dollar and car price levels) an electric or plug-in hybrid needs in the order of 5 to 10 years before the owner breaks even compared to purchasing and using a (otherwise comparable) conventional car. In five years the break-even point may come down to 3 to 5 years according to the most optimistic scenario. This is underlined by a majority of the respondents (senior executives form the world's leasing automotive companies) in the KPMG study who do not foresee a reasonably priced, mass-market electric vehicle available for at least five years.

At this moment in time the market segments served with BEVs are mainly those of the small to medium sized passenger cars and to some extent the luxury sports cars. Also some commercial cars are soon to be expected. But size and weight will stay modest. There is very limited supply of light and medium weight vans for use in the inner city (e.g. delivery vans, service vehicles). The sector of light and medium weight vans is fiercely competitive and more costly drive-line technology is difficult to introduce for that reason. From the economics as well as the ecologic /air quality perspective commercial vehicles used within city centers can make a real difference though (large difference in emissions, and a relatively high daily mileage.

BEVs with larger range and PHEVs are also expected, which will make range less of a problem. In particular PHEVs are considered as the stepping stone to mass deployment of electric driving. Recent research of KPMG shows that the vast majority of car executives in the KPMG research (around eight out of ten) believe that hybrid and electric cars will enjoy the biggest growth of any vehicle category over the next five years (although total sales are expected to lag well behind traditional internal combustion-powered cars over this period) [1].

With regard to charging speed it appears that Lithium-ion batteries are getting more and more suitable for fast charging. Also modern batteries can stand fast charging ever better, so that even using the fast charging option many times does not really hurt the overall battery life. This will eventually pave the way for large scale electric driving.

6.4 Market potential of electric vehicles

As said before the EV market is and will be for the years to come a sellers market: the demand is bigger than the actual supply of vehicles. However, market conditions are expected to improve significantly within 5 years: prices will drop (though not to the level of a conventional car) and the range will get larger, certainly in the case of PHEV. OEM vans and light trucks on the other hand will still stay scarce.

With present characteristics of the EV and availability of charging stations, the EV has already proven to fit - at least to some extent - in the mobility pattern of the users that have been interviewed. All in all, we may conclude from our research that there certainly is EV market potential given the similarities between and the size of selected user groups and it is likely that this will continue to be valid and even improve in the near future, at least for the innovators.

Presently, a few hundred (Austria, Netherlands, Denmark) up to around 3,000 EVs (Norway, Italy) are in use in most EU-countries. Future volumes of EV are difficult to generate, due to the highly qualitative nature of our research, yet volumes up to 10,000 EVs seem to be in reach for most countries, *if available*. The actual volume is highly dependent on the implementation strategy of the automotive sector over the next years (see also 6.3).

The volumes that will be realized in the market not only depend on the car production as it is, however. It is most likely that the mentioned user requirements will need to be fulfilled to a lesser or higher degree for the subsequent stages (early adopters, early majority). The contribution of public authorities, car manufacturers, charging infrastructure providers and intermediate partners such as leasing companies and providers of new service concepts etcetera is needed to make this happen.

In study 2 the policies of the countries involved will be assessed regarding electric driving. Recommendations will be derived that offer practical guidelines to policy makers on how to meet the market potential and make broad implementation of electric driving happen.

STUDY 2

7 ELECTRIC ROAD TRANSPORT POLICIES AND PLANS

7.1 Introduction

In this chapter essential aspects of electric road policies, policy measures and instruments will be defined and identified for each country involved in this study. The investigation is not comprehensive. In order to be able to supply valuable recommendations and a practical approach to overcome potential barriers the most important plans and best practices have been identified. This has been done in cooperation of the project partners and national contact persons in the supervisory panel.

7.2 Policies, policy measures and plans

As described in study 1 the participating countries found two main user groups that are likely to be important innovative users for EVs. These are private end users on the one hand and different types of large fleet owners on the other. We analyzed four different types of fleet owners who shared more or less the same motivations for transferring to electric mobility: Public authorities, taxi companies and delivery services were all inclined, maybe for different reasons, to follow up climate policies and improve the (local) environment as well as building an image of corporate social responsibility through acting as role models in electric mobility. In addition, utility or energy companies represent fleet owners who are interested in electric mobility due to its potential for market development for their main product – energy - as well as investigations of electric mobility's impact on the grid capacity.

All five likely innovative user groups for EVs (private end users and four types of fleet owners) reported an experienced added value from driving EVs – namely better comfort. The extra comfort was related to good driving conditions particularly related to acceleration for inner city driving as well as absence of both noise and stench. In addition, all user groups reported that they will only succeed as innovative users if they are provided with more and different types of EVs with a better range and more choices related to size and charging. In addition the fleet owners asked for better total cost of operation (TCO).

Fleet owners are interesting as future users of EVs because they are regarded as more inclined than private end users to consider the TCO of their car fleet rather than just the purchase price of the cars, which still tend to be somewhat higher for EVs compared to conventional cars. Interestingly private end users report that their motivation for electric mobility lies precisely in better TCO in addition to climate friendly means of transportation. End users' TCO, particularly in Norway, includes time spent in the car, or rather time saved to do other things since EV users are allowed to drive in the bus lanes and hence, as long as they constitute a minority, they do not get stuck in traffic congestions.

One way of improving the TCO of EVs is thus to extend the equation beyond mere factors as purchase price, interest rates on loans/lease agreements, required energy and cost of maintenance and also include estimations of environmental gains, valuation of consequences of added driving comfort (i.e. more motivated employees) as well as consequences of spending less time in the car and more time doing the real job.

In study 1 we described the main advantages from transferring to electric mobility as related to reduction of emissions and cost reductions related to energy and maintenance, as well as added value from increased comfort (due to no noise or stench from EVs as well as easy inner city driving) and image improvements. Reduction in costs related to energy and maintenance as well as potential profit from improved image and

comfort are 'local' values mainly interesting for the company or private end user. Hence these are values a company/end user may decide to include in their private financial bookkeeping. Reductions in emissions and stench/noise on the other hand, may be regarded as more long term (inter)national values not of immediate interest to the company or private end users. Such values must hence be given strong political assessments in order to make an impact. In the remainder of this chapter we will describe the different policies and action plans in the various countries.

7.3 Policies in the countries involved

The participating partners in this study come from the EU countries Austria, Finland and The Netherlands. In addition EEA partner Norway participated with case studies from Norway and Denmark. Finland with case studies form Finland and the UK. Based on the description of these countries in study 1 we learned that Finland has 1 EV per 100,000 conventional cars. Austria and The Netherlands both have approximately 5 EVs per 100,000 conventional cars. The current amount of EVs in Denmark is estimated to be somewhere between 150 to 500, which gives Denmark a ratio of 7–23 EVs per 100,000 conventional cars, while Norway has exceptional 155 EVs per 100,000 conventional cars.

In collaboration with the national contact persons in the supervisory panel each participating country selected relevant policies to be studied in their national context. These policies are more or less aimed at one or more of the likely innovative user groups identified in study 1 – the four different public and private fleet owners and private end users.

The investigated countries differ in many ways. Relevant for this study is that in addition to differences in ratio of EVs, the countries also differ in terms of EV-related energy situation (dependency on (imported) non-renewable or almost self-contained with renewable energy) and problems related to climate, air quality and traffic congestion. They experience different types of challenges with the implementation of EVs and understand the challenges differently, which is also related to the fact that the countries differ in industry profile, population density and in length of experience of dealing with electric mobility policy, which also means that they differ in terms of suggested solutions and targeted user groups.

Characteristic for the investigated policies is that Austria and Finland are described as countries that are eager to start with electric mobility but national policies have so far not been very powerful. In The Netherlands they have gained some more experience with electric mobility initiatives and ambitions, and more importantly they have come to identify some important shortcomings in these initiatives which raise interesting questions. It is way beyond the scope of this study to conclude that the policies of Norway and Denmark have been (most) successful even though they have the highest ration of EVs compared to conventional cars. Nevertheless, the experiences from these two countries offer some interesting food for thought. For one, particularly Norway, but also to some extent Denmark has generated a lot of experience from attracting private end users to EVs, which is interesting since end users are the key to reach mass deployment as they constitute the vast majority of all car owners. In addition, several of the studied initiatives in Denmark and Norway seem to have gathered somewhat longer experience which means that they provide answers to some of the questions and shortcomings pointed out in the other countries. It is hence interesting to make an additive analysis rather than a strict comparative analysis between these countries. Taken together, the experiences from all these countries serve as a good basis for suggesting a road map for the implementation of "Electric Road Transport" policies in Europe. It is also important to note that some of the experiences and differences between these countries should lead to important warnings against making *the* common European road map irrespective of the context of country and culture. Hence,

all initiatives may offer interesting lessons on their own, and particularly when they are read in relation to each other.

7.3.1 Policies in Austria

The studied initiatives in Austria are mainly in a start up phase which means that these initiatives are still gathering experience and that it is too early to draw any clear conclusions. Basically these initiatives are driven by climate policies and ambitions to reduce the dependency on fossil fuels. Austrian initiatives aim to develop *systems* for electric mobility, for instance by making EVs available and tempting to use. These initiatives also stress the importance of charging EVs with green electricity. Since price of EVs is regarded as too high and availability too low, and since these initiatives also experience the vast challenges of coordinating all the interested parties, they also suggest that more policy intervention and regulation is necessary, also because a change in attitude is likely to follow from a change in activities.

Austrian Mobile Power
Austrian Mobile Power (AMP) is a private initiative funded with national subsidy involved in many electric mobility projects like EmporA (see below). Through a pilot project they aim to make 20 EVs available for testing in companies and build up the necessary infrastructure and services for companies (since EVs are regarded as too expensive for end users). They want to build experience and identify integrated business models for leasing, charging, smart grids and services etc. The most essential conditions for the success project are public support and managing the engagement of all the partners in the consortium and creating enthusiasm and participation.

EmporA
EmporA is a national (subsidy) initiative where a joint venture of enterprises lead by the energy suppliers collaborates in planning a total electric mobility system. In this system, EVs, charging infrastructure and smart grids should be available to company fleets (and private users) in order to reduce CO_2 emissions, develop business potential and limit dependency on fossil fuels. They aim to reach their goals through testing user preferences and developing business models to make EVs available and attractive. In order to succeed with this work they regard policy interventions on all levels and the fulfillment of user requirements by manufacturers as most essential. They regard a focus on environmental aspects and climate policies as the most positive driver for changing the mobility system, but find that it is difficult to join forces towards new markets and new networks.

Raiffeisen
Raiffeisen leasing is a bank/leasing company which has many partners in different projects on the electric mobility side. It is a joint public/private initiative which has some projects in cooperation with Klima Aktiv (a political program for EM-projects) like the Model Region Eisenstadt with the energy supplier BEWAG (see below). The pilot project aims to make EV leasing available to all identified user groups in this study in order to reduce emissions and promote green procurement. They aim to identify business models for entire electric mobility systems and build up experience by making the use of EVs more attractive. Hence they aim to make vehicles, services and infrastructure available in order to allow people to get in touch with the electric driving. The biggest threat is the lack of available vehicles for transportation services and delivery service. They argue however that for specific user groups availability can be realized. They suggest using EVs in the tourism sector or for commuting. They have experienced that it is difficult to implement EVs in the every day's business, but easier in the tourism sector. They do not elaborate on this argument though. Essential conditions for making the project successful are manufacturers who must fulfill user requirements such as enough supply and more models in order to avoid a fading interest for EVs. The

partners recommend (local) governments to engage with personal involvement and to act as role models who drive EVs to show people how easy it is.

BEWAG

BEWAG is an Austrian energy supplier which leads a pilot project in cooperation with Raiffeisen leasing. The joint company/local government initiative - The model region Eisenstadt - focuses on E-taxi. Car sharing/pooling is also part of the concept. The project focuses on end users, taxi companies and local authorities as important role models as they can develop green procurement and business models for charging infrastructure and mobility services. The partners want to make the usage of EVs more attractive and facilitate availability of vehicles, services and infrastructure. They consider communication and reaching the user groups with information to be the most essential part of their approach, and recommend introduction of EVs to all users, for instance by showing EVs on the vehicle-market. Without information, there is no influence and no success, they argue. Therefore, communication is one of the most important points. Besides, companies and the taxi sector can be the biggest enabler in the model region, because they can cause fast economies of scale.

VLOTTE

VLOTTE is a model region aiming to provide the public with cheap rental cars. The model region VLOTTE is one of Europe's largest e-mobility model regions. The goal is to build up a new mobility case with infrastructure and EVs to a monthly regulated price, which can be used by everybody. The next phase of the project foresees the construction of rental stations for electric vehicles. The partners want to provide a market implementation project with technical possibilities because customers must want EVs and feel comfortable in them. People cannot be forced into using EVs. They address all identified user groups except taxi companies, who are regarded as the most problematic user group due to the long distances they have to cover continuously and on a daily basis. The driver behind the initiative is to limit dependence on fossil fuels and rather provide sustainable energy. By 2050 they want to produce their own energy and change the vehicles using fossil fuels to EVs. As part of this process they want to develop detailed documentation of the energy used by all the existing EVs in Vorarlberg, in order to compare emissions from fossil fuels with EVs. The pilot project aims to contribute to broader implementation and reach a higher market share of EVs by starting in their own organizations. The most essential part of the approach is the sustainable energy delivery because of the critical oil history and future. Hence they plan to implement their own energy supply delivered from photovoltaic and water power including their own charging infrastructure with 100 charging points using sustainable energy. These charging points should be located on high frequented traffic points and linked to public transport and long distance traffic. They offer a transportation ticket for a year in their deals as well. So far they have built 100 charging points and provided many cars for private use. Also the cooperation with the public transport works well. The partners want to involve the OEMs in their project as well. Policies and grants are considered essential conditions in making the project successful. In addition, users must be shown that electric driving is nothing to fear. The biggest enabler is to get people to test the fun of driving EVs. People cannot be forced to change to EVs, but by testing EVs they can start wanting it. Low prices of EVs should be provided by grants.

