NORTH SEA REGION ELECTRIC MOBILITY NETWORK
e-mobility NSR

Study on best practice and requirements for procuring fast chargers

Workshop report

Activity 4.4
Gothenburg

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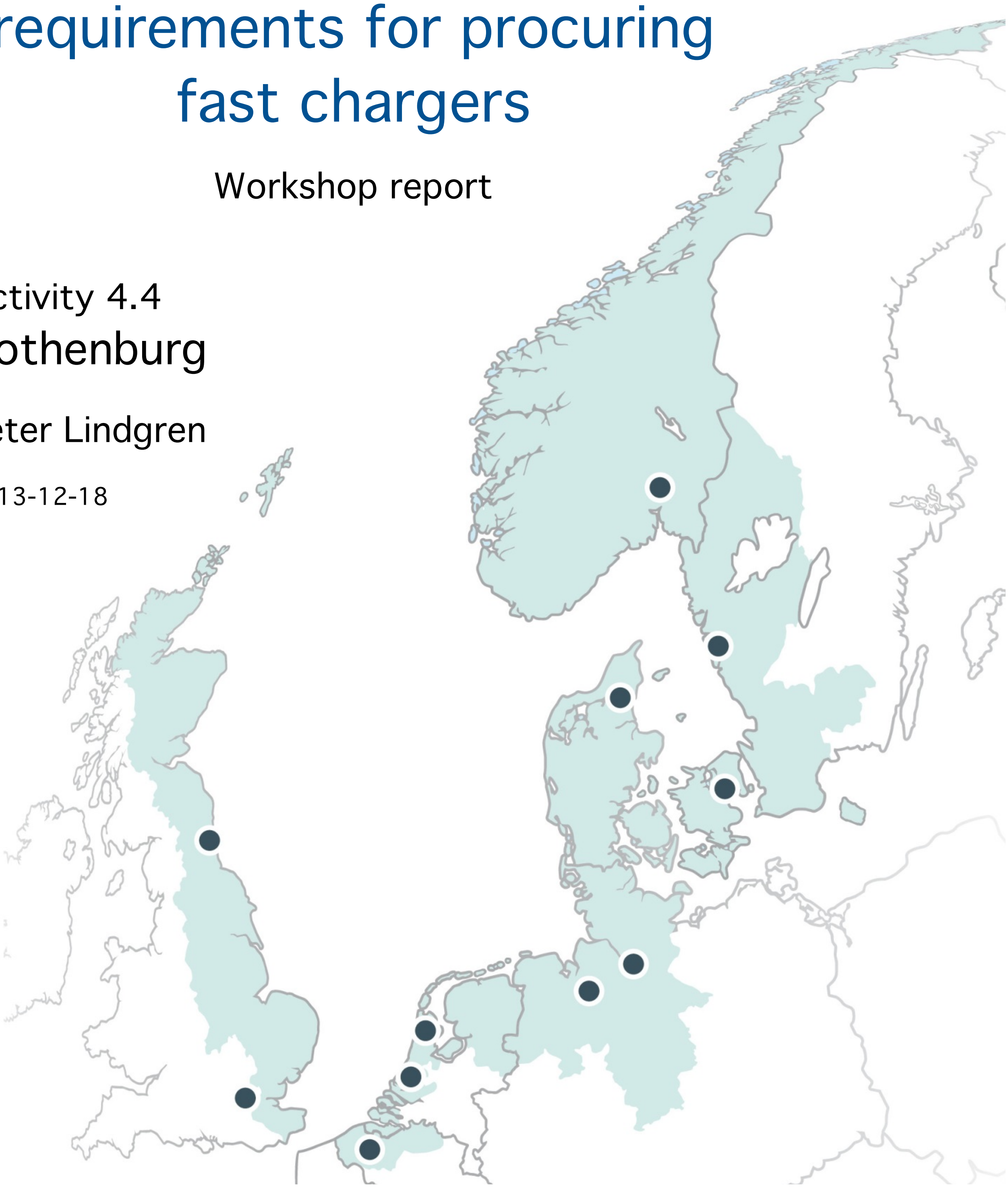

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CONSAT SUSTAINABLE ENERGY SYSTEMS

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GLOSSARY

AC	Alternating current
BEV	Battery Electric Vehicle
BMS	Battery Management System
CCS	Combined Charging Standard
CHAdeMO	CHArge de MOve", equivalent to "charge for moving”
CS	Charge Spot
DC	Direct current
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCS	Fast Charging Station
HEV	Hybrid Electric Vehicle
NEDC	New European Driving Cycle
PHEV	Plug-in Hybrid Electric Vehicle
V	Volt

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1. Executive Summary

In June 2012 exemptions from the Electrical Act in Sweden where introduced facilitating the establishment of Fast Charging Stations (Hereafter referred to as FCS's). This done by excluding FCS establishment from the standard mandatory applications and the following permits for selling electricity. The exemption qualifies entrepreneurs in general to sell electricity to fast charging vehicles as well as reserving parking spaces for special purposes such as charging of electric vehicles.

