Measure title: **Electrical vehicles in Aalborg**

City: **Aalborg** *Project:* **ARCHIMEDES** *Measure number:* **1**

Executive summary

As a part of a broader national trial, the City of Aalborg has organised a test of 10 electric cars (Mitsubishi MEV, Peugeot iOn and Citroen C1EV) by 80 families during a 2 years trial period. The trial started in March 2011 and as the cars are used by the involved families for periods of three months each, the 8 trial periods will be completed in March 2013 (21 months within the Archimedes project). This trial in Aalborg is expected to cover some 200.000 km driving, 30.000 KWH uses of electricity and 6,000 car charging for the 10 vehicles. The use of 10 EV by 80 families in Aalborg is a quite large trial for the scale of the city.

During this period data from the cars and chargers in Aalborg is automatically being logged to a central database together with data from the other 160 cars in the national project. The user experiences are collected by inquiries and by their posting blogs on the web log on www-testenelbil.dk.

This Aalborg EV trial differs from previous EV trials in the fact that the 80 testing families are ordinary car users, instead of environmental or technical nerds already convinced of the EVs advantages. The test families have been stratified sampled after a call for interested families, covering the aims of the trial.

The trial is made in cooperation with CLEVER, one of the main Danish EV players and the CIVITAS financing is supplementing funding from governmental funds and national sponsors.

The main aim is to identify under which conditions – and to what degree - the EV in its present technical version (OEM EVs), is an attractive alternative to ordinary cars, with the purpose to evaluate the possibilities of substituting the fossil fuel mobility by electro mobility in the future. The data collected through this experience gives a more realistic knowledge about the advantages or problems in using the cars in a daily life situation. The data enables a comparison between different fuels alternatives, and the information about the driving and charging patterns can be used for deciding the placement of charging points in the city.

Evaluation has been focusing on the costs analysis, the energy consumption, the effects in air quality and also the EV acceptance by test users

To have an even better data-sample to conclude on, the findings are based on the aggregated data from all cars and charging in the national project, including Aalborg tests results.

Results show some interesting figures:

- 6 months of the year the range of charge is below 70 km. and in the Danish winter the range is as low as 50 km. instead of theoretical 150km.
- When using real data an EV uses 68.2% less energy than a comparable petrol car and 59.1% less than the diesel version. The energy consumption is related closely with the weather conditions and also with the driver's style, among other factors.
- When taking Danish energy prices into account, the EV is 50% cheaper in energy consumption than a comparable petrol car and 25% cheaper compared to the diesel version.

- Also based on real consumption data, the EV emits 53.1% less CO_2 per km. for Well to Wheel, using the averages Danish CO_2 emission for electricity production; but the EVs environmental effect – the CO_2 savings – depends on how the electricity is produced.

- Regarding the acceptance results of survey before and after and of continuous trial blogging, on the positive side the users have noticed the reliability, the fast acceleration, the low noise level and the low fuel costs. On the negative side the users have been surprised by the unexpected low range per charging on colder days. As a consequence of this, in a Stated Preference evaluation, the EV was only preferred in 41% of the situations in an After test, instead of 48% in the same Before test.

The trial has reached to identify under which conditions the EV in its present technical version, is an attractive alternative to ordinary cars and has provided a lot if interesting information towards the future of electro mobility in this region.

A Introduction

A1.1 Objectives

The measure objectives are:

(A) High level / longer term:

- To reduce pollution in the city and to find alternatives to scares resources of fossil fuel.

(B) Strategic level:

(1) To research and demonstrate to which extend, and in which niches the electrical vehicles (EVs) can substitute vehicles on fossil fuel.

(C) Measure level:

(1) to gather experiences from ordinary users of EV

(2) to identify under which conditions the EV in its present technical version (OEM EVs), is an attractive alternative to ordinary cars.

(3) to evaluate CO_2 savings totally for the project and to indicate differences between CO_2 savings depending on the drivers' behaviour.

(4) to gather experiences with intelligent charging. User acceptance of postponed charging. The potentials for moving charging consumption from peak hour to night hours, and the potentials for maximizing use of electricity produced from alternative energy by controlling charging time by intelligent charging.

(5) to gather information on the EV driving patterns, for obtaining a strategy for where to place charging points.

A1.2 Target groups

- Ordinary citizens within the city of Aalborg using EV in their daily life, as opposed to EV fans or technical nerds and environmentalists.

Target area:

- The municipality area of Aalborg.

A2 Description

Several trials have been implemented on European level – and even in the City of Aalborg - but usually the users have been selected among technical nerds and environmentalist. User groups that tend to be more willing to accept functional and technical shortcomings of electrical test cars. This task has given a sample of ordinary families in Aalborg the possibility to test an EV in their daily life.

A sample of ordinary citizens has used an EV in their daily life for a period of three months each, for free. By using 10 EV in a period of two years (even though only 21 months insides the ARCHIMEDES period) we will gather experiences from 80 different ordinary families in Aalborg in total. The experiences are expected to cover some 200.000 km driving, 30.000 KWH uses of electricity, 17.500 car charging and test of different levels of intelligent charging.

The EV trial in Aalborg is done in cooperation between the City of Aalborg and Clever, who is one of the major players in EV in Denmark. The cooperation is agreed in a contract between the two parties, signed in January 2011. The trial is supported by public funds and national sponsors.

The participation in the trial is a part of the local ARCHIMEDES Project in Aalborg. CIVITAS ARCHIMEDES logos appear on the vehicles etc. and all experiences from the project are available for the ARCHIMEDES evaluation.

The trial is controlled by a local steering committee with participation from the EV Company and the City of Aalborg. A range of similar trials are ongoing in other parts of Denmark, and results from the other sites will be included in the evaluation.

A3 Person in charge for evaluation of this measure

Name of person	Jens Mogensen
Name of organisation	City of Aalborg
Direct telephone	+45 9931 2329
e-mail	jms-teknik@aalborg.dk

B Measure implementation

B1 Innovative aspects

Innovative Aspects:

- **New mode of transport exploited** – the demonstration project in Aalborg is large-scale compared to the size of the city and as a part of the total project, including some 175 vehicles, it is one of the largest EV trials in Europe. This project sets itself apart from all previous projects by testing only OEM cars, which are, or will soon be, available for ordinary users. This makes generalising the EV's potentials to be used by the public much more realistic.
- **Targeting specific user groups** – Several EV trials have been implemented on European level – and even in the City of Aalborg - but usually the users have been selected among EV fans and technical nerds. That is users who are willing to accept the functional and technical shortcomings of the electrical test cars. In this task a sample of ordinary citizens demonstrates to what extend an

EV will function as a part of their daily life. Again this makes generalising the EVs potentials to be used by the public much more realistic

- **New physical infrastructure solutions** – As part of the project charging infrastructure on different levels is developed and tested. This includes: New intelligent charging boxes for personal use in the car ports, Electrical charging points for roadside charging, and Quick Chargers for use in public or semi-public space.

B2 Planning of Research and Technology Development Tasks

Not relevant.

B3 Situation before CIVITAS

Before 2010 there was only a small numbers of EV in Denmark, less than 400 in total.

In the 1990s there was an ‘EV wave’ in Denmark. A number of EVs were manufactured as ‘handcraft’ or on small scale fabrics, and in broad circles the expectations were growing that the EV breakthrough was imminent. In fact the quality and reliability of the cars failed, and the EV breakthrough became a flop instead. This has caused prejudices against EVs as unreliable toys.

As a part of a national financial supported initiative a number of municipalities have the last couple of years purchase small fleets of EV. As the initiative was launched just before the OEM EV was released, most of these cars is hand-made or rebuild from petrol cars. The quality of these cars is in general very low and varying coursing a lot of problems and a low operational reliability.

Today EVs are manufactured at the major car factories and have to meet normal quality norms for production cars. One of the objectives for this task is therefore to eliminate the prejudices against EVs and demonstrate that the OEMs are as reliable as ordinary cars.

B4 Actual implementation of the measure

The measure was implemented in the following stages:

Stage 1: Planning the Methanol-fuel cell vehicle. *(15. September 2008 – 14. September 2010)*
As planned in the initial measure design, this phase was used to investigate the possibilities to implement a methanol-fuel cell vehicle project, and to negotiate with possible suppliers of such a vehicle. At the end it turned up that the technology was still so immature, that it was unrealistic to develop such a vehicle in the project’s time- and financial frame. As a consequence, it was agreed with the EU project officer, that the task was closed and replaced with the EV trial.

Stage 2: Planning the Electrical Vehicle trail. *(15. September 2010 – 1. March 2011)*
Contact was established to the national EV operator Clever[1]. Clever had the vision of a large-scale EV trial, support from Danish Energy Agency, under the Danish Ministry of Climate, Energy and Building, and contact or contracts to some potential national sponsors.

It was accepted by the EU project officer to use 90.000€ to do a local EV trial in Aalborg. A contract was developed between Clever and the City of Aalborg, and signed 20th November 2010 – as a part of the training and learning event for professional drivers.

[1] In June 2012, the EV company changed its name from ChoosEV to Clever. It is intended to use the name Clever in all contexts in the evaluation, also for activities when the company’s name was still ChoosEV. If the name ChoosEV is used, please read Clever.

Figure 1 Aldermann Mariann Nørgaard and CEO Henrik Isaksen are signing the project contract.

In the second half of this stage 10 OEM electrical vehicles were organised to be used in Aalborg. Potential test users were sought and applications from more than 1.100 families were received. Work on developing a dedicated intelligent charging unit for use in private carports was initiated. During the whole period the project had intense local press coverage.

