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Authors: Gustav Friis and Susanne Krawack

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Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Scope of the deliverable

The READY project (Resource Efficient cities implementing ADvanced smart citY solutions) aims at developing and implementing innovative solutions to reduce the needs for fossil fuels and release of CO2 to nearly zero in the two demonstration sites. The scope of the deliverable is to investigate possibilities for reduction of local transport and develop models for mobility management in the smart city demonstration districts.

The project started in December 2014.

This specific deliverable is presenting **mobility management models and measures to increase the use of EVs in Aarhus and Växjö**.

Context of the deliverable

This deliverable correspond to task 4.6 of the READY project: Mobility Management – **Reduction of Local Transport**.

Perspective of deliverable

This deliverable points out models to follow to further demonstration of EV mobility solutions in task 5.6 – lead by E.ON.

Involved partners

Several partners were involved in the elaboration of the deliverable by providing inputs including: Municipality of Aarhus, Municipality of Växjö and E.ON.

Executive Summary

The scope of the deliverable is to investigate possibilities for reduction of local transport and develop models for mobility management in the smart city demonstration districts.

The deliverable "D4.6.1 – Report on models for mobility management" has three main objectives:

1. To describe in which mobility context, the mobility management models will be elaborated
2. To briefly describe the challenges in the EV markets in Denmark and Sweden
3. To provide an overview over mobility management models and measures to increase the use of EVs

Both Aarhus and Växjö work to improve the mobility systems in the city, providing good mobility options for the citizens and for the guests to the cities. Well aware, that the transport sector is also being the biggest challenge to reach future climate targets, it is important to incorporate measures that can support further up-take of EVs, although the possibilities for the cities are limited. This will further be elaborated in this report.

The description of the EV market in Denmark and the faced challenges derives from READY deliverable 4.3.1, December 2016. It gives an insight in the market development, and why it, as the market situation is at the moment, is necessary to look into the mobility management models described in chapter four of this report.

The mobility management measures or models to increase EV mobility in the cities described in this report can be divided in to the following topics:

- Electrical Charging Stations
- The municipal fleets
- Car sharing models
- Promotion of electrical bikes
- Introduction of electric/hybrid buses in public transport

Some of the models are already in place in the cities some will be further investigated and potentially be implemented as part of **task 5.6** of this project.

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1. Introduction

The READY project (Resource Efficient cities implementing ADvanced smart citY solutions) aims at developing and implementing innovative solutions to reduce the needs for fossil fuels and release of CO_2 to nearly zero in the two demonstration sites. The scope of the deliverable is to investigate possibilities for reduction of local transport and develop models for mobility management in the smart city demonstration districts.

The deliverable "D4.6.1 – Report on models for mobility management" has three main objectives:

4. To describe in which mobility context, the mobility management models will be elaborated
5. To briefly describe the challenges in the EV markets in Denmark and Sweden
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The project started in December 2014.

1.1.Reduction of GHG emissions from transport

A number of different strategies exist to reduce the CO_2 emissions from the transport sector. For all motorised modes, **the most effective strategy** will be to shift the fuel from fossil to renewables. In most parts of the sector this will, however, both be difficult and not sufficient to meet the climate challenge.

The next strategy is to shift the mode of transport from individual, motorised modes to public and active transport modes such as walking and cycling. This will reduce CO_2-emissions, since one person-km in land based transport has the highest emission if travelled in a car with less than two persons compared to most trains and busses[1]. Shift from car to bicycle will of course reduce emissions. Also in freight, transport mode shifts from road to rail or sea will reduce emissions.

Figure 1: Iconic picture from Aarhus showing the use of space of different modes of transportation for 88 people.

[1] https://concito.dk/files/dokumenter/artikler/roadmap_endelig060614.pdf

The third strategy is to reduce traffic, and thereby also reduce emissions. The tools can be pricing, parking measures in urban areas, and other measures to reduce car transport. These measures will most often be used when there is a combination of challenges, such as congestion, noise and air pollution as well GHG emissions.

1.1.1. Shift in fuels

To shift the transport sector from fossil fuels to renewables will in most areas mean to electrify as much as possible. In countries like Denmark and Sweden, this strategy will certainly be very effective, due to the high amount of solar, wind and hydro energy in the power production.

However, there is a long list of renewable fuels which often seems to compete in a small market for green transport. They comprise electricity, hydrogen, bio fuels of different kinds, methanol etc. The potential for GHG reduction will in each case depend on the condition under which the fuel is produced. Several of the so called renewable fuels have only a slightly lower emission than conventional fuels in an immediate comparison[2]. However, we should also look into the future for sustainable solutions, and the prevision is that the power production will be based on wind, solar and hydro energy to a larger extend over the coming years, so the shift to electric vehicles will be the way to go.

Several scenarios have been elaborated in Denmark, and they show that the most effective measure to reduce GHG emissions from car traffic is to implement a fast transition to EVs. This could reduce the CO_2 emissions by 55% over 40 years[3]. The reason behind the time span is the time it takes to shift the whole vehicle fleet. The average lifetime of a car in Denmark is 17 years, so it is a rather slow transition. Furthermore, not all transport can be shifted to EVs.

For heavy vehicles, the EVs have not yet been fully developed – and might not be, so the available sustainable biofuels should be reserved for long distance road haulage as well as air transport, which is very difficult to electricity.

One of the main measures to facilitate the shift will be to the price of EV's to the consumers. Norwegian experiences with exemption of purchase tax and VAT on EV's as well as other incentives show how effective such measures are. Other costs are of course also important and the total cost of ownership for comparable car types will also be important. The insecurity of the second hand price of an EV as well as the lifetime of the battery are however also important for the individual car choice.

