El-Mobility

Final report

Acronym: El-Mobility

Title: Testing of electric vehicles in the Nordic island communities of Greenland, Faroe Islands and Iceland and evaluating the impact of increased use of electric vehicles on future transport

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1. General project description

Alternative fuel in transportation has been heavily discussed over the last few years and is reaching new heights within societies and governments. Volatility in prices, possible issues related to scarcity, and the environmental impact of burning fossil fuels are all relevant concerns linked to fossil fuels.

In an effort to curb the different impacts related to fossil fuels, three island societies, Faroe Islands, Greenland and Iceland have all declared a high interest in changing from the current fossil fuel based societies to increased use of electricity for future transport. All of the islands have possibilities to increase their renewable electric production: (1) Faroe Island from wind and hydro; (2) Greenland from hydro; and (2) Iceland from geothermal, hydro and wind. If this occurs, there is a possible option that these islands may replace fossil fuels that currently support transportation with renewable electricity.

Already considerable work has been done in Scandinavia using alternative fuels in the transport sector and Iceland has been looking at hydrogen and testing of hydrogen over the last few years. Included in the portfolio is electricity, and today many car manufacturers are now looking at "electric mobility" as one of the key solutions for the future which has triggered Original Equipment Manufacturers (OEMs) to currently test electric vehicles, pure battery, plug-ins and hydrogen.

This project was a two year project, which is partly sponsored by NORA and aims to look specifically at the pure battery vehicles. Battery vehicles may be more suitable in island communities or isolated rural areas than in other locations, mainly due to the battery limitation in range. In island or isolated communities this might not be a problem as distances are shorter and the user mode of vehicles is different from other locations. However the geographical setting poses different challenges for the technology. Cold climate, as well as snow, ice on roads and different topography is a difficult environment for battery vehicles.

The goal of the project is to test and evaluate pure battery electric vehicles (BEV's) in different environments in the North Atlantic. By testing different types of battery vehicles this project will address public acceptance, evaluate vehicle performance, identify potential markets, investigate grid implications and disseminate project findings and related education.

El-Mobility is a very ambitious project with strong partners which all share a common vision of greener transport future. The project will prepare key players and train staff, thereby supporting the future transport system based on electro-mobility. The project will also show the commitment of the small island nations towards sustainability in the future.

2. Key elements and deliverables

2.1 Key elements

From firsthand experience, before battery vehicles become viable for the public, it is necessary to demonstrate them in the environment and prove their viability. Until then it is of utmost importance to maximize the learning so that a potential market launch in the islands will be successful. The key elements in the project are:

2.1.1 Data collection

- It is necessary to understand the electric usage of the vehicles and the potential impact on the electrical infrastructure in each society.
- Maintenance issues – *i.e.* how do the vehicles perform in different environments, cold climate, topography, vehicle usage, performance, *etc*. Here training of maintenance staff is also a very important factor, spreading education regarding the future vehicle fleet.
- Cost of operation.

2.1.2 Infrastructure cost

- There are different opinions regarding construction of infrastructure for battery vehicles. For example the cost and implications of fast charging, smart polls for charging, *etc*. The goal is to investigate the potential cost of such an infrastructure and evaluate the necessity of such compared to home refueling.

2.1.3 Market assessment

- The acceptability of such vehicles is unknown. First results from surveys in Iceland and Denmark indicate that most people want electric mobility in the future, but at the same time they do not want to have any quality changes in operating such vehicles and they cannot cost more. This is very difficult to fulfill with pure battery vehicles. The project will therefore evaluate the market with the aim to understand the potential demand for electric vehicles in the near future.

2.1.4 Social acceptance

- See discussion above but also the impact of longer refueling time and shorter range. It is also important to evaluate the public trust on batteries in general as life time of batteries is usually shorter than the lifetime of conventional vehicles.

2.1.5 Dissemination

- The project will hosted a local workshop in each location, during the project period, to increase the awareness of electro-mobility and sustainable transport policies which often are the first steps within companies and governments in increasing the use of alternative fuelled vehicles.
- The project had high visibility and caught a lot of media attention in each location. All the vehicles of the project were marked and used the NORA logo. This was therefore a highly visible project for NORA and potentially strengthens further cooperation between the island nations.

2.2. Deliverables

All the key elements here above were described in the application and from those objectives the plan was to have four different deliverables.

1. Social acceptance and market assessment of electric battery vehicles
2. Vehicle performance, energy usage and impact of environment (geography, weather, topography, *etc*)
3. Evaluation on need of infrastructure and cost of new infrastructure
4. Final report, overview of whole project results (*i.e.* this report)

It was decided to combine all the deliverables in one final report, since it would be a more holistic approach and give a better overview of all the different segments. Following chapters will though be indicated with the number of deliverables for easier navigation.

3. Vehicle operation (Deliverable 2)

The project influenced partners to do more than they originally intended in 2009. Originally (according to the phase I application of the project) the plan was to demonstrate a retrofitted Citroen C1 BEV. But due to NORA's wishes to use a Nordic vehicle producer, it was decided to contact the Norwegian Th!nk vehicle manufacturer. This process ended successfully. Two Th!nk (Norway) battery electric vehicles were bought, one specifically for the project but the other one is of course a very positive addition to the fleet. Both were bought by Nukissiorfiit in Greenland with the support of NORA but the Self-Government also supported the activity (two cars instead of one). One of the Greenlandic Th!nk vehicle was then deployed in Iceland, for six months just as was originally planned with the Citroen C1 (figure 1). This change evidently increased Scandinavian cooperation in the project which is in all partners' opinion a positive step forward. But with this change Icelandic Hydrogen (which was on the original partners list) withdrew from the project and Icelandic New Energy took over their responsibility. Also, the fact is that retrofitted vehicles do not seem to have a high market acceptance in Scandinavia. The Scandinavian market has therefore been leaning towards vehicles that are produced and designed around the electric equipment, *i.e.* vehicles produced by the OEM´s mostly.

Iceland signed a MoU (Memorandum of Understanding) with Mitsubishi to get two Mitsubishi iMiEV battery vehicles for testing. These vehicles are one of the first planned serially produced battery vehicle from a large vehicle manufacturer. Mitsubishi agreed to use one of the first demonstration vehicles in this project for testing also in Faroe Islands and in Greenland. Two iMiEV's were imported to Iceland in May 2010, and one of those leased to the project. The vehicle was then transported to the Faroe Islands in January 2011 where it was supposed to be tested for 6 months, but unfortunately due to local regulations it was only allowed to stay on the islands for 3 months. After its stay in the Faroe Islands the car was transported to Greenland for demonstration for 6 months in April 2011 (figure 1).

SEV, in the Faroe Islands also increased their fleet of BEV's when they bought one Mitsubishi iMiEV and two Peugeot iOn. With all the above mentioned additional cars, the project had in addition results from four more cars than originally planned. These additions further added results to this project and therefore strengthened them.

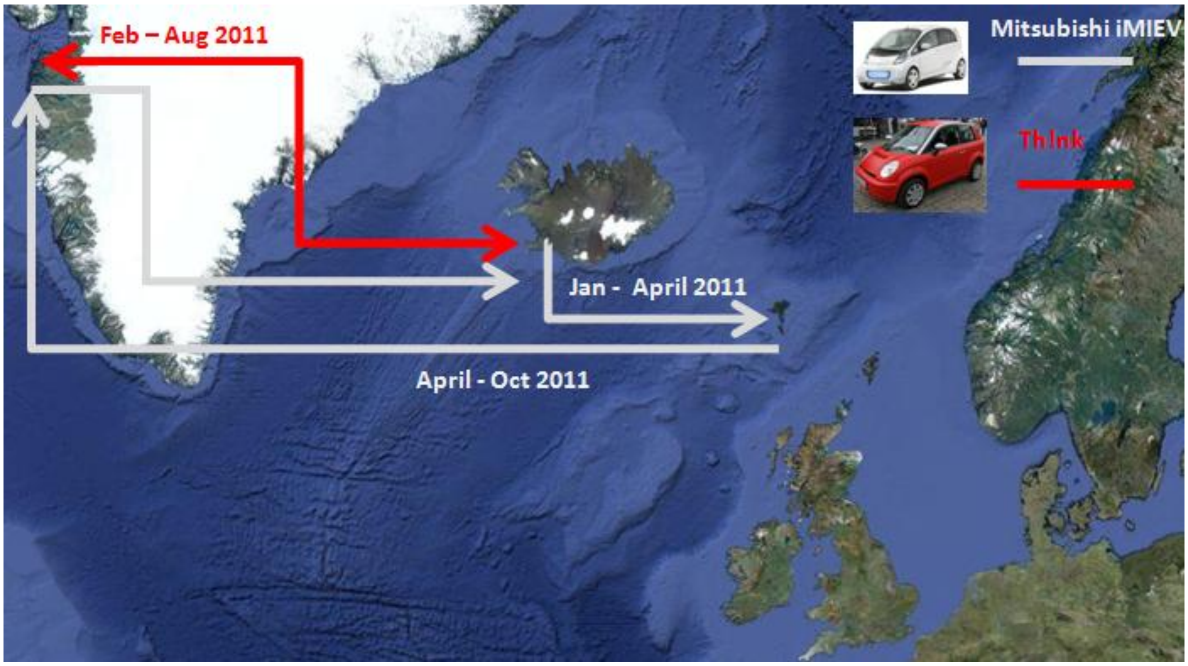


Figure 1: the transportation of the two BEV's (Mitsubishi iMiEV and Th!nk) between the three island communities

3.1 Faroe Islands

Due to its small size, highly developed infrastructure and relatively short driving ranges, the Faroe Islands are ideal for electric vehicles. Driving ranges going from a few kilometers up to approximately 90 kilometers with an average range of around 40 kilometers makes the islands very suitable for EV's.

Also with respect to the integration of renewable energy, the energy mix today is approximately 60% fossil fuelled and 40% renewable energy. In order to decrease the carbon footprint, the political ambition is to reach 75% renewable energy in the electrical sector within 2020, making the EV's even more eco-friendly.

3.1.1 The Vehicles

In the Faroese part of the project six EV's were tested during the test period: two Mitsubishi iMiEV, two Peugeot Partner and lately two Peugeot iOn.

One of the iMiEV's was initially a part of El-mobility project and has been on the different locations. The second one is purchased by SEV and forms a part of the project until finished, subsequently being a part of SEV's car fleet.

Figure 2: the two Mitsubishi iMiEV's used in the Faroe Islands (the grey one is from Iceland and the white one from the Faroe Islands).

Data for the Mitsubishi iMiEV:

Power	**Battery**	**Range**	**Max Speed**
47 kW	16 kWh Lithium-Ion (88 cells of 50Ah)	130 km	130 km/h

SEV also purchased two Peugeot Partner EV vans (Peugeot Electric Partner Origin Venturi). These cars were converted from traditional gasoline cars to electric cars by an approved Venturi factory in France.

Figure 3: the Peugeot Partner.

Data for the Peugeot Partner:

Power	**Battery**	**Range**	**Max Speed**
53 kW	21 kWh Zebra Battery	100 km	100 km/h

After a couple of weeks the Partners were returned to the car dealer due to some technical problems, and instead SEV got two Peugeot iOn.

Figure 4: the Peugeot iOn.

Data for the Peugeot iOn:

Power	**Battery**	**Range**	**Max Speed**
47 kW	16 kWh Lithium-Ion (88 cells of 50Ah)	130 km	130 km/h

Regarding the maintenance of the cars, personnel from the Mitsubishi dealer and Peugeot dealer went through intensive training courses, giving them skills to maintain the cars.

3.1.2 Overview of the operation

Each car was tested thoroughly by SEV personnel for a few days before handed over to our test persons, institutions and public and private organizations. This was done to avoid any unpleasant experience by the test persons, like failures, defects *etc*.

Unfortunately the two Peugeot Partner's didn't pass the initial test by SEV personnel, and therefore is not included in the projects results.

Originally SEV should have the iMiEV transported from Iceland for a period of 6 months. Due to some regulatory barriers, the car could only stay in the Faroe Islands for 3 months shortening the test period by 50%.

Due to the fact that the project only had the opportunity to test the car for 3 months including our own tests, there was only time enough for 3 test locations for this specific iMiEV.

Table 1: the users of the Icelandic Mitsubishi iMiEV in the Faroe Islands.

Mitsubishi iMiEV (LE K82) (The Icelandic vehicle)	
Test person /organization	**Test period**
Faroese Earth and Energy Directorate	21. March 2011 – 03. April 2011
Technical School in Torshavn	04. April 2011 – 10. April 2011
Private family 1	12. April 2011 – 19. April 2011

In March 2011 SEV purchased its first EV from the local Mitsubishi car dealer. This car was more or less identical with the Mitsubishi iMiEV already in the El-Mobility project, but a newer model.

As mentioned before, SEV's personnel tested the car for a few days before entering as a test car in the project. This car was an active part of the project for nearly six months with excellent availability.

Table 2: the users of the Faroese Mitsubishi iMiEV in the Faroe Islands.

Mitsubishi iMiEV (JR 277) (Registered 07.02.11)	
Test person /organization	**Test period**
NORA	14. March 2011 – 28. March 2011
Akstovan	30. March 2011 – 08. April 2011
Private family 2	09. April 2011 – 26. April 2011

Private family 3	03. May 2011 – 09. May 2011
Pharmacy	09. May 2011 – 13. May 2011
Private family 4	16. May 2011 – 27. May 2011
LBF (Engineering Consultant)	31. May 2011 – 20. June 2011
Private family 5	28. June 2011 – 04. July 2011
Faroese Telecom	05. July 2011 – 01. August 2011

As a result of SEV's claims regarding the two Peugeot Partners EV's, they had to return to the local Peugeot car dealer SEV got two Peugeot iOn, one being a part of the project, and one going directly into SEV's car fleet.

Table 3: the users of the Peugeot iOn in the Faroe Islands.

Peugeot iOn (EL 877) (Registered 31.05.11)	
Test person /organization	**Test period**
Private family 6	20. June 2011 – 28. June 2011
Home Care Service	17. Aug. 2011 – 17. Oct 2011

3.2 Greenland

Until now, electric cars have not been introduced widely in the Arctic, mainly due to lack of their availability. Therefore there is a lack of knowledge about their performance and battery life in extreme frosts and salty air. Nukissiorfiit has hence purchased two electric vehicles, to test and gain experience with electric vehicles. It should be noted that all OEM´s had turned down requests to provide vehicles to Greenland until this project was set up.

Today, Nukissiorfiit operates four hydroelectric facilities that supply five towns – Nuuk, Sisimiut, Tasiilaq, Qaqortoq and Narsaq – with clean, green energy. A 5th hydroelectric plant is under construction in Ilulissat and will be ready for full production in the year 2013. This will result in that 70 % of our energy will be based on renewable energy. There are also ongoing efforts to build a number of additional hydroelectric facilities in the country.

The circumstances in the capital, Nuuk, are truly ideal as a testing platform for electric vehicles, since 100% of the electricity production is renewable (100% hydropower) and the road network only covers the city (no road connections to other cities).

Figure 5: the EV's field test area in Nuuk.

Nukissiorfiit is currently replacing all consumer meters for electricity, water and heat with new automatic meter reading systems. Now there is a total of 43,000 automatic meters throughout Greenland. This replacement work will be completed by 2012, which will likely make Greenland the first country in the world where all meters can be read from a distance.