Stage 3: Running and evaluating the EV trial *(5. March 2011 – 4. March 2013) The Aalborg project includes 10 EVs which have been lent to ordinary families in Aalborg for periods of 3 months. The project period is 2 years, so a total of 80 families will have an EV in their family for 3 months.*

The families are randomly selected among interested families stratified according to different parameters such as age, gender, family types, number of children in the family and distance to work.

The first 10 pilot families started their 3 months trial on 5th March 2011.When the cars are turned over to new families each 3rd month, 1-2 press releases is/are sent out. Interested families are still encouraged to send in an application. New families are selected from the now more than 1.500 applicants, and an event is held to celebrate the turn over of the cars.

Evaluation is performed by different channels. The families are required to fill in a questionnaire before and after the trial period. They are required to blog their experiences at least once a week on the project weblog. The car is equipped with a data-logger logging mileages, energy consumption, driving patterns and routes; and an intelligent charging unit is installed at each family logging the charging amount and patterns. All data from cars and charging units are automatically downloaded to the central base where the data is analysed.

Figure 2 The EVs are handed over to the first users, while TV is recording the ceremony

B5 Inter-relationships with other measures

The measure is primarily linked to the other tasks in the ARCHIMEDES measure 1.' Bio fuels in Aalborg' as these tasks also concerns finding alternative fuels to help reduce dependency on fossil fuel and limiting the environmental impact of mobility.
The measure relates to the ongoing process in Aalborg – and the rest of Denmark – of establishing a comprehensive charging infrastructure for EVs. An intensive process that started up approximately at the same time as the EV project in Aalborg, but outsides the ARCHIMEDES Project.

Figure 3 Yet another EV line-up. Getting ready for ARCHIMEDES EV-day.

C Planning of Impact evaluation

C1 Measurement methodology

As the EV trial in Aalborg is a part of the national trial, evaluation will partly be based on data from the 10 vehicles in Aalborg, and partly on data from all ~175 vehicles in the national project. As the setup is the same in the national project as in the Aalborg trial – same cars, same selection methods for test drivers, same evaluation methods, etc. – the local results and the national results will be the same, but by using data from all vehicles a greater sample can be obtained, making the conclusions more valid. For the same reason a large part of the results and calculations have been done by Clever and originates from Danish presentations for the national project board. The data from Aalborg is included in the national data set. Via the national project a much broader evaluation of these data is done, than can be presented in this evaluation report. As the national project has a longer timescale than ARCHIMEDES, parts of the evaluation will first be done after the end of the ARCHIMEDES project.

C1.1 Impacts and indicators

C1.1.0 Scope of the impact

As the project is a part of a large national project, the experiences from the combined project, and the change in acceptance resulting from 1,400 families having tried an EV for 3 months each, being spread by a focused dissemination strategy, is foreseen to have a major impact on national, or even European level.

C1.1.1 Selection of indicators

NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
	ECONOMY					
2a		**Costs**	Operating Costs	Energy operating costs	Costs per pkm compared to a similar fossil-fuel vehicle	Euros/km, % compared to ordinary car.quantitative, measured and derived.
				Total Operation costs	Total costs for using an EV compared to a similar fossil-fuel vehicle – in the present price situation.	Euros. % compared to ordinary car. measured and derived.
	ENERGY					

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NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
3		**Energy Consumption**	Fuel Consumption	Vehicle fuel efficiency	Fuel used per vkm, compared to a similar fossil-fuel vehicle	KWH/vkm, % compared to ordinary car. quantitative, measured and derived.
	ENVIRONMENT					
5		**Pollution/Nuisance**	Air Quality	CO levels	CO emission	grams CO2 / km, % compared to ordinary car. quantitative, measurement
12			Noise	Noise perception	Perception of noise	qualitative, Weblog feedback. collected, survey
	SOCIETY					
14		**Acceptance**	Acceptance	Acceptance level	Attitude survey of current acceptance of the measure	Index (%), qualitative, collected, survey
	TRANSPORT					
18		**Quality of Service**	Service reliability	Reliability of OEM EVs	Number of breakdowns and other malfunctions of EVs.	No and %, quantitative, collected, measurement

C1.1.2 Methods for evaluation of indicators

Evaluation is performed by different channels. The families are required to fill in a questionnaire before and after the trial period. They are required to blog their experiences at least once a week on the project weblog. The car is equipped with a data-logger logging mileages, energy consumption, driving patterns and routes; and an intelligent charging unit is installed at each family logging the charging amount and patterns. All data from cars and charging units are automatically downloaded to the central base where the data is analysed.

No.	INDICATOR	TARGET VALUE	Source of data and methods[2]	Frequency of Data Collection

[2] As the EV trial in Aalborg is a part of the national trial, evaluation will partly be based on data from the 10 vehicles in Aalborg, and partly on data from all ~175 vehicles in the national project. By using data from all vehicles a greater sample can be obtained, making the conclutions more valid.

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No.	INDICATOR	TARGET VALUE	Source of data and methods[2]	Frequency of Data Collection
2a	Energy operating costs		Data on mileage and charging collected from data collection units in the vehicles and in the home-charger collected on a daily basis. NORM figures from NEDC. Data on consumption from www.spritmonitor.de. Danish figures for electricity cost and petrol-cost.	Continually from all cars and chargers. Data aggregated to trip and charging level. Data collected once a day. Evaluation based on data from March 2011 to June 2012.
2a	Total operating costs		Data on mileage and charging collected from data collection units in the vehicles and in the home-charger collected on a daily basis. NORM figures from NEDC. Data on consumption from www.spritmonitor.de. Danish figures for electricity cost and petrol-cost.	Continually from all cars and chargers. Data aggregated to trip and charging level. Data collected once a day. Evaluation based on data from March 2011 to June 2012.
	Vehicle fuel efficiency		Data on mileage and charging collected from data collection units in the vehicles and in the home-charger collected on a daily basis. NORM figures from NEDC. Data on consumption from www.spritmonitor.de.	Continually from all cars and chargers. Data aggregated to trip and charging level. Data collected once a day. Evaluation based on data from March 2011 to June 2012.
	CO levels		Data on mileage and charging collected from data collection units in the vehicles and in the home-charger collected on a daily basis. NORM figures from NEDC. Data on consumption from www.spritmonitor.de.	Continually from all cars and chargers. Data aggregated to trip and charging level. Data collected once a day. Evaluation based on data from March 2011 to June 2012.
	Noise perception		Data from survey, weblog, and communication with test users.	Continually. Surveys before and after each 3. month's user period. Weblog at least once a week from each test user.
	Reliability of OEM EVs		Data from operation statistics	Continually. Evaluation based on data from March 2011 to June 2012.

C1.1.3 Planning pre- and after-data collection

EVALUATION TASK	INDICATORS INVOLVED	COMPLETED BY (DATE)	RESPONSIBLE ORGANISATION AND PERSON
Pre- questionnaire to test users	13 and background variables	Evaluation includes continually collected data collected until June 2012.	City of Aalborg and Clever.
After - questionnaire to test users	13 and background variables	Evaluation includes continually collected data collected until June 2012.	City of Aalborg and Clever.
Qualitative feedback from users. Weblog to be filled in by test users at least once a week.	All indicators	Evaluation includes continually collected data collected until July 2012.	City of Aalborg and Clever
Collecting trip data on mileages etc.	All indicators	Evaluation includes continually collected data collected until July 2012.	City of Aalborg and Clever
Collecting data on charging. KW/H and charging point of time.	All indicators	Evaluation includes continually collected data collected until July 2012	City of Aalborg and Clever

C1.2 Establishment of a baseline

Baseline data is based on historic data for conventional cars supplemented with findings from The EV Network for Municipalities. Baseline data for operation costs for fossil cars is obtained from the Danish Car Owners Association (FDM) and from the internet site www.spritmonitor.de. Before-data is collected via surveys among test users.

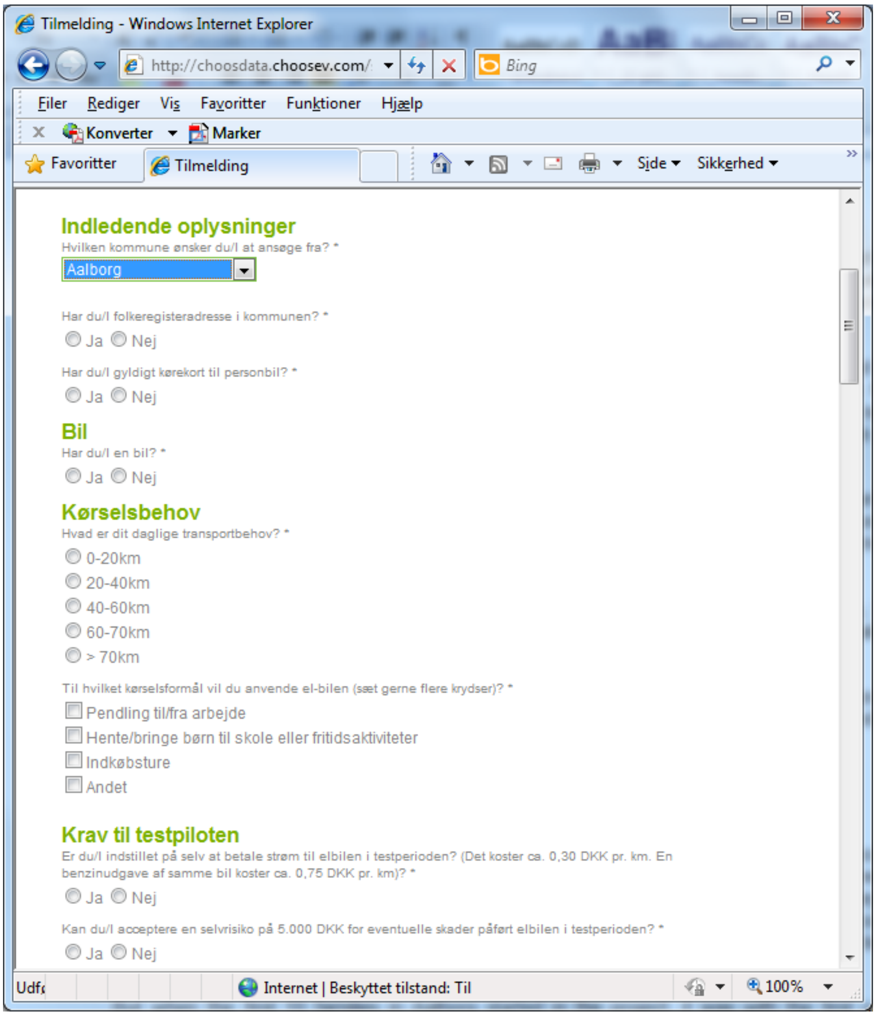

Figure 4 Collecting Before data from test users.