ElectroDrive Salzburg

ElectroDrive Salzburg (“we believe in electric mobility and green energy”) is a company initiative that receives national subsidy. ElectroDrive Salzburg is a model region offering EVs for monthly rent. They build up infrastructure for this region with 100% sustainable energy because they argue that only when the energy is 100% renewable it makes sense to use EVs. Their end users are role models from both B2B and B2C companies with CSR ambitions. They want to deliver the best infrastructure possible and aim to have 50 charging stations on public places delivering renewable energy. This will contribute to a greener image for the customers as well as for the company. The driver behind the initiative is to start new concepts

where people rethink mobility behavior through showing people new, better driving opportunities. Driving EVs is easier and reduces noise. Besides, implementing EVs leads to new changes in the whole value chain like new jobs and new ideas. It strengthens the innovation potential and opens new possibilities. In addition the partners want to be energy independent and fulfill climate policies. This is a pilot project that offers a limited number of vehicles which should hopefully lead to a higher share of EVs in Salzburg. The most essential part of their approach is related to financial support by the government as it is regarded as too expensive to do it on your own. Policy development, market development and societal involvement are regarded essential to make their project successful. If public funders would cancel their financial support or grants all research would stop immediately. Hence, public support is regarded as the biggest enabler for the project. They recommend to try new ideas, but to start small and then grow bigger. Furthermore, the focus should not only be on the end user, but also at the start address the B2B side. Although there is good policy support in Austria, they argue that more investments and more regulations towards electric mobility are required. With reference to earlier developments they argue that regulatory measures need to be defined. When people are first forced to do something, they will do it and get used to it. Next to pushing EVs it is important to push renewable resources, and governments need to realize the value chain of electric mobility. Charging points should not be far apart they argue, but should be available closeby.

Austrian evidence:
Several regional initiatives.
Company/private actors are active.
Some national subsidies.
Environmental aspects and green energy objectives.

7.3.2 Policies in Finland

The projects studied in Finland are also mainly in a start up phase where it is too early to draw any clear conclusions. Basically these initiatives are driven by climate policies but also by ambitions to generate profit. Finnish initiatives represent (planned) pilot projects from taxi companies, a local authority and interesting joint initiatives with partners from a variety of trades. These initiatives mainly aim to test EVs and build up charging infrastructure, and they point to a critical lack of knowledge and political consistency. On the national level there are different opinions, for example the Ministry of Trade seems to support EM, but the Ministry of Transport and Communications seems to fear that electric mobility may reduce the use of public transport instead of conventional car transport.

ECO2
The ECO2 project in the city of Tampere aims to reduce emissions and make all activities in the city more energy efficient. The participants want to be role models. They are just starting up the project and hope to have at least one EV in the city soon. They participate in the EU covenant of Mayors (aimed at reducing emissions), but find that it is difficult to measure if/how much reduction in emissions can be linked to EVs. Since convincing actors to change requires a lot of work and availability of objective knowledge they also suggest that the message should be top down and reinforced by evidence from research.

T3 area project
The T3 area project is a local joint public/private initiative with partners from local authorities and industry partners representing energy and mobile communications as well as a service providers for the automotive industry. They announced a demonstration initiative for EVs in the so called T3-area of Espoo in order to create an internationally recognized demonstration that increases the attractiveness of Espoo as an innovation hub and eco-conscious living area.

The initiative is aimed at building a better understanding of how new, more eco-conscious requirements have to be taken into consideration in city planning. The partners will work closely with research institutions in order to become a leading competence center for electric vehicles. Radical changes in the T3 area due to the building of the metro line (around 2016) and the tunneling of the Ring road (scheduled around 2025 - 2030) are the main drivers for the project. This will offer an excellent opportunity to provide new city planning innovations.
Espoo has signed the voluntary energy efficiency agreement for municipalities and has committed to implementing the climate strategy for the metropolitan area. By developing a concentration of electric vehicles, charging infrastructure and knowledge of use and maintenance they aim to act as a starting point for market penetration. The main measurable objective is that there should be 1000 full electric vehicles in the area soon after the metro opens in 2016. The main qualitative object is to build experience in car, battery, charging, and ICT technologies. A key component of the project is to develop the infrastructure needed to recharge the electric cars. The project will focus on the infrastructure needed for the wide-scale adoption of electric cars and on different ways to pay for recharging. The energy company and the City of Espoo have already worked together in promoting the wide-scale adoption of electric cars and development of the charging infrastructure. The partners had a slow start with their EV fleets, but new charging stations have been introduced and are becoming a standard item in all new large parking facilities for instance. The partners recommend that the government should be prepared to aid such initiatives also financially. Yearly taxes of electric vehicles should be reduced and purchase and infrastructure development should be subsidized. At the moment, neither companies nor private individuals are ready to take up the whole burden. Rare vehicles are still a problem for service availability and cold winter months requiring additional heaters in the EVs is seen as an image problem.

Helen Group

The Helen Group runs a joint public/private initiative under one of the largest energy companies in Finland. The other parties involved are the City of Helsinki and several companies related to energy, telecommunications, electricity infrastructure, charging infrastructure and import of cars. The project also creates scenarios for electric mobility for the year 2030 together with researchers from the Aalto University. The targeted user groups are primarily city authorities who can be front runners for green procurement and testing of new technology. Electric mobility is seen as a growing business area for companies focusing on electricity production and distribution. Being owned by the local authority, the energy company also has responsibilities in promoting the sustainability objectives of the city.
The drivers for the project are business development as well as reducing emissions (inspired by the Regions own, European and City level objectives). The network group works towards their goals by providing charging infrastructure and by acting as a front runner in using Smart Grids with smart charging and an optimization of network capacity and electricity production. Also Smart Invoicing will be developed.
A pilot project with a limited number of vehicles has started. Broader implementation in their own organizations is planned to work as role models. Lower parking fees were introduced for low emission vehicles in Helsinki, but the current definition of low emission vehicle is too technology dependent, since the ambition of less than 100 g CO_2 / km is based on current fossil fuel technologies.
Better definitions are needed to favor EVs. Hence, tax instruments are regarded as the government’s best available measure to promote new technologies. Even though society seems to be ready for electric mobility, it still remains an open question whether the vehicles are suitable to arctic conditions. Information provision and marketing are part of the process and they regard the change in public and political opinions as a success. The partners also recommend that the "teething problems" of new technologies must be considered for instance through better definitions of guarantees and responsibilities.

Other private initiatives

Oy Future Energy Finland
Partners of a joint private initiative in Finland search for economical benefits in addition to acting on green values in their plan to purchase EVs for taxi use during the next 10 years., The price must be feasible though. The partners ask for long term and predictable government policies rather than yearly changes in 'carrots' such as tax reductions. They also require available service and maintenance for EVs and a wider variety of different types of EVs. Oy Future Energy Finland has through their contacts with other related companies initiated a pilot project to test EVs (taxi and delivery services) in urban traffic. They do so to be a role model in improving air quality and reducing emission, but also to test possibilities for profitable business. They have developed a charging infrastructure for their EVs and use the media to increase public knowledge and to impact decision makers. They find that EVs are suitable for taxi purposes if charging can be done during the breaks, and they have also experienced considerably lower energy costs. They recommend utilizing the charm of the novelty now and they call for public funding and more initiatives from energy companies.

Itella
Itella, the former Finnish Post, has tested EVs in delivery use already in the 1990s. Now they have acquired two EVs which will be used on daily basis.

Finnish evidence
Some model regions and active municipalities.
Few active large companies participating several networks.
Some innovative small actors and networks.
No strong national government support or incentives.

7.3.3 Policies in the Netherlands

The policies studied in The Netherlands are the national action plan, four local action plans, an alliance between regional grid operators and a joint public/private partnership where more than 25 partners cooperate to purchase 3000 EVs before 2014. The action plans are dependent on national and EU policies encouraging electric driving as well as exogenous factors such as fuel and energy prices. The national driver for EV policies is ambitions about establishing The Netherlands as an international laboratory for electric driving in 2009-2011. The local action plans and the public/private partnership are primarily concerned with the air quality of the cities and fulfilling the climate policy goals, while the grid operators follow up on the actions from the other actors and want to estimate the impact of EVs on the grid capacity and gain experience. The Dutch projects seem to have gained somewhat more experience than the Austrian and Finish cases, and offer interesting experiences to learn from.

National Action Plan for Electric Driving
The central government's contribution in the National Action Plan for Electric Driving consists of three main ingredients:

1. The establishment of a 'Formula E team', with robust and authoritative chairperson and members from all industries is indispensable for the successful introduction and roll-out of electric driving. The team's primary task is to spur market development and remove obstacles. They have established a formal co-operation between government, companies and institutions to enforce breakthroughs regarding E-driving. The Formula E team has managed to attract interest from large EV manufacturers, and it is

expected that about 2500 EVs will be available for the Dutch market in 2011, much more than their relative market share.

2. Practical measures in 2009-2011 on the following fronts: (a) practical testing and demonstration projects, (b) launching customership, (c) recharging, energy and other infrastructure, (d) research, development and production of electric vehicles and/or parts for them, (e) formation of consortia and coalitions and (f) ancillary policy. The national government participates in DC-TEC (see below) with about 400 E-vehicles for the national government fleet.
3. A market introduction facilitated, coordinated and phased in by the formula E team. That means programmatic work, based on the central government's action plan and that of other pertinent studies and action plans. Important in this regard is that the most important stakeholders have unanimously selected the German Mennekes-plug as the standard in the Netherlands (as have Germany and Sweden).

Important fiscal policies at present which are applicable to EVs include exemption of tax on passenger cars and motor cycles till 2018 and exemption of road tax till 2018, exemption of taxable income for lease cars until 2014 and grants for public charging stations as well as grants to companies that invest in EV for commercial transport.

DC-TEC

The Dutch consortium for the tender of electric cars (DC-TEC) is a joint public/private initiative of about 25 companies (banks, electricity companies, delivery services, authorities) that will invite international tender for different types of EV classes, and aims to purchase about 3000 EVs. The goal of the consortium reaches beyond the mere procurement of EVs since they aim to disseminate knowledge on EVs, reduce barriers for businesses in electrifying their fleets through successful development of an EV market, and encourage automotive manufacturers to intensify their development of electric driving. DC-TEC aims at participation from large frontrunner companies that are capable to adapt their operations to the use of EVs and are managing the environmental impact of their operations. Basically the project facilitates the introduction of electric driving by bringing the market parties together in an arena that is characterized by optimal objectivity and transparency, and by pooling the purchasing power of many companies they ensure a major push for EVs at a competitive price. Financial support from the government is essential to make a more interesting business case, as are attractive lease-arrangements to eliminate the risk of a poor life cycle of the battery. Nevertheless, they argue that the market is leading, and if electric mobility takes too much effort from the government the market is just not ready, so it is important to listen to potential users/purchasers, because the initiative should be taken by the market. At the same time they also believe that infrastructure will not be a challenge and that companies that start electric driving will take care of the infrastructure themselves.

Stroomstoot

Stroomstoot is the local action plan on electric mobility for the city of Rotterdam. Before 2014 25% (350) of the municipality fleet should consist of EVs with access to minimum 1 250 charging points. The long term objective is to make all local public transport kilometers 100% electric. Rotterdam focuses on green procurement in the local authorities and companies transporting goods and people in the inner city. About 50 EVs are now in use. Since they aim for learning by doing project proposals will be individually tested by the municipality regarding their contribution to Stroomstoot.

Rotterdam will make an application with the foundation E-laad (see below) in close cooperation with the grid manager for charging stations in public space. Since charging infrastructure is not vandal proof Rotterdam plans to become frontrunner regarding innovative ways of charging without plugs and cables (induction and loops). Parking garages offer great opportunities to establish charging stations in (semi-) public space. Part of the parking spaces in new parking garages will be equipped with charging stations,

and they will research if building regulations can guarantee the supply of charging stations in parking garages. Parking permits for E-drivers will be free during the first year. They offer 100% subsidy on building costs and free green energy the first year for the first 1,000 applicants for charging spots at the premises of the user (private or company). No grant applications have been received so far since cars from the manufactures are not really available yet, so supply of sufficient and varied supply of EV and lower production costs of EVs is crucial. Many small and medium sized vans in the Rotterdam area have a mobility pattern that goes very well with electric driving. Moreover, the risk factor when using electric vans is smaller since they are being used in strict logistic patterns and mostly not employed for long trips.

Rotterdam supports the Green Mobility Center - set up by parties from the car market – which is lobbying with the biggest international firms, governments, EV manufacturers and energy suppliers to encourage E-driving. The Green Mobility Center will form the linking pin between the preferences of potential buyers of EV (companies and local authorities initially and later on individuals) and the supply of EV. Green Mobility has targeted to collect 5000 EV orders before mid 2012. To give governments, companies and consumers the possibility to experience electric transportation the first Green Mobility Center in The Netherlands will be opened in Rotterdam mid 2011. Stroomstoot also recommends new mobility services that unlink the possession and use of a vehicle since the use of a vehicle can easily be adopted in one trip (instead of the travel behavior of a long period). Hence, communication is seen as key to the introduction of electric driving since people need to be given a taste of electric driving which can convince them.

Rotterdam also recommends that even though the capacity of the grid is not expected to be an issue until at least 2020, the role of electricity companies and grid managers should become more evident. The initial high costs of EV are only increased by the need for extra charging infrastructure. And it is important to gain learning experiences to be ‘ready’ if the capacity is turning into a problem.

The local action plan for Amsterdam

The local action plan for Amsterdam includes ambitions for being an attractive location for innovative international business and targeting prominent role model companies with large fleets and car sharing agencies which already have monitoring systems in place and where the car can be fitted to specific trips rather than to the entire mobility pattern of the user. Stringent policy for green procurement means that all new municipality cars should be EV unless the use of the car requires functions not available in EVs. Key to the Amsterdam approach is public/private partnerships across energy companies, car manufacturers and prominent companies with potential buyers. Since demand is higher than supply they have signed an agreement with car manufacturers to create optimal conditions for electric mobility and will gain access to EVs in return. In addition, manufacturers will establish a sales and service network for the cars in the Amsterdam area. A cluster of EV related companies has emerged since they discovered that Amsterdam has access to a large range of specialized service providers in the industry. Amsterdam also works to educate companies and citizens about the use of EVs and hence actively supports marketing activities of all companies using EVs. The National Science and Technology Museum will host a 3 years long exhibition on EVs.

About 100 EVs are in use in Amsterdam and 100 grant applications are under consideration. They offer subsidy for 50% of the extra costs for EVs compared to conventional cars. Public charging spots are essential in Amsterdam since most cars have to be parked in public spaces. About 200 charging spots are established, and the city offers 100% subsidy for building costs of accessible charging spots in public places and 50% for building costs of charging spots in garages and private properties. In addition the municipality provides free parking and green energy at these spots. Renewable energy is not considered crucial for EVs but the link with sustainable energy will make electric driving even more visible and

attractive and the side effects are also believed to make Amsterdam an even more attractive city for residents and businesses.
Amsterdam recommends that local governments act as key stakeholders since they own the public space, air quality is a local problem and since electric driving is most suited (for now) for inner city driving.