An automatic meter is a type of consumer meter that can be read automatically, up to a number of times every day. A person thus doesn't need to be physically present in order to read the meter, *i.e.* this reduces the risk of making a mistake when reading the meter. For individual customers, this means that once the new meter has been installed, it will no longer be necessary to pay installments on the electricity bill. Instead, customers will be billed on a pay-as-you-go basis.

By the same token, these daily readings mean that a reading can be taken on the same day when someone moves in or out, hence a final bill can be written directly. As a further service to customers, it is possible for those who have had their meters replaced to track their own consumption via the Nukissiorfiit website. This makes it possible to log onto one's own meter and see how much electricity, water or heat is being used during a given period. Customers can thus immediately see the benefits of energy savings measures.

In the future these remote meters might be used e.g. to have a special rate for EV's.

In Nuuk there are approximately 2.500 cars and 120 km road. Therefore it could be a good platform for EV's in the future, also the project has showed that Nuuk is almost perfect for EV's. There are though some difficulties regarding the implementation, *e.g.* very few private houses have outdoor electric installations, and only 10 Amp fuse installed indoors (the Think BEV needs a 13 Amp fuse). But the largest threat against EV's in Greenland is the low oil price. One liter of gasoline or diesel is only 5, 57 DKK which makes it very difficult to make the EV's competitive to ordinary cars.

The Government of Greenland made a law that made EV's free of VAT and taxation until January 2014. Also the Government of Greenland supported the project by funding to the installation of the first vehicles.

3.2.1 The vehicles

Th!nk

Figure 6: the Th!nk *vehicles outside of Nukissiorfiit's headquarters in Nuuk, Greenland.*

Data for the Th!nk:

Power	Battery	Range	Max Speed
30 kW	23 kWh ZEBRA Z36	160 km	110 km/h

In May 2010 two Th!nk EV‘s were ordered and they received in July 2010. They have performed well and live up to expectations.

The blue one had a down time for a month due an error on the PCU; which was replaced with a new one on the warranty.

Once, the red one had a down time due to changing of a broken cabin heater. It was replaced on the warranty. In November 2011, a storm broke the left door window. At that moment it was not possible to receive any spare parts from the manufacture or dealer, because of Th!nk’s bankruptcy. So a temporary window had to be made. But the ordered spare parts were delivered in January 2012 from Germany and USA to repair the window. Unfortunately the rear wheel axle, which damaged in an accident in Iceland, has not yet been delivered.

The Th!nk cars have now been driven over 12.000 km each and we have only change the cabin air filter at service.

Overall there has been a good acceptation of the Th!nk. There are small things that might be better, such as rear windscreen wiper missing, rear seats and larger eyeshades.

We have installed an electric cabin heater in the two Th!nk, so that the car is ice free in the morning. The users are very satisfied with that solution in the wintertime.

Positive aspects: Drive distance 80-120 km/charge. Easy to use. Large trunk. 7 years battery warranty.

Negative aspects: Discharge, due to battery heating. Difficult to get spare parts.

Figure 7: picture from the training course at Th!nk in Auskog, Norway.

In order to buy and get Th!nk cars delivered to Greenland it's obligatory to take a training course at Th!nk's factory in Auskog, Norway. The training course was a requirement from Th!nk because there were no resources in Greenland to support service on the cars. The car's fleet manager from our collaborator ISS and the project manager from Nukissiorfiit were therefore sent on a two day training course which made them able to service and maintain the cars.

Our Collaborator ISS gave their garage in use for the EV's in the project.

The local Mitsubishi car dealer has also trained their staff to do service and maintenance on iMiEV's.

Mitsubishi iMiEV

Figure 8: the Icelandic Mitsubishi iMiEV outside the headquarters of Nukissiorfiit in Nuuk, Greenland.

The Icelandic Mitsubishi iMiEV was received in July 2011 and delivered back at the end of September 2011. In Greenland it drove 2732 km and performed well. Data for the Mitsubishi iMiEV was presented in chapter 3.1.1.

Test drivers were very pleased with the car because of the equipment and drive capacity. But there were some people that were afraid to try the car because it was with right hand steering. Also, it is the users' opinion that the iMiEV is more like an ordinary car because of the equipment and 4 doors.

There was no trouble with the car, but once a driver ran out of battery. Attempts to charge the car with a mobile generator didn't succeed. And since the iMiEV cannot be towed a lorry was used to pick up the car and bring it to the charging station.

The car was very quick and the longest distance driven in one charge was 84 km. But the Icelandic iMiEV was not tested in winter conditions, but there are two other iMiEV's in Nuuk to get that experience from.

Positive things: Equipment. Drive capacity. Local garage. Large manufacture. Can be parked for a long time without discharging the battery.

Negative things: The short range due lower battery capacity than the Th!nk. Cannot be towed.

3.2.2 Overview of the operation.

Table 4: the users of the vehicles in Greenland and test periods.

The users of the vehicles	Test period	iMiev	Th!nk
The Premier, Kuupik Kleist	July 2010 – August 2010		X
Minister of Housing, Infrastructure and transport, Jens B Frederiksen	July 2010 - August 2010		X
Singer, Nive Nielsen	August 2010, one week		X
ISS	September 2010, 3 weeks		X
Electric Authority	September 2010, one day		X
Police and Fire department	September 2010, one day		X
Police Academy	September 2010, one day		X
Public day, test event	October 2010, one day		X
Municipality Sermersooq	November 2010, 2 weeks		X
Department of Climate and Energy	November 2010 – December 2010, 3 weeks		X
National phone and post company	December 2010 – January 2011, 3 weeks		X
Workshop: car dealers and fleet owners	January 2011, 2 days		X
A taste of Greenland	August 2011, 2 weeks		X
Public	July 2010 – October 2011	X	X
Internal test as company car	July 2010 -	X	X

3.3 Iceland

Icelandic circumstances are truly ideal as a testing platform for electric vehicles, since 100% of the electricity production is renewable (75% hydropower and 25% geothermal power). The Icelandic road network does not make the BEV’s as ideal in Iceland as in Greenland and the Faroe Islands. The Icelandic road network is much larger (total of around 12900 km). Due to that and the short range a BEV is more likely to replace the second car of a home and/or be a part of car fleets.

About 20 BEV’s have been registered in Iceland since 1976. Most of them were retrofitted but in the recent years importation of new (OEM manufactured) BEV’s has started. Two Mitsubishi iMiEV’s were imported to Iceland in 2010 with the aim of gaining experience and test in the arctic circumstances of the Northern hemisphere.

3.3.1 The vehicles

Mitsubishi iMiEV

There were two Mitsubishi iMiEV‘s used in the Icelandic part, where one was leased to the project itself. They were serial produced in 2009. The vehicles are equipped with a 16 kWh lithium-ion battery pack which consist of 88 cells (3,7 Volt each). The eclectic motor has 47 kW power (equals to *ca.* 63 horsepower), which is similar power as in an equally sized gasoline car.

The car is registered with the range of maximum of 120 km on full charge (according to information from Hekla car dealer) and it takes around 7-8 hours to fully charge the car. Data for the Mitsubishi iMiEV was presented in chapter 3.1.1.

Figure 9: the Icelandic Mitsubishi iMiEV with the NORA logo

Th!nk

The third BEV that was used in the project in Iceland is a Th!nk designed by Norwegians but produced in Finland. The car was rented for six months from Nukissiorfiit in Greenland.

The car has a front wheel drive and is powered by sodium-nickel-chloride batteries (ZEBRA Z36). These batteries differ substantially from the batteries used in the Mitsubishi iMiEV, mainly for the reason that these are high-temperature batteries that keep the temperature around 260-350°C.

The vehicles are equipped with a 23 kWh battery pack and the electric motor has a maximum of 30 kW power (equals to *ca.* 40 horsepower).

The car‘s registered range is maximum of 160 km (in summer time) and 90 km (in winter time) and it takes 8-9 hours to fully charge the vehicle. Data for the Th!nk was presented in chapter 3.2.1.

Figure 10: the Greenlandic Th!nk vehicle in the north of Iceland (Picture from the National Power Company).

3.3.2 Overview of the operation and users profile

The operation of all three vehicles went quite well in Iceland and got a generally good acceptance of those who tried the vehicles.

The users and test periods of the vehicles were various, and are displayed in table 5.

Table 5: the users of the vehicles in Iceland and test periods.

The users of the vehicles	Test period	iMiEV	Th!nk
Minister of Industry, Energy and Tourism	May 2010 - January 2011	X	
Reykjavík Energy (Orkuveita Reykjavikur)	July 2010 - August 2010	X	
National Power Company (Landsvirkjun)	June - July 2010 and May - August 2011	X	X
Public	August 2010 - May 2011	X	X

Of these four users only two got the opportunity of using both cars (Th!nk and Mitsubishi iMiEV): Public trial and the National Power company. These two projects will be used as case studies for the El-mobility project and the data from these two projects will be presented and analyzed in chapter 4.3 Iceland

When the Mitsubishi iMiEVs were imported to Iceland one person with the local car dealer (Hekla) was trained for the maintenance of the cars. The cars were checked regularly at the dealership to calibrate the batteries and to check for any malfunction-codes.

There were no maintenance personnel in Iceland to maintain the Th!nk vehicle while it was in the country. But if some difficult technical issue would've come up, it would've been necessary to ask a trained Th!nk-personnel ('flying doctor') from Greenland to solve it.

3.3.3 Unforeseen incidents

Unfortunately the Icelandic team experienced two minor car crashes in the test period.

a) Mitsubishi iMiEV, had a small fender incident when it was impacted from the rear (no injuries), this damage was quite easy to fix (figure 11).

Figure 11: the Icelandic Mitsubishi iMiEV, red circle indicating the damaged impact area.

b) The Th!nk vehicle had damage to the rear (figure 12), which was more difficult to fix, and it proved to be extremely difficult to get spare parts due to the fact that the Th!nk-manufacturer went bankrupt.

Figure 12: the Greenlandic Th!nk vehicles, picture indicating the damaged impact area

The project also had problems with the insurance company. Providing spare parts is not simple and it was costly to obtain spare parts. Also wrong spare parts came at first so it was not possible to fix the vehicle fully. The insurance company only offered a very low compensation for the crash and the issue is still not resolved. As can be seen from chapter 3.2.1 still some spare parts for the vehicle are still missing and therefore a final fix of the vehicle has not been made.

This issue shows that the insurance industry is not fully ready to handle problems with new type of vehicles. Also they do not realize that it can be more costly to fix such cars than normal cars. This is something that the market has to be aware of during the initial marketing stage.

4. Data (Deliverable 1 & 2)

It was not possible to use the exact same data collection methods for all locations. The three countries all had their way and agenda to collect the data, with log-books, GPS-monitors, interviews *etc*. Still all partners had to obtain certain data for comparative studies, but in general for the project substantially more data was collected than was described in the project application. All the partners were very positive to this as it would make the project more reliable and make the outcome more comprehensive (see additional data in annexes).

4.1 Faroe Islands

4.1.1 Technical performance data

Method

Each test period started with a presentation of the car. All possibilities and limitations were explained, and the test person got a thoroughly introduction of how to use the car. For each test drive, the person who drove the car was responsible for filling out a "test drive journal" stating the following:

- During the drive:
  - Date and time for the specific test drive
  - Driven distance (trip counter start / trip counter stop)
  - Consumption (Charge indicator start / Charge indicator stop)
  - Outdoor temperature
  - Indicate if following loads have been in use during the specific test drive: Air condition, Heat, Radio, Lights
- During charging:
  - Time and date (start charge / stop charge)
  - Charge status (start charge / stop charge)
  - Odometer
  - Outdoor temperature

In addition to these parameters, all cars were fitted with a remote read kilowatt-hour meter, giving SEV the opportunity to log the charging pattern for each user within a 15 minutes resolution (Annex I).

After each test drive there were interviews with the person or representatives from the institute/organization focusing on their experience.

All data collected from the test drives was transferred from the test drive journal into EXCEL for further data processing. Data from the remote read meters was imported into the same spread sheet to enhance the accuracy of the actual energy consumption for each test drive.

<u>Data collection</u>

During the test period the tested EV's had no technical problems at all. The technical availability is nearly 100% for all cars.

Following chart indicate the total driven distance and the respective total energy consumption for each car during the test period.

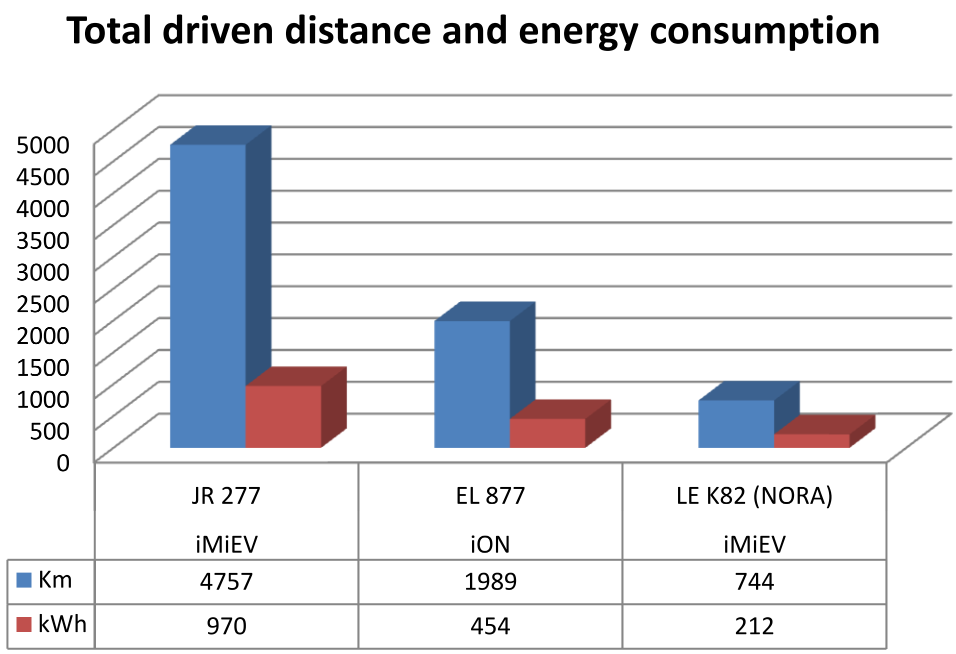


Figure 13: driven distance versus energy consumption for each car.

On basis of this data an average number for driven distance pr. kWh can be calculated with the formula "Total Driven Distance" divided by "Total Energy Consumption". As illustrated in the chart, there are some differences between the cars.

A reason for the differences between the cars, especially regarding the Icelandic iMiEV, can be attributed to the rather few kilometers driven. However, according to the test persons and SEV personnel in general, the Icelandic iMiEV had a lower range than the other new cars. Another crucial point is of course the driver's attitude and behavior when driving such a car, and that's definitely reflected on the range.