C1.3 Methods for Business as Usual scenario

Business as usual includes not running an EV trial. When evaluating the EVs and the experiences with the EV, comparable data from fossil-fuel cars of same size will be used as business as usual data. Data on conventional cars' actual consumption is acquired from www.spritmonitor.de. The dataset includes data from 59 conventionel Peugeot 207 cars.

C.2 Measure results[3]

C2.1: Energy

C2.1.1: Fuel consumption

It is the assumption that the EV uses less energy than a fossil car, due to the higher energy-efficiency in the electrical engine.

Calculating the expected energy use during operation can be done in different manners. Most available calculation is based on theoretical figures as energy consumption measured after the NEDC (New European Driving Cycle). Calculating the energy consumption for the Peugeot Ion model and the Peugeot 207 1.4 petrol and diesel based on the NEDC energy consumption, shows the following result:

Vehicle	Peugeot Ion	Peugeot 207 1.4	Peugeot 207 1.4 HDi
Fuel type	Electricity	Petrol	Diesel
Energy-consumption NEDC	0.135 kWh/km	17.2 km/l	23.8 km/l
Energy-equivalent		9.17 kWh/l	9.98 kWh/l
Energy-efficiency (kWh/km)	0.135 kWh/km	0.533 kWh/km	0.419 kWh/km
Consumption compared to Petrol car	25,3%	100%	78,6%

Tabel 1 Comparing energy consumption based on NEDC measurements

The calculation shows that after the theoretical NEDC measurements the EV uses 74.7% less energy compared to a comparable petrol car and 67.8% less than the diesel version.

Calculating the energy consumption based on real figures for fuel consumption

One of the great advantages with this trial, is that a very massive amount of realistic data have been generated, so it is possible to calculate real consumptions opposed to the theoretical figures calculated on the basis of laboratory measurements.

It is common experience that it is often very difficult for most petrol car in daily traffic to do as many km / l as the NEDC indicates, partly because the NEDC driving cycle doses not reflect the drivers traffic pattern, partly because the NEDC does not include energy consumption from the cars equipment. For an EV it might be even more difficult as heating in wintertime or air conditioning in the summer time, due to the EV' better motor energy efficiency is responsible for a relative larger part of the total energy consumption in the vehicle.

In the following, the same three cars will be compared, but based on real figures for consumption.

The figures the Peugeot Ion EV is based on data from 175 cars, (Peugeot Ion, Citroën C-Zero and Mitsubishi iMiev which is technological the same car), which have done more than 2.000.000 km and over 19.000 charging. The result is energy consumption 58% above the NEDC figures. The reason for this and the factors, which have influence on the energy consumption, will follow below.

[3] As the EV trial in Aalborg is a part of the national trial, most of the measure results are based on data from all vechiles, not only the 10 vehicles in Aalborg. For the same reason a large part of the results and calculations have been done by Clever and originates from Danish presentations for the national project board.

The figures for the Peugeot 207 is collected on www.spritmonitor.de where 59 owners of Peugeot 207 1.4 have registered their mileages and energy consumption. The persons have logged between 2 and 238 refuelling each. The result is an averages energy consumption of 13.7 km/l for the petrol car which is consumption 20% above the NEDC figures and 19.2 km/l for the diesel car, which is 24% above NEDC figures.

When using these real figures, the result of the energy comparison is as follows:

Vehicle	Peugeot Ion	Peugeot 207 1.4	Peugeot 207 1.4
Fuel type	Electricity	Petrol	Diesel
Energy-consumption, real figures	0.213 kWh/km	13.7 km/l	19.2 km/l
Energy-equivalent		9.17 kWh/l	9.98kWh/l
Energy-efficiency (kWh/km)	0.213 kWh/km	0.669 kWh/km	0.52 kWh/km
Consumption compared to Petrol car	31,8%	100%	77.7%

Tabel 2 Comparing energy consumption based on real figures

The calculation shows that when using realistic figures for consumption an EV uses 68.2% less energy than a comparable petrol car and 59.1% less than the diesel version.

Factors, which influences the EVs energy consumption

As expected the trial shows, that energy consumption is very depending on factors as individual driver style, speed, road structure (urban, rural, highway) and not least the weather.

As in an ordinary car energy consumption depends on the specific trip. City traffic and open-road driving take different amounts of energy. Highway traffic with 130 km/h takes a lot more energy than a 110 km/h road – and using the 80 km/h main road might make the difference between running out of power and being able to reach your destination.

Based on measurements for 175 cars doing 2 mill km in one year, the averages energy consumption is 0.213 kWh/km +/- 0.05 kWh. As the battery in the cars in the trial has a capacity of 16.3 kWh the consequence is, that the operation range is between 63 km and 100 km on a full battery, with an averages of 76.5 km – as opposed to 120 km according to the NEDC measurements.

The very short real range as opposed to the twice as long range in the sales material makes it very important for the user to understand the factors which influences the energy consumption and thus limits the range.

Figure 5 illustrates the importance of two of these factors. The driver style and the weather (temperature)

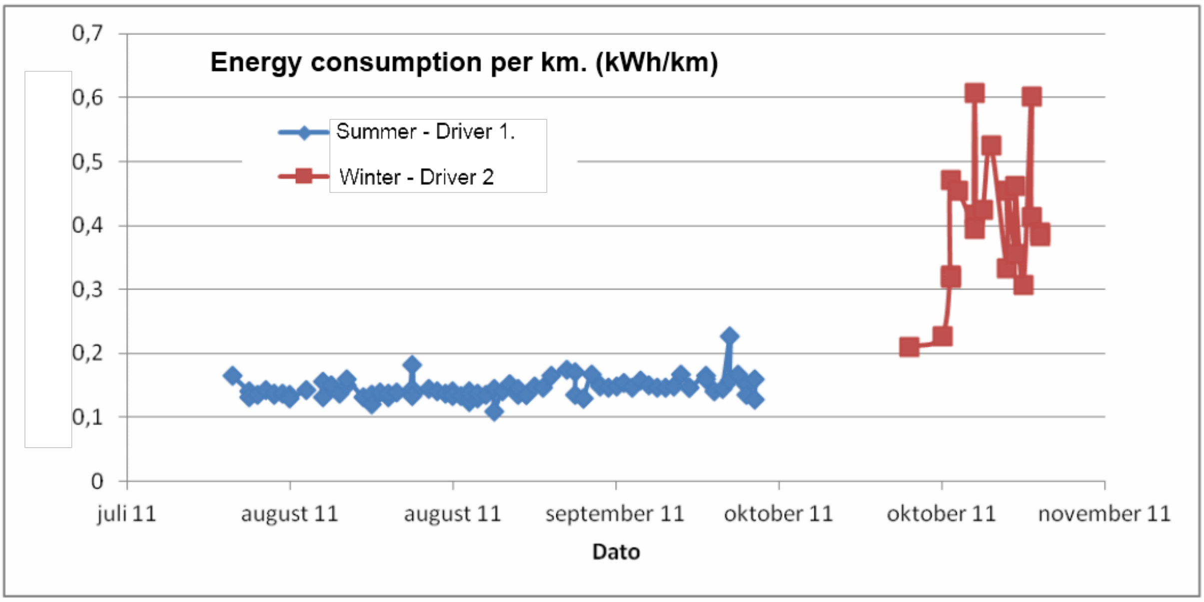

Figure 5 Example of one car's energy consumption as the combined result of temperature and driver.

The energy consumption per kilometre from this specific car is twice as high in the second situation as in the first, as a combined result of different driving style between driver 1 and driver 2 and of using the cars heater in the winter.

As illustrated in Tabel 2 the energy efficiency of a petrol car is only 1/3 of the energy efficiency of an electrical car. A major part of the 3 times larger energy consumption ends up as heat in the petrol engine. As a result, there is a lot of surplus heat to be used for defrosting the windows and heating the cars cabin in the winter time.

This is not the case in the EV. There is almost no surplus heat, and electricity has to be used for defrosting and cabin heating. In the present version of the EV, the heater is constructed as a large, but not very efficient immersion heater. As the EV engine is very energy efficient the electricity use for defrosting and heating constitutes a significant draw on the battery. The consequence is a significant increase in energy consumption per km, and as a result a marked reduction of the range.

To evaluate the size of these effects of weather, analysis has been done on all trips and charging over an 8 months period.