The local action plan of Utrecht
The local action plan of Utrecht involves many aspects related to mobility planning since they do not count on the progression of electric mobility to satisfy the Europeans standards for air quality in the short run. Key to the Utrecht approach are the establishment of a charging network, green procurement in the municipality and expectations towards the market to initiate electric mobility. They point to a privately funded fast charging network in Houston, other private initiatives for car pools with EVs and different electric city distribution services. So far there are three charging stations with free electricity in Utrecht based on a private initiative and they are considering applying for free public charging stations from E-laad (see below). They do not have many EVs, but the city has supported other electric transportation means like boats and bicycles, and they have received national subsidy to purchase 18 e-taxis.

Utrecht recommends establishment of close cooperation between neighboring large cities and the national government in order to align actions and learn from each other/share experiences. They also ask for larger involvement of the national government beyond grant schemes for pilots and rather enforce standardization for charging, large-scale public campaigns on TV to encourage electric driving, cheaper parking rates for green cars, and Ministers acting as role models with EVs.

The local action plan for sustainable mobility Den Bosch
The local action plan for sustainable mobility in Den Bosch aims to have a minimum of 10% EVs by 2020, but has not formulated any objectives regarding charging points. They have 11 public charging stations and multiple private charging stations (partly funded by E-laad). About 40 EVs are held by companies and the municipality, as well as 3 mid-sized busses. Similar to Utrecht they expect market parties to be active. They will consider subsidies for new but proven technologies to enable serious up scaling of electric mobility.

Den Bosch points to important conditions: More attention should be paid to the spatial arrangements as where and what types of charging stations should/can be established. Further, uniformity between municipalities and transfer of knowledge and experience is essential since the wheel gets reinvented over and over again regarding for instance required length of charging cables and how to handle parking at charging stations. This does not only apply to inter-municipal cooperation but also intra-municipal since the electric mobility policy in Den Bosch is initiated and coordinated by the department of environment, which has to rely on other departments as well since important links exists, for instance to overall transport policy, economy and education. They recommend establishment of a local contact point for electric driving to underline the importance of electric mobility and to bring parties together in order to facilitate initiatives, and to create effective coalitions with market parties to find and select the best business cases with the highest environmental impact. Finally they make a crucial point about not considering electric mobility as an isolated topic but provide embedding in adjacent issues such as supply of energy, spatial structure and sustainable mobility.

E-laad
E-laad is a foundation initiated by cooperating regional grid operators. They aim to establish and fund 10,000 charging points across The Netherlands in order to estimate the impact of e-driving on the grid and to gain experience. Hence a nation wide cooperation between grid operators is seen as crucial, especially in The Netherlands with plenty local grid operators, contrary to for instance Ireland and Portugal who have

one national grid operator and are much ahead in establishing charging points. Local government is the natural partner for the grid managers since they hold a large part of the shares and own the public space. 90% of Dutch households are unable to park on their own property and hence need to park on public ground. This means that there is a tremendous need for charging points in public space which must be catered for through local policy and regulation and only few municipalities have realized this (future) need for public space and charging points.

Most cities are very reluctant to encourage electric driving, so the establishment of charging points is far behind schedule. So far about 90 charging points are established on request from municipalities and 10 from end-users. About 250 requests for charging points are being processed. Municipalities argue that charging spots are big and ugly and therefore difficult to fit in the environment. The association of Dutch municipalities is now trying to create more awareness among the municipalities, and E-laad is also hoping that the prices of charging points will drop drastically. In order to succeed with the project they also look for an approved market model for the charging network with clear role descriptions for each partner (grid managers, electricity companies, suppliers of infrastructure, municipalities etc.) regarding for instance prices of charging at home or in public space. Also in an international perspective arrangements should be made such as standardization of the plug and the way payments should be transferred. E-laad also argues for the need to align all parties involved in order to make the Netherlands attractive for manufacturers and secure availability.

Dutch evidence:
Strong national support.
Many local initiatives and subsidies.
Focus also on affecting markets and manufacturers with active interventions.
Non-governmental actors as role models, information providers and initiators
Public/private networking.

7.3.4 Policies in Norway

The policies studied in Norway are the “incentive package” defined in the national action plan aimed at all identified user groups, a national funding program to halt the increasing greenhouse gas emissions from transport in all user groups, a joint public private initiative initiated by the national action plan for the electrification of the transport sector aiming at local authorities, utility companies and end users, and finally a venture set up by neighboring Norwegian and Swedish municipalities cooperatively aiming at local authorities and utility companies. Climate policy is the main driver for the initiatives, which have introduced various policy instruments to enable EM, and have reached the exceptional ratio of 155 EVs per 100,000 conventional cars.

Incentive package (national action plan)
The national goal is to reach 10% EVs within 2020. The essential aspect of the incentive package is to stimulate demand for EVs in order to push technology development and make EVs a contender (in the long run) to conventional cars rather than an addition, hence the strongest incentives are directed towards the buyers with reduced road tax, exemption from tax and VAT upon purchase, 50% off taxes on company cars, free passage on state road ferry-links and toll roads, use of bus lanes and free public parking. EV commuters also receive an additional refund of expenses per km driven to and from work. The most valued incentives are free parking and toll road admission as well as access to bus lanes, which drastically reduces time spent in the car since most EVs are allocated in and close to larger towns. The long term ambition is a reduction in emissions while the short term driver is to create a technological shift in the

carpool. The main intention is to make the EV competitive with conventional cars and incentives are hence directed towards decreasing the perceived limitations of current EVs by offering other benefits. Norway is experiencing a steady growth in EVs, and the only aspect slowing down progress seems to be lack of access to a sufficient amount of (good and cheap enough) EVs. Hence the key now is to achieve increased production of EVs, better batteries and reduced prices. It is also important to connect the carrot to the whip by developing EV incentives in relation to taxes on conventional cars. Another important aspect to consider is the fact that strong economic subsidies for EVs also attract new groups of car users among former pedestrians, cyclists and users of public transport and not only among drivers of conventional cars.

Transnova

Transnova is financed by the Norwegian Ministry of Transportation and provides funding for different projects promoting environmental friendly transport solutions. Transnova aims to reduce CO_2 emission in the transport sector through supporting development of new transportation technology based on renewable energy, increased use of environmental friendly transportation, increased use of public facilities for transportation by bicycle and by foot, and limiting transportation needs through better use of available transportation capacity, and promote solutions that replace transportation needs. The funds from Transnova complement other governmental funding programs for research and innovation, but also Transnova supports research for instance on barriers against EV implementation and battery development. In 2010 they funded about 2000 new charging stations, and they are moving along with smart grid solutions.

Transnova finances charging facilities in order to arrange good conditions for the use of EVs. This also supports the psychological factor since a feeling of guaranteed access to charging and knowledge about their location through an interactive database/map makes it a real option for more people to buy an EV. They will consider funding of fast charge options in cooperation with commercial actors. The Norwegian partners are looking to share experiences with other countries and consider cooperation with Nordic countries to extend the database of charging facilities. They also cooperate with Nordic countries to establish them as one market for EVs in order to make it more attractive for EV suppliers since Norway is a small country/market. This cooperation is considered essential. In addition to funding of charging facilities and pilot projects they support Green Car Norway (see below) in order to stimulate public and private fleet owners, they cooperate with Green Highway (see below) to establish a corridor of charging facilities between Norway and Sweden and they also build (networks of) knowledge and competence because they realize the possibilities to achieve the goals alone are limited, also because there are many aspects they cannot influence, like e.g. the regulatory framework. Essential conditions for the success of electric mobility are a good (national) regulatory framework, and predictability in terms of regulatory framework and economic incentives in order to be able to stay ahead in the development. Transnova argues that the only reason why Norway today has a lot of EVs is that the political regulatory framework has facilitated it. In the long run EVs will be able to compete with conventional cars (regarding size, range, charging time etc) and the need for a regulatory framework for the use of EVs will eventually be less, yet regulations to ensure a competitive purchase price will be more important because people think it is costly to buy and it does not help to make only the use of the EV cheaper. Hence it is also important to encourage green procurement and transport planning in a wider perspective in order to investigate and facilitate the need for charging spots beyond the urban areas.

Green Car Norway

Green Car Norway is a joint public/private initiative owned by Energy Norway, an organization representing about 270 companies involved in the production, distribution and trading of electricity. The board members also represent the Norwegian Association for Local and Regional Authorities and a non-profit environmental organization committed to fighting climate change by promoting carbon-free energy

solutions. Their main driver is political ambition about reductions in emissions and improvements of air quality. In addition they regard EVs as a potential path towards independence from specific energy sources since EVs can be filled with “anything that can be put into a power plant”. Hence the energy suppliers regard EVs as a potential for energy efficiency and increased electrification. The overall focus of the project is to increase the number of chargeable vehicles owned or leased by end users and companies. They aim to stimulate a faster phasing of EVs by facilitating use through providing a) infrastructure and b) good regulatory framework in a transitory phase since a good regulatory framework and national and international incentives are regarded as essential in a transition phase. In addition they provide information to those who are going to own, use, and run EVs and they function as an objective resource center which delivers facts for the consumer, media and others who need it. This is also done in order to present Norway as an attractive market for deliverers, and they aim to work towards making manufacturers/deliverers see Norway as an attractive market for EVs. The aim is to clarify barriers for the phasing of fleets of electric vehicles, and offer practical advice to fleet owners who want to phase in EVs. Green Car will aggregate and make available experience with planning, decision and purchasing processes from fleet owners with EVs, so that others can make use of this experience. The project will gather and share experience from practical use, e.g. user education, information, service needs, safety issues, user patterns and user areas, and create enthusiasm for chargeable cars and communicate best practice.

The first phase (2010) primarily focuses on public and private fleet owners (incl. local authorities and utility companies). Purchase of EVs in the public sector moves slowly, so by 2014 they aim for 10,000 EVs in the public sector and 5,000 in the postal services. Since the “incentive package” is regarded as a success for private consumers they do not work actively towards end users at this moment. Their main approach is to kick start a market for chargeable cars, i.e. make it develop faster than it otherwise would have developed, if economic factors were to be the main generator. “The climate can’t wait for the market. It’s not only a Norwegian effort but a global effort to kick start a commercial market, by putting some public funding into it in order to reduce costs, increase volume, and eventually reach a critical mass and thereby have created a sustainable commercial market on its own faster than it otherwise would have”.

Their instruments include the development of tools which will make it easier for consumers to orient themselves better. On the website of the partners people can find e.g. calculators comparing the costs of having EVs to conventional cars, find information about service deliverers, assessment of infrastructure, and suggestions to the national authorities about good regulatory framework and incentives. In addition to their website tools they actively seek out and visit local authorities and offer assistance in procurement and use of EVs in order to make it a positive experience the authorities should want to repeat. In order to establish a well functioning second hand market for EVs they work towards the Norwegian Automobile Federation to set up regular tests for EVs similar to necessary tests for regular second hand cars. They aid importers towards international attention from suppliers, so they can better compete for the limited volume of chargeable cars available. “This market is an incredibly dynamic market. What you know today is “old news” tomorrow. In order to keep up you have to speak with all actors involved, and often!”

The biggest enabler for the project is the very analytical approach Green Car Norway utilizes. They share the drivers for goal achievement in two groups:

1. Exogenous drivers which are beyond their control.
2. Endogenous drivers that they can actually influence.

They have considered the endogenous drivers and asked “what can we do, where can we contribute and with what in order to reach our goal?” It is a project approach rather than a “climate” approach and can in theory be used on any project, not only EVs, they argue. There are a number of stakeholders and interests that all require attention. The most difficult is to build bridges between politicians and commercial actors.

"What we're trying to do is stimulate investments by private consumers, the public, those who can build infrastructure etc. At the same time we're dependent on an incentives-package (economic and regulatory) that is more or less a game. These incentives are politically unpredictable and make for a harsh investment-environment for all". Political agreement and predictability with regards to incentives would speed up the process. In one way it would also reduce costs for the authorities because commercial actors would dare to invest.

National authorities are more critical than local and regional in terms of providing predictability through the incentives-package. Green Car Norway recommends that other authorities set goals and concrete milestones. "We have to take what is a global trend and make it local. Norway is a small country and we are practically insignificant in terms of the world succeeding or not. We do however have an opportunity to benefit locally and make sure that, morally speaking, the nation Norway takes responsibility. Local benefits are extremely important and the industrial potential in Norway connected to these cars is fairly unknown. It is important and absolutely necessary to start the process of "what's in it for us" and not only relate it to global warming. "One important issue right now is the business model that the development of charging points is built upon. In Norway we have built these through a collective effort. A new national infrastructure however is not possible to build in this way, and in order to expand someone has to develop business models and want to invest. Here we have something to learn!"

Green Highway

Green Highway (funded by the EU) is a venture related to the cooperation between energy companies and three neighboring local authorities in Norway and Sweden in order to create a green transport axis (Sundsvall - Östersund - Trondheim, SØT) along a renewable energy belt, including investments in electric vehicles, charging infrastructure, renewable fuels, testing and development, as well as building up and spreading knowledge of this. The Highway is 450 km long and now offers 235 charging points distributed at 12 locations. The longest stretch without a public charging point is 95 km. The project has attracted a lot of media attention and the partners regard it as a success to be continued. The energy companies want to be leading in the local context and take responsibility as experts on EVs.

The project aims at extensive development and implementation of environmentally friendly transport systems and solutions based on renewable energy from water, wind and biofuels in collaboration between public and private participants in order to reduce emissions and enhance further investments in renewable energy in the region. The target group consists of the transport sector and other companies with substantial driving in service along the SØT axis, municipalities, counties in the region, the population in general and national, as well as international tourists. The aim of Green Highway is to survey the need of establishment of filling stations for environmentally friendly fuels and establishment of charging poles for electric vehicles along the axis. The result shall be concrete in the form of web-based map solutions and other information material. Exchange of competence between Norway and Sweden will be central. Norway can through the project greatly improve its green vehicle fuel-infrastructure and learn from Sweden; Sweden can gain competence in electric vehicle / charging station possibilities from Norway. They aim to create a catalyst, by informing both the consumer and companies that alternatives are present.