1.1.2. Shift of transport mode

To shift from car to bike will of course reduce GHG emissions as well as air pollution and congestion. However, the bike is mainly used on shorter trips, and even if there is a substantial introduction of electric bikes the total impact on CO_2 emission is limited. The reason of course is that the long trips and highway traffic provides the largest part of CO_2 emissions and can hardly be shifted.

Shift to public transport will also reduce GHG emissions, especially when the extra passengers can be transported in the existing system, maybe with a few duplications of bus or train rides. If the increase in passengers is due to an extensive upgrading of public transport, the reduction of GHG will in reality

[2] https://concito.dk/files/dokumenter/artikler/roadmap_endelig060614.pdf
[3] https://concito.dk/files/dokumenter/artikler/roadmap_endelig060614.pdf

be reduced, as the number of passengers who would not have travelled if the improvement of the public infrastructure would not have taken place, will raise. In such cases, the GHG impact can even be negative.

Shift from car to active or public transport modes has generally a positive impact on GHG emissions, but this in combination with the impact on congestion, greening of the city etc., these activities are relevant.

The measures to make people shift from individual car to public transport and bike are mainly parking policies, reduced speed and allocation of road space to alternative uses. In Swedish and Norwegian towns, also road pricing is used as a congestion reducing measure.

1.1.3. Reduce mobility

If the first mentioned measures are not sufficient to achieve an acceptable GHG emission from the transport sector, it will be necessary to reduce the car-based mobility in order to simultaneously reduce the CO_2 emission from the sector. Furthermore, air transport has a growing GHG emission[4], and if not shifted to biofuels, it might be necessary to reduce air travel and airfreight.

As road transport accounts for the major part of the emissions, the most debated measure is a form of road pricing scheme. This can lead to a substantial reduction in GHG emissions if introduced in the right way. If efficient, a road-pricing scheme will also lead to increased capacity utilization and to a shift to public transport and bicycle, so this type of measure can well address all strategies.

The combination of the strategies can prove beneficial to obtain the EU reduction targets for GHG emissions outside the CO_2 trading sector. However, if the shift of fuels is successful, there is less need to shift peoples transport behaviour from car to other modes and even to reduce the car based mobility, when viewed only from a GHG perspective.

If a fast shift to EVs is implemented the further reduction of CO_2 emissions by also introducing a package of mobility measures (mainly pricing) will only further reduce the emission reduction by 10 % points. If the same package of mobility measures is introduced on top of a slow uptake of EVs in the market, then the impact on CO_2 reduction is 40% points[5]. This result is of course based on the fact that shifting from 100% RE cars or reducing mobility on them have hardly any impact on CO_2 emissions.

[4] https://concito.dk/files/dokumenter/artikler/roadmap_endelig060614.pdf
[5] https://concito.dk/files/dokumenter/artikler/roadmap_endelig060614.pdf

2. Mobility in Aarhus and Växjö

Both Aarhus and Växjö work to improve the mobility systems in the city, providing good mobility options for the citizens and for the guests to the cities. Well aware, that the transport sector is also being the biggest challenge to reach future climate targets, it is important to incorporate measures that can support further up-take of EVs, although the possibilities for the cities are limited. This will further be elaborated in this report.

This chapter describes the mobility frameworks in Aarhus and Växjö, respectively.

2.1. Mobility strategy in Aarhus

The City of Aarhus, like many other European cities is growing. In 2030, it is estimated around 50,000 people will have been added to the current population of 325,000 " a growth of more than 10 %. 30,000 more jobs will move to the city and approximately 20,000 more cars if there are no changes to the mobility patterns. This is a challenge, since the road network at certain times of the day already suffers from congestion.

In the Municipal Development Strategy (2016), Smart Growth has high priority. Following the strategy, the city should grow denser in the future, moving travel destinations closer to each other and making the public transport system more efficient. Furthermore, the smart choice of mobility is an important part of the Municipal Development Strategy, supported by infrastructure projects, such as the almost completed light rail and super commuter bike paths.

The Smart mobility project investigates how existing road infrastructure can be used in a more efficient way, by letting citizens address the challenges they are facing prohibiting them from being more flexible in their transportation. The project is further described later in this report.

The last point addressed in the development strategy is how we make better use of existing infrastructure. Road infrastructure is not used very efficiently resulting in very short, but hectic peak hours.

By following this strategy, the demand for transport should decrease. An analysis carried out by the municipality in 2011 estimated that the city would see an increase in number of trips by 60 % in 2030 compared to 2008 numbers, so the challenge to create a well-functioning mobility system is clear.

2.2. A new mobility plan in the making

The new **Downtown Mobility Plan (2017)** for the City of Aarhus replaces the existing Downtown Traffic Plan from 2005. The main objective of the existing traffic plan has been to rearrange the hierarchy of roadways. This was done to redirect much of the traffic going through the downtown area out on the surrounding ring roads in order to connect the city better with its redeveloping waterfront.

The main objective of the Downtown Mobility Plan is to build on this hierarchy to accommodate a denser and more liveable downtown area. This means a more space-efficient mobility system, where rising mobility needs are primarily to be met though a focus on active and public travel modes as well as reduced commuting distances.

Figure 2: A lot of different levers need to be used to create a well-functioning mobility system

The Downtown Mobility Plan is intended to achieve a modest 'tarmac to trees' goal, where surface parking and road space is converted to squares or green spaces where possible. To reach that goal the City of Aarhus employs a variety of soft and hard measures that can be crudely split into three categories.

First, access to the strategic road network will be removed for selected residential streets while existing bidirectional streets are converted to one-way streets with a single lane. This will improve traffic flows on the strategic network and encourage local residents to consider alternatives to the car. Meanwhile, the leftover road space can be used for cycle lanes, bus priority lanes, wider sidewalks or green spaces.