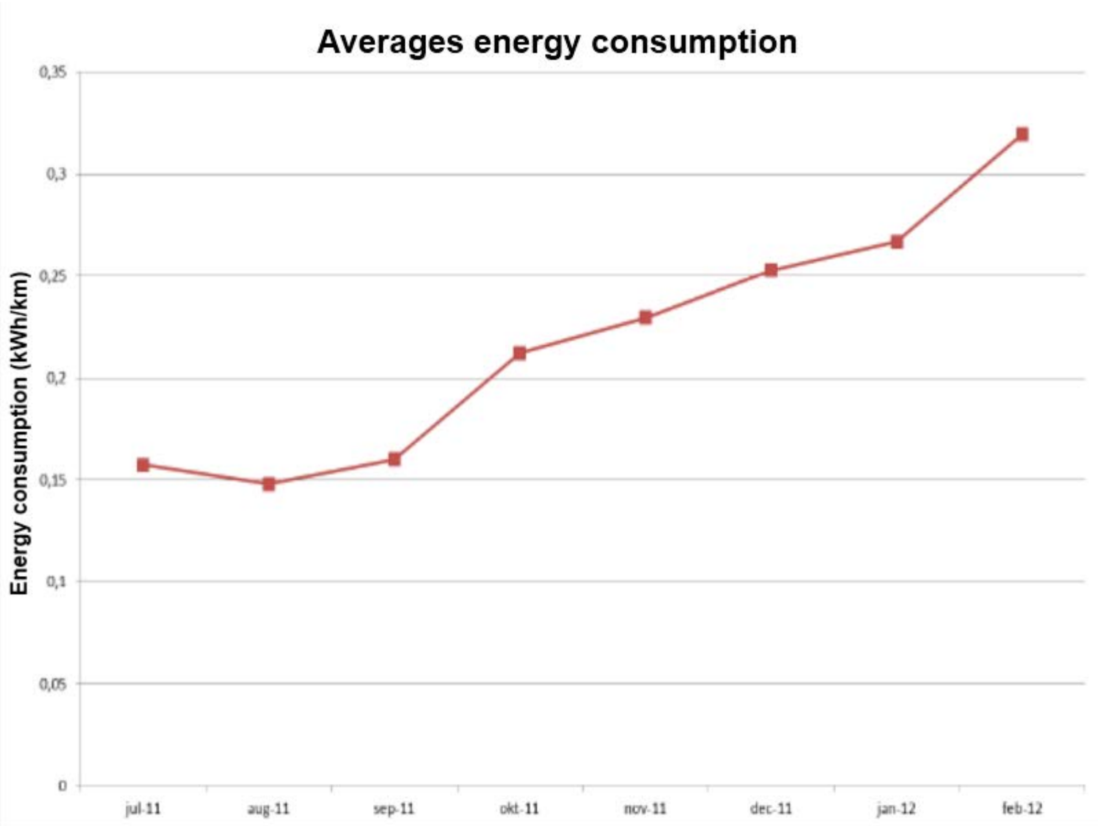

Figure 6 Average energy consumption per km aggregated for each month.

Figure 6 illustrates that there is a clear seasonal fluctuation with lowest consumption in the summer time and a rising consumption in autumn and winter. The difference in energy efficiency is very large. In fact, in average the energy consumption per km is twice as high in the winter that in the summertime – and the expected range on each charging thus only the half.

In next page, Figure 7 illustrates that even though there is a spread between data as a consequence of other factors as driver and driving conditions, also on day level there is a clear relationship between energy efficiency and time of year. As a side point it can be concluded that there is no systematic difference in energy efficiency between the three car models.

Figure 6 and Figure 7 supports the assumption that there should be a close relationship between energy consumption per km and the temperature. Based on the data on trips for 175 cars and 19,000 charging, Figure 8 shows that this is indeed the situation.

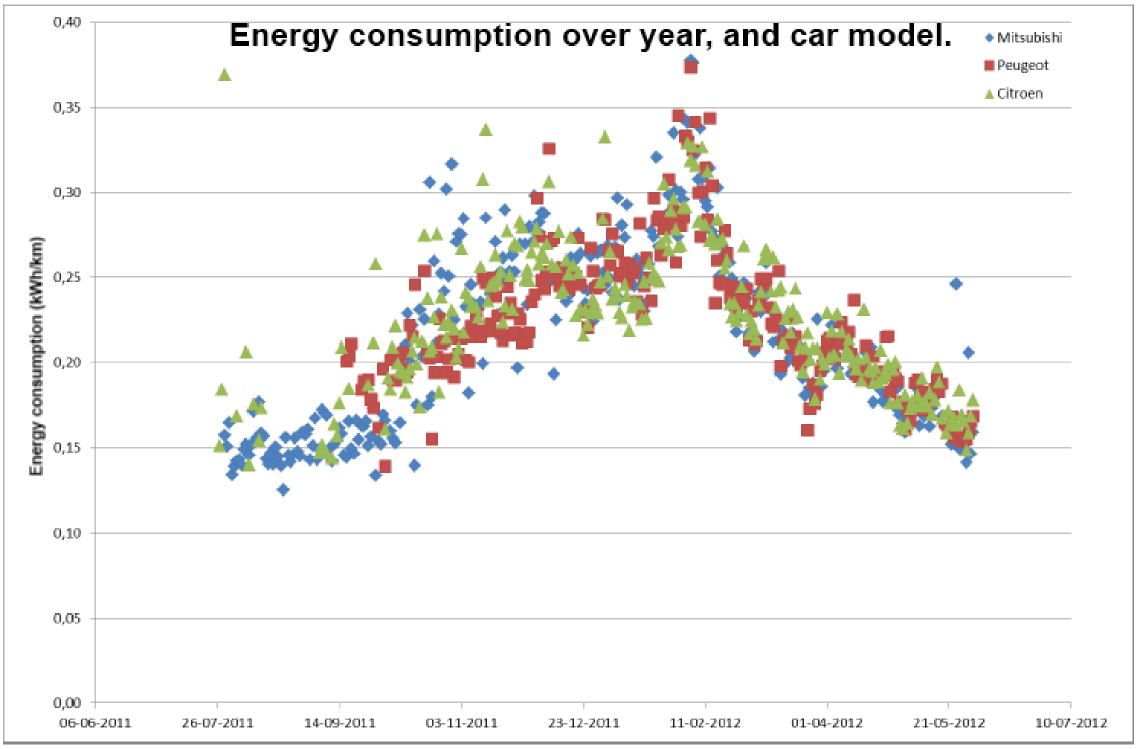

Figure 7 Energy consumption per day and car model. The figure is based on 19,000 chargings and each dot represents between 1 and 33 chargings of same carmodel same day.

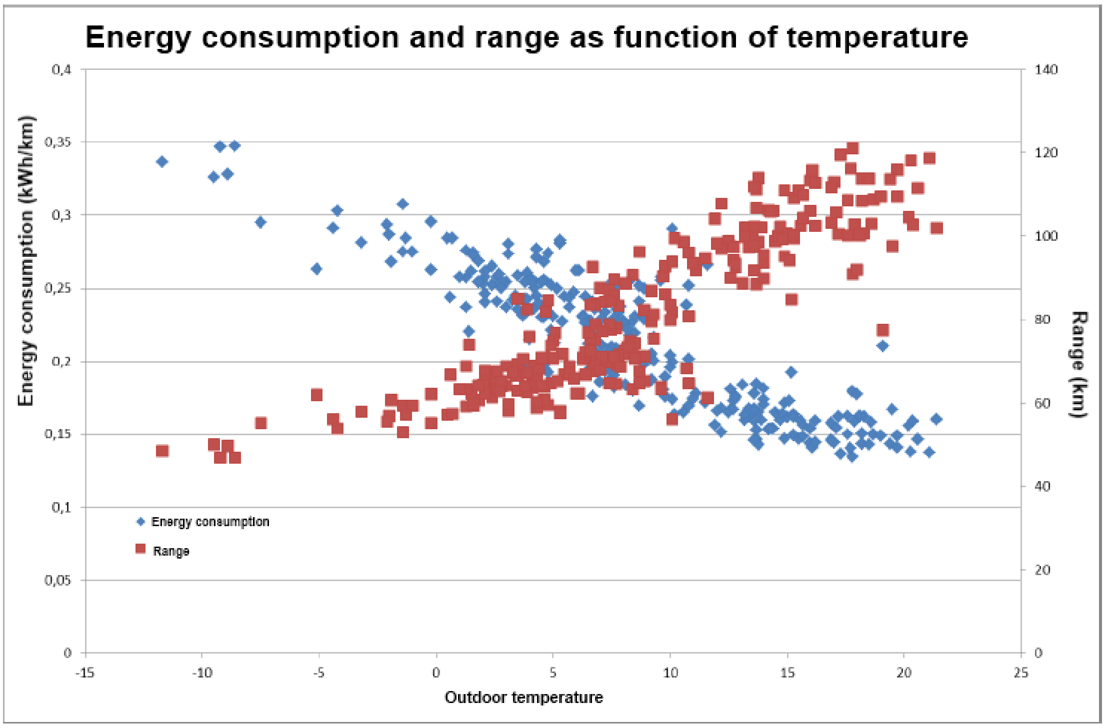

Figure 8 Energy efficiency as a function of outdoor temperature. Each dot represents the averages of all charging on one day. The number of charging per day ranges from 2 to 153, with an averages of 62 charging a day. The energy consumption is calculated for each car and charging based charged energy and on mileages since last charging.

Figure 9 illustrates the significant and very close relationship between the time of year (temperature), the energy efficiency and the resulting range for the cars.