The electric vehicle seminar and tour in all the three SØT cities (Sundsvall 2010, Östersund 2009 and Trondheim 2008) aims to give municipalities, companies and the population in general a knowledge boost concerning electric vehicles as a useful and environmentally friendly alternative, and, included in this aim, refute the widespread prejudices against electric vehicles. They present the state-of-the-art within electric vehicle technology, and present the potential and usefulness for electric vehicles, by spreading user experiences from companies with several electric vehicles in use. Learning from the competence and experience in Trondheim (a Norwegian municipal authority with the most progressive EV project/highest

rate of EVs) is important, and during the process all the partners have collected experience through participating in the seminars and meetings, meeting people, gaining media coverage etc. This competence has then been transmitted through e-mail, meetings, seminars, their website and so forth. “Our ambition when entering this was to learn more about the EV and how the development is going. We soon realized that there is not much knowledge out there, and locally we became those who could answer questions, even though we did not know much”.

The most important condition for the project’s future success is a broad political understanding that renewable energy in the transport sector is an important issue, and that local energy companies find it interesting and show interest in working together, but companies that enter into it have to make sure that time and resources are provided to be able to work with it properly. Regarding learning by doing they recommend having one, central project leader in order to collect and distribute information properly. In such a project there is a lot of information coming from different sources and a designated project leader would make it easier to distribute and sort the information. “Good coordination will make sure we know what is happening in the other places/companies/ municipalities and thus avoid repeating or starting from “scratch” so to speak.” This is also important for keeping the competence they are building. They recommend that other local governments facilitate building of EV infrastructure, parking spaces and charging poles, and test incentives in the form of free parking, tax reductions and such.

Norwegian evidence:
Very strong national support, including tax reliefs.
Environmental benefits as an objective.
System thinking.
Information provision.
Regional initiatives.

7.4 Illustrating examples from policies in other countries

7.4.1 EVs and infrastructure in France

In Europe, France is one of the leading nations in the creation of an infrastructure for EVs. A pilot project in Paris has installed 178 charging points on 101 locations across Paris and the suburbs. The Ministry for the Environment of France supports the installation of another 400 charging points in France up to 2015. In the meantime Renault has introduced 100 EVs, the so called Z. (ero) E. (mission) cars for Paris.

The French government is aiming to have 2 million EVs and 4.4 million charging points by 2020. The plan is a public investment of € 1.5 billion to establish a network of 1 million charging points by 2015 and support for battery technology. The French automotive company Renault wants to build up a €625 million lithium-ion battery plant with a public contribution of €125 million towards the total.

7.4.2 EVs in Italy

In Italy 400 public and private charging points for EVs are planned in Rome, Milan and Pisa in cooperation with Enel, the biggest energy supplier in Italy, and Daimler. This project is called “e-mobility Italy” and was scheduled to start in September 2010. Also in the region of Lombardy 270 charging points are under construction, built by Enel and Renault-Nissan.

The Ministry for Industry and Economic Development has developed the program “Industria 2015”. Part of this program is to fund opportunities for sustainable mobility, particularly the electric vehicle. The funding budget of € 180 million has been distributed in early 2009.

A fine development on EV integration is found especially in Emilia Romagna, Lombardy, Tuscany and Lazio, supported by the national programs for EVs like PNR – a National Research Program and PRIN - Research Project of National Interest.

The Italian government launched the program “scrappage – park renewal” with a budget of €1.0 billion, to remove polluting cars older than 10 years and support the implementation of new vehicles. The incentives ranged from € 1500 up to € 6000, depending on the CO_2 emissions of the new vehicles. The goal of the Italian government is a share of 12.4% EVs by 2030.

7.4.3 EVs in Germany

In Germany 1500 EVs are registered, which makes for 0.035% of all vehicles. The EV guideline for Germany is the “National Development Plan for Electric mobility“. This plan states that till 2011 they will focus on the market and technical development for EVs. From 2011 – 2020 they aim for a high market share so that by 2020 they will reach 1 million EVs in Germany.

To reach this goal Germany will spend € 500 million through 2012 focusing on battery technology and building up a network of charging stations across the country. Germany will not offer subsidies for private consumers. The government focuses fully on R&D and EV-networks. In total Germany presents eight model regions. The German government works together with science, industry and participating municipalities to build an infrastructure and try to position electric mobility for the public. The five biggest energy providers are involved in all model regions of Germany.

7.4.4 Electric vehicles and charging infrastructure in the UK

In the UK the road sector is the largest source of carbon emissions from transport and has the greatest potential to reduce the emissions in coming decades. There are both environmental and economic imperatives to start doing things differently.

The Office for Low Emission Vehicles (OLEV) within the Department for Transport (DfT) works in close collaboration with industry and other government departments to develop and strengthen the capability of ultra low carbon vehicle manufacturing and its associated supply chain in the UK. An example of joint industry government working, the UK Automotive Council provides a forum for ensuring high-level discussions between the automotive industry and Government and a long-term strategic framework for the sector’s development. OLEV participates in both the Technology and Supply Chain working groups which focus on low carbon technology road-mapping and strengthening the UK-based ultra-low emission vehicle supply chain development.

Collaborative research and development programmes can contribute to the development of a stronger UK-based supply chain for ultra-low emission vehicles. One of the principal aims of the Low Carbon Vehicles Innovation Platform (through which the Government’s program of research and development for low carbon vehicle technologies is delivered) is to help the UK automotive sector benefit from the growing demand for low carbon vehicles.

The reports “UK’s Low Carbon Transport Innovation Strategy” and “A review of the UK innovation system for low carbon road transport technologies” state that hybrids or electric cars, which can be re-charged from the electricity grid, can have a very significant role in a longer time scale. In April 2009 the Department for Transport and the Department for Business, Innovation and Skills, published the “Ultra-Low Carbon Vehicles in the UK” vision document. This document outlined the comprehensive package of Government measures, worth nearly £400 million, to accelerate the transition to these ULC-Vehicles for motorists and the UK automotive sector. After this document, DfT published a program on consumer incentives to use EVs. Of the registered vehicles in the year 2007 there were 2000 electric cars and 4,000 light goods vehicles. All together this was approximately 0.2‰ of the total fleet. In year 2009 the total amount of EVs had risen to 8,000. DfT’s “Investigation into the Scope for the Transport Sector to Switch to Electric Vehicles and Plug-in Hybrid Vehicles” outlines many tasks and recommendations for further development.

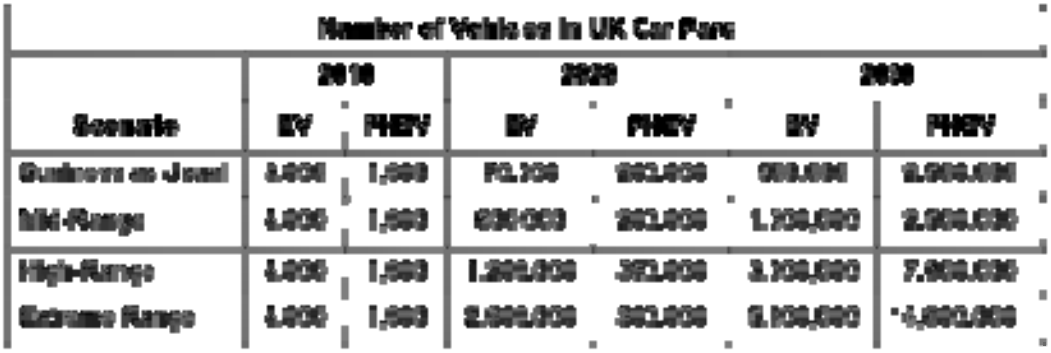

FIG: 7.1: DfT’s investigation presented four scenarios for the introduction of EVs as illustrated in the table above.[2]

The Joined Cities Plan

The Joined Cities Plan, announced by the Energy Technologies Institute (ETI), aims to help cities across the UK to deploy a cost effective and compatible network of recharging points. The £11 million plan has been created to help support the spread of a single national network that will ultimately enable plug-in vehicles to be easily used and recharged anywhere, including at home. The cities belonging to the plan are Birmingham, Coventry, Glasgow, London, Middleborough, Milton Keynes, Newcastle, Oxford and Sunderland. Nowadays there are a number of charging points in the UK. For example the City of Westminster has 12 on street and 48 in its car parks. The new Westfield Centre in west London has 30 EV charging bays, and the Highcross Centre in Leicester has over 100.

Implementation of the strategy has already started. London, Milton Keynes and the North East England are about to receive 11,000 charging points over the next 3 years, according to a 30 million pound Plugged-in-Places scheme announced in February 2010. At the same time the Plug-In Car Grant scheme was announced. From January 2011 onward, there will be a 25% discount on the price of an electric or plugged-in-hybrid vehicle.

Source London

London has launched the electric vehicle scheme Source London, aiming for London to be the electric capital of Europe. The aim is to allow more convenient and highly accessible ways to charge electric vehicles and have 100,000 electric vehicles on the road as soon as possible. The use of EVs is

[2] Http://www.dft.gov.uk/pgr/scienceresearch/technology/lowcarbonelecvehicles/#.

encouraged, for example by providing parking benefits and congestion charge discounts. Charging points will be placed in phases starting in spring 2011. Ultimately the aim is to have a charge point within one mile for every Londoner. The usage of charging points is allowed for registered customers with an access card. The vision is specified in the “Electric Vehicle Delivery Plan for London”, and more specifically in “London’s Electric Vehicle Infrastructure Strategy”. There were over 250 charging points in operation in London in December 2009. The goal of the infrastructure strategy is to deliver 25,000 charge points across London by the year 2015. Most of them would be installed in workplace park sites The number would also include fast charge sites, 500 on street and 2000 on off-street public park sites. Transport for London is working alongside numerous public and private partners to make this vision a reality.

Projects are launched to collect information about the real life usage of electric vehicles. Data is collected for the deployment of the recharging points and the impacts and requirements for larger implementation of EVs. Glasgow has started trial of 40 EVs. Cities of Birmingham and Coventry have started CABLED project that will showcase 110 electric cars across the cities and West Midlands. Vehicles are available for a minimum 12-month lease. It is a primary aim of this project to show that ultra low carbon vehicles are a practical alternative to conventional cars in the urban environment. To achieve this, a small network of charging points will be installed in areas of Birmingham and Coventry, together with charging points at selected users’ homes and workplaces.

Milton Keynes and Oxford have been collaborating in the development of common operability of EVs. EV drivers based in Oxford will be able to use charging posts installed in Milton Keynes and vice versa. Milton Keynes is encouraging widespread use of electric cars by the provision of several hundred charging posts over the next three years. The first charging posts have been already installed. Oxford now has more than 20 charging points installed. Financial support for the project has come from the Government-backed Technology Strategy Board Chargemaster Plc. The company has introduced state of the art Chargevision software enabling EV owners to see online where charging posts are and whether they are currently available.

The UK government is urging to make year 2011 a year of electric cars. It eliminated the need for planning permission for charging points, thus encouraging site owners and local councils to build them on streets and in outdoor car parks.

7.4.5 Integration of EVs and energy production in Denmark

The studied policies in Denmark are also driven by climate policy and ambition to reduce emissions, but the main drivers are promotion of business opportunities and increase production of renewable energy.

EV network

The EV network (Elbilsnætverk) is a national initiative for information and subsidy under the Centre for Green transport, which is a department in Færdselsstyrelsen, a public management organization under the Danish Ministry of Transport. The Centre for Green transport administers national funds for promoting sustainable transport. They have developed guidelines for green procurement of passenger cars and lorries. These guidelines are continuously updated and now also include recommendations for the procurement of transport services. They arrange information meetings and host networks and partnerships in order to make the Centre for Green transport a relevant knowledge centre for sustainable transport and promote knowledge sharing across organizations, business divisions and other interested parties. Hence the Center for Green Transport has established an EV network for municipalities and regions. Many municipalities are now considering to buy or to lease EVs for their daily business tasks because they

represent government bodies which must take the lead as role models towards more sustainable transport, and because they are looking for ways to reduce their TCO. Since few municipalities or other organizations have much experience with the use of EVs, the municipalities have a lot of questions which are hard to answer. Within the EV network they gather and share knowledge about procurement, use and general experiences with EVs as means of transportation. They host meetings with speakers from public and private organizations, where members can ask questions and participate in debates. The network also aims to share knowledge with the public beyond the network and has therefore set up a website where they post facts, articles and experiences communicated within the network. As of October 2010 they have 55 members from different municipalities and regions, including 35 municipalities and 3 regions from all over the country.

ChoosEV/TestoneEV

ChoosEV/Testenelbil.dk is a joint initiative of enterprises driven by business development goals, limiting dependence on fossil fuels, providing a market for green energy and ambitions to reduce emissions. ChoosEV offers an innovative package, making it easy, safe and practical to switch to EVs. They deliver EVs and charging stations, offer financial solutions, management of the fleet, counselling and environmental optimising of EVs and infrastructure. ChoosEV is a Danish company owned by various energy companies and a leasing company. ChoosEV runs a project called TestoneEV (Testenelbil.dk) aiming at municipal and private end users in order to spread experience with the practical use of EVs and gain knowledge about how to implement more EVs and how to integrate them in the grid.

ChoosEV is a private service provider (leasing of EVs and provision of green charging). Testenelbil.dk is a pilot project with a limited number of vehicles. They offer a subsidy scheme for users since test periods are free of charge, and they provide charging infrastructure with green energy. ChoosEV provides an online map for available charging stations as well as an intelligent system for charging stations – ChoosPOWER – which automatically charges the EV while the supply of green and renewable energy is the highest.

Their objectives are to have 300 EVs in use in 30 municipalities all over the country, learn from experiences with driving EVs over 6 million km and approximately 300,000 chargings, have 2,400 Danish families test an EV for 3 months in order to gain ”real life” experiences and learn to understand the dis/advantages of EVs. They gather knowledge and experience about practical use and possibilities in order to transgress the barriers and to see whether EVs are supported by policy and society.

Try1EV

Try1EV is a joint public/private initiative initiated by the State owned research institution called the Danish Technological Institute. The project involves a consortium of five partners including an energy company, two municipalities and a local/regional fund investing in projects for innovators and business opportunities, as well as initiating education within innovation, energy and communication technology.

The driver behind the project is to reduce emissions of greenhouse gases. Denmark must limit its dependence on fossil fuels and instead increase energy production from windmills. EVs with batteries for storage go well with all these reasons, also because they can create an energy buffer when excess wind energy is stored in EV batteries. This is an interesting potential for business development: The project members want to develop EV pools which can contribute to making the region a centre of competence within the EV industry. Knowledge and experience from the project will show local businesses and innovators where the potential for innovation is, and they will be given opportunities to test their ideas on these users.