Second, local businesses, citizens and interest groups in busy downtown areas will get the option of using on-street parking for non-parking purposes at selected times such as during summer, on weekends or after office hours. This will favour active and public travel modes to these destinations due as well as allow more outdoor seating or green spaces through parklets or other temporary installations.

Third, the existing parking restrictions for the city core will be expanded to cover the entire downtown area as well as the surrounding neighbourhoods. Since visitors will have to pay for parking, this will free up more on-street parking spaces for residents while making active and public travel options a more sensible option for long-distance commuters. Furthermore, the parking revenues can be used to construct underground parking facilities that will further free up surface area for a more liveable public realm.

2.3. Smart mobility in Aarhus

The text in this chapter is a re-use of an article written by Liv Maria Stender Boisen and Gustav Friis, City of Aarhus for the Thinking Cities Magazine in May 2016[6]. The chapter applies the behavioral aspect to mobility, in order to understand the importance of travel behavior, also when shifting to the use of EVs.

Encouraging people to use alternatives to the car, not only reduces congestion, but by leaving the car behind, people gain a better quality of life by spending more time with family, exercising more, less stressful work lives and experiencing nature in a new way.

The Smart mobility project based in the City of Aarhus, Denmark has been running for three years and is now working to change travel behaviour amongst citizens to reduce congestion in the city. Within the Smart mobility project, the key messages do not entirely concern mobility, traffic and transport, due to those rarely being an issue relevant to people. How to make a day work well, on the other hand, is crucial for the way people live their lives, and therefore the projects focus is communication.

Improving people's everyday life is the primary target of the Smart mobility project while working with the citizens of Aarhus. Instead of promoting mobility options via campaigns, the project is in direct contact with test persons that volunteer for various mobility solutions. Smart mobility inspires these people and provides the necessary framework to make it possible for real behavioural changes in travel.

2.3.1 User driven innovation

The citizens of Aarhus are at the centre of Smart mobility's user-driven innovation. The goal is to fulfil their needs and improve quality of life, while at the same time providing solutions to generate direct benefits for those involved changing their travel behaviour. A good example of this would be that a test person in one project could replace their car with a faster mobility option and therefore would have more time to spend with their family.

The projects all represent a specific way of thinking in the Smart mobility project. The Smart mobility project wants to investigate thought patterns and routines of citizens when they change their travel behaviour. The user-driven projects in Smart mobility answer many interesting questions in relation to behavioural change. These questions are:

- What motivates an individual to change their travel behaviour?
- What is the expected benefit?
- Does the person benefit from changing their travel behaviour?
- What problems does an individual meet after having changed their travel behaviour?
- Do the advantages outweigh the disadvantages of the changed travel behaviour?
- Which barriers does an individual need to overcome in the changing process?

With these questions at hand, the following paragraphs will give a short overview of a few of the Smart mobility projects.

[6] http://thinkingcities.com/

2.3.2 365 days on the bike

In April 2015, Smart mobility started the project “365 days on the bike”. For this project, 30 car commuters from a suburb of Aarhus replaced their car with an electric bike. For one year, they committed themselves to bike as much as possible in return for bimonthly health measurements, free service and maintenance, and the possibility to participate in competitions based on their tracked trips.

The participants all stressed that experiencing nature in a new way from the bike is one of the key factors motivating them to continue. Benefits, such as fresh air, new smells (that might even compete with the new car smell), the changing of season and peace of mind are mentioned in relation to their daily bike rides. Secondly, the participants were motivated by competition in relation to number of kilometres they travel and active days on the bike; they can measure themselves against each other on the website: www.365.smartmobilitet.dk. The feeling of having time to exercise is also an important motivation factor.

Barriers in maintaining these new habits are bad lighting on dark cycle paths, poorly maintained roads and the lack of winter salting. The project gave the participants the opportunity to give feedback to the maintenance department at the City administration, who implemented efforts to solve the outlined problems.

Figure 3: Motivation to change behaviour through communities and competition

2.3.3 Super Commuters

For three months in autumn 2015, 15 car commuters replaced their cars with a folding bike and free public transport. This project aimed at testing how a combination of sustainable modes of transport could fit into the daily life of commuters. Many of the participants were parents, looking for a flexible alternative to time-consuming car trips. However, this solution did not return value in terms of the expected benefits: improved health and better economy.

The participants were blogging every week during the project in order for the Smart mobility project to collect knowledge about drivers and how they changed during the project. Many participants were families with small children and since their new habits were more time consuming and did not provide more time with the family or exercise on the bike it was not a habit they wished to maintain. Time is for this particular target group of the essence. If the new habit takes too much time it is not a habit that will become a part of their everyday routines.

2.3.4 Early Birds

In December 2015, six dedicated people from the suburb south of Aarhus participated in the Early Birds project. The participants agreed on driving to work earlier than normal in order to avoid the morning rush hour for three weeks. During that time, they blogged about their experiences. The participants all pointed out that they gained valuable time with the family in the afternoon and that they felt less stress and became more productive at work in the early hours before colleagues started to show up and office hours started. The greatest concerns were related to the fact that it can be hard to leave work early even though you checked in early. It seems that driving early is an easy intervention to carry out, mostly perceived as a positive and rewarding habit for the participants. Smart mobility is now in the process of upscaling the Early Bird project in collaboration with businesses in Aarhus.