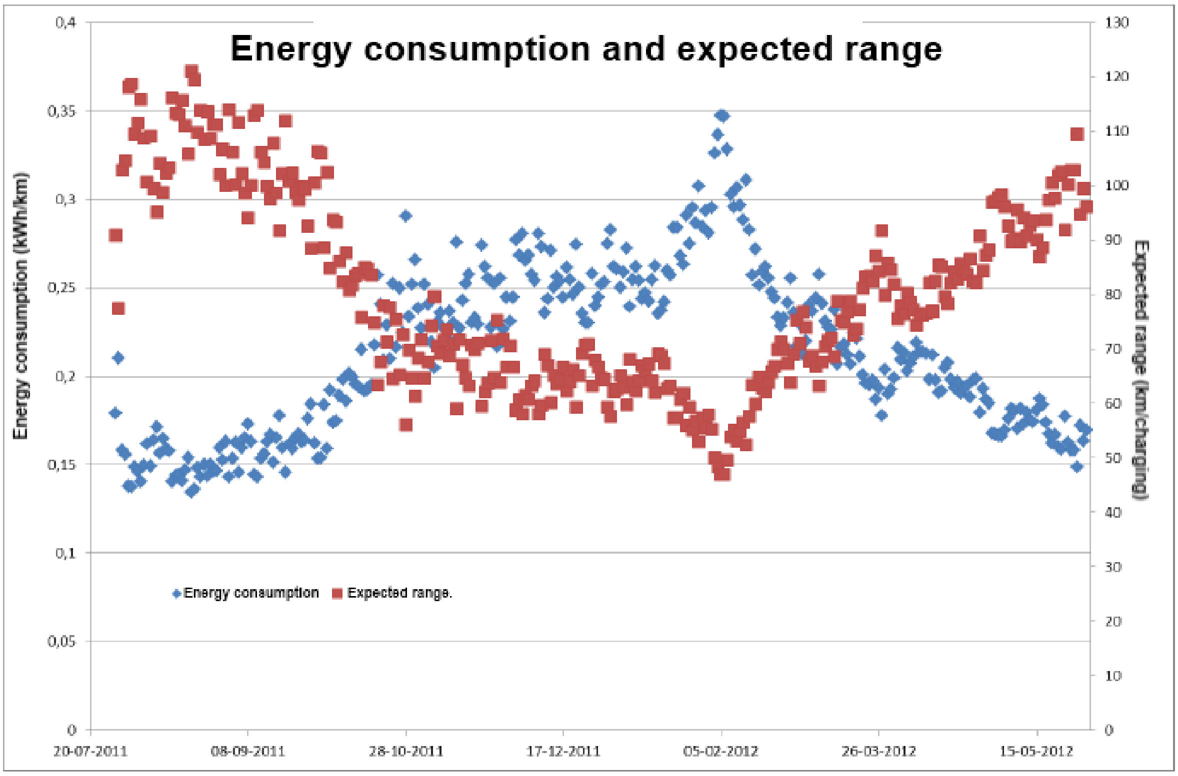

Figure 9 Energy consumption and expected range.

An important finding is that the expected range in the winter is only half of that in the summer. This conclusion holds for the existing type of car heaters.

This finding is of major importance for the spread of EV. For the major part of potential EV buyers expected range is one of two major hurdles when deciding, the other being price. When considering if an EV can fulfil the families' requirement, the family first considers if the official range 150 km/charging in the car brochure is sufficient. When talking to people who know more on EV in reality, they are told, that the range is not 150 km but between 90 and 110 km. For this reason the EV is suddenly not a possibility for more of the potential buyers. And when you realises that almost half the year you will have a range below 70 km, the EV is only a realistic option for few families.

C2.2: Economy

One of the assumptions is that the EV is much cheaper than a fossil car in operation costs, partly due to the higher energy-efficiency in the electrical engine and partly due to the expected lower maintenance costs in the electrical engine, which is much simpler and with fewer moveable parts compared to a diesel engine. Section C2.1.1 has evaluated the fuel consumption part of this hypothesis, whereas the maintenance costs will be part of the calculations in Section C2.2.3.

As costs per kWh is different for electricity, petrol and diesel, the conclusions from C2.1 have to be calibrated with the different price factors before conclusions can be drawn on the Energy Operation Cost. In this section the calculation will be done for the Peugeot Ion model compared with the Peugeot 207 1.4. Petrol and a Peugeot 207 Hdi Diesel

C2.2.2: Energy operating costs

Calculating the energy operation cost based on NECD measurements

Based on the theoretical energy consumption figures measured after the NEDC, calculating the energy operating cost for the Peugeot Ion model and the Peugeot 207 1.4 petrol and diesel, shows the following result:

Vehicle	Peugeot Ion	Peugeot 207 1.4	Peugeot 207 1.4 HDi
Fuel type	Electricity	Petrol	Diesel
Energy-consumption NEDC	0.135 kWh/km	17.2 km/l	23.8 km/l
Energy-equivalent		9.17 kWh/l	9.98 kWh/l
Energy-efficiency (kWh/km)	0.135 kWh/km	0.533 kWh/km	0.419 kWh/km
Cost per kWH	0.2740 €/kWh	0.1812€/kWh	0.1544 €/kWh
Cost per km	0.03758€/km	0.09664€/km	0,06443€/km
Cost compared to Petrol car	38,9%	100%	66,7%

Tabel 3 Energy Operation Cost based on NECD measurements

The calculation shows that after the theoretical NEDC measurements it is 61.1% cheaper in energy operation cost to use an EV than a comparable petrol car and 42% cheaper compared to the diesel version. The economical advantages of using an EV is less than the energy savings calculated in the previous section due to the higher €/kWh price for electricity than for petrol or diesel.[4]

Calculating the energy operation cost based on real figures for energy consumption

In the following, the energy operation costs will be calculated for the same three cars, but based on real figures for consumption, from section C2.1.

When using these real figures, the result of the cost calculation is changed:

Vehicle	Peugeot Ion	Peugeot 207 1.4	Peugeot 207 1.4
Fuel type	Electricity	Petrol	Diesel
Energy-consumption, real figures	0.213 kWh/km	13.7 km/l	19.2 km/l
Energy-equivalent		9.17 kWh/l	9.98kWh/l
Energy-efficiency (kWh/km)	0.213 kWh/km	0.669 kWh/km	0.52 kWh/km
Cost per kWH	0.2740 €/kWh	0.1812€/kWh	0.1544€/kWh

[4] All prices are officiel consumer prices including all taxes and duties.

Cost per km	0.06040€/km	0.12081€/km	0.08053€/km
Cost compared to Petrol car	50%	100%	66.7%

Tabel 4 Energy Operation Cost based on real figures for energy consumption

The calculation shows that when using realistic figures for consumption it is 50% cheaper in energy operation cost to use an EV than a comparable petrol car and 25% cheaper compared to the diesel version. As in the previous calculation the economical advantages of using an EV is less than the energy savings due to the higher €/kWh price for electricity than for petrol or diesel

C2.2.3: Total Operation costs

At the micro level – for the individual potential EV purchaser – the total operation costs are more crucial than that the energy operation costs.

When comparing the costs for having an EV to the costs for an ordinary car, you have to consider the total cost: The price for the car and the expected resale value, and the cost for running the car: the energy and the maintenance and repair costs, including possible renewing of the batteries.

The price for the car: In Denmark cars are very expensive as they are heavily taxed. The registration fee that is added to the car price is usually 180% of the car price, a little less if the car is very energy efficient. Until 2015 EVs are exempted from this registration fee. But in spite of this, EVs are more expensive than comparable conventional cars.

When the OEM cars first became available in March 2011 the price for the EVs in the project was 37,000 € without tax compared to some 13,500€ including tax for a comparable conventional car. Today it is possible to buy the same EV for 23,500€ - 30,000€ without tax.

On the one side, the EVs are less complicated to manufacture than a car with a combustion engine. So the price should be less. On the other side the car factories have had some R&D costs that have to be covered, and as long as supply is limited, the factories will take as high prices as the market allows. At the moment supply is increased as other companies are now marketing new models – and have priced them lower.

The feedback from the test families indicates that, seen from their point of view, they might be genuinely interested in exchanging the old car with a new EV – for the sake of environment for one thing – but when confronted with the choice between a small EV or a big comfortable family car, space and comfort win. Or when comparing a new conventional car the same size and comfort as the EV, the amount of money saved is a critical factor.

So even though there has been a price cut in the last year, the EVs are still too expensive to purchase, in absolute terms and compared to ordinary cars.

The resale value: As the EVs are relatively new on the market the resale value and the demand for used EV are unknown. The effective lifetime for the technology in the current EVs is unknown. The pace with which new technology will be developed, making the car technically obsolete is unknown. And the expected lifetime for the very expensive battery package is unknown.

All in all, a buyer of a new EV has to calculate the risk of a low resale value in the cost for buying an EV.

The car factories and the EV operators are aware of these uncertainties and their negative impact on potential customers' willingness to buy, and are trying to mitigate the problems: The Danish EV operators are trying to make the leasing companies guarantee a fixed resale value after a number of years.

Some EV manufactories are selling their electric cars with a rental contract for the batteries, even though the batteries are a fixed part of the car. By keeping the ownership of the batteries the companies remove the uncertainty and risk for a big investment in new batteries from the EV buyer.

Energy costs for running the EV: As shown in C2.1.1 the energy costs for running an EV are in general lower than the fuel costs for a comparable conventional car, but Section C2.2 illustrates that the difference depends on more parameters.