Municipalities have already some experience with EVs. In order for EVs to be a viable option for companies the price must be much lower. In order to gain momentum for electrification of transport they have to rely on private end users to adopt EVs, and this is a target group left unattended by other Danish initiatives. Hence, they aim to learn more about end users in order to learn how to develop the EV for the masses. Try1EV is the first demonstration project in Denmark where normal people/end users test EVs. The project will investigate what happens to the grid when EVs are connected to charging infrastructure, as well as provide input to businesses that can develop new technologies and services to the EV market. They hope to boost business and create new job opportunities. Finally they also want to test EV use in municipal homecare and internal transport. Municipalities want to test whether they may gain fiscal profits from reduction in fuel costs from driving EVs.

The project runs from March 2009 to December 2012 and provides 13-16 EVs. 8-10 EVs are to be tested by 100 families who keep the EV for three months each for free, 2-4 EVs to be tested in two different municipalities (two in home care services and two in technical maintenance). One EV will be used as back up and the last one will be used for tests at Danish Technological Institute.

The project members find it challenging to create more and positive interest for EVs with the public. The project did receive much media attention at first, but decreasing interest from media, as well as persistent negative image of EVs, mainly related to the image of the Ellert, the first Danish EV and other non-OEMs, and also to the lack of access to OEMs. Nevertheless, user experiences are reported on open access blogs characterized by 100% honesty, which means that a lot of the problems are reported. It is difficult to get across the very positive and reaffirming reports about current EVs as a viable alternative to conventional cars. The website functions as a discussion forum where people can give each other advice and share experiences, and the project strongly recommends keeping this as honest as possible.

Because of the limited amount of EVs they have to phase the test with families. They also gather experiences from each test period and try to adjust information/services to the next group. It is important to gather experiences from test drivers both at summer and winter. In the first phase 8 families test the EVs for 12 weeks, and then they have one week for service on the EVs between the test periods. They have announced that test families will have to win a competition in order to participate. They change the criteria for the competition based on what they learn from each test period. “We focus on what the users find problematic, for instance problems with using the EV in winter. We do not want to contribute to negative experiences and negative image of EVs, so we make sure that the use of the EV will fit into the families’ everyday lives”.

Despite all the problems the users have experienced they are very positive towards EVs. This, despite the fact that the EVs lacked winter tires, the heating is inadequate or lacking, often the users experience start up problems etc. The test families are aware that they are testing a new technology and hence accepted the problems. Actually, they report that they will be happy to try again, but would prefer testing it over the summer. Generally the users report that it is comfortable to drive EVs, but the high price and short range are major obstacles for making EVs a viable alternative to conventional cars.

The essential conditions for the project are policies and the market: Nationally the Energy Agency’s pool for EV projects is important. They have also received regional funds, and they stress the importance of policies of other countries, since it is difficult to adopt policies across countries with different energy supplies. Regarding importance of the market, manufacturers must fulfill user requirements such as enough supply of EVs of good quality, wider range of EVs, EVs with 4 seats and servo, and battery development to secure faster charging. Regarding service providers they recommend that service providers are available every 70 km since that is the current range of the available EVs.

They have learnt that end users time and again became hostages in a financial game between three partners: the actor responsible for providing the cars, the actor responsible for the system and the provider of components for the electrical drive, and the actor responsible for service on the cars. None of the partners have made any profit from the project, and the service costs were much higher than expected. As many other informants they find it challenging to handle such constellations of actors. Hence, service infrastructure is insufficient and difficult to access. “We have spent way too much time on organizing the different partners providing the EVs and the service of them. Physical distance between test site/users of EVs and the service infrastructure must be reduced! With regard to the potential market penetration of EVs access to service will be crucial”.

They also recommend that implementation of EVs must differ in different countries due to different energy supplies, and hence subsidies must be different. “It is challenging to introduce EVs as climate neutral alternatives in Denmark when Danes learn from Germany that EVs are as bad for the environment as conventional cars. People do not understand that this may be the case in Germany if EVs are charged on electricity from coal while it will not be the case in Denmark where EVs will be charged on wind energy and potentially cause zero CO_2 emission”. So, policies cannot be directly transferred from one country to another. This is also a challenge for the branding of EVs and how to build their image among ordinary people.

Tax exemptions are crucial for the penetration of EVs. But the tax exemptions must regard both the EV and the energy supply. Users lack incentives to use energy when it is cheaper. Hence taxation on energy/electricity must be changed to stimulate a) purchase of EVs, and b) charging of EVs when demand is low. It is important to learn from the differences between the countries.

The Danish Electric Vehicle Alliance

A joint initiative of enterprises, The Danish Electric Vehicle Alliance is an independent trade association under the Danish Energy Association. They represent about 60 member organisations from the large energy companies and large industry organizations as well as service providers for EV, car importers and researchers and consultants. Any company with commercial interests in the introduction of electric vehicles in Denmark, including plug-in-hybrids, can apply for membership of the alliance. The objectives are to be an important player in making Denmark a pioneer country for promotion of electric vehicles. This should be done by benefiting from the synergies between the energy sector and the industries involved in introducing the electric vehicles.

The project addresses utility companies, suppliers of infrastructure, car manufacturers and dealers, suppliers of components for electricity industry and EVs, consultants for Danish EV industry, indirectly local authorities, end users and all other user groups as well. These user-groups are addressed in order to promote business development, encourage the best ideas for new business, and build bridges between utility companies and car industry. It is also an important object to promote and assist in networking among the members and new players.

Drivers for the project are mainly business development related to the promotion of more use of sustainable energy (in transport) and an increased production of sustainable energy, particularly from windmills, which makes EVs an interesting alternative. EVs can be used to balance the energy supply since they can be charged when there is extra capacity on the grid, usually at night when demand is low, and since charging can be stopped when supply is low. The basic driver is to reduce emissions.

This is a pilot project for establishing networks between trades that are not used to cooperate, and they also apply political lobbyism. Their instruments are “carrots” and information: making use AND production

of EVs more attractive through networking and political lobbyism, which may include “whips” in terms of “threats” about lack of interest etc. They worked hard to exempt EVs from registration taxes beyond 2012. Tax exemption is an important carrot not only for end users but for attracting and maintaining the international investors who regard Denmark as a potential country for business set ups. In order to attract investors and EV industry Danish Government must prove their political intentions about EV implementation. Their instrument is for instance to introduce the views of their member organizations from the car industry who say that they are only interested in establishing/extending their business in Denmark if car taxation is changed.

Due to the position the alliance has managed to achieve they now serve as an obligatory point of passage for the media in all cases concerning EVs. While the organization previously had to contact the media whenever they wanted to communicate a case, media now call them whenever a case is connected to the EV industry. And they managed to promote the views of car manufacturers and other industry partners as headlines in important news papers. Their statements actually functioned as whips since they said they would take their business to other countries if national policy did not provide good conditions for EVs.

As a trade organization they are also represented in governmental working groups for electrification of transport where they discuss strategies for car taxation, charging infrastructure, demonstration projects etc. The most essential part of this approach is political lobbyism and networking which builds bridges between different trades and optimizes knowledge. Communication towards policy and towards the industry in terms of encouraging partnerships/business is most important. In some way this also means that they indirectly contribute to making vehicles and charging infrastructure available as well as regulation. All these measures are important for business development. They have managed to create a positive image of the opportunities with EV and EV industry in the media.

The essential condition for this project is that 50% of their success relies on external conditions like the general financial state of the society: When the economy improves this will create better conditions for new technologies like EVs. The technological solutions exist already but cannot do the job on their own. The alliance can adjust some of the social and cultural conditions but admit that they do not yet know about all relevant conditions. They can to some extent adjust the political will, but without a solid financial fundament the political intention will not make much difference. Competing technologies related to oil price and access as well as development of biogas might also pressure the EV, but this is not seen as very likely.

The biggest enablers for the project are Denmark’s experience with and access to wind energy, which means that they have important and relevant knowledge and competence as well as a need for establishing connected industries, like EV, and also new forms of distributing and applying the energy. “We have over time developed extensive knowledge about how to integrate wind energy which is one of our main assets”.

They recommend establishing a network with other municipalities, like the Danish EV network and to learn from the designated “environmental municipalities” like Copenhagen that shows that it is possible because they want to become climate neutral and hence have decided to implement EVs. “Don’t let the credit crunch stop you, but search for financial incentives like the test project which supply municipalities with the price difference when they buy EVs that are more expensive than a comparable conventional car”.

7.5 Conclusions

Similar for more or less all initiatives is the motive for electric mobility provided by climate policy and ambitions to reduce CO_2 emissions from road transport. Important barriers for more or less all countries are the lack of access to EVs, and problems with co-aligning initiatives across international, national, regional and local borders as well as across and between relevant trades. Reluctance for financial support slows down the development in some countries.

There are obvious differences between the countries in terms of (national) supply of renewable energy to be connected to EVs which yield some interesting differences in strategies. Differences in population density and availability of land for charging infrastructure are also evident and important for future national strategies.

There are also obvious differences between the studied European countries in terms of what user groups have been addressed by policy and various initiatives for electric mobility. Large fleet owners may be more inclined to transfer from conventional cars to EVs due to more experience with calculating TCO rather than mere purchase price, hence many of the initiatives aim at large public and private fleet owners. If however, we are to reach mass deployment of EVs we also have to reach the private end users, which have been specifically targeted by initiatives in Norway and Denmark. A little surprising barrier is the fear that electric mobility may reduce public transport use, cycling and walking instead of conventional car use.

We do not have a coherent picture of what role EU and national governments have played so far. The (inter)national climate policy ambitions are obviously important for most initiatives, but climate policies rarely provide guidelines for how to manage transition phases where many and large actors at different levels need to work in tandem towards the goal. A common challenge described by many of the initiatives is hence lack of consistent and unchanging national policy which should signal a strong national interest in providing good infrastructure for electric vehicles and related services in order to create a market interest and in order to attract deliveries of the scarce good that EVs today are. Another challenge mentioned by most initiatives is the hard and persistent work required to co-align the many and large actors at different levels who need to work in tandem towards the goal, to make them come together and share experiences and create enthusiasm in order to maintain the work. Also in cases where networking is not very important stakeholders have asked for opportunities to learn from more experienced initiatives or actors in order to avoid wasting time and resource on reinventing the wheel over and over again.

Reading about the policies and experiences from the various countries described above may hence serve as one type of important input for how to develop further policies. In addition, we will summarize the most important lessons from these experiences in the next chapter in order to provide learning experiences across the countries.

8 RECOMMENDATIONS

8.1 Introduction

'Everybody' agrees that the reduction of CO_2 emissions of road transport is a big challenge. We have good ideas and knowledge about improvements, but fiscal, cultural and political barriers are numerous. In addition we have to operate within a socio-technical regime where the alternative (EVs and EM) has to compete with the existing technologies (conventional cars and fossil fuel infrastructure). Since different political and technological actors have differing visions for the future (technological system) and where to place necessary funding and investments, many actors will opt to minimize risks through incremental rather than radical innovations and investments.

The objective of this chapter is to provide policy makers with recommendations based on best practices regarding electric road transport within a holistic approach. It is beyond the scope of this study to evaluate the specific initiatives studied. Therefore we will not provide examples of best practices based on specific cases. Rather, we recommend that all initiatives should be read in sequence since they represent different types of challenges experienced by different countries which together may offer interesting lessons for the integration of electric road transport. Nevertheless, we will in this chapter report important lessons to be learned from the studied initiatives, and recommend that they be read as interrelated and interdependent lessons on different conditions for the integration of electric road transport.

8.2 Communication is key to the introduction of electric mobility

Some actors argue for the need of information campaigns which should signal to everybody a need to change transportation behavior. Communication is seen as key to the introduction of electric driving since people need to be given a taste of electric driving which can convince them to change. Since change cannot be forced, especially since prices of EVs are regarded as too high, several initiatives mention the importance of informing people or giving them a taste of how fun EV driving may be. Role model companies, leasing companies, car sharing agencies and EV taxis may be one way of informing people about the fun and practicalities of EVs. But some initiatives also recommend regulations to force transition because history has shown that people soon get used to new systems. To act or to inform should not be a question about either or. Rather, information should be done both through campaigns and through action. Interestingly some initiatives also report that they manage to use media coverage actively to impact decision makers by making headlines where relevant industry partners threaten to take their business abroad unless the national government signals strong will and initiative for enabling transition to EVs.

8.3 Authorities should act as role models and 'market shapers' to seduce early movers

One way of showing national interest in electric mobility is to have governmental authorities function as role models. National, regional and local governments should make EVs available and visible in their day to day operations in order to show other actors their will to change to EV as well as showing that EVs are actually catering for their transport needs (launching customership).

The market can be shaped by the authorities in two ways:

1. **Large, coordinated vehicle purchases** can help ensure minimum levels of demand to encourage commencement of vehicle production.
2. **Implementation of recharging infrastructure** should be coordinated with expected vehicle purchases. Governments will need to lead such coordination efforts.

8.4 Accurate knowledge and practical evidence is needed to raise confidence

There is a need for accurate information on in-use performance (e.g. range, recharging times, recharging grid location information and expansion plan) to raise consumer confidence. Local authorities as well as other early movers report lack of knowledge about whether it is wise to change to EV and how they may go about such a transition and hence ask for consistent (inter)national policies. The sections on national policy and coalition of actors below provide recommendations for how to gather and share knowledge. In addition it is important to gather real life experience from EV users and disseminate this widely in various forms. Knowledge centers on EV may act as key stakeholders for many initiatives since they can provide objective information about EV possibilities, they can cater for exchange of experience and also contribute to lobbying for better EV conditions.

8.5 Consistent long term policies are needed

A number of recommendations can be derived from the national best practices:

1. **A comprehensive dependable policy framework should be established**
   Governments need to establish a consistent and dependable incentive framework to support the implementation of electric-drive vehicles. Most initiatives mention the importance of national policy and regulations which go beyond climate policy and provide consistency also funding for initiatives. A dependable policy framework, e.g. valid through 2020 in order to give stakeholders a clear view of the road ahead, enables early decisions to be made, and reduces investment risks.
   OEMs are currently seeking to secure near- to medium-term markets through policy agreements that ensure adequate volumes for OEM returns. Overall policy goals should be established (e.g. energy security, low CO_2 emissions) with clearly stated national ambitions and appropriate incentives so manufacturers can tailor their production to achieve these policy goals. This may also contribute to attracting interest for business development from (foreign) manufacturers and contribute to establishing a market for EVs where manufacturers commit to deliver EVs to the specific country since competition between buyers is harsh.