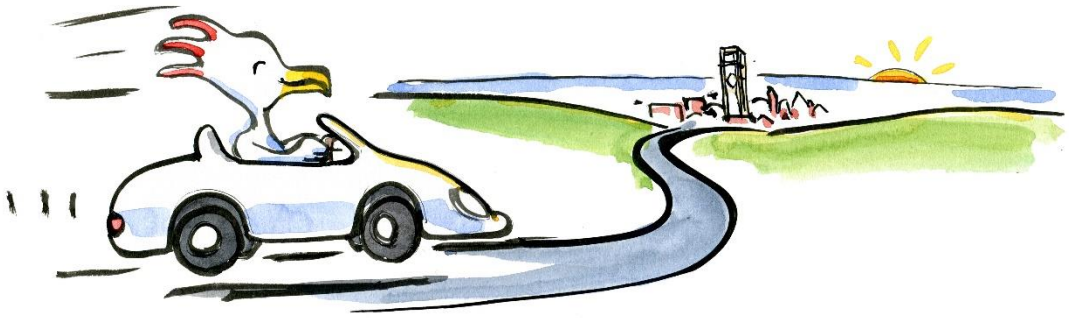


Figure 4: Early Birds avoid traffic congestion by leaving home before the peak hour in the morning

2.3.5 Valuable experiences: Upscaling and anchoring of the projects

In 2016 and 2017, the Smart mobility Project works specifically on two aspects. One is to create a road map for the upscaling of projects based on effective evaluation – does this measure work and will a large-scale implementation of the measure reduce congestion? We, The Smart mobility project, will also include knowledge based on participating citizen feedback. How can people be motivated to change their travel behaviour and what factors are important to them when they choose their mobility methods?

The second aspect is integrating projects in other organisations. Many results are lost when a project ends. Therefore, during the lifetime of a project, it is important to share information and experiences

and facilitate the integration of it in an organisation that will continue. Already a Walking School Bus[7] has been sustained in another department in the city.

2.4. Mobility strategies in Växjö

The current transport plan for Växjö was adopted in October 2014. The introduction to the plan set up the mobility strategy in a growing city with a growing mobility demand.

"In the coming years, Växjö will grow from a small town where journeys are made with private cars, to a larger and more attractive city with distinct urban qualities and regular regional connections. This transport plan focuses on capacity and more efficient and sustainable transport. As the community grows, we will ensure that more people can be transported in the same area. We will develop a city where walking, cycling and public transport can handle the bulk of the transport needs of residents, and where low impact vehicles are used."[8]

The transport plan focuses on five main focus areas with a number of sub-strategy areas:

- Sustainable vehicle traffic
    - Localization
    - Roads and Parking facilities
    - Freight Transport
    - Electric Vehicles
- Cycling
    - Improve and develop bicycle infrastructure
    - Operation and maintenance of bicycle infrastructure
    - Information
- Walking
    - Develop and improve pedestrian paths and walkways
    - Operation and maintenance of pedestrian paths and walkways
- Developed public transport
    - Traffic planning and accessibility
    - Transit points
    - Operation and quality
- Mobility Management
    - IT (in order to reduce travel)
    - Mobility Management

In contrary to the city of Aarhus, the Växjö Transport plan does have a dedicated strategy for electric vehicles. The goal is to make the use of electrical vehicles easier and convenient, and to increase the share of electrical vehicles in Växjö. The concrete mobility management measures are presented in chapter 3.

[7] http://www.xn--gbus-qoa.dk/forside/

[8]http://www.vaxjo.se/upload/www.vaxjo.se/Kommunledningsf%c3%b6rvaltningen/F%c3%b6rfattningssamling/Styrande%20dokument/Milj%c3%b6%20och%20fysisk%20planering/Transportplan_Vaxjo_kommun_eng.pdf

The following text is the description of the status of EVs in Växjö at the time of the adoption of the Transport plan:

"Electric vehicles have long been viewed as the solution to many transport-related problems, but despite having been introduced in the early 1990s, the market uptake of electric vehicles – mainly cars – has been sluggish. One explanation is that electric cars have a high purchase price and a relatively short range requiring additional planning for longer trips. Electric bicycles however are already established with a dramatic increase in sales. According to a simple survey, retailers in Växjö sold more than 150 electric bicycles in 2013, representing an increase of more than 100 bicycles compared to the preceding year. At the end of 2013, there were 10 electric cars, 186 electric hybrids, 11 plug-in hybrids and 200–300 electric bicycles, electric mopeds and special electric vehicles in Växjö Municipality.

The municipality had four cars, two vans, eight mopeds, about 40 electric bicycles and 23 other vehicles powered by electricity. Växjö Municipality participated in the national electric vehicle procurement program organized by the City of Stockholm and Vattenfall. There is an increased interest from municipal departments and companies to purchase vehicles through this procurement program. There is also interest in increasing the number of electric service vehicles within the technical administration among others.

Experience from the EU project ELMOS, where 450 residents had the opportunity to borrow 28 electric bicycles for a three-week period from the Municipality, points to a high rate of user satisfaction resulting in ten percent of the participants purchasing their own electric bicycle. In the next step of the project, electric cars will be introduced via a car-sharing scheme along with the introduction of car-pulling possibilities on campus. The aim is not to simply replace a fossil fuel car with an electric one, but to replace many cars through the use of car-sharing and car-pulling.

Växjö Municipality is also a part of the Green- Charge project led by the low emission vehicle association Miljöfordon Syd. The project aims to increase the number of electric vehicles and improve the charging station infrastructure in Southeastern Sweden.

At the end of 2013, there were six charging stations within the Municipality spread over different neighbourhoods. In addition, there were about 5,000–10,000 power outlets (e.g. for block heaters) in residential and commercial parking garages that can be utilized for recharging electric vehicles."[9]

[9]http://www.vaxjo.se/upload/www.vaxjo.se/Kommunledningsf%c3%b6rvaltningen/F%c3%b6rfattningssamling/Styrande%20dokument/Milj%c3%b6%20och%20fysisk%20planering/Transportplan_Vaxjo_kommun_eng.pdf

3. Electric mobility in Aarhus and Växjö

The following description of the EV market in Denmark, and the faced challenges is from READY deliverable 4.3.1, December 2016. It gives an insight in the market development, and why it, as the market situation is now, is necessary to look into the mobility management models described in chapter four of this report.