Costs for maintenance and repair: There is a big difference between the experiences with OEM cars used in this project and the experiences with hand-built or rebuilt EVs from the national EV Network for Municipalities. While the general quality is often rather low and the costs therefore high for non-OEM cars, the quality of the EVs in this test is high and the cars are reliable. See section C2.4.1

The 10 cars in Aalborg have done more than 150,000 km without technical problems. As mentioned in C2.4.1 there are some minor self-inflicted teething troubles with the 12V batteries going empty, but when this problem is solved, the EVs are almost ‘maintenance free’

Compared to a conventional car the EV is rather simple. Most of the checkpoints on a regular service visit of a conventional car do not exist on an EV so the services should be cheaper. Only the brakes require more services and attention, as they are less used due to the brake effect from the energy regeneration system.

When the maintenance cost is calculated based on a 5 yearly services contract, the services costs for an EV are 26.67€/month. The comparable costs for a Peugeot 207 is 57.24 €/month. Calculated in this manner the maintenance costs is 53.4 % lower on the EV compared to a similar diesel car.

The evaluation shows, that the price for a regular service visit after the first year without a fixed services contract, differs from 120€ to 400€ with an average of 240€.

Batteries: The possible cost for replacing the battery pack is one of the big unknowns in calculating the financial viability for the EV. The batteries are still expensive and do have a limited lifetime. The lifetime is still uncertain, but is expected to be 5 – 7 years. In the Danish context this means that the batteries have to be replaced once in the middle of the car’s lifetime. This cost could be seen as an accumulated fuel cost and be divided out over the km driven. But if the lifetime shows up to only be 4 years, you have to replace the batteries twice and the km cost calculated will be much higher.

This uncertainty is one of the factors that restrain interested buyers from buying an EV. As described above, the EV operators and the car sellers are trying to remove this uncertainty by setting up leasing arrangements where they still own the battery and thereby take the risk.

If you put the costs for new batteries on top of the energy costs, or if you lease the batteries - with the current subscription offers from the EV operators - the ‘energy costs’ will be the same or higher than the fuel costs for a petrol car.

Conclusion: As part of the demonstration, the EV company has made two comparisons between two different EVs and their petrol counterparts. The result is in both cases that the EVs over 5 years are 5-10% cheaper in total operation costs – even with today’s EV price. As the calculations are based on more assumptions and factors as resale value and battery lifetime are still unknown, the calculations will not be part as this evaluation.

2.3 Environment

2.3.1 CO_2 levels

One of the most important drivers for changing from fossil fuelled cars to EVs, is the assumption that the EV is ‘cleaner’ and an effective mean to reduce the CO_2 emissions.

Two different models can be used to compare the CO_2 burden between an EV and an ordinary car.

'Tank to Wheel': In this model the focus is on the CO_2 emission per km from the energy in the battery / fuel tank. According to this model, the EV is CO_2 neutral as opposed to the internal combustion engine.

'Well to Wheel': This model includes the energy consumption – and thus the CO_2 emission – from producing the 'fuel' that is the electricity or the fossil fuel.(Well to tank)

Often the Well to Wheel is used for EV whereas Tank to Wheel is used for fossil fuelled cars, making it an unfair comparison. In this evaluation Well to Wheel is used for both car types, and the calculation is done both for NEDC based figures and based on the consumption figures from the project.

Vehicle[5]	Peugeot Ion	Peugeot 207 1.4 HDi
Fuel type	Electricity	Diesel
Energy-consumption NEDC	0.135 kWh/km	0.419 kWh/km
Energy-consumption, real data	0.213kWh/km	0.52 kWh/km
Well to Tank	359 grams CO_2 / kWh	45 grams CO_2 / kWh
Tank to Wheel	0 grams CO_2 / kWh	267 grams CO_2 / kWh
Well to Wheel	359 grams CO_2 / kWh	312 grams CO_2 / kWh
Well to Wheel per km, NEDC	48 grams CO_2 / km	130 grams CO_2 / km
Well to Wheel per km, Real data.	76 grams CO_2 / km	162 grams CO_2 / km
CO_2 emission compared to diesel car, NEDC	36.9%	100%
CO_2 emission compared to diesel car, real data	46.9%	100%

Based on consumption data from the trial, and data in: Well-to-Wheels analysis of future automotive fuels and power trains in the European context WELL-TO-TANK Report Version 2c, March 2007. http://ies.jrc.ec.europa.eu

Tabel 5 Comparing CO2 emision from EVs and diesel car.

Tabel 5 shows that based on the norm figures and on real consumption data, the EV emits 63.1% and 53.1% less CO_2 per km.

When calculating the Well to Tank (battery) emission from producing the electricity, different approaches can be taken.

The most EV negative argues, that the EVs normally are charged during peak hour for electricity consumption. Right after arriving home from work, and when all washing machines are stared and the dinner are cooked on the electrical cooker. Charging the EV is seen as the marginal consumption and the CO_2 emission shall thus be seen as the CO_2 emission from the marginal electricity production, which in the peak hour is the production from the polluting coal power plants.

The most EV positive argues that when intelligent charging soon is implemented, charging will take place in the nights, where there will be a lot of surplus energy from the windmills. The extra CO_2 emission from using this energy in EVs is thus zero.

[5] As the petrol Peugeot emits 30% more CO_2 per km than the diesel version, the compariasion is only shown for the EV's closes alternative, the diesel version.

As a third approach, the average CO_2 emission from the electricity production could be used. This approach is used in the calculation in Table 5.

A statement from the Danish Energy Agency is, that in the coming future a fourth approach shall be used: An extensive expansion of the numbers of EV will cause a similar expansion of the Danish electricity production, and therefore the emission from the new EV shall be calculated as the average emission from the production on this new part of the production system. As a major part of this expansion is planed to be based on sustainable energy, mostly wind power, the CO_2 emission from the expansion will be lower than the present average, used above.

C2.3.2 Noise

The engine in the EV is noiseless compared to the internal combustion engine. From an environmental point of view this is a big advantage.

Two of the data sources for evaluating the perception and impact of the noise are the user input on the projects web log and the feedback from users after their test period.

A very frequent and marked feedback from users on both channels is that they were surprised over how quiet the EV was. Both when driven, but also that it was a new and surprising experience to be in a completely quiet car waiting for green lights.

The test users appreciated this a lot, more than they had anticipated in advance.

From the society's point of view, the number of EVs is so low, that no difference in the city environment can be registered.

From a safety point of view the absence of noise from the can constitute a potential traffic hazard.

The noise from the engine is only one part of the noise form the car. Other sources are noise from wheels and noise from the air passing past the car. Whereas the engine noise only increases slightly with the speed, both the noise from the wheels and from the air rises as a potential function of speed.

The EV being more silent than an ordinary car is thus only true for lower speed levels as in the city centre. Different sources indicates from 16 km/h to 35 km/h as the level, where the noise from the EV is at the same level as for an ordinary car.

Before the test all users were instructed to be very aware of the potential safety problems that could be caused by the absence of noise. A common observation from some of the test drivers were, that more attention were required when passing cyclist, as these tend to orientate themselves by the sound from cars coming from behind.

No accidents are registered as a consequence of the lacking noise, but posts on the blog for example explain how a mother had to teach her children to be visual aware of the EV coming down the driveway of the house, as the car could not be heard.

C2.4 Transport

C2.4.1 Quality of services – Electrical vehicles.

Before the start of this project, EVs were manufactured as 'handcraft' or on small scale fabrics rebuilding cars - originally designed and built as petrol cars - into electrical vehicles. In general the quality and reliability of these cars showed out to be very poor. Even from the larger workshops rebuilding petrol cars in series the quality was very variable. One car could function almost without problems while the next car from same workshop almost all the time was dysfunctional with all kind of different failures.

But, when the first 10 families in Aalborg started in the project, it was with the first cars on the market that were designed and manufactured as EVs from the beginning. And the cars were produced by the big auto companies, Peugeot, Mitsubishi and Citroën according to normal quality procedures and requirements. The cars are Citroën C-Zero, Mitsubishi Imiev and Peugeot Ion. In fact, the three cars are almost identical, manufactured from the same drawings.

Experiences from the first year and the first 2 mill km. here of 150,000 km in Aalborg, shows, than these cars have no technical teething troubles. The operation has been very trouble-free, except for some problems with the capacity of the 12 V battery used for light and computer systems.

Operation statistics confirms this - data from one year and 170 EVs:

Empty 12 V battery	57
Technical failure	3
Traffic accidents	4
Flat tyre	3

The statistic illustrates, that apart from the more or less self-inflicted problems with the draw on the 12 V battery – see bellow, the cars have been remarkably dependable.

The feedback from the ordinary families in the test shows that they are very satisfied with the technical quality of the cars.

Figure 10: One of the 'triplets' used in the project

The families are quick to notice the strengths of the electrical vehicles.

The acceleration is impressive, in general and especially compared to the size of the car. The car is noiseless. The value of this seems to surprise the families. In Denmark cars usually have manual gearboxes. The ease of driving a car with only one gear is suddenly discovered by the drivers.

The families are very satisfied with the technique in their electrical cars, but when asked and on the blog two types of comments are given:

- The first types relates to general design of the cars. The cars used in the project so far[6] are small. They are OK for everyday use, but there is too little room for baggage for longer trips, no room for a pram or for when shopping heavily. Not even room enough for 3 children if one or two of them are using car seats. And there is no clock in the car and a clock is seen as basic equipment in a car.
- The second type relates to suggestions for improving the electrical design. Using the air conditioning or the heating system consumes a lot of electrical power. In a petrol car there is a lot of surplus heat that can be used for heating the car. In the electrical car all heating consumes electricity and thereby reduces the already limited range - as described in section C2.1.1. To counter this, two measures are proposed. First, the cars are changed so it is possible to heat or cool, the car before a trip, while still connected to the grid. In this way energy for heating is drawn from the grid. The car is warm, but the batteries are still full when starting the trip. Second, the cars in the project are equipped with an old-fashioned heater, designed without attention to best use of energy. Heating systems in new cars will be designed more intelligent, for example using the heat pump technology using 2/3 less energy than a current 'immersion heater'.