2. **Policies at the various policy levels (EU, national) should give a clear message about the political will to support transition to electric mobility, also as a basis for the subsequent lower policy level**.
   Most initiatives also mention the need for a clear message about the country's will to support the transition to electric mobility. This is also related to a critical lack of knowledge and objective evidence about alternative technologies as well as objectively proven (climate) benefits from transferring from conventional cars to EVs.
   A clear initiative about the transition to EV must hence be signaled from the EU and national level in order to provide local authorities with clear purposes to change. This may guide also the harsh competition between countries getting EVs into their market, since production volumes are still smaller than the demand.

3. **National policies are needed to facilitate co-alignment between actors and between national authorities**
   National policies are important for more reasons, such as co-alignment of diverse actors in a strong network. They also may contribute to international standardization e.g. of charging facilities. E.g. the Dutch government has decided to go with the same plug as Germany and Sweden.
   Policies are also needed to promote R&D, especially for advanced energy storage; these can include corporate tax incentives and direct spending on R&D programmes. In this field co-alignment will enhance the efficiency and maybe the effectiveness of research.

4. **To the extent possible, policies should not favour particular technologies but promote good performance** (e.g., low CO_2 emission vehicles, fuel diversification and improved energy security).
   Thus, CO_2 and other exhaust emission-based standards, taxes, etc., are generally superior to ones that directly promote the use of EVs/PHEVs. However, some "technology picking" policies may be unavoidable, such as supporting the provision of EV/PHEV recharging infrastructure.

5. **Policies should make up for initial shortcomings of the electric mobility system**
   Another important aspect of clear and consistent national policies is that EVs still represent an immature technology with "teething problems" and are hence in need for "child care and upbringing" in terms securing:
   - access to infrastructure
   - access to service providers
   - comparable costs between EVs and ICE vehicles (e.g. through fiscal incentives)

6. **Policies should aim at achieving first cost and full ownership (life-cycle) cost-equivalence between EVs/PHEVs and similar ICE vehicles**, at least during the transition period aimed at building sufficient confidence from all stakeholders (e.g. customers, battery and vehicle manufactures and recharging grid investors). Based on empirical data, some consumers (especially early adopters) may tolerate some level of ownership cost increment for EVs/PHEVs as compared to ICEs, but the smaller this increment, the larger the likely market size for EVs/PHEVs.
   Fiscal incentives are a means to achieve this. Regarding fiscal incentives it is important to connect the carrot to the whip by developing efficient/clean vehicle incentives in direct relation to taxes (whips) on conventional cars. An important aspect to consider is the fact that strong economic subsidies for EVs also attract new groups of car users among former pedestrians, bicyclists and users of public transport and not only among drivers of conventional cars.

7. **Clear targets will enable national action plans to be cost effective**
   To limit policy (and tax payer) costs of encouraging EV development and deployment, governments can set targets such as market penetration targets, cost reduction targets, maximum spending caps or time limits for programmes. However, there is a risk of ending programmes before they succeed. Any limits should be clear to all stakeholders so these can be factored into decision making (both for investors and potential EV/PHEV buyers).

8.6 Involve local authorities as key stakeholders

Local authorities play an important role as key stakeholders since they have to implement national climate policies and more importantly since air quality is a local problem and since electric driving is most suited (for now) for inner city driving. Furthermore, local authorities often own the land which has to be used for public parking and in many cases also own the land which has to provide access to charging facilities

since in many cities car owners cannot park or charge on their own premises. Simple measures like availability of parking places and lower parking fees also belong to the toolbox of local authorities. Some local authorities are proactive. Rotterdam, in close cooperation with the grid manager applies for charging stations in public space. Since charging infrastructure is not vandal proof Rotterdam plans to become frontrunner regarding innovative ways of charging without plugs and cables (induction and loops).

8.7 Build a future-proof charging infrastructure

Most initiatives aim to develop (normal) charging infrastructure and fast charge is not seen as very crucial yet. If EVs are used mainly inner city and supported by technical improvements of the battery fast charging options will only provide added value function as a psychological factor. For some innovation research/possibilities however fast charging is mentioned as interesting. Furthermore, some of the cases report important precautionary actions where they make sure that the currently developed charging infrastructure easily can implement fast charge options when/if it becomes available. Only one of the cases reported actual use of smart grid solutions for charging EVs with renewable energy (when supply of renewable energy is high).

Charging infrastructure and national differences in available parking
The UK initiatives seem to opt for implementation of EVs through securing access to charging facilities. Some of the Austrian initiatives argue that charging spots are already available right next to everybody through the existing electricity grid. The Dutch cases on the other hand demonstrate a situation where transition to electric mobility must be done in close cooperation with city planners since 90% of Dutch households are unable to park on their own premises within the reach of their private electricity subscription. This means that there is a tremendous need for charging points in public space which must be catered for through local policy and regulation, and only few municipalities have realized this (future) need for public space and charging points. This is also relevant in terms of new models for eco-conscious city planning as well as new modes of transportation planning.

Charging infrastructure and national differences in grid operators
Nation-wide cooperation between grid operators is seen as crucial, especially in The Netherlands with plenty local grid operators, contrary to for instance Ireland and Portugal who have one national grid operator and are much ahead in establishing charging points. Local government is the natural partner for the grid managers since they hold a large part of the shares and own the public space.

Charging infrastructure and (inter)national/local authorities and energy suppliers
Many municipalities argue that charging spots are big and ugly and therefore difficult to fit in the city environment. More attention should hence be paid to spatial arrangements like where and what types of charging stations should/can be established. The association of Dutch municipalities is now trying to create more awareness among the municipalities. In order to succeed with the project they also look for an approved market model for the charging network with clear role descriptions for each partner (grid managers, electricity companies, suppliers of infrastructure, municipalities etc.) regarding for instance prices of charging at home or in public space. Also in an international perspective arrangements should be made such as standardization of the plug and the way payments should be transferred.

8.8 Gain learning experiences with smart grids

Countries differ in terms of national, regional, local or private energy companies and access to green energy. Access to sustainable energy may be crucial for making electric driving more attractive. Many cases report that the EV-caused strain on the grid is not likely to be a problem towards 2020. Nevertheless, many initiatives ask for more involvement from energy companies in order to gain learning experience and to be "ready" if/when the capacity should become a problem. Another relevant difference between countries is that the Nordic cold climate causes extra strain on the grid since particularly Norway has a high share of electric heating rather than district heating. Blackouts are already a threat, and EVs may strain the grids even more unless smart grids are developed and installed. Another drawback with the cold climate is that the range of even new EVs are strongly reduced and requires extra charging compared to warmer countries.

Several of the initiatives also report on interesting collaboration with the energy companies. This is particularly the case where energy companies see or seek business opportunities in relation to electrification of road transport, and regard this as a potential for increased electrification. In Denmark interesting coalitions seek business development by providing green energy from windmills to EVs and develop smart grid solutions which charge the EV when supply of green and renewable energy is highest. Hence they seek to increase energy production from windmills and build up competence for new innovations related to EVs in a wide sense. Therefore Danish actors recommend relating the introduction of electric mobility to the countries' energy profile in ways which interlink carrots and whips beyond the relation between EVs and conventional cars, but also relating interlinked carrots and whips to access to renewable energy in order to give EV users incentives to charge the EV when access to green energy is high.

In a few cases the coalition of partners related to energy companies report that they have developed interactive databases and maps indicating available charging spots. This is important in order to overcome cultural barriers against EV since such maps show availability of charging spots and how far you can drive an EV and still easily find (available) charging. In Finland the development of smart invoicing using vehicle identification interests energy companies.

8.9 Look for the optimum between the market leading the way and government incentives/regulation

Several initiatives argue strongly that the market should lead the way towards new low emission transportation solutions without too much intervention from the government. Important to stress in this regard is that government intervention may go far beyond fiscal support and incentives, like being role models, signaling clear and consistent support for electric mobility, and setting up learning networks between and within countries.

The question about market or policy lead transition is also related to the development of infrastructure for service providers and for charging. Access to extended choices of service providers within the range and across the spread of EVs is crucial for developing a market, but service providers are hesitant to establish before there actually is a market for their services. The initial high costs of EVs are only increased by the need for extra charging structure. Some cases argue that charging infrastructure will eventually be developed by the companies which start electric driving. This belief in the market however ignores the market potential for energy companies and the importance of their engagement in transition towards electric mobility. More importantly, the "market lead argument" also ignores the potential strain on the grid

as well as the importance of public planning and building regulations etc. in order to cater for potential availability to charging spots.

In some cities parking garages are found to offer great opportunities to establish charging stations in (semi-)public space. Hence it is important to make sure that (building) regulation allow and secure that parts of the parking spaces in new parking garages will be equipped with charging stations.

8.10 Coalitions of partners will smoothen the pathway to electric mobility

Co-aligning actors is important in order to signal interest to manufacturers and create a market pull for EVs through optimal conditions for EVs and EV related services, which also creates a need for and good conditions for service providers. Coalitions of actors may also contribute with important lobbying towards both government and market, and they may function as an objective knowledge centre providing interested actors with relevant information about EVs and business opportunities. Further, knowledge sharing is important for development of business opportunities and more production of renewable energy, for establishing synergies between the energy sector and EV-related industries, and also for providing real life experiences with EV use, which may lower the threshold for users/companies/authorities considering transferring to EVs.

Several initiatives recommend more coalition of partners. A Dutch municipality recommends establishment of close cooperation between neighboring large cities and the national government in order to align actions and learn from each other and share experiences. They also ask for larger involvement of the national government beyond grant schemes for pilots, and rather enforce standardization for charging, large-scale public campaigns on TV to encourage electric driving, cheaper parking rates for green cars, and ministers acting as role models with EVs. Several of the cases from Norway and Denmark demonstrate exactly the strengths of such coalitions across municipalities (for instance the Danish EV network) and across relevant industry partners (like the Danish EV alliance). Further, uniformity between municipalities and transfer of knowledge and experience is essential since the wheel gets reinvented over and over again regarding for instance required length of charging cables and how to handle parking at charging stations. This does not only apply to international or inter-municipal cooperation but also intra-municipal cooperation and cooperation across authority levels since electric mobility policy usually requires the coordination of several interlinked departments from department of environment, to for instance departments for overall transport policy, economy and education. One possibility is hence to establish a (local) contact point for electric driving to underline the importance of electric mobility and to bring parties together in order to facilitate initiatives, and to create effective coalitions with market parties to find and select the best business cases with the highest environmental impact.

This is also related to a crucial point about not considering electric mobility as an isolated topic, but rather to embed electric mobility with adjacent issues such as supply of energy, planning of spatial structure and sustainable mobility. Some of the initiatives recommend new mobility services that unlink the possession and use of a vehicle since the use of a (leased) vehicle can easily be adapted to the trip instead of the travel behavior of a long period. Increased use of environmental friendly transportation should be linked to increased use of public facilities for transportation by bicycle and by foot, and to general limitation of transportation needs through better use of available transportation capacity, and promotion of solutions that replace transportation needs. Hence, electric mobility should be linked to (regulations for) spatial planning in general.

Coalitions may contribute to kick-start a market for EVs which is regarded as important since “the climate cannot wait for the market to get moving”. They need to liaison with all relevant actors and speak to them often, and the local and regional authorities implementing the EV policies are important partners in such coalitions as well as energy companies and grid operators.

Coalition of partners and building (networks of) knowledge and competence are important because actors realize they have limited possibilities to achieve the goals alone, also because there are many aspects they cannot influence e.g. like the regulatory framework, which is essential, while several actors together may be strong enough to influence the regulations.
Challenges of co-aligning partners should not be underestimated. Particularly the bridge between policy and commercial actors is challenging to build. Commercial actors require some commitment from predictable policy, but in the long run this should reduce costs since the market would get moving.

Since it is challenging to co-align partners and to manage the cooperation properly special attention should be paid to building up and maintaining the competence they develop for instance with extra management resources. Hence, offering assistance for the establishment and maintenance of coalitions is crucial.

9 COLOFON

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APPENDIX 1 Summarized answers to the questionnaires on user requirements

1 PUBLIC AUTHORITIES

1.1 Non-users of EV

Cities that responded to the questions include:

- City of Tampere (Finland)
- Os, Hordaland (Norway)
- Assens (Denmark)
- Graz (Austria)
- Dordrecht (Netherlands)

Have you ever considered procuring one or more EVs? And why?
4 out of 5 interviewed authorities will possibly procure one or more EVs within one year, mostly small city cars and vans. The fifth authority thinks the range of EVs is not sufficient, because they are located in a sparsely populated community and their cars are 24/7 in use.

The 3 most important reasons to start electric driving
The main reason to start electric driving is less/no emissions (in general), although reduction of noise is mentioned in 2 specific cases as well as a general concern for the environment. Also mentioned are image improvement and marketing of the municipality. Only the city of Graz mentioned potential cost savings.

What are the 3 main conditions to actually procure EVs?

- TCO, compared to conventional alternative should be at least equal.
- A larger range, compared to present EV availability.
- Extended availability of charging points (fast charging was mentioned by only 1 respondent).

Battery exchange or lease systems were also mentioned by 2 respondents to reduce anxiety about the life cycle of the battery.

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
This appeared to be a difficult question, with few answers. A few respondents mentioned fiscal policies to reduce the high price of EV. Also stricter standards regarding sustainable procurement have been mentioned.

1.2 Users of EV

Cities that responded to the questions include:

- Kristianstad (Norway)
- Tromso (Norway)
- Horsens commune (Denmark)
- Hedensted (Denmark)
- Steyr (Austria)
- Pechtoldsdorf (Austria)
- Rotterdam (The Netherlands)

- Amsterdam (The Netherlands)
- City of Kurikka (Finland)

How many EVs do you have in use? And what type are they?
>10 EVs are used by the cities of Amsterdam and the cities in Norway (mostly Thinks), whilst the cities in Norway have a far smaller fleet. Authorities in Austria, Finland, Denmark and the city of Rotterdam have 1 to 4 EVs in use (more than half of the fleet in case of Austria!).

Makes vary (though mostly Thinks), but they have the following characteristics in common:

- Merely small city cars.
- Typically drive less than 80 km/day, within the maximum range.
- Take more than 4 hrs to recharge.
- Are used daily.

Where and when do you charge?
All vehicles are charged at the own premises with renewable energy (or not known). Most of the interviewed authorities charge their vehicles only over night, although the battery is full. Some always charge while parking, and just one authority charges the vehicle only when it is necessary or battery is empty.

Do you use fast charging?
7 out of the 9 interviewed authorities do not have the possibility to use fast charging, only one can use fast charging regularly.