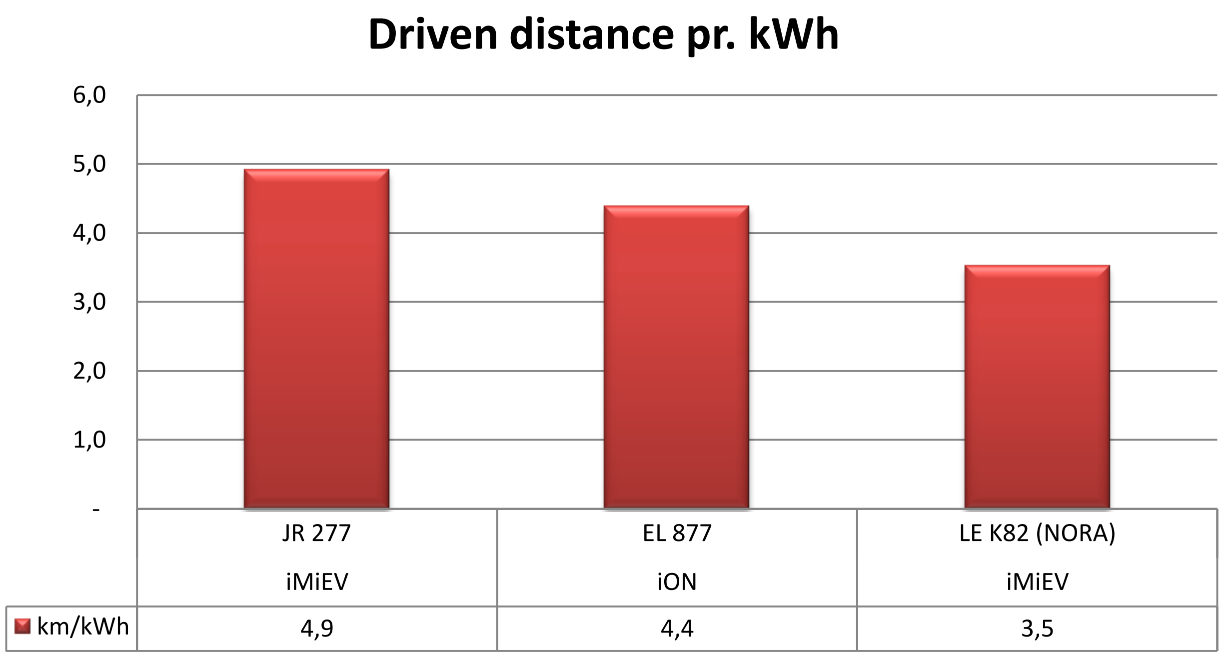


Figure 14: driven distance pr. kWh.

The energy cost in the Faroe Islands is 1.83 DKK/kWh meaning that the average energy cost pr. kilometer is approximately 0.429 DKK/km.

Compared with a similar car of the same size on gasoline (18.5 km/l), the energy cost pr. kilometer is nearly 0.6 DKK/km.

Unfortunately there were rather few days with snow or temperatures below zero degrees during the official test drives, so the batteries dependency on temperature has not been tested thoroughly. During the test drives the temperature range was between 2 – 13 degrees. In the chart below the average range pr. full charge is shown. The numbers are average for all three cars, and as indicated, the range seems to be depended on the temperature.

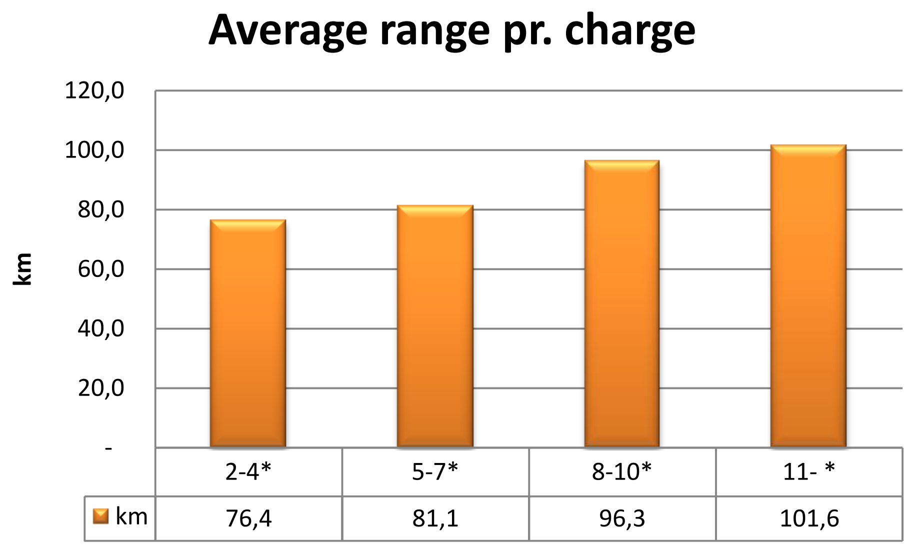


Figure 15: average range pr. charge in different temperatures (°C).

What amount is attributed to the reduced capacity of the battery and what amount is attributed to the increased usage of the electrical heating has not been examined in detail, but the next chart divides the outside temperature into three groups. Each group is the again divided into two groups, indicating if the electrical heat has been ON or OFF during the drive. Even though this chart is based on few data, and specifically tested on the Mitsubishi iMiEV (JR 277), we clearly see a difference in the range when the electrical heat is on or off.

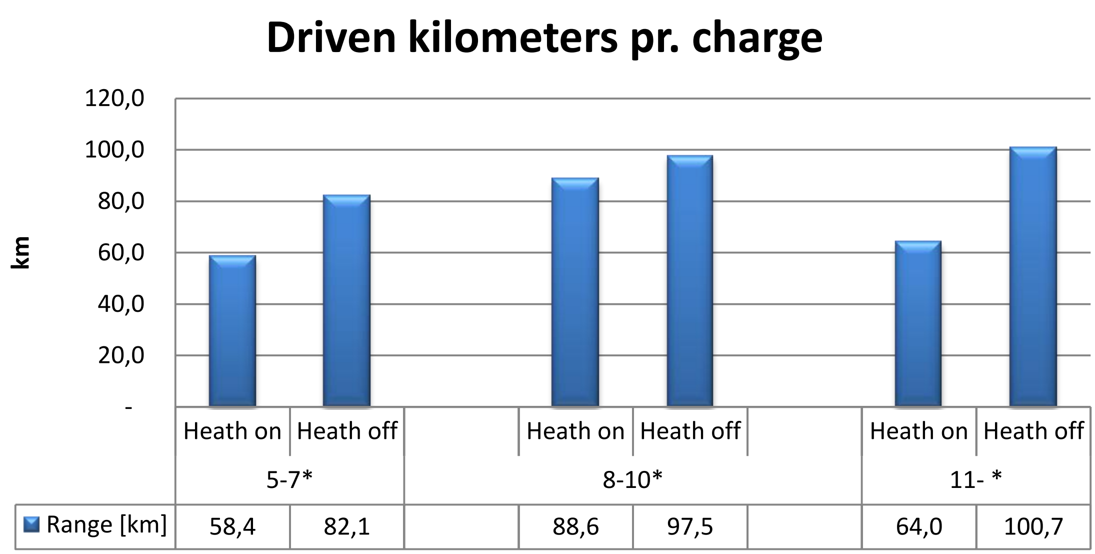


Figure 16: driven kilometers pr. charge.

During the test period there were a few days with snow and temperatures down to minus 3-5 degrees. During these days we can definitely conclude that the electrical heat has a rather high influence on the range.

One issue that has been discussed among the test persons and the public in general, and subjected to negative comments, is the charging time. The charging cables used, *i.e.* the cable between the car and charging pole, are all fitted with a current limiter, limiting the current to 10 amps. With this limitation the charging time, 5% to 100% are measured to be approximately 7 hours and 15 minutes. As indicated in the chart, the charging is quite linear.

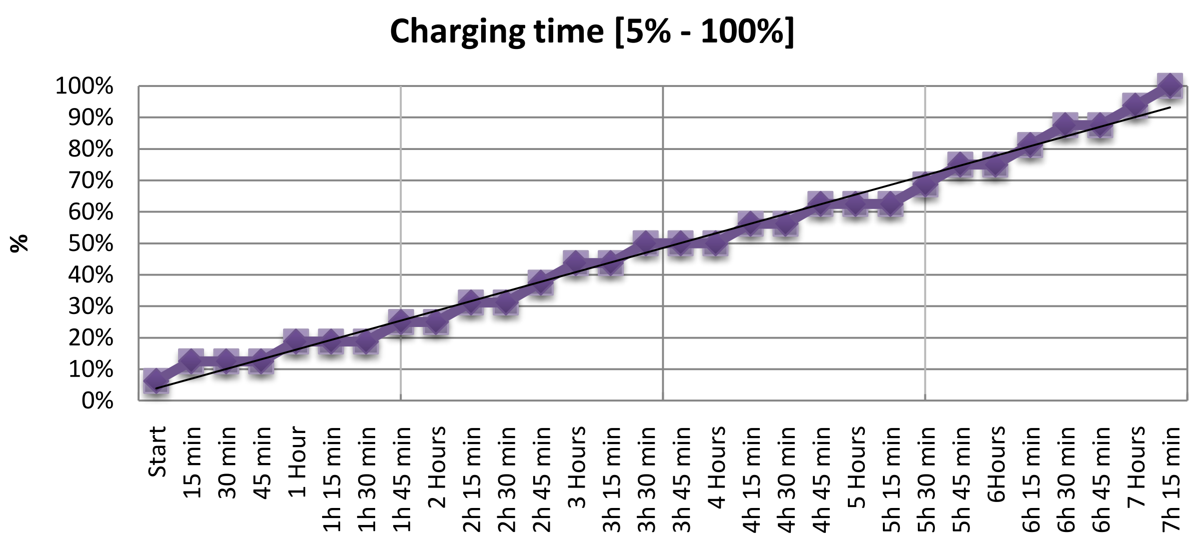


Figure 17: average charging time from 5% to 100% charge for the two Peugeot iOn.

Based on dates from the test drives the specific Carbon emission for each car can be calculated. This figure is highly dependent on the energy mix in the area. For the past years the average energy mix for electricity production has been 60/40%, *i.e.* 60% fossil fuelled and 40% renewable energy. In the Faroe Islands, Sundsværket is the main fossil fuelled Power Plant, producing very close to 100% of oil based energy. In average 1 GWh is produced from 215 ton HFO at this power plant. The specific CO_2 emission [$kgCO_2$/kgfuel] for this power plant is calculated to be 3.3 $kgCO_2$/kgfuel. In the following chart, the specific Carbon emission is illustrated for each of the tested car, when 'fuelled' in the Faroe Islands, with the average energy mix indicated earlier.

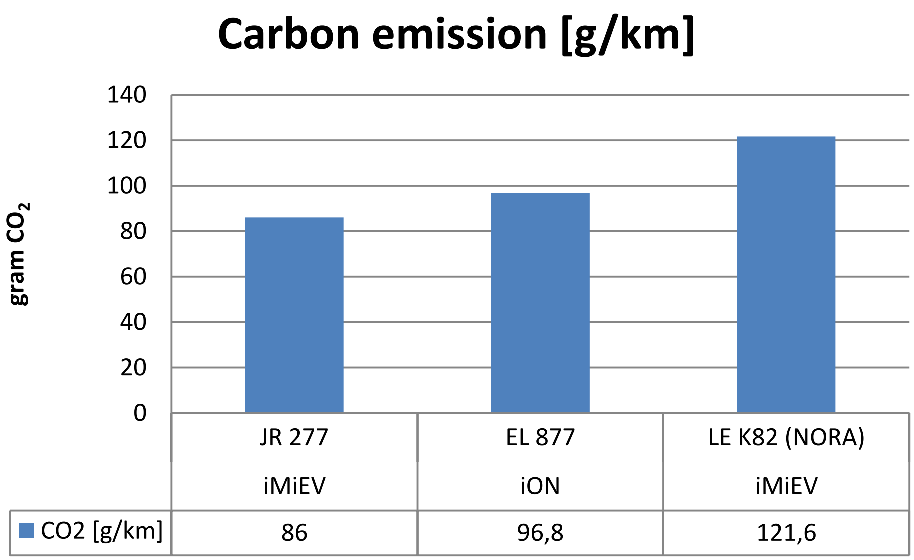


Figure 18: carbon emission (g/km) of different BEV's.

4.1.2 Social acceptance

Based on the interviews with the involved test persons and organizations, and test-persons in our own organization, it is possible to draw up some headlines regarding the social acceptance. Additionally a lot of feedback was collected from the workshop in the Nordic House in February, and not to forget a lot of feedback from the public in general as a result of the high media coverage since the project started.

In general people are very optimistic toward this new transport technology, and after the initial presentation of the car and its functionality, they are quite confident trying the car and to find out how the car fits to their normal transportation needs. After each test drive, the car and its suitability was evaluated.

Positive aspects:

- The car is easy to drive with excellent acceleration
- Perfectly suitable for city driving, small and maneuverable and noiseless
- Expectations of low maintenance cost

Negative aspects:

- Range too short, in general less than 90 km.
- Charging time too long
- Range decrease drastically when heat is turned ON
- Purchase price is too high

The most common statement was that the car was a pleasure to drive, but that the range was too short and the price too high. When the range is extended to approximately 200 km and the price is more reasonable, many definitely would consider an EV as being an alternative.

The El-Mobility project and the media coverage in the country have made the public in the Faroese more aware of the EV's potential.

4.2. Greenland

4.2.1 Technical performance data

Method
The Energy Agency in Denmark has an ongoing project on data collection from EV's with the purpose of gathering data from the use and drive pattern of EV's. The data collections consist two parts:

First part is an automatic collection of data which includes drive pattern, energy consumption, time of charge *etc*.

The second part is a manual collection of numbers of cars, type of use, type of EV's and strategy.

The Energy Agency made a contract with the company Vikingegaarden, to deliver data loggers to each car and the development of a data system for automatic log of data from the EV's. The data loggers are equipped with a SIM card and send the data directly to the system. Vikingegaarden delivered 3 data loggers to the project and on the Vikingegaarden website, following data can be observed.

- State of charge. Speed. Numbers of vehicles in use. Where the car is placed. Distance. *etc*.

When the Th!nk was lent to Iceland, we still received data from the car.

The cooperation with Vikingegaarden has been perfect and we have received a fine support and data for the project. Vikingegaarden delivered the data loggers at no cost which means that the only expenses are the SIM cards and data traffic. The operating cost of the data loggers are approximately 100 DKK / month for each logger. When the Greenlandic Th!nk was in Iceland the data cost was 1200 DKK/month because of a high SIM-card cost. On the web page it's possible to see where the cars are, at what speed, the consumption, driven distance and how much power left on the battery (see screenshots in Annex II). The energy agency in Denmark published a report in march 2012, where the Greenlandic Th!nk EV´s data is included.[1]

To log the use of the EV's in the project a booking calendar was made in the mail system of Nukissiorfiit. The Booking system has performed very well, and the internal users have accepted the system. The receptionists at the company also helped a lot with the project, by handling the keys to the cars and give feed back to the project.

Data collection

Data from the field test:

When the EV's were tested in Greenland there was a mismatch between the expected range (*etc.* – manufacturers' indications) and the actual figures.

The Th!nk EV is equipped with a 23 kWh Zebra battery and a 30 kW motor. The longest trip of the Th!nk was 121 km but the average use 44 km/day. Average speed 28 km/h. Since the Th!nk is equipped with high temperature batteries it needs power to keep the battery heated, in the winter time, and it uses 4 KW each day for that purpose. The cost for this needs to be added but it is approximately 6,50 DKK in winter but lower or close to 5,75 DKK (3,5 KW) in summer. Those numbers need to be added to the total consumption. In the summertime it drives around 4,5 km/kWh but in winter time 3,5 km/kWh. When consumption from the standby and the cabin heater is added it is only 2 km/kWh in the wintertime. This means that the consumption of the Th!nk vehicle is more expensive in the winter time, compared to ordinary fossil fuel cars.

By remote meters it was possible to receive data from the consumption of electricity to the EV's in the project.