Even when the car is not used, there is a small drawing on the 12 Volt battery from the car's computer. This drawing is greater in the test cars as the cars are equipped with a dedicated surveillance unit with data collection and communication modules. As a result the 12V battery can be emptied in 14 days or in as little as 4 days in extremely cold conditions where the capacity of the battery is low. An empty 12V battery results in a non-functioning car computer and a car that does not run, even if the main battery is full.

The 12 Volt battery is charged from the main battery and only when the car is used. As the battery is not charged from the 200V grid, the battery can go empty even if the car is connected to the charging station. This problem has to be solved. Probably it can be fixed with a small design alteration, changing the rules for how and when the battery is charged. This problem is unique for the cars used in this test.

C2.4.2. Intelligent charging

As described in section 2.3.1 CO_2 levels, the EVs environmental effect – the CO_2 savings – depends on how the electricity is produced. When charging in the peak hour in the daytime a larger part of the electricity is produced from polluting coal, than when charging in the night, where consumption is low and a larger part of the electricity is produced by renewable sources as windmills.

One of the objectives of the trial is thus to evaluate how charging can be moved to night time by intelligent charging. Because the national trial continues after the end of the ARCHIMEDES trial in Aalborg, this objective can not be fully evaluated yet, but this section will outline some of the present findings.

Data shows that the maximum use of the cars in the project is 3 hours a day. That is, there is still 21 hours free for charging. In averages the cars are charging 3.3 hours a day with 80% of all charging being finished in less than 5 hours. So there is plenty degrees of freedom to move charging to a point of time where the electricity is cleaner and cheaper.

As a first test the users were explained that they ought to postpone the charging to after 20 o'clock for the sake of environment, but without giving them any financial motivation. The postponement should be done manually as the timer in the charging box showed up to have some technical errors.

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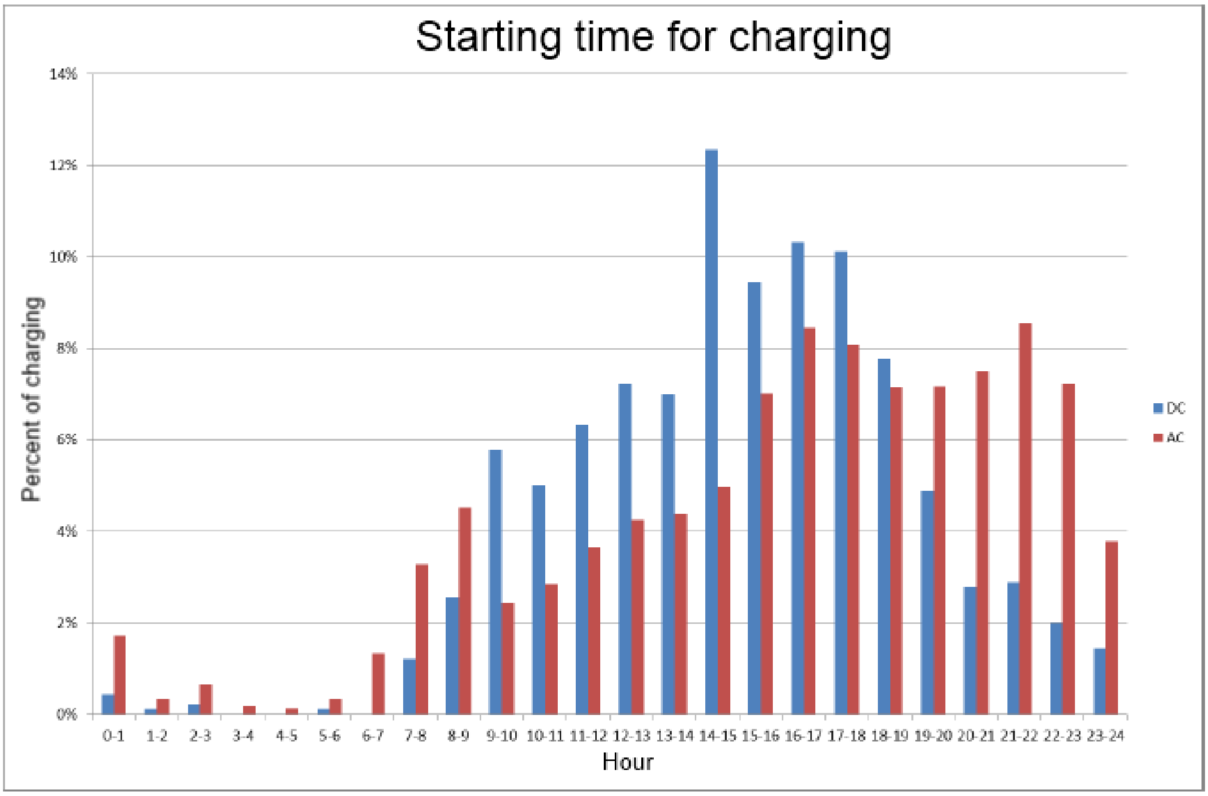
[6] From June 2012 a number of Nissan Leaf have been added to the project, including one in Aalborg. It has not been possible to include expediencies with these bigger cars in this evaluation.

As a result 29% of the charging has started between 20 and 1 o'clock, but 1/3 of all charging still starts in the peak hour between 16 and 20 o'clock.



Figur 11 Starting time for 19,000 charging. Pleace notice that the blue DC chargings (Quick Charging) only accounts for 5% of the charging

The next step in the national project is that financial motivation to charge outsides peak hour have been given to a subset of the test users by letting them pay for electricity after the variable spot tariff, which is normally not open for private users. At the same time their test period is extended from 3 to 6 months to have more reliable results. In the first half of the period the users themselves shall control the charging time by using timers on their own charging point in the carport, in the second half the charging pint will be remotely controlled from Clever.

C2.5. Society

C2.5.1 Acceptance.

To use an EV for 3 months gives you new experiences, and a changed attitude to EVs.

On the positive side the users have noticed the reliability, the fast acceleration, the low noise level and the low fuel costs. On the negative side the users have been surprised by the unexpected low range. As they did not themselves pay for the car, the high car prise was only a negative factor for the users that considered buying an EV after the trial[7]. Another negative experience, that many users have indicated, is that the EVs in the project are too small to fulfil the families need. But this is not a necessary attribute of all EV.

Before- and after survey have been done as a Stated Preference Surveys. Not all data have been analysed yet, but one main finding is interesting. Based on a long list of questions in the Stated

[7] Information based on weblog input and communication with users.

Preference the readiness to choose an EV compared to an ordinary car is lower in the After survey than in the Before Survey.

	Before	After.
Male	45 %	38 %
Female	51 %	44%
Average	48 %	41%

Tabel 6 Number of times the EV are prefered over the conventional car in the SP.

As the readiness have fallen from 48% to 41%, the attitude have changed, so 15% of persons who were ready to choose an EV before trying them would prefer an ordinary car after the test period.

But 41% in total is still willing to choose the EV. These figures illustrates that the trial have reached one the purposes of this trial, to identify under which conditions the EV in its present technical version, is an attractive alternative to ordinary cars.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	To gather experiences from ordinary users of EV	★★
2	To identify under which conditions the EV in its present technical version, is an attractive alternative to ordinary cars.	★★
3	To evaluate CO2 savings totally for the project and to indicate differences between CO2 savings depending on driver behaviour	★★
4	To gather experiences with intelligent charging. User acceptance of postponed charging. The potentials for moving charging consumption from peak hour to night hours, and the potentials for maximizing use of electricity produced from alternative energy by controlling charging time by intelligent charging.	★ It has not been possible to finalise this part of the project insides the ARCHIMEDES project period.
5	To gather information on the EV driving patterns, for obtaining a strategy for where to place charging points.	★★ Data on all trips has been collected.
NA = Not Assessed O = Not Achieved ★ = Substantially achieved (at least 50%) ★★ = Achieved in full ★★★ = Exceeded		

C4 Upscaling of results

The EV trial in Aalborg as a public supported trial will end after two years that is in March 2013. The national project will continue for a period there after.

The experiences will be utilised in the continued public work for promoting clean vehicles including EVs. After the trial 80 families in Aalborg will have own experiences with electrical vehicles, and a lot more people will have tried one, or have access to experiences among neighbours or relatives.

The basis for ‘upscaling’ is thus present, but the success of the EV will depend on the development in price and range.

C5 Appraisal of evaluation approach

As a part of the large national trial the ARCHIMEDES project have benefited from a large evaluation setup. The evaluation setup has collected far more data, from more sources than an isolated trial in Aalborg would have had resources to do. And in the national project more resources have been allocated to analyse these data. But the negative side of the cooperation is the two different time schedules resulting in interesting parts of the evaluation taking place after the end of the ARCHIMEDES project.

All in all the synergy effect of doing it in common, brings the ARCHIMEDES project more knowledge and experiences than would be expected if an isolated trial had been done in Aalborg.