In what way is the operational use of the EV(s) different from the conventional alternative or your other vehicles?
In most cases (7) EV and conventional vehicles are interchangeable. One authority mentioned that the EV has a different/smaller coverage of the area and another mentioned less passenger capacity. However, none of them had to bother about any organizational restructuring to employ EV.
N.B 2 authorities remarked that since the car is so quiet they have to pay extra attention for pedestrians.

Why did you decide to start using EVs? The three most important factors!
The most important issue to buy an EV was fewer/no emissions (particulate matters and NOx) as well as improving image and marketing of the city, sometimes politically inspired. Several authorities got their cars through the participation in a research/demonstration project.

In what way have you been encouraged/pushed by the government to start electric road transport?
Most authorities participate in pilot projects that are partly financed by national/regional government. Norway, Finland and Denmark mention they have been encouraged by dedicated charging infrastructure. Also green procurement is mentioned, in The Netherlands as well as in Norway. In The Netherlands, air quality standards are an important driver.

What are the main conditions to make you actually extend the number of EVs?
All interviewed authorities are considering extending the number of EVs within the next 1-5 years, with the exemption of Finland that speaks of ‘eventually in the long run’ (mark: their fleet is rather small).

All countries mention (with exception of The Netherlands):

– TCO compared to conventional alternative should be at least equal or decrease.

Also mentioned are:

– Larger range and/or availability of fast charging.
– More choice of EV and models.

The Dutch municipalities mostly care about:
– More choice of EV and models.
– Extended availability of slow charging.

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
Nearly all authorities mention the high purchase price of EV and ways to reduce the price gap between EV and conventional vehicles, such as revised tax on leasing, VAT reduction, other fiscal policies and grants/subsidies or more tax on gasoline.
Regulation is mentioned as well, e.g. regarding:
– Maintaining air quality norms and green procurement standards.
– Demonstration projects to give potential drivers a feel of what it is like to drive electric.
– Support to technological developments.

Most authorities feel national and EU governments are busy encouraging electric driving and have in a way already profited from the policies suggested.

Interesting quotes
"I just want to stress that we have developed a loving relationship with our EVs. The employees almost fight to get access; the departments who received the first EVs wanted a second one when we received the last lot. The employees are very creative in naming their EVs while the conventional cars are just given a number. We have for instance EL-vis, Eldorado and Elton John in our fleet!"

"Private companies like "Choos/Ev" and "Better Place" have initiated national projects. Choos/Ev tests EVs in 30 municipalities and Better Place tries to establish infrastructure for EVs. Such attempts are also valuable "policy measures". In addition we have local funds and investment companies that play a crucial role in initiating projects. Energi Horsens in our region represents a fund which is involved in several projects: development of a new EV "Ecomove", a network for producers of components for EVs called "Bright Ignite" and sound effects for EVs "ECTunes".

2 DELIVERY SERVICES

2.1 Non-users of EV

Delivery companies that responded to the questions include:
– Foundation of Binnenstadservice (InnerCity Logistics Service) (The Netherlands).
– Postal Services Austria.

Have you ever considered procuring one or more EVs? And why?
Key characteristic of Binnenstadservice is freight consolidation: different shipments for different customers are combined into one vehicle, for which otherwise various are needed. The freight volume is such that a van would not suffice, also because of the load carriers. However, Binnenstadservice feels electric drive is at the moment not well suited for trucks. The Austrian Postal Services will possibly procure one or more EVs within the next year (types still under discussion; may vary from small city car to light truck).

The 3 most important reasons to start electric driving
The most important reasons are (potential) cost savings and fewer/no emissions (CO_2, particulate matters and NOx). Also corporate social responsibility is an important issue (also as a marketing strategy).

What are the main conditions to actually procure EVs?
Similar conditions are mentioned:
– TCO, compared to conventional alternative should at least be equal.
– More choice of EV and models such as light trucks.
– Guarantee of the residual value of the car.

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
Subsidies are a lot of trouble and reimburse only part of the additional costs. Binnenstadservice would therefore prefer a lump sum reimbursement at buying an EV. In Austria, lots of grants are offered but an overall strategy is missing to communicate best practices and recommendations and to convince delivery companies and other potential user-groups. On EU level, more strict regulations are desired to create a level-playing field.

2.3 Users of EV

Delivery companies that responded to the questions include:
– Peeters Transport (The Netherlands)
– Duncker Transport (The Netherlands)
– Itella (former Finnish mail) (Finland)
– Cargo (Austria)
– REWE Group (Austria)

How many EVs do you have in use? And what type are they?
The two Dutch delivery companies and Itella use EV for actual inner city deliveries (2 heavy vans, 2 vans and 1 light truck) whereas the Austrian delivery companies use passenger cars for manager trips (1 Tesla Roadster) and demonstrations (3 Thinks). Only the vehicles for demonstrations are additional and are in use max 3 times/week, the other EV replace conventional vehicles and are used on each and every work day. Most vehicles drive max 70 km/day, well within their range. In the Finnish case however, the vans drive 100 km/day on average, whereas the vehicles have a range of 80 km.

Where and when do you charge?
They all charge at the premises of the company at night (slow and green), and the passenger cars also charge at the premises of the employee. The Finnish vans charge wherever they are parked.

Do you use fast charging?
The Tesla Roadster always uses fast charging, the vans in Finland occasionally use fast charging and the other vehicles only use slow charging.

In what way is the operational use of the EV(s) different from the conventional alternative or your other vehicles?
The Dutch companies as well as the Finnish company indicate that their EVs are interchangeable with conventional companies since they have multiple vehicles that are used for just inner city transport. It just required some changes in the logistics. The Austrian EVs are used for a different/smaller covering of the

area, which requires some thinking in advance: when you go and where you go, thinking of parking space and charging stations, etc.

Why did you decide to start using EVs?
Dutch delivery companies both state they act on image and marketing reasons, hoping that 'electric' delivery will bring them more work. Also, they feel it is exciting and new and they would like to gain learning experiences. Potential cost savings are expected from lower maintenance costs rather than lower energy costs, since present gasoline cars are also very efficient. The Austrian companies and the Finnish company claim that fewer emissions, image and marketing are the main reasons to start electric driving.

In what way have you been encouraged/pushed by (local) government to start electric road transport?
The Dutch companies, the Finnish company and one Austrian company received a subsidy on procurement. Both Dutch companies mention they would also have purchased the vehicle without subsidy.

Are you considering extending the number of EV?
The Dutch companies expect to extend within the next 1-5 years. For one Austrian company and the Finnish company this is within 1 year whereas the other Austrian company has not decided yet.

What are the main conditions to make you actually extend the number of EVs?
Both Dutch companies and the Finnish company mention that:
– The TCO, compared to conventional alternative should decrease.
– More choice of EV is needed.
Also the marketing aspects of EV (more work) should be proved in reality.

The Austrian companies and the Finnish company mention:
– A larger range is needed;
– Purchase costs and/or TCO should decrease;
– Comfort should be equal to a conventional car (heating is problematic!)

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
Dutch companies do not necessarily need financial support from the local government, but prefer supporting policies such as:
– Extended delivery times, the right to drive on the tram track, a more strict environmental zone, to be given priority at load/unload spots.
They are both still in discussion with the municipality on this.

Also mentioned by the Austrian company is:
– Access to pedestrian areas and forbidden driving areas.

Furthermore, both Austrian companies indicate the absence of focus and a master plan to make EVs more attractive and conventional vehicles less attractive. For instance by providing basic infrastructure and higher fuel prices or by providing a city charge for conventional cars.

3 UTILITY AND ENERGY COMPANIES

3.1 Non EV-users

Energy companies that responded to the questions include:
- Energi Viborg (Denmark)
- Oppdal Everk (Norway)
- Verbund (Austria)

Have you ever considered procuring one or more EVs? And why?
Both Scandinavian companies merely employ vans (and an occasional truck), whereas the Austrian energy company employs passenger cars for the holding. Both Scandinavian companies are of the opinion that at present no electric car qualifies for the job. In one case they specifically aim for a 4WD. The Austrian company may decide to lease/purchase a mid-size electric passenger car.

The 3 most important reasons to start electric driving
The main reason - that is shared by al three companies - is improving the image and marketing of the company. Next to this, an overall concern for the environment and corporate social responsibility was pointed out.

What are the main conditions to actually procure EVs?
Both Scandinavian companies are most concerned about technical conditions, such as:
- More choice of cars, i.e. 4WD and the fear that they would "eat" batteries.
- Good access to maintenance services.
- Safety and operation reliability.
- Speed range more like conventional cars.

The TCO should decrease, yet higher is admissible (due to the environment). One Scandinavian company is on the look out for reliable cost information and best practices for his situation.

In case of the Austrian company (mid-size passenger car), the main condition is to have a TCO equal to conventional car, followed by equal comfort, larger range and extended availability of (fast) charging.

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
The Scandinavian companies have not informed themselves about (potential) EV policies, since they consider electric driving not relevant to their company.

The Austrian energy company sees standardization i.e. regarding data exchange as an important task of the government (national as well as EU). Also they feel that research on EV is quite good and extensive in Austria, but actual implementation lags behind as crucial conditions (lower price, availability of charging) are not/insufficiently met.

Interesting quote
"Politicians think they can manage and decide but things have to be carried out into practice in a rather different reality. We need the products, in this case EVs to be developed to fit our needs. That is, we need a larger variety of EVs to choose from since we depend on 4 wheel drive and lots of storage space for tools".

3.2 Users of EV

Energy companies that responded to the questions include:
- Eidsiva Energi (Norway)
- NTE (Nord-Trøndelag Elektrisitetsverk) (Norway)
- Syd-Fyns Energi (Denmark)
- Øst-kraft (Denmark)
- BEWAG (Austria)
- SALZBURG AG (Austria)

How many EVs do you have in use? And what type are they?
All energy companies have 1-6 EVs in use with the exception of one Austrian energy company that employs about 40 EV. By far the most cars are small city cars of various brands, yet mostly Thinks. Two companies do each have an additional van and one company also owns a Tesla Roadster.

Remarkably, all companies have 'additional' electric vehicles that are not a replacement of conventional cars. This is illustrated by their less extensive use in some cases (3 days/week). They are in use for business visits and services, but also for commuting, promotion and marketing. In all cases the daily use in km is well within the range of the vehicles (max 160 km) with the exception of the Tesla roadster (max 380 km).

Where and when do you charge?
All interviewed companies charge at the premises of the employee and/or the company. Two companies mention other/public charging points. 5 of 6 utility companies charge with renewable resources. Nearly all charge over night, although the battery is full or while parking.

Do you use fast charging?
All interviewed utilities have no fast charging spots available.

In what way is the operational use of the EV(s) different from the conventional alternative or your other vehicles?
Some mention the EVs are used for shorter trips or trips with fewer passengers, but generally speaking, the operational use is more or less the same or considered adequate. On the plus side, the EVs are being praised for their comfort and aptness for inner city use and access to the environmental zone.

Why did you decide to start using EVs? The three most important factors!
The primary reason for utility companies is to improve image and for marketing (pushing renewable energy). Also overall concern for the environment is mentioned, next to experimenting with new mobility concepts.

In what way have you been encouraged/pushed by (local) government to start electric road transport?
The Scandinavian companies have not received any government support (apart from fiscal policies); both Austrian companies though have received a subsidy on the procurement of EV.

What are the main conditions to make you actually extend the number of EVs?
3 of 6 utilities/energies have planned to extend the numbers of EV within the next year. Two consider extending in the next 5 years and one is well supplied with EVs (the Austrian company with 40 EV).

Various conditions are pointed out, and for each company in a different order of importance:
– Availability of fast charging spots.
– More choice of EV and models.
– TCO, compared to conventional alternative is at least equal.
– Purchase price should decrease, as people unfortunately see the purchase costs first, they don't see the TCO in total.
– Larger range, compared to present EV, especially for maintenance cars.
– Comfort (heating) in winter needs to improve.
– The speed, compared to conventional alternative, should increase.
– Guarantee of the residual value of the car.

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
All companies mention grant/subsidies/fiscal policies to support the procurement of EV. One Austrian company emphasizes standardization to find out the needed standard, the other Austrian company points out that investment in battery technology is needed.

The Danish companies are more or less content with present policies. One Norwegian company complains that incentives are just aimed at city-dwellers and rural communities are being neglected. Austrian companies feel that Austria is offering a good program and good actions, but efforts and financial support are too limited, which stops the progress.

Interesting quotes
It's important for us to be frontrunners. There are still too many myths about the "dys" functionality of electric vehicles. Yesterday we had representatives here from the regional authorities and we showed them the EVs and told them how well they function.

More companies should make the same effort and take some initiative to "kill" the myths through introducing EVs to their employees. After all we are regular people with cars at home as well.

The most important for us is predictability and long-term thinking by the government. The industry is currently presenting more types of vehicles that our kind of company needs - more vans and utility-vehicles. I hope that there will be a more complete selection of cars that we can use but in the end it's up to the car-industry".

4 TAXI COMPANIES

4.1 Non-user of EV

Taxi companies that responded to the questions include:
– Rotterdam Taxi Centrale (Netherlands)
– Kajon Oy (Finland)

Have you ever considered procuring one or more EVs? And why?
Both companies employ more than 100 vehicles, in both case vans/minibuses are a sizeable portion (33% - >90%). In the Rotterdam case, electric taxis are being discussed and may be procured within the next year. Kajon Oy however is of the opinion that electric cars are not suitable for their company.

The 3 most important reasons to start electric driving
Reasons that are shared by both companies are 1) improving image and marketing of the company and 2) less emissions. Primary reason for the Finnish company would be cost savings, however.

What are the main conditions to actually procure EVs?
For the Finnish company TCO at least equal to conventional cars are considered essential, whereas the Rotterdam taxi company is willing to pay a little extra (+5%) and is more concerned about the reliability of the car and replacement in case of problems. Range is an issue to: In the Finnish case, the cars are used nearly 24h/day and therefore much larger range is needed or fast charging. In case of Rotterdam an extended range of 150 km with slow charging, yet abundant charging spots will do.

What are the most effective policies/policy measures to encourage electric driving by (local) authorities? Are they sufficiently addressed?
The Finnish company is not informed on (potential) EV policies, since they consider electric driving not relevant to their company. The Dutch taxi company, however, claims that financial support for a reliability guarantee and the higher purchase costs would definitely help. So far, the municipality has not agreed to offer this support, otherwise he would have started procuring EV.

4.2 Users of EV

Taxi companies that responded to the questions include:
– Taxi Centrale Amsterdam (The Netherlands)
– Kijlstra Leeuwarden (The Netherlands)

How many EVs do you have in use? And what type are they?
Kijlstra is using two electric vans (converted Ford Transits) for contract transport (8 persons) and cruising streets as replacement of conventional vans, whereas TCA has recently procured 5 Fiat Doblo's (Microvett) to be used as street taxi (additional vehicles). All taxis are used daily in the inner city area.
All taxis drive max 200 km/day, which is little beyond the maximum range of the vehicles.