[1] The report can be found here: http://www.ens.dk/da-DK/KlimaOgCO2/Transport/elbiler/forsoegsordningforelbiler/nyhedsbreve/Sider/nyhedsbrev-nr-1.aspx

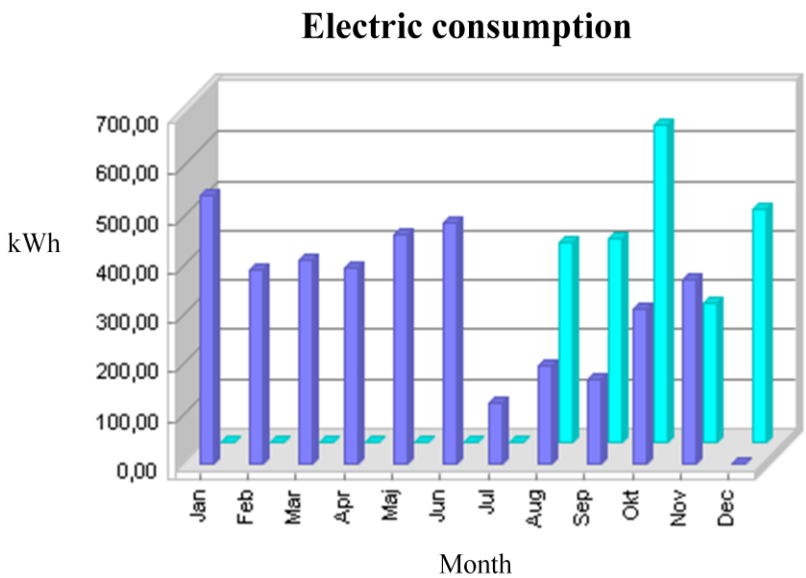


Figure 19: the electric consumption in the charging station of one of the Th!nk EV's, the dark blue is data from 2010 and the light blue from 2011.

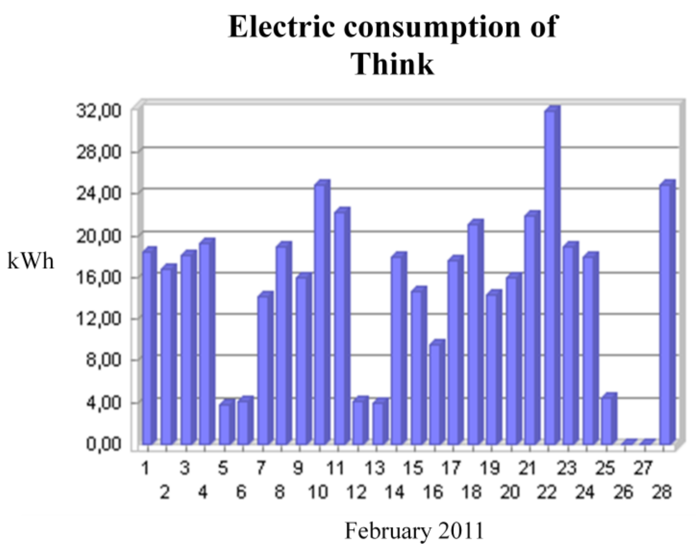


Figure 20: the total electric consumption in February on the charging station to the Th!nk.

By range and the battery capacity of the day, we are able to determine the actual consumption of the vehicles. The Mitsubishi iMiEV is equipped with a 16 kWh lithium-ion battery and a 47 KW motor. The longest range of the iMiEV was 84 km / day. Though no data has been received from Iceland these measurements show similar figures as for the Th!nk, *i.e.* 4 km/kWh. Still the iMiEV has no standby consumption.

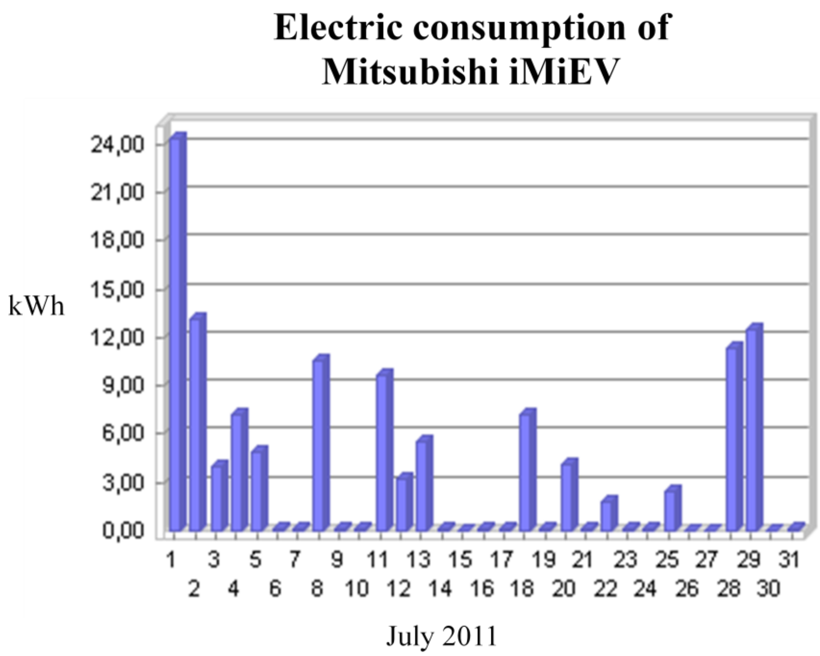


Figure 21: the electric consumption of Mitsubishi iMiEV in July 2011.

As can be seen in figure 21, there is no electric standby consumption in the weekends but because of the holiday period there was a lack of use during the month of July.

Due to a smaller battery pack and a larger motor, the iMiEV has a shorter range than the Th!nk, but on the other hand the Th!nk has higher fuel consumption than the iMiEV.

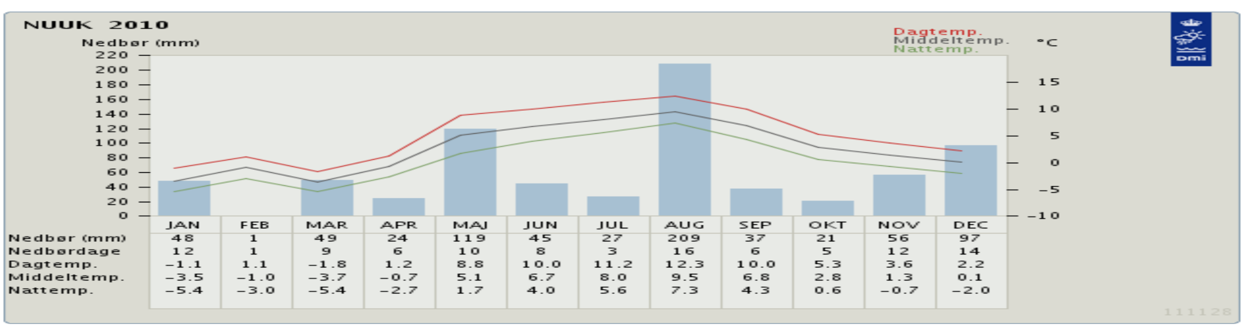


Figure 22: the average temperature and precipitation in 2010, but the temperature can drop to minus 25°C.

The tested EV's have performed well in the Greenlandic climate. So the technology is approved in Nuuk. Both cars are suitable for Greenlandic conditions even though temperatures can be extreme as can be seen in figure 22.

4.2.3 Social acceptance

Questions to drivers and Feedback: Public and Company use (22 drivers)

	Good	Neutral	Poor
The EV generally:			
How was it to use, drive and charge the car?	20	2	0
Did the EV perform well?	19	2	1
Usefulness:			
Did the EV fulfill your needs?	15	5	2
Are there something missing to fulfill your needs?	3	3	16
Did the EV perform to your drive pattern?	20	2	0
Infrastructure:			
Was there something that makes the EV easy / difficult to use in Nuuk?	17	4	1
Was it enough only with one Charging station?	7	4	11
At what time of the day or night did you charge the EV?	Night(13)	Current(5)	Continuously(4)
Expectations:			
Did the car live up to your expectations?	16	4	2
Total	**130**	**31**	**37**

Course: Questionnaires from drivers.

Below are the keywords from the social acceptance research.

The EV generally:

1. How was it to use, drive and charge the car?
    - Easy and quick. Nice to use. Surprising good to drive. Silent and comfortable. Perform well. Good to city driving. A little afraid of automatic transmission. Fine acceleration. Disadvantage with only to seats. Sorry to delivered it back.
2. Did the EV perform well?
    - Yes but it have no rear windscreen wiper. Perform well. Need a sound telling that the engine is turn on. Yes when you got the knowledge of the car. Thumb up. The car performs well.

Usefulness:

3. Did the EV fulfill your needs?
    - Is too small to replace our car. Like my own car but more client. Yes but needed rear seats. Yes it fulfils our needs. As private car yes, as company car to small. Yes to city driving. Need 4x4 at work. Better than I thought. Not for my family but as company car. Overall yes.
4. Are there something missing to fulfill your needs?
    - It should be bigger. Rear seats. Bigger model for work. Need 4x4. Larger eyeshade. Larger trunk space. Need trailer hook. Need to be wider, too small for large people. No comment it fulfill my needs.
5. Did the EV perform to your drive pattern?
    - Yes, we have short distance to everything. Fine as my own car. Perfect. Yes it is easy to drive and park. Need a charging station at the harbor. Yes it is a nice little car. Almost. Yes just I remember to charge it. Yes it performs well and easy to drive. Perfect for costumer visits. Yes Very well.

Infrastructure:

6. Was there something that makes the EV easy / difficult to use in Nuuk?
    - Bad view on the rear window doing lack of windscreen wiper. Like automatic drive. You need bigger attention to the pedestrian because the car is silent. The size of the car is perfect for city driving.

7. Was it enough with one charging station only?
    - Yes, it depends of how you must drive. Maybe at work and also at home. Don't know. No. Yes. Need a charging station at on the harbor. Yes it was ok. If more EV's coming to town we need more charging stations. I am worried about vandalism or misuse on public charting stations. It would be good if there was a few charging stations in town, but not a problem for me.
8. At what time day or night did you charge the car?
    - Continually. At night. Most at night but also a few times a day. I charge the car every second night. When needed.
9. Where did you charge the car?
    - At work. Home. The charger was placed at work. The charger was placed at my home. Mostly at work. At Nukissiorfiit.

Expectations:

10. Did the EV live up to your expectations?
    - Fine experience. I would by one if it was not was that expensive. Yes but it too small. It fulfils my expectations. Perfect in Nuuk. Yes fine. It performing well, nice to drive, easy to use, so yes. Better than expected but need rear windscreen wiper. I am surprised that it could be that easy. Much better. Yes and more. I think

> EV’s have a great future in Greenland. Mostly yes but there are things that could be better. Yes but I need light in the key at night. Yes should get used to no sound of the engine. Was well instructed before test it so it was a great experience.

By the users in the test period, we find out that the cars were fittest as company car in the municipality care sector, cleaning sector, and other companies there have a low or medium need for driving. Companies like the Post office with large need of driving the EV’s have their limits. The Post office could drive 4-5 hours continuously one charge both it were not enough to fulfill their needs.

4.3 Iceland

4.3.1 Technical performance data

Method

Technical data was collected from two types of users:

1. The public trial:

The public trial had the objective of demonstrating electric vehicles (both BEV‘s and FCEV‘s) and give public families the rare chance of trying electric vehicles for a months period and given that opportunity to see how and if the vehicles meet with their daily requirements.

After advertising and going through applications, eight families were selected for the trial. They all got a seminar before starting the trial where presenters went through safety issues and where the main features of the cars were introduced. Also the importance of keeping a log-book (for data collection) was emphasized.

Before and after test driving there was a semi-constructed interview in order to get an overview of the participants’ expectations vs. experience and to see if their demands were fulfilled after trying the cars for one month.

2. National Power Company trial:

The National Power Company was interested to try EV’s in order to see how the cars’ features would fit the needs of their personnel. The company had tried FCEV’s for some time, but was interested to try these different BEV’s. The company therefore test drove the Mitsubishi iMiEV for a month and the Th!nk vehicle was tested for two months. The Th!nk vehicle was test driven at every work-station that the company runs around the country (see figure 23) and stayed at each station for about a week.

The drivers kept a log-book (for data collection) and were also asked to answer a survey which results were supposed to reflect on how the workers viewed the BEV and how they liked their performance.

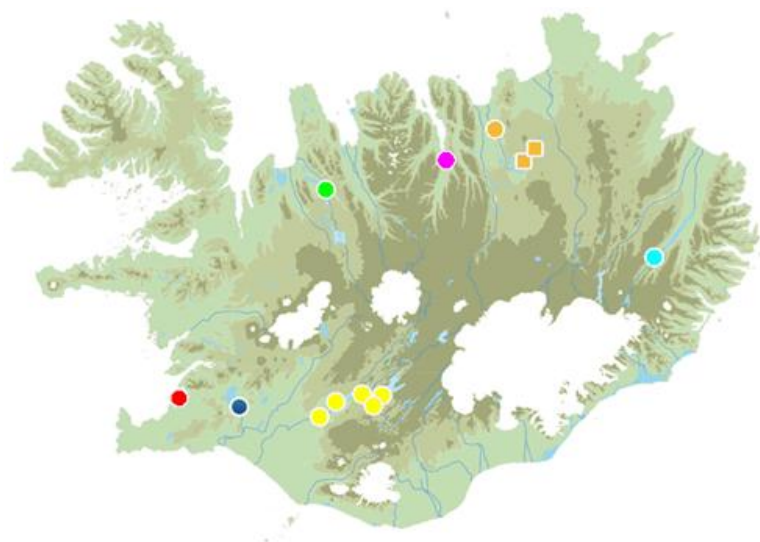


Figure 23: all work stations of the National Power Company (Picture altered from http://www.landsvirkjun.is/starfsemin/virkjanir/).

Table 6: The National Power Company's usage of the Th!nk vehicle summer of 2011, arranged by chronological order. The color codes show where the work-stations are on Figure 23.

Color codes	**Location of the vehicle**	**Number of days**
(red dot)	Headquarters of the company in Reykjavík (RVK)	4
(dark blue dot)	Sogssvæðið (OAS)	7
(yellow dot)	Þjórsársvæðið (OAÞ)	7
(red dot)	Headquarters of the company in Reykjavík (RVK)	4
(green dot)	Blöndustöð (OAB)	7
(magenta dot)	Technical department in Akureyri	5
(orange square)	Mývatnssvæðið, Laxárstöð/Kröflustöð (OAM, LAX/KRA)	8
(cyan dot)	Fljótsdalsstöð (OAK)	11

Data collection

Data was collected in three ways:

- Log-books
  - Name
  - Date
  - Conditions (temperature and weather conditions)
  - kWh after each charge
  - Km driven per trip
- SAGA-monitors (GPS system)
- Interviews
  - Semi constructed (before and after test drive)
  - Questionnaires

1. Public trial

When the data from the log-books was investigated there was quite a difference to how well they were filled out, but nevertheless a good overview of the performance of the cars was achieved. When temperature was plotted with outside temperature there was an apparent correlation in the data. Where consumption of energy increased as temperature fell (figure 24).