The e-mobility products and services market in Denmark has requirements related to the market segments of relevance. The main market segments are the broad and conventional:

- B2C – Business to consumer
- B2B – Business to business
- B2G – Business to Governmental institutions (ex. Universities, hospitals, municipalities etc.)

Expectations are that the market segmentation will be more complex as the market is maturing from its current time wise short presence.

The market has been characterized with an initial B2C first-mover interest (the geek, the environmental concerned and the daredevils), then expanding with local political long term environmental targets from governmental institution replacing their petrol car fleets with electric vehicles, followed by corporate companies wanting an inexpensive environmental friendly transportation and a political correct awareness.

What today is missing is primarily an uptake in the B2C market and this is deemed to come with lower EV prices and larger driving range. Time wise, this is expected to happen in 2018 as the technology push is developing new EV platforms fast with larger battery capacities at a lower cost pr. kWh.

In Denmark, the number of EVs significantly started to develop in 2014 and 2015 due to a combination of new EV models arriving to the market, the development of fast charging networks across Denmark that to a much better degree connected the different regions - and notably the continued incentive on EV registration tax on the EV purchase price. However, in 2016 registrations taxes where applied by the Danish government and since then a significant drop in volumes has taken place.

In Aarhus, a total of 328 electrical cars were registered by February 2017. In total, this is 0.3 % of all registered cars in Aarhus. Including the surrounding municipalities (East Jutland), there is 882 out of 374,616 registered cars. This equals 0.23 %.

By the end of 2016, there were 48 electrical cars, and 87 plugin hybrids in Växjö, according to national statistics. In total, this is 0.3 % of all cars in Växjö.

For Växjö, this is the development 2013-2016:

Year	Electric cars	Plugin Hybrids
2013	10	11
2014	20	22
2015	30	55
2016	48	87

The total numbers of EVs (cars) in Sweden by the end of 2016 were 7,532 electric cars and 18,832 plugin hybrids. In total 0.55% of all cars in Sweden.

4. Measures to increase the number of EVs in Aarhus and Växjö

4.1. Measures to increase the number of Electrical vehicles in Aarhus

The transport demand in Aarhus is increasing as the city is growing. In the **"Municipal Development Strategy" (2016)**, smart growth has high priority. The city is growing denser in the future moving travel destinations closer to each other and making the public transport system more efficient. By following this strategy, the demand for transport should decrease. Furthermore, the smart choice of mobility is an important part of the development strategy, supported by infrastructure projects, such as the almost completed light rail and super commuter bike paths.

However, to ensure a successful transformation to a society, a change in car technology is also crucial, so that renewable energy also can find its use in the transportation sector. Although scoring quite high on international hit lists, the number of electric cars sold in Denmark is still very low, and in 2016 the sale of electric cars has been almost next to zero due to change in charges. The challenge is therefore, **how to encourage the use of electric cars in the city of Aarhus?**

4.1.1 Electrical Charging Stations

In 2012, Municipality of Aarhus included a section in the parking policy about EV charging stations. It stated that reservation of parking spaces should be made, to make it possible to charge an EV in large parking facilities and on the street in the inner city. Furthermore, it was decided that the implementation of EV charging equipment should be considered when establishing new parking facilities.

In 2015, Aarhus City Council approved a strategy for EV Charging stations on public parking spaces in the city.

The overall goal of the strategy is to support the spread of environment friendly vehicles, especially EVs. To ensure that this goal is being fulfilled, the City of Aarhus develops a strategy that encourage and initiate the spread of these kinds of vehicles. As a kick-start of the strategy, the City of Aarhus will be overly welcoming wishes to establish EV charging infrastructure.

Furthermore, the municipality will, along with the development of the city, inspire and work towards incorporating infrastructure that support the use of environment friendly vehicles. This is, for example, done by ensuring parking with charging stations when establishing both private and public parking spaces. The establishment of charging stations completely rely on the market.

Quick chargers are currently being established near retails and along the highways in Denmark, but it is not impossible that quick chargers in a near future can be placed on street level. However, due to the size and the design of the quick charging stations, placing them on street level is not without problems.

To support the development and an increase in the number of EVs the current EV Charging Strategy does not include any requirements to the design of the charging station. These requirements await an increase in the number of electric vehicles on the streets of Aarhus, as well a technological development to a level where it will be feasible to set requirements for the design itself.

When applying to establish EV charging stations in the public domain, the municipality will consider if the proposed charging station fits into the public space. The following will be evaluated when the application is received:

- How long will the charging station be functioning?
- Which type of charging station will be established?
- Where will the charging station be placed?
- Design
- Functionality
- Size

Besides this, there will also be requirements to the *standard* of the charging station. The purpose is to ensure that all public available charging stations established in Aarhus in the future meet the same standard and that they can handle the expected future technology and power supply.

An important element of the strategy is that only one parking lot (out of the two covered by a charging station) will be reserved (by signing) to EVs. The number of reserved lots can be increased along with an increase of the demand for EV charging.

4.1.2 Car sharing in the municipal fleet

The majority of the municipal fleet is appointed to the elderly care and already electrified. However, the City of Aarhus, as part of the Smart mobility project has in February 2017 carried out an analysis of the possibilities to replace poorly used conventionally fuelled vehicles with electric cars in a car sharing system. The analysis was carried out in three sections of the Technical Department sharing one address (Kalkværksvej 10, Aarhus) in the proximity to the city centre with approximately 230 employees. The three sections share the vehicles, and the analysis was carried out for the full year of 2016.