C6 Summary of evaluation results

- After the theoretical NEDC measurements the EV uses 74.7% less energy compared to a comparable petrol car and 67.8% less than the diesel version.
- When using real data for consumption an EV uses 68.2% less energy than a comparable petrol car and 59.1% less than the diesel version.
- The energy consumption is very depending on factors as individual driver style, speed, road structure (urban, rural, highway) and not least the weather.
- Based on measurements for 175 cars doing 2 mill km in one year, the averages energy consumption is 0.213 kWh/km +/- 0.05 kWh. As the battery in the cars in the trial has a capacity of 16.3 kWh the consequence is, that the operation range is between 63 km and 100 km on a full battery, with an averages of 76,5 km – as opposed to 120 km according to the NEDC measurements
- There is a clear seasonal fluctuation with lowest consumption in the summer time and a rising consumption in autumn and winter. The difference in energy efficiency is very large. In fact, in averages the energy consumption per km is twice as high in the winter that in the summertime – and the expected range on each charging thus only the half.
- The official range for the EV in the car brochure is 150 km/charging. In fact, in daily use under optimal conditions the range is only between 90 and 110 km. But this figure is very sensitive to temperature, and almost half the year you will have a range below 70 km, with 50-60 km in cold winter.
- After the theoretical NEDC measurements it is 61.1% cheaper in energy operation cost to use an EV than a comparable petrol car and 42% cheaper compared to the diesel version. The economical advantages of using an EV is less than the energy savings due to the higher €/kWh price for electricity than for petrol or diesel.
- When using real data for consumption it is 50% cheaper in energy operation cost to use an EV than a comparable petrol car and 25% cheaper compared to the diesel version.
- As part of the demonstration, the EV company have made two comparisons between two different EVs and their petrol counterparts. The result is in both cases that the EVs over 5 years are 5-10% cheaper in total operation costs – even with today’s EV price. As the calculations are based on more assumptions and factors as resale value and battery lifetime are still unknown, the calculations will not be part of this evaluation.
- Based on the norm figures and on real consumption data, the EV emits 63.1% and 53.1% less CO_2 per km than a comparable diesel car.
- The engine in the EV is noiseless compared to the internal combustion engine. From an environmental point of view this is a big advantage. From a safety point of view the absence

of noise can constitute a potential traffic hazard. The users were surprised over how quiet the EV was. Both when driven but also that it was a new and surprising experience to be in a completely quiet car waiting for green lights. The users appreciated this a lot, more than they had anticipated in advance. No accidents or close accidents are registered as a consequence of the lacking noise.

- The statistic illustrates, that apart from the more or less self-inflicted problems with the draw on the 12 V battery, the cars have been remarkably dependable. Feedback from users shows that they are very satisfied with the technical quality of the cars.
- SP surveys shows that the readiness to chose an EV over an ordinary car have fallen from 48% to 41% between before and after survey. 15% of persons who were ready to choose an EV before trying them would prefer an ordinary car after the test period. As this is the result of a complicated Stated Preference Survey, it is hard to tell which single factor have caused this effect, but it is the generel impression that the two factors, high price and limited range is the two main factors. But 41% in total is still willing to choose the EV. These figures illustrates that the trial have reached one the purposes of this trial, to identify under which conditions the EV in its present technical version, is an attractive alternative to ordinary cars.

C7 Future activities relating to the measure

The trial will continue in Aalborg until March 2013, and the national trial for a period longer.

D Process Evaluation Findings

D0 Measure / focussed measure

Not a focus measure.

D1 Deviations from the original plan

The Description of Work described the development and implementation of a methanol-fuel cell vehicle. At the end it turned up that the technology was still so immature, that it was unrealistic to develop such a vehicle in the projects time- and financial frame. As a consequence, it was agreed with the EU, that the task was closed and replaced with the EV trial

The EV trial were planed and agreed with EU. There have been no deviations from this revised plan. The remaining parts of section D Process Evaluation Findings will focus only on the new task.

D2 Barriers, drivers and activities

D2.1. Barriers

Very few or no barriers occurred.

Preparation phase

Technological: The transition from the planning phase to the operation phase was planed to be between the 1st of February and the 1st of April 2011. The start date ended up to be the 5th of March as this was the first date the OEM cars could be delivered in Denmark. And this was only possible because CLEVER had reserved the cars a long time ahead. Had the project been ready for an earlier launch, the lack of OEM cars would have been a barrier. As the cars were ready at the planed time of launch the barrier did not have any significance for the project.

D2.2. DRIVERS

General Drivers experienced in the planning, implementation and operation phase

Problem related: A growing understanding of the seriousness of the climate change crisis and the emerging fuel shortages problem in the society, have created a positive attitude and an understanding for the need to find alternative means of transport.

Political / strategic / Financial: As a consequence of the above mentioned raising awareness which coincided with the time the project were planned and initiated, there were a growing political focus on, and political support for the EVs. This resulted in national financial support for EV.

Technological: As a consequence of the same awareness on international level, the large car companies invested a large amount of resources in EV research and development. Just at the same time as the trial in Aalborg started the first OEM EVs were ready to be released. This gave the possibility to do a realistic trial with ordinary users and reliable cars.

Technological / Financial: From a more or less ideally climate point of view, the founder of Better Place, Shai Agassi, choose to invest a considerable millions of euros in EV and EV infrastructure in Denmark as a showcase. At the same point of time two electricity suppliers choose to invest a similar amount to compete in the field. They were more motivated by creating new commercial potentials for their main product, electricity. And at the same time interested in influencing the development of charging infrastructure and intelligent charging. Both subjects with potentials for big consequences for their business.

Implementation phase

Involvement, communication: There was an overwhelming interest from the potential users to take part in the project. This made the project go smooth and created a positive hype around the project. The reason for the interest was presumable a combination of interest for sustainable solutions, a fascination of new technology and the prospects of having a new car for free in three months.

The combined effect of awareness, technical drivers and financial positive possibilities created the favourable environment for the EV trial.

D.2.3. Activities

Institutional: On national level the Danish Energy Agency, under the Danish Ministry of Climate, Energy and Building, used the political favourable climate to establish a money pool for EV trials, and formed a forum where municipalities could exchange experiences on EVs.

The EV company defined the national EV trial and received pledge for financial support from the Danish Energy Agency.

Positional: In Aalborg the funds from the methanol fuel cell trial were reallocated to the EV trial. This was possible due to a positive attitude to EVs and the trial from the EU.

The politicians and citizens in Aalborg supported the trial. The citizens' support resulted in more than 1,600 applications from potential test users.

Involvement, communication: As the press were positive to the trial, press releases were issued before all events. The press releases were used, and the press coverage helped to bring attention to electrical vehicles and sustainability.

To support the EV hype the City of Aalborg established free EV charging points on 2 different public parking places.

To disseminate the results and to gain experiences from other municipalities the City of Aalborg participated in the national EV forum for municipalities.

Together with 3 other larger cities in Denmark, the City of Aalborg compiled a set of 'standard terms' for establishing charging points on public owned parking- or road areas.

To evaluate the possibilities for using EVs elsewhere in the municipality, the City of Aalborg established an EV board with representatives from different departments of the municipality. This group developed an intern strategy for use of EVs.

D3 Participation

D.3.1 Measure partners

Following there is a brief description of all project partners and its level of involvement with the measure:

The city of Aalborg, City, Leading role. As the ARCHIMEDES partner in Aalborg The City of Aalborg is responsible for local trial in Aalborg together with Clever. The division of responsibilities between the two partners is fixed in the contract between the partners.

Clever, Private company, Leading role. Clever is responsible for the national trial. They are responsible for local trial in Aalborg together with The City of Aalborg. The division of responsibilities between the two partners is fixed in the contract between the partners

D.3.2 Stakeholders

The Danish Energy Agency, under the Danish Ministry of Climate, Energy and Building, National governmental organisation.

The Danish Energy Agency, is a remote stakeholder in the Aalborg Project. They are sponsoring parts of the project, but are not part of the Steering Committee.

City of Aalborg EV group. Participants on administrative level from different departments of the municipal administration. Is a reference group for the local project.

D4 Recommendations

D4.1 Measure replication

Through this measure, both the city and the citizens have gained a more realistic knowledge about the advantages and problems in using the cars in a daily life situation, and thus shown that the EV, in its present technical version (OEM EVs), can be an attractive alternative to ordinary cars to some very specific uses, mainly as the family’s second car. That we have found the EVs limitations and thereby established, that for some purposes the EVs is not suitable, is even as important to avoid new prejudices.

Replication of the trial in other cities will spread the knowledge of the EVs, remove prejudices, and will help promote EVs for the right uses. At the same time spreading the realisation, that the EVs at the moment is not supposed to be a substitute for the majority of conventional cars, is an important fact to avoid broken expectation, which could else wise lead to bad-will for the EVs.

Another part of the trial has been to collect data on energy use, emissions and technical reliability to compare the performance to conventional cars. The findings from the 170 Electrical vehicles in the national trial, probably covering more than 4.5 mill. km when the trial ends, will constitute such a large data set, that there is no need for duplication the trial, for collecting more data of this type.

An EV trial following the set-up in Aalborg could easily be replicated in other European cities. The cost for a trial is partly acquiring and running 10 EV for 2 years and partly having personal resources dedicated to project management and evaluation.

The spread of EVs in the cities would benefit from such a duplication of the trial. The replication of the trial in a number of other cities is thus recommended.

D4.2 Process

At the present there is a large public interest in electrical vehicles. Of course this interest is enlarged during the trial by the possibility of having a car three months for free. As in the Aalborg trial this interest has to be used to boost the focus on alternative fuels and sustainability in general. Apparently a broad EV trial is a subject that the local press can be made very interested in, leading to large and positive press coverage.

The public interest and support gained in this way should further be used to link the sustainability to the political level.