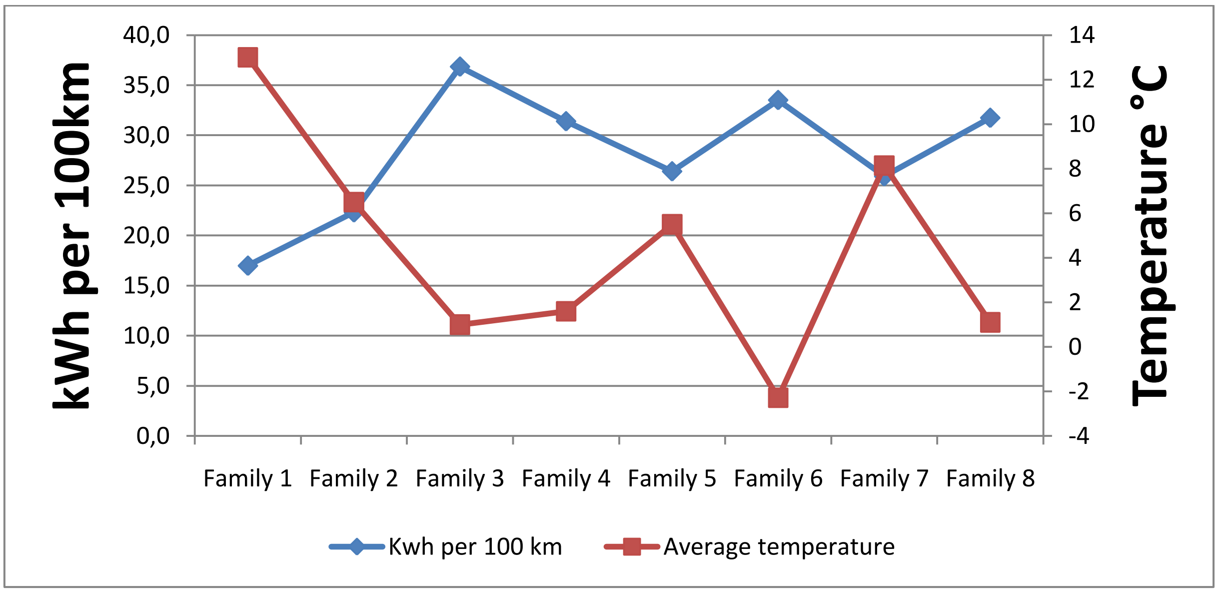


Figure 24: graphical demonstration of the correlation between the temperature and the cars' usage of kWh.

Due to the high correlation between the kWh consumption and the outdoor temperature the average kWh consumption and temperature was done for each season (summer, autumn, winter and spring), see table 7.

Table 7: energy consumption of the BEV's tests in Iceland (iMiEV and Th!nk).

	Summer	Autumn	Winter	Spring	Official brochure	Average for the test period
kWh per 100km*	17	22,31	33,91	29,07	9,3	28,13
Mean temperature	13°C	6,5°C	0,11°C	3,3°C		
*average						

Table 7 shows that the kWh consumption increases to an extent in colder outdoor temperatures. One of the reasons could be that the central heating system consumes a lot of energy when in use. Also, that the consumption numbers differ highly from the official brochure.

2. National Power company trial

The test results will be displayed for the Th!nk vehicle.

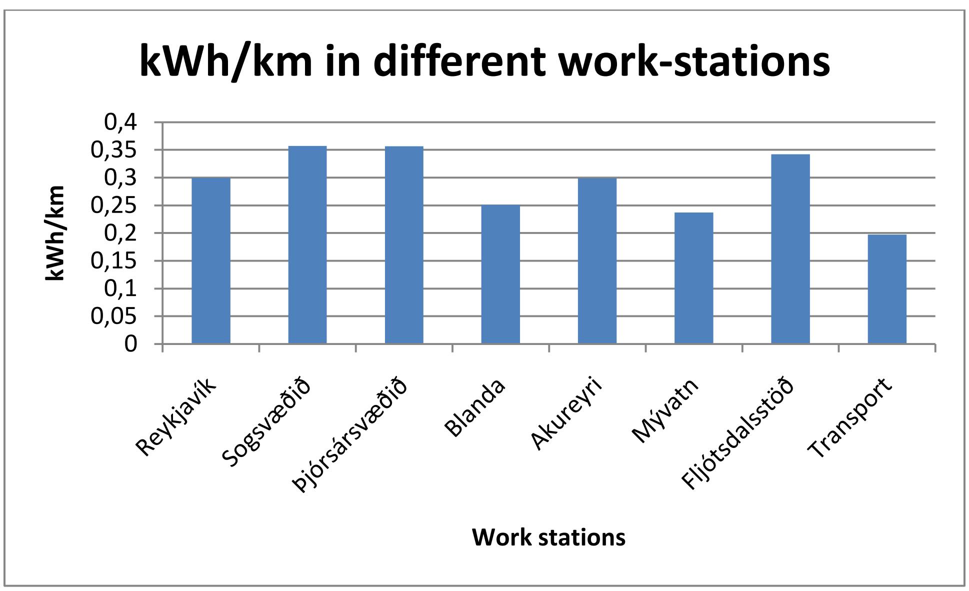


Figure 25: usage of kWh/km of the Th!nk vehicle in different work-station of the National Power Company.

The kWh/km usage of the Th!nk vehicle, as displayed in figure 25, is quite equal between work stations (between 0,23 – 0,35 kWh/km). The "transport column" is obviously the lowest in figure 25, which is not surprising since the usage of kWh is less when long distances are driven with quite equal speed (moving the vehicle from one work station to another).

The longest range in one charge with the Th!nk was 178 km[2] when the vehicle was transported in the south of Iceland. The longest range in one charge with the Mitsubishi iMiEV was 98 km when the vehicle was transported in the south of Iceland.

4.3.2 Social acceptance

Alongside the technical data collection the users experience and outlook was also investigated.

1. Minister of Industry, Energy and Tourism

The Minister had the Mitsubishi iMiEV to her disposal for around 8 months. The test drive was not a great success, mainly due to the lack of range and low endurance of the batteries (especially during the winter time). The Minister's driver stated that the low range of the vehicle did not fulfill the need for the Minister's daily driving pattern.

2. Reykjavík Energy (Orkuveita Reykjavíkur)

Reykjavík Energy test drove the Mitsubishi iMiEV for *ca.* 2 months (during the summer time) and they were quite pleased with the vehicle. There were though some negative aspects, for example complaints about the range, especially when electronic equipments were used.

3. National Power company

The National Power company had the chance of trying both BEV's, but their test drive with the Th!nk vehicle was more extensive than the one with the iMiEV since the company tried the Th!nk in all of their work stations.

In general the users were positive towards the car and surprised how quick and powerful the vehicles were. But when asked about the usefulness of the car in each station the answers varied.

- *Reykjavík:* Would fit for small errands all year around.
- *Sogssvæðið:* Would fit well in the area almost all year around (*ca.* 11 months).
- *Þjórsársvæðið:* Due to the high altitude of the area and rough winters a BEV would not perform very well in the area.
- *Blöndustöð:* Due to the fact that most roads at this work station are dirt roads and with the addition of rough winters a small BEV would not suit the area.

[2] It should be noted that this is way longer than indicated by the producer. It should be noted that the vehicle declined around 300 m elevations during the drive and was driven at around 65 km/hour. Still a very promising performance.

- *Akureyri:* Would fit for small errands all year around.
- *Mývatnssvæði – Laxárstöðvar:* Due to the high altitude of the area and rough winters a BEV would not perform very well in the area.
- *Mývatnssvæði – Kröfluvirkjun:* Due to the high altitude of the area and rough winters a BEV would not perform very well in the area.
- *Fljótsdalsstöð:* Workers in the area saw the potential of the car to be used in one of the tunnels (1 km one way) of the power plant.

In relation to the trip the Th!nk went around the country there were three events were public was offered to test drive the vehicle and in these events there were also experts that could answer the questions that came up. These events were a success and there was a general positive outlook toward the vehicle. Many were curious about the price of the vehicles as well as the endurance of the batteries. People saw the potential of the car to run small errands.

These events and the trip the Th!nk took around the island attracted a lot of local and national media attention.

4. Public trial:

Two interviews were conducted in the public trial; one before test driving and one after test driving BEV's.

a) Interview before test driving:

Expectations for BEV's:

- Light, small and neat, easy in the city
- Nice to have 'a fuelling station' in the garage
- Curiosity: regarding the endurance of the batteries and the lifetime of the vehicles to see if it can keep up with traffic speed about the power

In the interview participants were asked what they expected the range and charging time of the vehicles to be, results are displayed in figure 25 and 26.

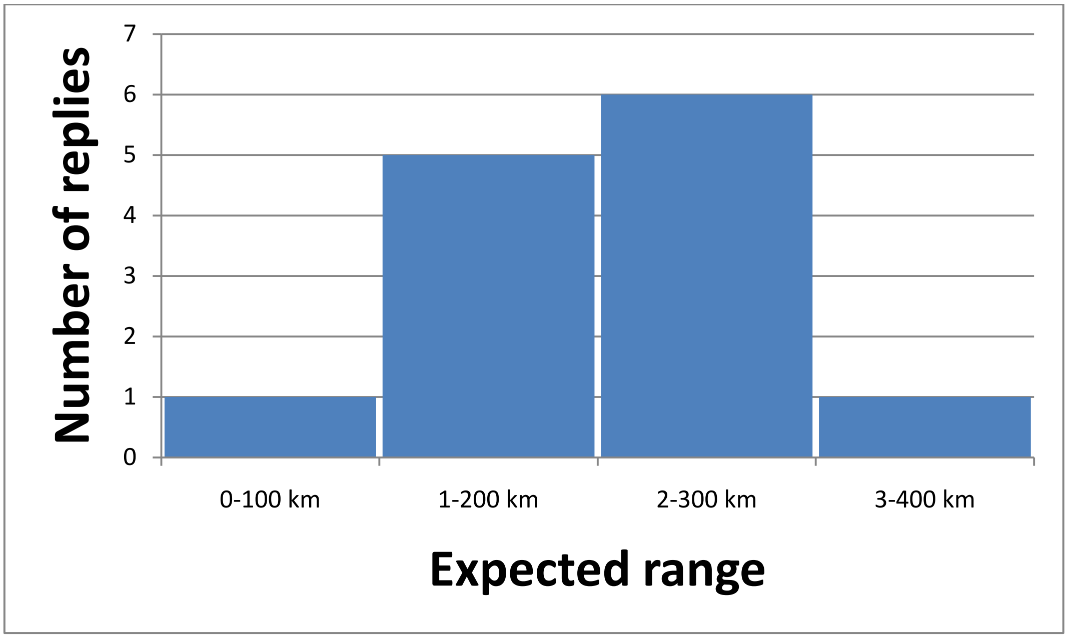


Figure 26: expectations of the public regarding the range of BEV's.

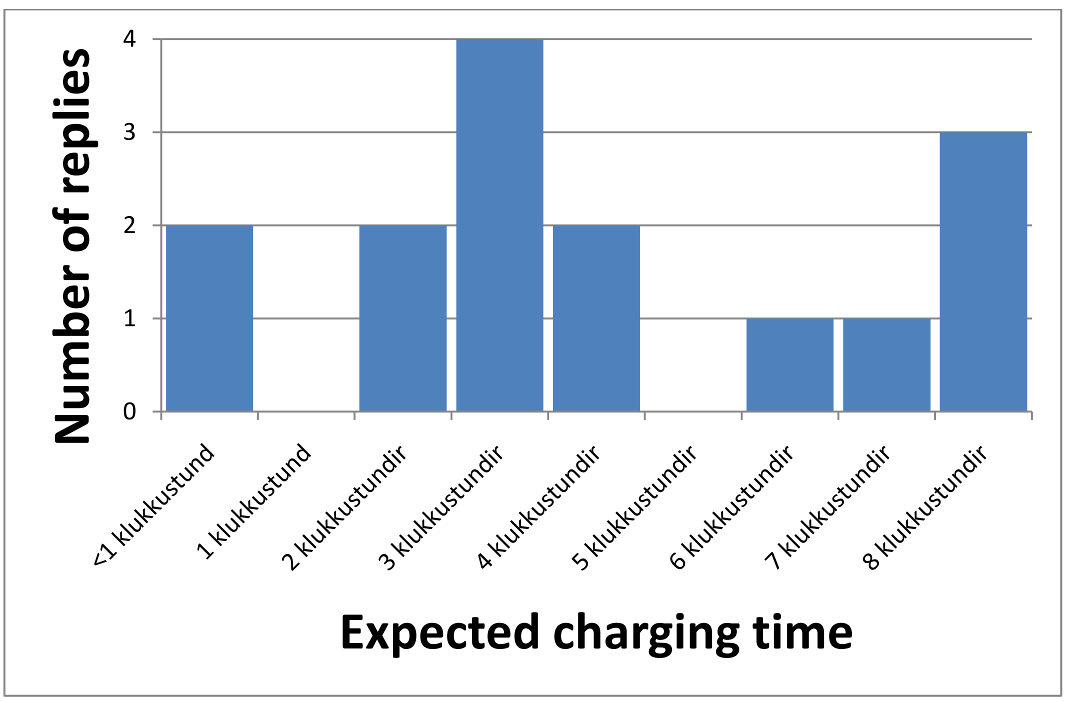


Figure 27: expectations of the public regarding the charging time of BEV's.

When figure 25 and 26 are studied it is apparent that public expectations are in some way unrealistic. The range of the two vehicles is in reality between 50 – 120 km per charge. But more than half of the participants expected the range to be more than 200 km per charge. Similar results can be seen when asked about the range of BEV's, where many of the participants appear to expect shorter refueling time (between 2-4 hours) when the refueling time of the two vehicles range between 7-12 hours (e.g. depending on the available ampere of the electric current).

b) Interview after test driving

When asked about charging behavior it was revealed that the families always charged the car at home or at work (when available) *i.e.* never used charging posts available in Reykjavík. Also, the car was usually plugged in overnight, thus the families did not know how long the charging process was.

But most participants were surprised by the power of the car and really liked the way they felt when driving – because they knew that no pollution was coming out of the exhaust pipe. But due to the limited range of the car, participants viewed the BEV as a potential second car of the family and that it was perfect for errands within the city limits (figure 28).

Positive aspects:	**Negative aspects:**
- Surprised by the power	- Limited range
- 'Good conscious' driving	- Insecurity to reach destination
- Operational cost very low	- That the car was too silent
- Good as a second car	- The car air condition is unefficient and high in electricity consumption
- People "think" and plan their trips	

Figure 28: positive and negative aspects from participants after test driving.

One of the interesting parts of the positive aspects was the fact that people 'think' and plan their trips better with the EV than before. One reason of course the limited range but also as they could read from the meters when regenerating energy *etc*. Many of them stated later that they have changed in general their driving behavior and noticed savings in fossil fuel. Most users actually say they are more aware of their driving behavior with after using electric vehicles, which then saves fossil fuel when they drive such a vehicle (figure 28).

4.4 Safety aspects

One of the elements that need to be taken into consideration are safety aspects. In the society there is little knowledge of the EV technology and related safety issues. It is important that at an early phase such issues are tackled, specifically those related to first responders, policy, fire brigade, *etc*.

Regulatory bodies need to be up to date regarding the technological development and how to react. Accidents are one thing but vehicle inspection is another. Those working in the field need adequate training and therefore vital the government bodies take those steps before accidents happen. These vehicles are already on the market and it is evident that the number will grow in the near future.

There are some important safety aspects in case of an accident. If an accident occurs, the police or fire department need to be able to cut off the power of the vehicles and also need to understand the wiring of the car. On the EV's there is a relay in the engine room you can activate if it has not been activated automatically by the crash. The relay disconnect the high voltage power of the car (except the battery) so you can work on the car safely. Also the risk of fire was discussed.