Over one year, cars were used 298 days out of 366. 55 % of these days, at least one car was idle all day. All ten cars were only used at the same time 36 days, and in total only 58 hours. Nine or ten cars were used at the same time for 99 days, but in total only 278 hours.

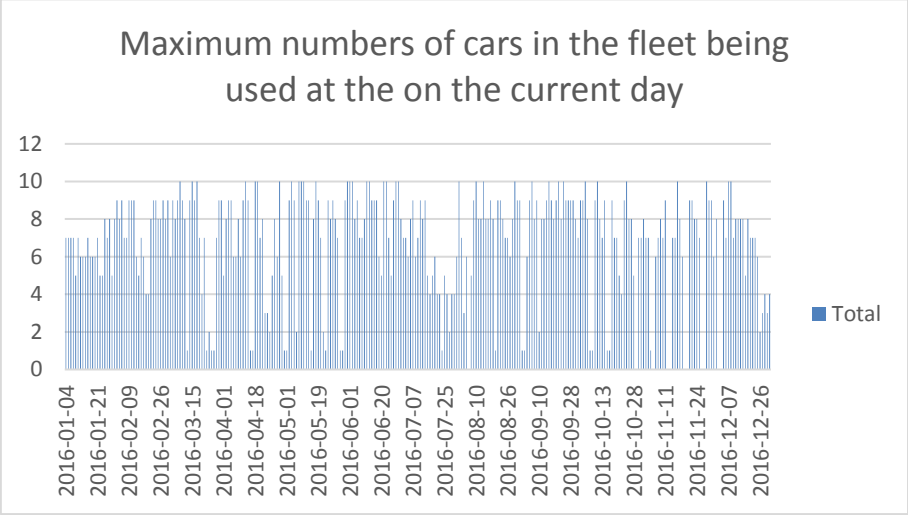


Figure 5: Number of cars in the municipal fleet at Kalkværksvej, being used at the same time sometime during the day

The two last cars in the system are covering a very limited peak demand for cars. Therefore, it will be investigated if it could economically feasible to join an electric car sharing system to cover the peak demand for transport.

The investigation will be carried out during the first months of 2017.

4.1.3 Campaigning to increase the interest of electric bikes

The following article was written to the newsletter of the Cycling Embassy in Denmark in September 2015. It explains the concept of a bicycle library, which promotes bicycles, including electrical bicycles.

In Aarhus Municipality, the new bicycle library gives citizens in the district of Skejby the opportunity to try out different bicycles. This will hopefully persuade them to leave the car at home in the future.

In May and June of 2015, Business Park Skejby and Aarhus Cykelby (Aarhus Cycle City) hosted a so-called bicycle library. The purpose of the library was twofold:

- *Giving people living within cycling distance from Skejby, but who drive their car to work, the opportunity to borrow and try out different types of bicycles that could prove an alternative to the car.*
- *Pampering people who already cycle with easy access to bicycle services and advice making life as a cycling commuter a little bit easier.*

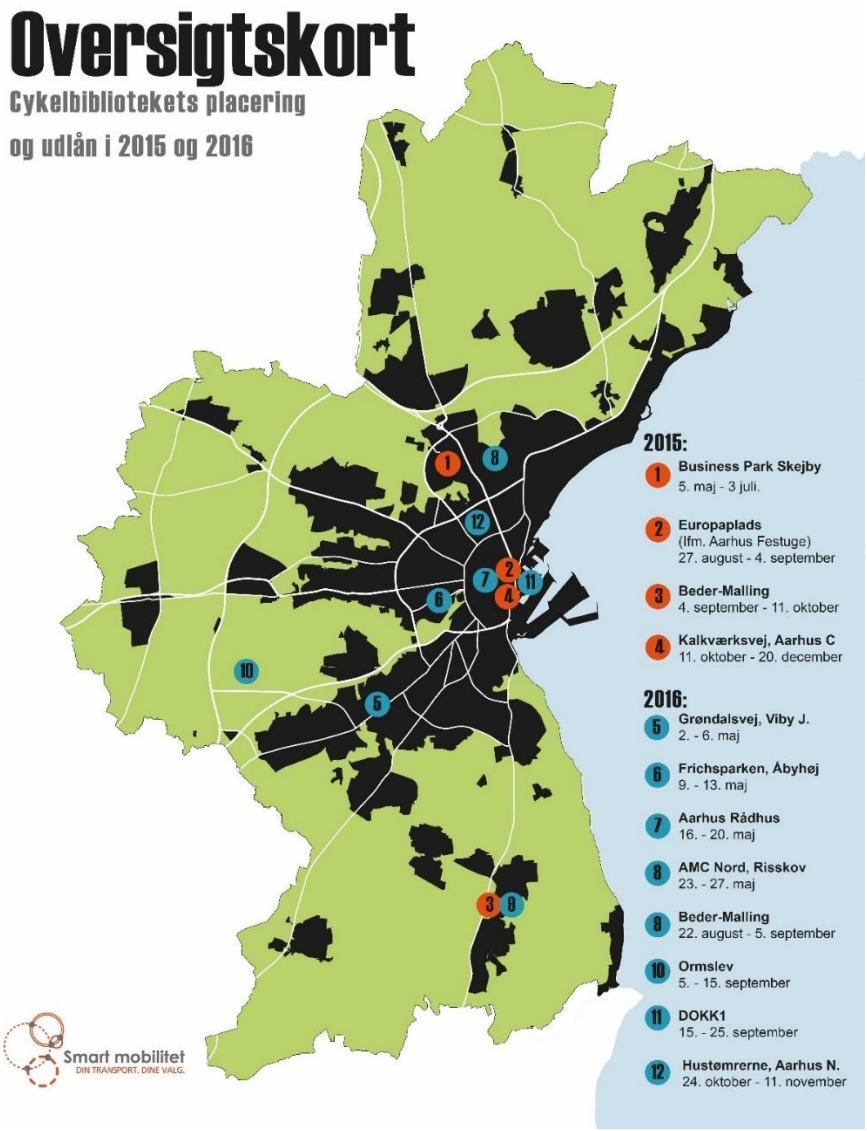
The library consisted of two containers that had had a bicycle library and a repair shop built inside. The library was placed centrally in the area in front of VIA University. The library was manned Mondays, Wednesdays and Fridays. It was possible to borrow lightweight commuter bicycles, carrier bikes, electric bikes, foldable bikes and bicycle trailers.