Where and when do you charge?
Kijlstra charges at a public fast charging point (the only fast charging point in the Netherlands so far) near the premises of the company, always while parking (each coffee break). TCA has been supplied with 5 charging points (380V) and charges overnight (max. 5-6 hours). Both companies use renewable energy.

In what way is the operational use of the EV(s) different from the conventional alternative or your other vehicles?
The EVs have a smaller covering of the area. However since most of the transport takes place within or quite near the city, and a large part of the fleet consists of conventional vehicles, this situation is not considered problematic.

Why did you decide to start using EVs?
Both companies mention:
– Improving image and marketing and the desire to become more prominent, as the taxi product is of a boring uniformity.
– To gain experience: how does the battery keep up? What are the true costs of electric driving, what is the actual kilometer cost price, what is the optimal combination of the size of the battery (costs) and performance?

In what way have you been encouraged/pushed by (local) government to start electric road transport?
Both have been encouraged by subsidy on procurement (from the municipality) and dedicated charging infrastructure (from the municipality, resp. the electricity company, to gain experiences on fast charging. One also mentioned privileges (e.g. free parking).

Are you considering extending the number of EV?
TCA aims to extend the number of EVs within 1 year. The Kijlstra taxi company needs more experiences with winter time to decide. They already found out that heating of the vehicle is limiting severely the range of the vehicle.

What are the main conditions to make you actually extend the number of EVs?
Conditions that are shared are:
– TCO, compared to conventional alternative should be at least equal, as for large scale deployment a business case is essential. However, in the case of Leeuwarden the business might work out well. That is, if the vehicle holds up in the winter.
– More choice of EV and models.

TCA also requires a larger range than the present EVs.

What are the most effective policies/policy measures to encourage electric driving by local authorities? Are they sufficiently addressed?
Both feel that financial support regarding procurement and fast charging infrastructure is essential. Kijlstra prefers a more permanent way of encouraging electric driving by fiscal policies and tax exemptions on vehicles and tax on fuels and electricity to subsidies that only reach the front runners. TCA feels very much encouraged, as the municipality is very keen on electric taxis and has contributed largely to the project.

Interesting quote
"My drivers love the electric vehicle for its driving comfort and so do the passengers since it allows them to have a proper conversation!"

5 (PREMIUM) END-USER

5.1 Non-users of EV

Background characteristics

Aspect	Private person (Denmark)	Private person (Norway)
Household situation	Partnership, no children living in	Partnership, living with children
Work distance	Retired	4 km
Type of residential area	Outskirts of city	Outskirts of city
Number of cars in household	1	1
Type of car	Mid-size passenger car	Mid-size passenger car
Ownership of car	Private	Private
Use of public transport	once a month or less	1-3 times a month

Potential procurement of EV

Aspect	Private person (Denmark)	Private person (Norway)
Have you ever considered procuring an EV?	I looked into the benefits and disadvantages of EVs and decided it was not for us	I am certain an EV is not suitable for our/my situation from what I hear in the media
What would be a reason for you to procure an EV instead of a conventional vehicle?	When EVs become just as reliable as conventional cars we can save money and contribute to the environment	In case of the same size and driving range as a conventional car. If I was to buy a second car for my family I would perhaps think differently.

Conditions for the actual procurement of EV

Priority	Private person (Denmark)	Private person (Norway)
1	More choice of EV and models, more storage space and passenger seats	Same size as conventional vehicle
2	Extended availability of slow charging spots	Same comfort as conventional vehicle
3	Larger range, compared to present EV	More choice of EV and models
other	Availability of fast charging spots More in-car information, to reduce range-anxiety	

Interesting quotes

"I think it is remarkable that I have never seen a commercial for an electric vehicle.

If the EV had been very good with equal standard, comfort, driving range and size compared to a conventional vehicle and was promoted widely according to these characteristics, buying an EV would have been an option for me regardless of costs, policies and incentives".

5.2 Users of EV

Background characteristics

Aspect	Private person (Denmark)	Private person (Denmark)	Private person (Norway)	Private person (Norway)
Household situation	Partnership, living with children	Single	Partnership, living with children	Partnership, no children living in
Work distance	Student	2 km	4 km	12 km
Type of residential area	Center of the city	Outskirts of city	Village	
(Easy) access to a conventional car	No	No	Yes, whenever needed	Yes, whenever needed
Use of public transport?	Once a week or more	Once a week or more	No	
Brand and type of EV	Citroën Berlingo Eléctrico	Ellert	Think City	Citroen Saxo
Size	Small city car	Small city car	Small city car	Small city car
Ownership	Private	Private	Private	Private
Frequency of use		Daily	Daily	Daily
Km/day (on average)	Short trips		75 km	75 km

Aspect	**Private person (Denmark)**	**Private person (Denmark)**	**Private person (Norway)**	**Private person (Norway)**
Max. range in km			160-180 km	70
Time needed to fully recharge			8 or 10 hours	5 hours
Travel area		Inner city	Inner city and surrounding area	Inner city and surrounding area
Position of the EV	Replacement of conventional vehicle	Replacement of conventional vehicle	Replacement of conventional vehicle	additional
Additional purchase costs (euro) compared to conventional alternative (net costs, any subsidy included)			None compared to conventional vehicle when all subsidies are taken into account	Have saved a lot of money from buying this car (free parking, toll roads and no gasoline).
In case of replacement, is EV of similar size as replaced conventional car?	Smaller	Smaller	Smaller	
For what purpose(s) is the EV used (multiple answers possible)?	Commuting	Commuting; business	Commuting; business; shopping, school, kids	Commuting; business; shopping, school, kids
Where do you charge (multiple answers possible)?	At own premises and public spaces	Premises of company and public spaces	At own premises	At own premises
Do you make use of fast charging?			No fast charging available	No fast charging available
When do you charge your EV?			Only over night, although the battery is full	Always while parking, although the battery is full

Reasons for procurement of EV

Priority	Private person (Denmark)	Private person (Denmark)	Private person (Norway)	Private person (Norway)
1	I want to contribute to the environment	I like new technologies/being an innovator	Time saving	Cost savings (on fuel)
2	Cost savings (on fuel)	I want to contribute to the environment	Cost savings (on fuel)	Free road toll
3	I like new technologies/being an innovator	Less stench	I want to contribute to the environment	Free parking
Else	Less noise, less stench	Less noise		

Government involvement

Aspect	Private person (Denmark)	Private person (Denmark)	Private person (Norway)	Private person (Norway)
In what way have you been encouraged by (local) government to procure an EV?		United Nations Climate Change Conference in Copenhagen	Privileges, such as free parking and environmental zone	Tax exemption and less road toll
Most effective policies for private users	Local: service providers/ recycling of batteries	National: CO_2 E Race, a project to create awareness	Local: no road toll; national: VAT exemption, economic measures, driving in collective driving lines	Local: no road toll, free parking

Interesting quotes

"Lowering the purchase price is important, as well as expanding the flexibility of the car so that it becomes more like a conventional car: planning and insecurity about charging is a hassle, driving range must increase, charging time must decrease, and the EV needs more passenger seats and luggage space.

Even though I have saved money I have spent a lot of time on fixing and repairing the car (Citroën Saxo). Local service providers must therefore be accessible and reliable".

APPENDIX 2

Literature review on policy recommendations for governments (Finland, UK)

The Finnish report of the ***Rapporteur on the "electric vehicles (EV) as a part of the Finnish transport system, climate policy and transport policy"*** has made several recommendations for market development for EVs. Possible introduction of EVs will require various measures. From the viewpoints of transport policy and cost-effectiveness perspectives in Finland it is not fully justified to try to maximize the size of EV fleet in circulation immediately. The recommendations are split in three classes of importance.

Recommendations:
First, the following recommendations should be adopted:
Development of skills, expertise and knowledge

- in addition to research and development, there should also be targeted service workshop activities, periodical technical inspection activities and rescue personnel training

EV charging requirements to be included in various authority regulations, e.g. code of building regulation, first related to slow charging
Creation of information system for public charging points
Initiation of large field operational tests with 500-1000 EV

- in close cooperation with all stakeholders
- to cover all aspects of concern

Ensuring the EV safety aspects (currently on going activity with Ministry of Transport and Communications and Safety and Chemicals Agency TUKES).

Second, the following recommendations should be adopted:
Demonstration of smart charging in the power grip;
Guidelines to be prepared for fast charging.

Third are the following recommendations:
Building the required fast charging infrastructure.
Deployment of wide scale initiatives to foster EV market uptake.

The UK - King Review recommendations: the King Reports suggest 14 recommendations for the European Union and UK Government on vehicle emission reductions and cleaner fuels. Several recommendations include domestic specifics but they should be used as a reference of possibilities on the scope, depth and width the various actions of governments. The list below covers *only those recommendations that are related to EVs*.

Reducing vehicle emissions
Recommendation 1: support the EU's proposed regulatory approach for vehicles, demand consistent emissions standards and support the target date of 2012. The EU needs to agree on the details to give the industry certainty and ensure the benefits of reductions in new car emissions.

Recommendation 2: the EU should implement the 130g/km target based on the sales weighted average emissions of new cars sold. The EU should set individual manufacturer targets and monitor the weight of vehicles in the run up, in order not to provide manufacturers with perverse incentives to increase vehicle weight.

Recommendation 3: The EU should to adopt a 100g/km new car sales weighted average target for 2020.

Recommendation 4: The EU should set in place a process for regular target setting every 7-10 years (or in line with future model cycles) to ensure that the industry can invest in and bring CO2 saving technologies to market with certainty.

Recommendation 5: The Department for Transport, working with the European Commission, should design a CO_2 target for vehicles that captures the full CO_2 impact of vehicle production, disposal, usage and the production of the fuel or power used by the car.

Cleaner fuels

Recommendation 6: The Department for Transport should assess to reduce the carbon intensity of the fuel mix covering all fuels, through a Low Carbon Transport Fuel Obligation, alongside other options.

Recommendation 7: The European Commission should develop policy instruments to provide flexibility between fuel and vehicle targets. EU to mandate that fuels and vehicles should be balanced such that the overall costs of reducing CO_2 emissions are minimised.

Recommendation 14: Options to facilitate the efficient use of electric vehicles (such as smart metering, time-of-day pricing and fast charging points) should be considered alongside existing functions.

The King Review addresses also the consumer actions reflecting the market development. It was the consumer choices where King saw scope for wide-ranging UK Government actions, making 13 separate recommendations.

Consumer choices

Recommendation 15: Government should strengthen demand side policy measures to enable and encourage consumers to choose best in class or downsize.

Recommendation 16: The introduction of the fuel economy labels to inform consumer purchase decisions. To increase their impact the Department for Transport should:
Extend the labels beyond new cars to cover second-hand cars registered from March 2001 that are sold through dealerships;
Extend the labels to cover new and second-hand vans once the required information on CO_2 emissions is published for all new vans.
Make display of the labels compulsory on all vehicles in the range of the scheme; and
Include comparative information on CO_2 emissions and fuel economy on the label.

Recommendation 18: Regulation of vehicle advertising should be strengthened so that information on CO_2 emissions and fuel economy is presented in a more prominent and consistent form in advertisements across all media. This should include a requirement to display comparative information on emissions relative to other vehicles in class.

Recommendation 20: The Department for Children, Schools and Families should ensure that children of all ages have the opportunity in school to learn how driving contributes to CO_2 emissions and how different choices can reduce this impact.

Recommendation 21: The local authorities to introduce measures that incentivise consumers to choose lower emission vehicles where they are appropriately designed and are introduced with the objective of reducing CO_2. Where introduced, measures should:
Be based on carbon emissions rather than technology, equally incentivising all vehicles with equivalent CO_2 emissions.
Be maintained for a reasonable period of time to give consumers confidence in opting for lower emission vehicles. However, they should also be reviewed over time as the CO_2 emissions of the average car decline; and
Not encourage people to drive more, by making it easier or cheaper to do so, leading to increased congestion and higher CO_2 emissions.

Recommendation 22: All public bodies should look to match central government by setting an ambition to reduce the average emissions of new vehicles procured for administrative purposes to 130g/km by 2010-11.

Recommendation 23: The Department for Transport should promote the benefits of undertaking training in more efficient driving techniques, both to individuals and businesses, as part of the "ACT ON CO_2" campaign, and should provide accreditation to suitable training programmes.

Recommendation 24: The Department for Transport should work with the European Commission and manufacturers to ensure an evidence base is developed on what dashboard technology could be safely incorporated into vehicles to promote more efficient driving. The European Commission should then regulate to make appropriate technology mandatory in all new vehicles sold in the EU. The Government should also promote and incentivise the retrofitting of technology to existing vehicles.

Recommendation 25: All local authorities should ensure that smarter choices are a priority in their local transport strategy.

Recommendation 26: The Department for Transport should work with local authorities to establish how a widespread implementation of personal travel planning could be sustainably funded. To strengthen the evidence base on the benefits of personal travel planning in different settings, the Department for Transport should consider establishing new pilots to assess the effectiveness of personal travel planning in larger urban areas.

Recommendation 27: All large public sector bodies should have a workplace travel plan in place by 2010.

Recommendation 28: Local authorities should consider promoting car clubs in their area as part of their local transport strategy. The Department for Transport should also raise awareness of car clubs so that people can make informed decisions over whether they are an appropriate option for them.

The King Review drafted several recommendations for R&D activities as well.

Research and development
Recommendation 29: Government and independent bodies responsible for public R&D funding to increase the share of the funding assigned to low-carbon R&D, including low-carbon vehicles.

Recommendation 31: The Technology Strategy Board and its partners to extend the Low Carbon Vehicles Innovation Platform to provide clear demonstration opportunities for new low-carbon vehicle technologies through implementation of experimental fleets linked to future procurement opportunities.

Recommendation 34: The Research Centre on Sustainable Behaviours to make low carbon cars an early priority, including the potential for future approaches to road charging, drawing on the Department for Transport's findings.

Recommendation 35: The Research Councils should urgently identify a limited number of critical long-term challenges and focus research efforts and funding around them, exploring innovative approaches to instil a sense of urgency and excitement for the research community and the wider public.

Recommendation 36: The UK Government should explore with other EU countries whether an EU level price could be developed to find low-cost solutions for retrofitting to existing cars to reduce their emissions by a minimum of, say, 25%.