Figure 29: introducing battery vehicles to the police in Greenland, the commissioner of police, Bjørn Bay

Providing training can be costly as specific trainers need to be on site. Cooperation in this field might safe resources for all the players. The three governmental bodies could therefore evaluate if it might be beneficial to work together on the subject and do joint training for key players – or send "trainers" to learn and such trainers could then travel to the different sites in the island societies to train others.

4.5 Summary/Comparison

The three countries that collaborated in the El-Mobility project have much in common, among other things because these are all isolated island societies in arctic circumstances. But there are of course cultural, political and economic differences between the countries.

4.5.1 Technical data

As has been described earlier the execution of data collection differed between the countries, since each and one had their own agenda in introducing this new technology in their environment. Also, the project changed a lot – especially in respect to the vehicles used. The Icelandic iMiEV was the only vehicle that travelled to all countries, and was supposed to be tested in each country for at least 6 months. But unfortunately due to regulatory issues the vehicle was only allowed to stay in the Faroe Islands for 3 months for testing. Even though the project had some difficulties in the transferring of cars the project expanded more than partners ever expected when all partners decided to invest, as well as achieving data from other BEV's in their countries (data from total of 8 cars). The fact that the project partners all decided to invest in their own small BEV fleet also induce the visibility of these type of cars on the street, because even though they might be few cars they are in such small societies that they become very noticeable.

The consumption of BEV depends on many factors, e.g. how the car is driven, what setting is used when driving the car (many of the cars have E-mode, which has less electricity consumption and more equal driving), if the air condition is used *etc*.

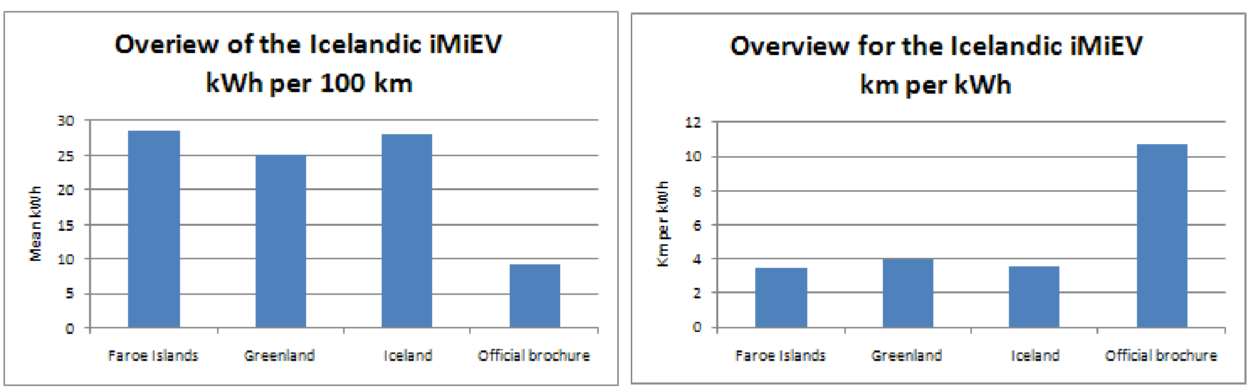


Figure 30: different electricity consumption of the Icelandic iMiEV in the three countries. The picture above displays how many kWh is needed to drive 100 km but the picture below displays how many km you can drive by using on kWh.

The only car that travelled between all three countries is the Icelandic iMiEV and if the data achieved from the usage of it is investigated, the consumption does not vary much between Iceland and the Faroe Islands but Greenland demonstrates substantially less kWh per 100 km.

This could be due to the fact that the car stayed in Greenland from April – August, which are much warmer season than the car was tested in e.g. in the Faroe Islands. It is though important to state that this sample is only one car and in addition quite short period in each country which does not give the overall mean consumption.

It is apparent though, both from interviews with participants and measurements that SEV conducted in the Faroe Islands (figure 16) and Iceland (figure 24) that the air condition uses the electricity to the extent that it severely affect the range of the cars. This is evidently bad news for the countries located in the North Atlantic. One solution to this could be to install cabin heaters, as Nukissiorfiit in Greenland did with their Th!nk vehicles. Then it's possible to plug in the cabin heater, set a timer (perhaps 30 minutes earlier than the user is planning to drive the vehicle) and then the interior of the car is heated before the driver starts the trip.

Electricity production in Iceland is 100% renewable (hydro- and geothermal power, with the addition of some wind power experiments), Greenland has already five cities which are hydro powered but the Faroe Islands are still partially dependent on electricity produced with fossil fuel. This means that when an EV is driven in the Faroe Islands it emits between 86-121,6 grams of CO_2 per km (numbers based on the vehicles tested in the islands, see figure 18).

4.5.2 Social acceptance

The social studies conducted in the El-Mobility project are mostly based on interviews with the public and drivers of the cars with addition to media connected to the events and workshops held in each country (more detailed discussion of the workshops in chapter 7). It is important to keep in mind that the sample is very small and quite few cars that people got their experience from, but its results are nevertheless an indication of what the public's perspective is and how people are experiencing this new technology.

When comparing the results of the social aspects there are a lot of similarities between the three countries. In general people were pleased with the car, it was easy to drive, most people were surprised by the power and how comfortable it was. Participants soon realized the potential of the car for driving within city limits and they liked the silence of it even though it was pointed out at several occasions that the lack of noise coming from the car could potentially be dangerous for pedestrians – especially where traffic speed is low. The silence of the car was also uncomfortable for some of the drivers (of the Th!nk) because it was difficult to tell if the car was turned on or not.

There were also some negative aspects, especially connected to the range and the charging time. In Iceland expectations (before test driving) demonstrated that people have unrealistic expectations regarding range and charging time. It can possibly be partly blamed on the media coverage these vehicles have gotten, *i.e.* that people can expect cars with over 500 km range and fast refueling coming soon to the market. Also if the official brochure of the Mitsubishi iMiEV is investigated the expected range of the car is 130, but the longest distance the car ever reached was 98 km per one charge. This information gives the public unrealistic expectations and will ensure their disappointment of the technology.

People were quite consumed by the specks of the cars, and it is obvious from the interviews that looking past the fact that these cars possess a new technology the users want the basic specks of the cars to work. Therefore there were some complaints about the size, number of seats, windscreen wipers, the lack of power of the central heating system *etc*. It was also apparent from interviews that the specks of the car was depending on the using patterns of the drivers, which even had quite different using patterns (and often different using patterns between personal and work usage). Sometimes the vehicles were not usable by a company because they needed 4x4 vehicles due to the position of the work station, which had nothing to do with the fuel type of the vehicle. But usually the cars were most suitable for families or companies with low or medium driving behavior (cleaning sector, municipality care sector *etc*.) but not for families or companies with high usage of the car (post office, taxi drivers *etc*).

The charging behavior of people was most of the time to charge the cars during the night (most frequently every second night). Some drivers plugged their cars in at work (if available), but where charging posts were available they were never used. This indicates that need for heavy infrastructure implementation is not necessary, infrastructure issues will be further discussed in chapter 5.1.

Regarding the operation cost, people were very pleased with the low operation cost of the BEV‘s (it should be taken into account that the test drivers do not have any knowledge of the possible battery lifetime), but when they were informed about the price of the vehicle there was much surprise and people were not willing to pay such high price for a vehicle, specially with regards to the negative aspects of the car itself (limited range, long refueling *etc*.), but cost issues will be further discussed in chapter 5.2.

5. Infrastructure (Deliverable 3)

5.1 Infrastructure issues

There are different opinions regarding construction of infrastructure for battery vehicles and there are different ideas regarding cost and implications of fast charging, smart polls for charging, *etc*.

The importance of heavy investments in electric vehicle infrastructure is often overestimated when the future of electric vehicles is analyzed. Unlike most alternative vehicles a specific infrastructure is not necessary because every household has their own fuel station for electric vehicles. Special infrastructure with plugs in public places will work more as extra service than essential circumstances for electric transport. The limited range of electric vehicles seems to fulfill the everyday need for most consumers. The users are aware of the limitations and quickly adapt their daily route to their real life experience with the range of the vehicle. According to our results from interviews with users, electric vehicle drivers are not likely to be interested in short time plug in possibilities. One or two main hubs e.g. at home or/and at work should be enough and plugs at every parking place seem to cost a lot without add too much to a common service for electric vehicles.

There are two types of charging possibilities for electric transport:

1. Normal 230V plugs

It can take up to 12 hours to fill an empty electric vehicle battery with a normal 230V plug. It is therefore unlikely that drivers bother to plug in when they park for less than an hour and it is highly unlikely that users would accept long trips with minimum 8 hour stops between every 100 km leg. In conclusion, heavy investments in public charging posts could be a waste of limited recourses. The only technique that could possible benefit from a large scale plug in infrastructure is the ‘plug-in hybrid’ technology which has a very limited electric range. The plug-in hybrid Prius has for example only 20 km range and a battery that can be fully charged in an hour and a half. The biggest advantage of plug in hybrids is that they have extended range with their backup combustion engine. The plug in vehicle is therefore not in an acute need for plugs in every parking lot even though the user would be more likely to use one because of the small battery. It could be argued that public money would be more wisely used in subsidizing those kind of vehicle rather than invest in public charging posts.

Recent project by Vattenfall[3] in Germany where 50 BEV’s (MINI) used by private household, car sharing services and in the vehicle pool of Vattenfall were demonstrated showed interesting results that support our previous statements that: “Users with Home Charging Device practically did not use Public Charging Stations”. Even though there were 50 charging stations in the test city of Berlin (electricity charged). However Vattenfall foresees a possibility to use BEV´s as buffers for wind energy but then connected to smart grids. They are already doing first tests and more information should be available from such tests at later stage.

[3] Meeting with Vatenfall in 2010 by the Icelandic team.

2. Fast-charging stations

Fast charging stations, are stations that can charge battery-powered car to 80 percent capacity in as little as 20-30 minutes.

Fast-charging stations are an addition to the service level of electric vehicles. Fast charging stations could both serve as an emergency fuel stations and as a range extender of electric vehicles possible daily routs. If electric vehicle driver has an access to a fast-charging station in the neighborhood, which could add 50 km range in only 10-15 minutes it could potentially decrease the driver‘s range anxiety. With fast charging stations drivers will probably be more daring in their use of the limited battery range. If fast charging stations work well they can increase the long distance possibilities for electric vehicles. Still the lifetime of battery is an issue with fast charging. Still some electric vehicle manufacturers claim that 1-2 fast charging a week will not affect the lifetime of the battery. Another consideration for the user is the warranty of the battery which might change depending on how frequently such stations are used. Fast chargers will probably be installed in commercial facilities and along highways or at existing gas stations so drivers can top off their batteries during long-distance trips. Fast-charging stations require a careful planning to prevent e.g. grid problems. Such charging require load management constraints in order to prevent ‘mini-peaks’ and localized impacts on grid reliability.

The cost of providing infrastructure is high. There are two considerations, the cost of the plug and the cost of providing electricity to the location. There are a number of studies available for the cost of the polls *etc*. however all costs need to be calculated and providing power to different location can be very costly and that costs varies from one location to another. Therefore it was decided not to publish a cost in this study for such installations as the cost is so different from location to location.

5.2 Operation cost

One of the first things that usually pop up to peoples mind when asked about BEV’s are the expectations for low operation costs. But what people must bear in mind is that even though operation cost (fuel and maintenance cost) is low the vehicle itself is still expensive and potential buyers must keep in mind that the lifetime of the vehicle is still not fully known (see figure 31).

In some countries, (e.g. Norway) where BEV’s have been on the roads for some time, secondary market has been established for the used batteries. Also, there have been ideas about renting the battery instead of buying. In figure 31 the positive and negative economical aspects of buying BEV are listed.

Positive aspects of purchasing a BEV:	Negative aspects of purchasing a BEV:
- Low fuel cost	- High price of the vehicles
- Lower maintenance cost	- Short lifetime (question of depreciation)

Figure 31: few positive and negative aspects of purchasing a BEV.

As mentioned before the electricity is produced in different ways in the three countries that participated in the project. But what's also varies is the prices of electricity and fossil fuel, as can be seen in figure 32.

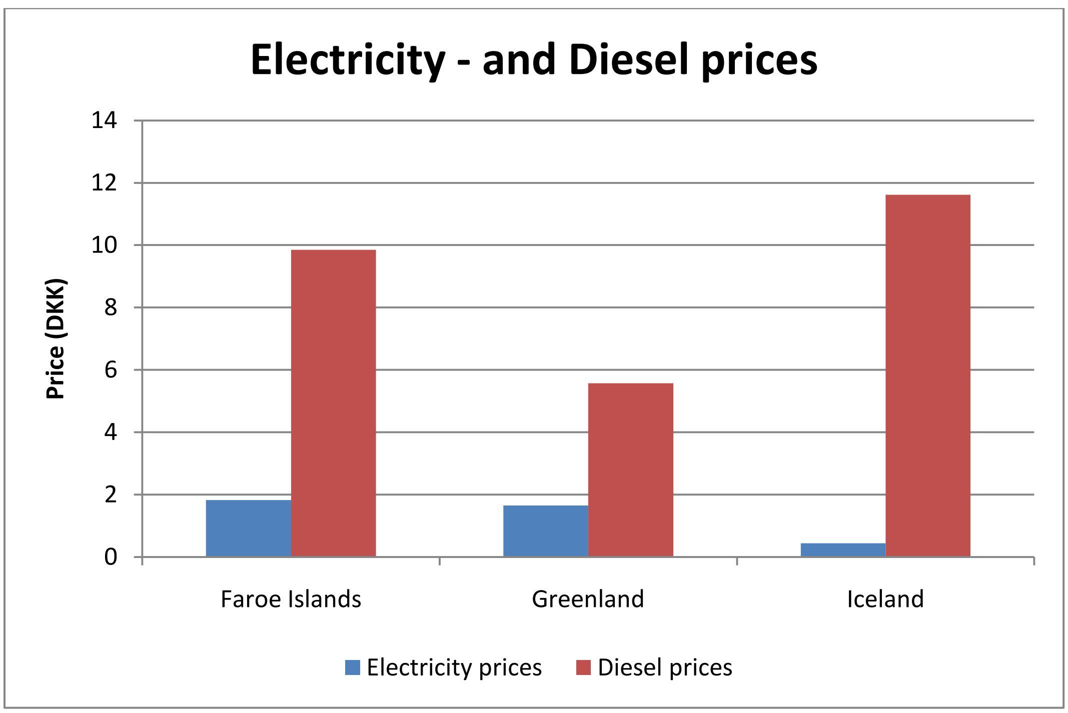


Figure 32: electricity- and diesel prices in the Faroe Islands, Greenland and Iceland.

Even though refueling of BEV's is often thought to be cheap, in comparison with gasoline/diesel, which is not always the case. When the three countries working on this project calculated the cost of driven kilometer of a diesel fuelled car (in a comparable size to the Mitsubishi iMiEV) the results were interesting.

In figure 33 the cost of operating BEV and a comparable diesel car is compared Greenland, the Faroe Islands and Iceland. For Faroe Islands it is a little bit cheaper to drive a BEV, per 100km., (*ca.* 7 DKK difference), but Iceland it is over 4 times cheaper to operate a BEV (*ca.* 45 DKK difference). But on the other hand, due to extremely low oil prices in Nuuk, Greenland it is cheaper to drive on diesel oil than on electricity. Due to different electricity prices in different towns of Greenland, only two towns were economically suitable for electric vehicles (see calculations in Annex III). If there electricity prices were lower for BEV's it would be a more attractive alternative in Greenland.