Figure 6: The Bicycle Library

The bicycle library was marketed through flyers and posters that were delivered by bike couriers to businesses in the area. More than 400 people visited the library to get their bikes serviced. 44 people borrowed a bicycle for up to five days while 145 people came by to try out the bicycles. Two businesses had a special event organised for their employees. Furthermore, there have been more than 1,000 unique hits on the press coverage of the bicycle library on Business Park Skejby's website.

During Aarhus Festival, 2015 the bicycle library moved into the city centre where festival visitors could borrow one of the library bikes for a short period of time. After Aarhus Festival, the bicycle library moved to the suburb of Beder-Malling. Here interested citizens have the opportunity to test if a bicycle is the solution to their everyday transport needs.

In 2016, the Bicycle library was touring the municipality again. The impact assessment will be carried out in 2017.



4.1.4 Community Based Electric Car Sharing

A partnership between the City of Aarhus and TADAA! Electric Car Sharing has been established to investigate the potential of electric car sharing in the city. The aim of the project is substitute 1000 conventionally fuelled cars by 200 shared electric cars by the end of 2017.

Within the project, TADAA! provides electric car sharing to citizens and companies in small and large communities. The project is running in 2017 as Aarhus becomes "European Capital of Culture".

TADAA! is different to other car sharing schemes in the country in the way they are providing the cars, namely through closed communities such as housing association, companies and public intuitions where there is a demand for flexible mobility. The cars have their unique parking spot in the

community, close to the users and restricted to the members of this community. This means that you will only share the car with your neighbours or colleagues.

Figure 7: Picture from www.tadaacar.dk

By March 2017, the scheme is implemented at two housing association in the city with a total of 18 cars.

The scheme is a new way of sharing a car, and an alternative way of introducing electric cars to the city. Neither car sharing schemes or electric cars have been mobility game changers in Aarhus. By establishing a community based electric car sharing scheme, the partners of the project hope to reduce carbon emissions by changing to electric cars, and to make better mobility and better liveability in the city.

By substituting 1000 conventionally fuelled cars with electric car sharing, the City of Aarhus will save up to 46 tonnes of CO2 pr. month. If the project is successful, this equals an annual save in CO_2 of 303 tonnes in 2017 alone. This amount only equals 0,067 % of the total amount of CO_2 emissions from road traffic[10], so there is still a long way to go. However, by the implementation of a new mobility service, the pathway for a new way of understanding mobility may be formed.

[10]https://www.aarhus.dk/sitecore/content/Subsites/gogreenwithaarhus/Home/NyhederGoGreenWithAarhus/Nyheder/Eldelebiler-skal-erstatte-diesel-og-benzinbiler.aspx?sc_lang=da

Figure 8: Various options for sharing mobility in Denmark

4.1.5 Traditional electrical Car Sharing

Currently, there is one traditional electric car-sharing car in Aarhus. By traditional, a car public available car, with a fixed location. The only provider of a traditional car-sharing scheme, LetsGo[11], has a total of 17 cars in the fleet in Aarhus out of 185 vehicles in the Country distributed between eight cities.

The conventionally fuelled cars are easy to implement, although they are still missing their final break through outside of Copenhagen. Since the business case in most cases require free public spaces, not all parking spaces in the city can be allocated. As of March 2017, 17 public parking spaces have been allocated.

In the 3rd quarter of 2017, the parking policy in the City of Aarhus will be revised. This may affect the possibilities for establishment of traditional electric car sharing, depending on the outcome of the policy.

4.1.6 City Cars

In 2015 and 2016, new free-floating car-sharing systems arrived in Copenhagen, Denmark. DriveNow[12] and Green Mobility[13] are the current operators of electric city cars in the City. Whereas DriveNow is in many European Cities, including Stockholm, Green Mobility, which is a Danish company, is currently operating only in Copenhagen.

[11] https://letsgo.dk/en/vehicle-descriptions/2122317/
[12] https://dk.drive-now.com/en/
[13] http://greenmobility.com/

The City Car concepts are highly flexible, since the cars does not have a fixed parking space. This, however also challenge the municipality parking strategies. A city car can be parked wherever you want, but the operating company has to pay the price for parking. A traditional car-sharing car has an allocated spot and, at least in Aarhus, can require a car sharing licence that at a fixed rate can park at a space allocated to car-sharing cars.

Although the city car models provide flexibility to the user in terms of the possibility to pick up a car near you and park it at your destination, it is therefore a challenge to implement due to parking policies and legislation.

4.1.7 Drive and Ride

A new player has emerged to the Danish market introducing a new way of car-sharing. Spiri[14] combine car-sharing and carpooling in a new concept, where you can drive the shared car for free if you bring a long a passenger going in the same direction as you.

The electric cars are picked up and delivered at dedicated hubs, whereas the driver and the passenger meet at virtual bus stops located on the drivers' routes.

The system is not operationally in any Danish context yet, and will probably be difficult to implement successfully, since they are facing the same challenges as the traditional electric car-sharing schemes (see above), as well as diving into a very undeveloped market of demand responsive transport in form of carpooling.

Despite the challenges, the system is considered a mobility management model to be investigated further in order to promote EVs.

4.1.8 Investigate possibilities to introduce electric buses in Public Transport

In 2015, the City Council in Aarhus decided to start an investigation of the possibilities for an electric bus line in Aarhus.

On the basis studies of electric buses in Gothenburg (SE) and Copenhagen (DK) as well as preparation work focusing on one specific bus route, it was decided to let the bus operating company (Busselskabet Aarhus Sporveje) proceed with a public tender on electric buses in 2016.

In January 2017, Busselskabet Aarhus Sporveje published a periodic indicative notice without call for competition[15] prior to the tender. Operation is foreseen in 2018.

[14] http://www.spiri.io/spiri/on-demand/
[15] http://ted.europa.eu/udl?uri=TED:NOTICE:2858-2017:TEXT:EN:HTML&tabId=1

4.2. Measures to increase the number of Electrical vehicles in Växjö

"Although electrical charging infrastructure and electric vehicles are touched upon in the municipal energy plan, we recognize the importance of including them in the transport plan as well. Electric vehicles have an important role to play in reducing noise pollution and local emissions generated by the transport sector within the city. Electric bicycles and car-sharing schemes with electric vehicles also show great potential for replacing private cars. 'Electric vehicles' is meant to cover both passenger vehicles and vehicles for freight distribution."[16] *The strategy:*

Make it easier and smoother to use electric vehicles.	*Increase the share of electric vehicles and electric bicycles in Växjö*

4.2.1 Electrical Charging Stations

"Locate relevant strategic points (car parks, workplaces) for electrical charging stations and work towards the establishment of charging stations at those points. Collaboration with the private sector might be necessary. "

There is currently over 40 public charging spots in Växjö, and yet a few that can only be used if your instance work in a specific office building or stay at a hotel. As part of the **READY project**, Växjö is in the progress of developing a strategic plan for EV charging infrastructure during the spring.

You can find information about EV charging in Växjö by visiting www.uppladdning.nu

4.2.2 The Municipal Fleet

"Lead by example by increasing the share of electric vehicles (e-bikes, cargo bikes, electric cars, light trucks, etc.) in the municipal fleet. "

The municipal organization carried out a public tender of vehicles just this autumn. A wide range of EVs where included in this, and we now have the possibility to buy EVs that are personal cars, mini buses, and transport vehicles. By the end of year 2016, the municipal EV fleet consisted of:

- 18 electric person cars (out of 323….),
- 12 transport vehicles (out of 239),
- 10 mopeds (out of 31) and
- 23 other electric vehicles (out of 39, mainly this vehicles used by park/street maintenance unit of technical department).

There is a huge interest for increasing the share of EVs in the municipal organisation.

[16]http://www.vaxjo.se/upload/www.vaxjo.se/Kommunledningsf%c3%b6rvaltningen/F%c3%b6rfattningssamling/Styrande%20dokument/Milj%c3%b6%20och%20fysisk%20planering/Transportplan_Vaxjo_kommun_eng.pdf

4.2.3 Campaigning to increase the interest in all types of EVs

"Conduct campaigns and collaborate with various stakeholders with the aim of increasing interest in all types of electric vehicles, electric vehicle sharing schemes, electric bicycles and so on among businesses and the public."

Especially work related to electric bikes has been carried out. Actions like "try an electric bike during two weeks" etc., has caused a massive use of electric bikes in Växjö. Some campaigns are directed to public, some towards companies.

Once a year we have a public fair about sustainable transport systems, and then we usually show electric cars and bikes to the public. Special days on the topic of electric vehicles, where it has been possible for the guests to try electric cars has been organised.

Figure 9: "Try an electric bike during two weeks" in Växjö

4.2.4 Investigate possibilities to introduce electric/hybrid buses in PT

"Investigate the possibility of introducing electric/ hybrid buses in municipal public transport."

The discussion is on, but there is no current output.

5. Conclusions

This report presents various mobility management measures to increase the share of electric mobility in the cities of Växjö and Aarhus. The transformation to a fossil free society is an important objective in Aarhus, and transport is one of the biggest challenges in this respect in the years to come.

- For all motorised modes, **the most effective strategy** will be to shift the fuel from fossil to renewables.
- **The next strategy** is to shift the mode of transport from individual, motorised modes to public and active transport modes such as walking and cycling.
- **The third strategy** is to reduce traffic, and thereby also reduce emissions.

However, the transformation to EVs does not come by itself; it must be supported by mobility management measures. In the mobility plans for Aarhus and Växjö, mobility management measures have prominent roles. Whereas mobility management and EV's have specific strategies in the transport plan for Växjö (2014), working with mobility management measures is an integrated part of the field in Aarhus. Over the last three years this work has been specifically been carried out through the project Smart mobility.

Improving people's everyday life is the primary target of the Smart mobility project while working with the citizens of Aarhus. Instead of promoting mobility options via campaigns, the project is in direct contact with test persons that volunteer for various mobility solutions. Smart mobility inspires these people and provides the necessary framework to make it possible for real behavioural changes in travel.

The understanding of real behaviour and the many reasons for behavioural changes has influenced the way of working with mobility management within the READY-project. The ECOSENCE technology was foreseen to also contribute to the knowledge of travel behaviour and readiness for changing to EVs. However, the solution did not support collection of knowledge of the road users beyond mode of travel and distance. This was considered insufficient data for the purpose of working with the complex mobility management measures to increase EV mobility.

The mobility management measures or models to increase EV mobility in the cities described in this report can be divided in to the following topics:

- Electrical Charging Stations
- The municipal fleets
- Car-sharing models
- Promotion of electrical bikes
- Introduction of electric/hybrid buses in public transport

Some of the models are already in place in the cities, some will be further investigated and potentially be implemented as part of **task 5.6** of this project.