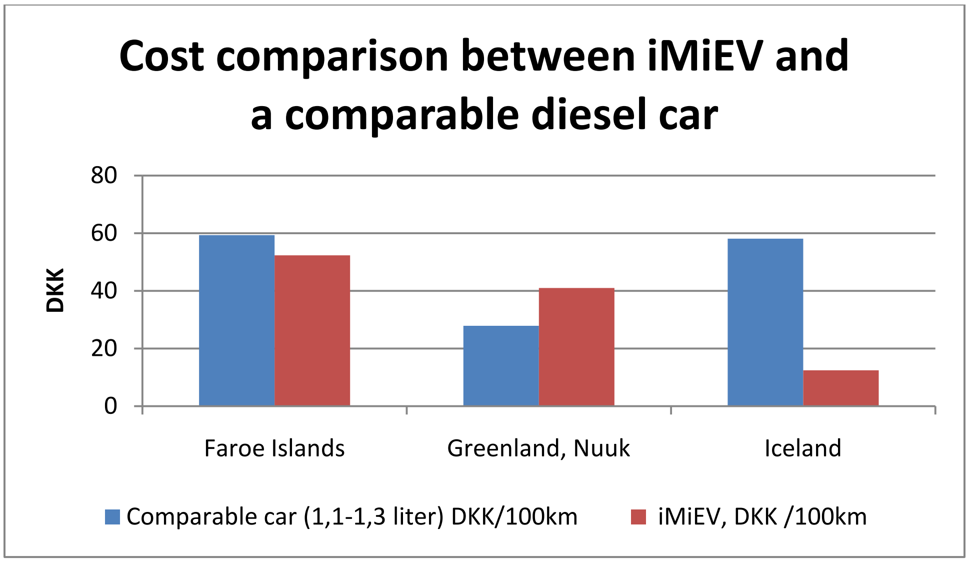


Figure 33: cost comparison between the Icelandic iMiEV and a Comparable diesel car (5 liter per 100 km) in the three countries[4].

[4] *Faroe Islands: Light and power prices: 1,83 DKK/kWh - Diesel price: 9,85 DKK/Liter*
Greenland: Light and power prices: 1,65 DKK/kWh - Diesel price: 5,57 DKK/Liter
Iceland: Light and power prices: 0,44 DKK/kWh - Diesel price: 11,62 DKK/Liter

6. Market evaluation (Deliverable 1)

The goal of the project was to evaluate the potential market in the three island societies. However the project was small and therefore it was not possible to do a detailed market assessment. Still, the interest for this project was much higher than the participants originally anticipated.

At the onset of the project the goal was to have only two cars in total in the project. However with the project good connections were set up with vehicle providers. This led to the opportunity for the countries actually to obtain more vehicles, a very positive step. Finding customers for those vehicles was not complicated which indicates that there is a high acceptance for such vehicles.

During the project key players were interviewed and asked regarding potentially using battery powered vehicles in the future. There was an overall consensus as can be seen for example in chapter 2.1.4 above. The general agreement was though that when talking to private vehicle owners then a battery vehicle could easily replace vehicle no. 2 in the household. Many of the companies that used vehicles though stated that part of the vehicle pool they had could easily be battery vehicles, specifically service vehicles.

Greenland and Faroe Island have the unique situation that their transportation network is very small. Faroe Island is a small island community and a battery vehicle can almost get to anywhere in the island from Torshavn. This drastically increases the potential for the vehicles being implemented in a larger scale than in other societies. The same applies to Greenland where communities are not connected together with a road network. Travelling around for example Nuuk then a battery vehicle provides you with all the necessary range needed for any errands. This is very evident from the customer reactions, like here below from ISS:

"*Buying a Th!nk (battery vehicle) was the real solution because of the range and the warranty. It felt like a good car to start with.*
In the future ISS will try to get more EV's, but it is difficult to get EV's to Greenland because of the manufacturer's issues about sending their cars to a small and cold country and have their doubts about how the car will perform there.
Our partnership with Nukissiorfiit has been ok. In a small country it is better to work together in a project like this, to make it work. To be in a project like this has been exiting, because we were able to be the first in Greenland to drive and repair EV`S. We have high hopes for the future, because we have proven that EV`S work in a cold climate and we can save money by investing in them."

Most of the companies in all the countries provided a similar answer. Still very few vehicles have been introduced in the three islands. The reason for a slow uptake so far is mainly (just to name key issues):

- Availability of vehicles

  - Before the project no producer was willing to provide vehicles to Greenland. Still obtaining cars is difficult. Many of the OEM´s[5] have stated that they will only deliver vehicles where there are strong incentives in place.
- Availability of service
  - Service is lacking and it is difficult for car importers to provide such service as it is expensive to train maintenance people and also to have a stock of spare parts.
- Cost
  - The vehicles are still much more expensive than conventional vehicles
- Lack of infrastructure
  - There are very few charging points in the three islands – and no fast charging
- Technical faith
  - Trust for batteries is not very high. It is important that some key players start using such vehicles so that they become part of the "norm". Also by seeing such vehicles in traffic the public´s trust in the technology will increase.

Due to these factors it was very difficult to evaluate the potential market size. The key criterion is cost. This can be observed in Norway where battery vehicles have been very successful. No country in the world has been as vigorous in providing incentives as Norway:

- No Import Tax
- No VAT
- Very low annual registration fee
- Free parking in publicly owned parking spaces
- No road toll
- Access to bus lanes
- Free admission on national road ferries for the car (not the driver)
- Increased mileage allowance in public sector (NOK 4 / km instead of NOK 3.50 / km)
- Only 50% taxable benefit if used as a company car

Following this the sales of battery vehicles has been very high – over 1.000 cars last year alone. The current accumulated fleet is 5.500 vehicles which is 0,25% of the total fleet. This number is far higher when you look at the total of new cars sold in 2011 when approximately 1,6% of total new cars sold were BEV´s. Taking into account the very positive feedback from customers in this project there are indications that the market share for battery vehicles could at least be of same size or even larger. The table here below shows the number of new cars sold in the three island societies over the last three years. It also shows the potential number of vehicles sold if the same number of vehicles would be sold in those communities as in Norway.

Another important factor that needs to be taken into account is the operation cost in the countries. As can be seen in figure 33 there is a large difference in the cost of driving each km. In Iceland and Faroe Island fossil fuel is heavily taxed, just as in most of the other Nordic nations, however

[5] Original Vehicle Manufacturer

fuel carries almost no taxes in Greenland. This will definitely have an impact on the customers' behavior when deciding to buy a electric vehicle.

As can be seen from this discussion the share of battery vehicles of new cars can easily be drastically increase, specifically in Iceland and the Faroe Island given that the price of the cars can be lowered to a competitive prices with small gasoline vehicles. As vehicles are taxed in both countries the best way to reduce the cost would be to provide incentives by reducing taxation. It is expected that battery vehicles will be more expensive for some time now and therefore if the goal is to increase the share of renewable electricity in transport then it will be necessary to provide some incentives. The situation is more complicated for Greenland as there is such a little difference in the cost of operating an electric vehicle and a gasoline vehicle.

Another important factor related to government (or government institutions) and that is the responsibility of being a role model. It is important for future customers to 'get used' to have such vehicles on the road. In this case governments (national or community) should lead the way and if they themselves are not the forerunner of using the technology – who then. By seeing the technology on the streets the customers get used to the technology and then 'believe' that the technology is mature enough for the normal market is increased.

One of the goals of this project was to do a market evaluation. However as can be seen from the discussion here above there are many factors that will affect the market – specifically governmental actions. Based only on interviews done in this project the conclusion would indicate that the potential market for battery vehicles would be large as almost all users in the project were very positive towards the technology and stated that they would be willing to buy such a vehicle if...... and there the factors mentioned in this chapter were listed, specifically those regarding cost. It is therefore difficult to draw concrete conclusions in this chapter, however there are indications that the market share of electric vehicles can be drastically increased specifically if government actions are taken, like those mentioned for Norway.

7. Dissemination

One of the key elements of the El-Mobility project was to host a local workshop in all the three countries during the project period. The aim of the workshops was to increase the awareness of electric options in transportation as well as sustainable transport policies.

The El-mobility project and its workshops were highly visible in all three countries and drew a lot of media attention. In every workshop the conference participants have been offered to try available BEV's in their community, where the NORA supported vehicles were labeled with the NORA logo. In the Faroe Islands 150 people showed up in the Nordic House in Tórshavn for the electric car conference to observe a whole day of interesting and various electric mobility themed presentations as well as grant opportunities. The conference was a great success and the following day's news about the event was headlined in the country. In Greenland two independent workshops were held in the cultural center Katuaq in Nuuk. The conference which was themed with electricity for the transport sector (both battery and hydrogen) was attended by 35 people and even few governmental figures. In Iceland a workshop was held at the premises of the University of Reykjavík. Around 80-100 people attended the work shop which was an excellent platform for people working in parallel fields.

In the following chapters the dissemination in each location will be described in details.

7.1 Faroe Islands

150 people on electric car conference in the Nordic House

The first electric car conference in the Faroe Islands was in the Nordic House in February 2011.

Figure 34: about 150 listeners are at the electric car conference in the Nordic House

SEV and Jarðfeingi were promoters of the conference together with NORA (Nordic Atlantic co-operation), which was an offspring of this project. SEV represent the Faroe Islands in the project and form together with Jarðfeingi a working group that among other things coordinate the electric car day in the Nordic House. The conference in the Nordic House was for invited, representing authorities, car importers and others, but other interested are also admitted.

Altogether there are hundred and fifty listeners.

During the conference there were 9 presentations:

- ChoosEV, Danish project "Test en elbil"
- Vikingegaarden, Charging points *etc*.
- SEV, "Integration af elbiler i det Færøske elsystem"
- SEV, "NORA elbilprojekt"
- Nukissiorfiit, "El-Mobility i Grønland"
- DONG, "Strategier for opladning af elbiler"
- Icelandic New Energy, "Clean vehicle demonstrations in Iceland 2000-2010"
- Islensk NýOrka, "El-mobility in Iceland"
- NORA, "A dynamic North Atlantic Region through collaboration"

All presentations are available on SEV's homepage (http://www.sev.fo/Default.aspx?ID=1816)

SEV will be prepared

Some people may have asked the question, why SEV is in front in the implementation of electric cars. The answer is simple, there is at great progress in this area, and before we know it, electric cars are a commercial and competitive traffic solution for many people. At that time we will be prepared with our part of the system, namely the providing of electrons, Hákun Djurhuus, SEV's Managing Director said at the opening of the conference.

Figure 35: Hákun Djurhuus, SEV's Managing Director, opened the conference

Beside this, there are many other details left to be solved, so we expect that many players will assert them self, and we welcome them all, Hákun Djurhuus said and pointed out, there will be several flexible users in the system. This opens new possibilities, and SEV hopes to be able to combine this with ours huge resources of wind.

The GRANI-project

The manager of SEV also mentioned the GRANI-co-operation that the electric company also is promoter of with DONG Energy as an important partner.

The powerful natural energy in the Faroe Islands, and the research in the GRANI-project will with no doubt, get international interest, and this will be the Faroese contribution to a better world, where the electric car will be a natural and fast growing part of the traffic net, Hákun Djurhuus said

Figure 36: SEV's Technical Manager Finn Jakobsen, Johan Dahl, Minister, and Jákup Sørensen, NORA

He said tank you to the Minister concerned, Johan Dahl, and his administration for their great interest in electric cars and was glad that the Government of the Faroe Islands for some years forward has exempt electric cars from registration fee, to encourage people to obtain these.

He was also glad for the goodwill and interest the Faroese car importers have for the electric cars.

During the lunch break it was possible for the participants to test drive the four EV’s and the exclusive Tesla Roadster.

The general feedback from the participants was positive and people seemed happy with this initiative.

7.2 Greenland

El-mobility workshop:

Nukissiorfiit, one of the El-mobility project partners conducted a conference on the 9th of August 2011 in the cultural centre Katuaq in Nuuk. The conference was organized as two independent workshops, where the topics were: electric cars and hydrogen.

The target audience for the two workshops was the Greenlandic population generally, and the goal was to provide status on the development of electric cars and how they work in Greenland and current status on hydrogen in the North Atlantic area.

At this event there were speakers from Iceland, Norway, the Faroe Islands and Greenland. In total around 35 people attended the conference among them, participants from Kommuneqarfik Sermersooq, Nukissiorfiit and representatives from the country's car dealers, schools, the press and other interested individuals.

Figure 37: Th!nk in front of the Greenlandic hydrogen station.

<u>*Practical information*</u>

Jens H. Nielsen, the El-mobility project contact from Nukissiorfiit was interviewed after the conference:

"My view is that the day was very successful. There were many good presentations, where the focus was on practical information", says Jens who was also glad they got a lot of questions and open dialogue between the presenters and other participants. Jens also shares this positive attitude with Birtha Bianco, Nukissiorfiit's head of HR and the holiday acting energy director for Nukissiorfiit and Jens B. Fredriksen Naalakkersuisoq of Housing, Infrastructure and Transport. They both attended the first few hours of the conference and each held an opening speech.

Positive experience

Largest part of the day was devoted to electric vehicles and the El-mobility project where representatives from the participating companies, from Iceland, the Faroe Islands and Greenland, gave status update on the project.

"Generally, the experience from the project has been positive, but we can also learn from each other's negative experiences and thus avoid making the same mistakes", says Jens H. Nielsen.

Participants behind the steering-wheel

During the lunch-break, in between the two workshops, participants had an opportunity to test drive various electric vehicles. The event took place in the parking lot outside Katuaq, and got a lot of attention from passing tourists, locals and the press.

Figure 38: four BEV's in front of the cultural centre Katuaq in Nuuk, 9th of August 2011

"In total we demonstrated four electric vehicles, two Mitsubishi iMiEV (from Iceland and DeresAuto) and two Th!nk cars (from Nukissiorfiit and ISS)", says Jens H. Nielsen. For more adventurous conference participants, there was also an opportunity to take a trip on two electric mopeds (from the sport store Ittus) and two Segway motorized, self-balancing, and 2-wheeled transportation devices (from ISS).

Three birds with one stone

Since many of those who are engaged in electrical solutions in the transport sector are also active in an organization called NAHA (North Atlantic Hydrogen Association) it was decided to have the General Assembly in conjunction with the El-mobility conference. This also created the opportunity to host a smaller event to talk about the status of various hydrogen projects in the North Atlantic region. All the presentations from the workshops can be found at this website:

http://www.nukissiorfiit.gl/dk/om_nukissiorfiit/igangvaerende_projekter/el_mobility/

Public test-driving in Nuuk:

Figure 39: public test event, October 2nd 2010.

Nukissiorfiit arranged a public test event for the citizens in Nuuk. Everybody with a driver's license could take a drive with the EV on a marked route. It was a good publicity for the project and a fine way to get social acceptance from the public for EV's.
There were approximately 80 persons who took a test driver and the cars drove continuously for nearly 4 hours and the consumption at the end of the test were 35 and 45 % left. Also the press was present and there was good feedback both from the press as well as the public.
The local police authorities, kindly allowed us to use the Self rule place, which is normally closed for traffic.

The EV's in the press:
In the project period there has been positive reviews in the news and television. All the articles and TV item have been contributory to make social acceptance and awareness of introduce the EV's in Greenland.

Delivering the Th!nk to Governmental representatives

Figure 40: members of the government took a drive on electric cars.

On Wednesday 14th July the CEO of Nukissiorfiit, Svend Hardenberg, handed over the keys of two electric cars to representatives of the Government of Greenland. The event was held in the capital city, Nuuk, where the public also got the opportunity to see the two electric cars Nukissiorfiit has purchased. The premier, Kuupik Kleist, and the Minister for Housing, Infrastructure and transport, Jens B. Frederiksen were test drivers of the two zero emission and virtually noise-free vehicles for one month.

Th!nk appearance in the TV-programme 'A taste of Greenland'

Figure 41: a taste of Greenland. Cris Coubrough (the cook) and the Premier, Kuupik Kleist.

One of our Th!nk EV's was lent to the TV program "A taste of Greenland". A taste of Greenland is a program about Greenlandic food and culture. It'll be shown on Air Greenland Atlantic plane and distributed by TVF worldwide, it has for example been sold to BBC World will be shown in over 45 countries. By loaning the Th!nk to the TV program, we branded the project in a positive way.

7.3 Iceland

El-Mobility - Workshop in Iceland 3rd of June 2010.

In the beginning of summer, a work shop was held in Iceland where specialists, working in the field of alternative fuel and vehicles, specifically focusing on electric mobility, were invited. Overall, thirteen experts presented their field and gave an update on current projects. Around 80-100 people attended the work shop and the event was an excellent platform for people working in parallel fields and who share similar goals.

Figure 43: about 100 listeners were at the alternative fuel conference

Figure 42: the Mitsubishi iMiEV presented for the Minister of Industry

Two Icelandic universities launched the conference by introducing projects with retrofitted electric cars. In addition, Reykjavik University (RU) presented their projects that involve for example analysis of different driving patterns of individuals and companies as well as their possibilities for using alternative fuel and technology. Recently, RU drove one of their retrofitted electric cars around Iceland with stopovers in small towns, both for charging- and educational purposes. RU emphasized the importance of community's attitude towards alternative fuel. Furthermore, they'd like to see increased and strengthened incentive system. The University of Iceland (UI) pointed out that everyday driving, for an ordinary family, is less than 60 km, with a maximum speed of *ca.* 80km/h. Therefore, for an ordinary family, the second car could possibly be an electric vehicle with lower range than conventional car. The representative from UI also stressed the importance of preventing overstatements and hypes in the field of alternative fuel, since it usually leads to false hopes and disappointments of the customer which ultimately leads to public rejection.

Framtíðarbílar (Future cars) is a recent development association that has, among other things, retrofitted an electric car. They stated that they are experiencing substantial lack of market opportunities (caused by high cost and need of infrastructure). They, as many others, underlined the importance of governmental supports e.g. to buy vehicles and creating an incentive system.

Figure 44: many attended the demonstration of different vehicle driven by alternative fuel

In the work-shop the newly imported Mitsubishi iMiEV was also presented at the conference as the first, public available, mass produced electric vehicle for European markets. The pros and cons of the vehicles were presented, and an interest for further importation of the cars was stated.

A recently established umbrella organization, Samtök um hreinorkubíla (Association for clean energy cars), presented their concept as a platform where specialists, importers and interested actors work together towards common goals. The organization invites all companies and people, working with alternative fuel, to work toward the goals of increasing public awareness, know-how and cooperation as well as involving educational institutions.

Figure 45: various vehicles with alternative fuel were demonstrated at the conference (methane, electric, hydrogen etc.

What most of the specialists mentioned in their presentations was the need for unifying concessions regarding import taxes and VAT for alternative fuelled vehicles and their spare parts. For example some vehicles are exempted from all taxes – others carry VAT and no import taxes and some carry VAT and reduced import taxes. This creates confusion and makes cost comparisons complicated, as currently electric vehicles are more expensive than similar gasoline versions and can therefore carry very high VAT as that is percentage of vehicle price.

In general, people seemed to agree that there would probably not be one ‘winner’ in the field of alternative fuel and the Minister of Industry stated that the government, itself, would not pick one alternative fuel over others, on the contrary it would rather be the market and/or technology development that would steer the way.

After the meeting, there was an exhibition of vehicles powered by alternative fuel where the minister of industry and other participants got the opportunity to test drive the vehicles. The Minister took her time to study and test drive different vehicles. Media was also present at the meeting and the event got a good media coverage.

Græna Orkan

Vistorka í samgöngum

The website of Græna Orkan/EcoEnergy

http://www.graenaorkan.is

The outcome of the work meeting was that much has been done in the field of newenergy-vehicles and there are plenty of retrofitted vehicles (e.g. electric, hydrogen and methane) currently on the streets of Reykjavik. Due to the good media coverage it increased the public attention toward el-mobility and the possibilities in the future. Following the conference the government launched a new project Græna Orkan (EcoEnergy). That initiative is focusing on increasing awareness of electric and alternative vehicles.

However it is important to keep in mind that these changes can be expensive but are at the same time very important steps to gain better understanding and to create a knowledge base for these new technologies.

The general feedback from the participants was positive and people seemed happy with this initiative. Some mentioned that there is lack collaboration and information sharing regarding alternative fuel in Iceland and that this event could possibly be a platform to increase cooperation within the field. The El-mobility project had therefore a very successful kick-off in Iceland as the first vehicle in the project is already running and the workshop got much better feedback than originally expected.

8. Conclusion

In general the outcome of the project was beyond the expectations laid out in the beginning. At the onset the situation was for example for Greenland that no vehicle provider was willing to provide vehicles to the country. This has now changed. The project has put the three island societies on the radar of BEV producers which is a very positive step.

From firsthand experience, before battery vehicles become viable for the public it is necessary to demonstrate them in the environment and prove their viability. Also during the initial stage the vehicles are more expensive than comparative fossil fuel vehicles and therefore a threshold for public ownership of the vehicles. The car manufacturers are convinced that the cost of such vehicles will become more competitive in the near future. Until then it is of utmost importance to maximize the learning so that a potential market launch in the islands will be successful. This project made this possible.

The idea was to test the vehicles in different environments and if successful and if the market responds the plan is to evaluate the possibility to drastically reduce the dependence of the North Atlantic on fossil fuels.

The project partners all agree that it was a very successful project. There are many obstacles to overcome in the coming years so that BEV´s will be a large part of the vehicle pool in the countries. Many of them are directly connected to government actions, related to social issues and economics. Issues such as codes & standards, training of staff (first responders *etc*.) and vehicle cost (taxation) to name a few can all be addressed by governments. Still the project has gotten very strong political support and governments have all declared their ambitious goals to increase the market share of EV´s. However actions are needed

The El-mobility project was just the first step. However knowledge from the project can be used for further studies but specifically the outcome can help future players regarding approaching the market. The project created interest from many private persons and companies. However most of them stated that cost obstacles need to be overcome before they are willing to take next steps. In this sense governments can also be a key promoter – *i.e.* by themselves buying and using such vehicles and making them a norm in traffic.

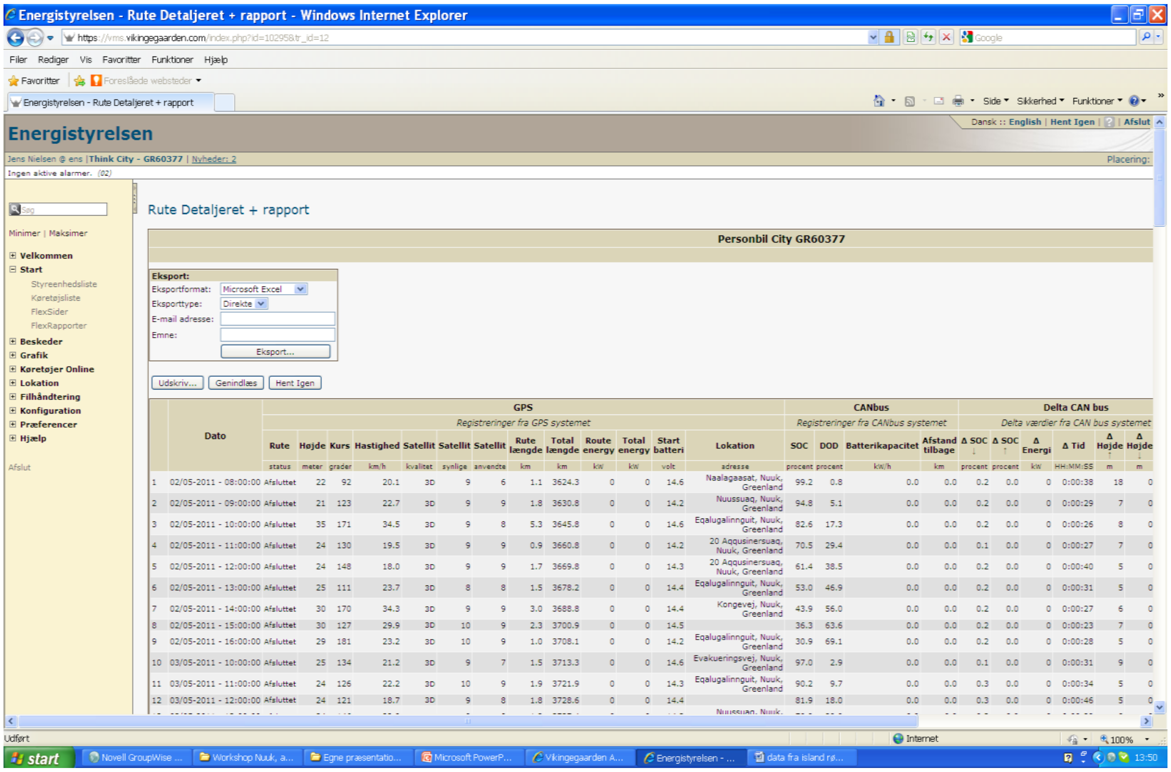
The project team is convinced that electric mobility has a bright future in the North Atlantic. However the three island communities are a very small market on the global scale and further cooperation in this field is therefore recommended. In that way resources can be used more efficiently and there will be more success stories.

Annex I

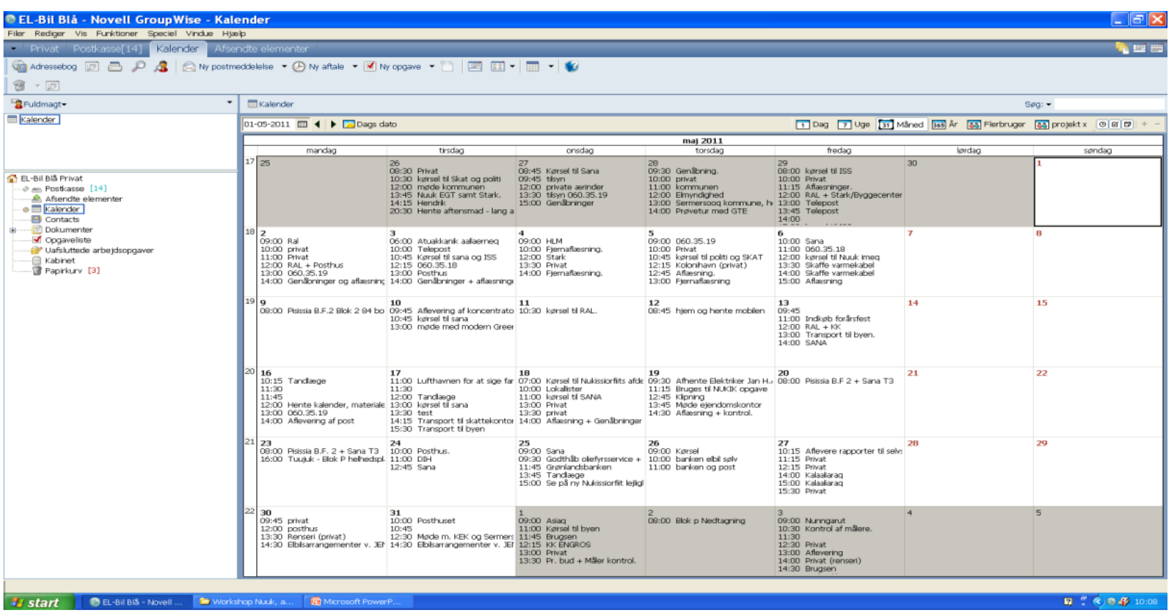
Charging pattern, measurements by SEV.

Annex II

Screenshots from the WebPages at Vikingegaarden:



Screenshot from the booking calendar for the EV's



Annex III

The following calculations are approximate, as data was obtained on the experience data for the electric car in Nuuk.

Th!nk City electric car:
In Nuuk.

- In Nuuk: 1 kWh = 1,65 DKK (Light and Power)
- 23 kWh x 1,65 = 37,95 DKK / charge
- 100 km / 23 kWh = 4,35 km / kWh
  = 0,37 DKK / km. In Nuuk
- In Nuuk: 1 kWh = 0,68 DKK (fishing industry)
- 23 kWh x 0,68 DKK = 15,64 DKK / charge
- 100 km / 23 kWh = 4,35 km / kWh
  = 0.16 DKK / km. In Nuuk

In Narsaq and Qaqortoq:

- In Narsaq and Qaqortoq: 1 kWh = 3.33 DKK (Light and Power)
- 23 kWh x 3.33 DKK = 76.59 DKK / charge
- 100 km / 23 kWh = 4.35 km / kWh
  = 0.77 DKK / km. Narsaq and Qaqortoq
- In Narsaq and Qaqortoq: 1 kWh = 1.49 DKK (fishing industry)
- 23 kWh x 1.49 DKK = 34,27 DKK / charge
- 100 km / 23 kWh = 4,35 km / kWh
  = 0.34 DKK/ km. Narsaq and Qaqortoq

In Sisimiut:

- In Sisimiut: 1 kWh = 1.65 (Light and Power)
- 23 kWh x 1.65 DKK = 37.95 DKK / charge
- 100 km / 23 kWh = 4,35 km / kWh
  = 0.37 DKK / km. In Sisimiut
- In Sisimiut: 1 kWh = 0.68 DKK (fishing industry)
- 23 kWh x 0.68 DKK = 15.64 DKK / charge
- 100 km / 23 kWh = 4,35 km / kWh
  = 0.16 DKK / km. In Sisimiut

In Tasilaq:

- In Tasilaq: 1 kWh = 2.87 DKK (Light and Power)
- 23 kWh x 2.87 DKK = 66.01 DKK/ charge

- 100 km / 23 kWh = 4,35 km / kWh
  = 0.66 DKK / km. In Tasilaq
- In Tasilaq: 1 kWh = 1.19 DKK (fishing industry)
- 23 kWh x 1.19 DKK = 27.37 DKK / charge
- 100 km / 23 kWh = 4,35 km / kWh
  = 0.27 DKK / km. In Tasilaq

As can be seen from the above, Nuuk, and Sisimiut are preferred to electric cars as 0.37 DKK / km is cheaper than the diesel car. In Tasilaq, Narsaq and Qaqortoq the cost of electricity is too high compared to diesel at light and power tariff. So in these cities it would be preferred if electricity for BEV's could be bought with the same rate as the fishing industry. It costs approximately half the cost of energy for driving a year for electric cars. Which is equivalent to 6 years prior to the LCC (life cycle costs) are the same for electric vehicles versus diesel in Greenland. (5,000 km / year) if the difference is included in purchase price.

If the car is driven more than the 5,000 km per year the prices will similar decrease proportionately.