The placement of the FCS strongly affects how much it is used. It is generally agreed that FCS's should be placed on the perimeter of the vehicles ranging area as to increase the range as much as possible. One can focus on a structure of FCS's strengthening positions in and around larger cities or trying to interconnect cities by placing a chain of FCS's in between. Or you can do both. The recommended distance between every FCS varies from 40km to 90km. We suggest today's vehicles can handle around 80 km from stop to stop in wintertime.

After the strategy of needs and geography is laid when planning for establishing a FCS, it is important to start a dialogue with the grid owner, mapping essentials as grid connection possibilities, capacities and other planned infrastructure in the area studied as well as getting a quote on the FCS-grid connection.

Secondly clearing the permits from the local authorities must be done. If all is cleared it's time to look at the actual FCS.

The exact placement depending on access from main road, occupation of the customer while charging, security aspects as to not invite crime or even the feeling of insecurity that can limit the use of a FCS.

Keep in mind weather considerations such as roof or no roof, snow clearance, lighting, perhaps on the cord glove to guide a connection, user friendliness in general.

When it comes to the choice of standard there are mainly three standards, CCS (Combined Charging Standard), CHAdeMO and Supercharger (car manufacture Tesla's own specific solution) whereof the two first are available on the market. Our recommendation is to go with the FCS called "The

Combo”, having both CHAdeMO and CCS connectors. In addition, it is also possible to have Type2/Mode3 connector included with up to 43 kW AC power.

Perhaps If decided that the FCS is to be commercial the method of payment should be decided.

Rules and regulations regarding the safety aspects, for an example, child access and electric safety should be taken into account.

At the end of this report, there is a checklist for easy procurement of an FCS.

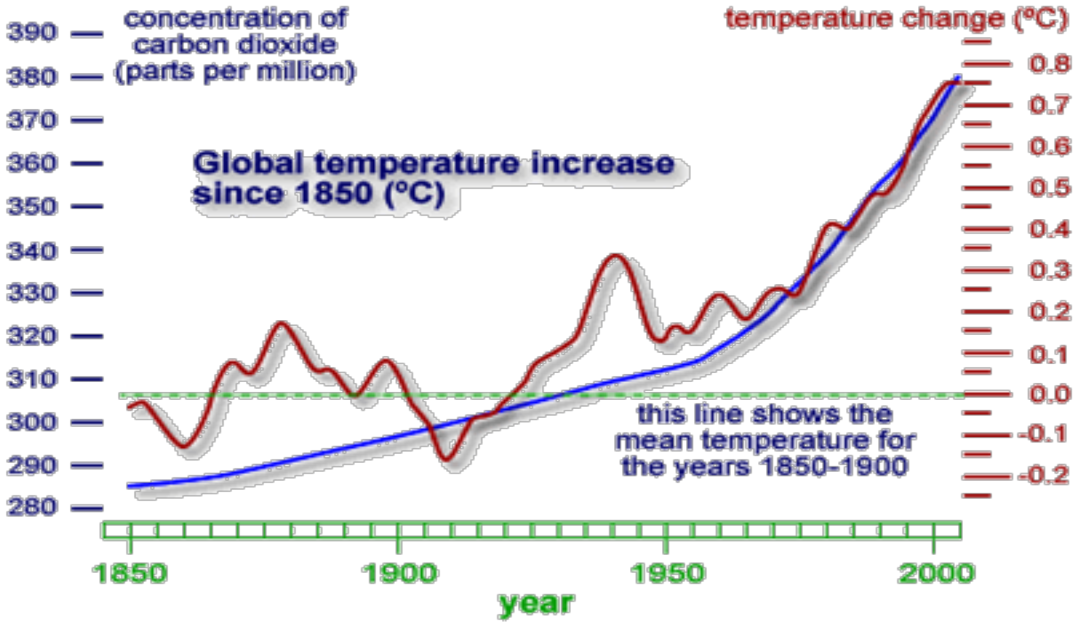
2. Introduction

This report is focused, on studying and evaluating the best practice of how to implement fast charging stations/infrastructure. The report also aims at studying the necessary requirements that need to be met when prospecting fast charging stations. We also take a glance at the current market situation and try to highlight considerations important from a developing market point of view.

The field of electromobility is developing quickly, from the interest of enthusiast 5 years ago to a full-grown market today. In the next few years a variety of electric cars and hybrid cars will be introduced and the prognosis of most car manufacturers is that the average consumer will consider buying an electric car during the nearest fifteen years. From the government side there is pressure to build the infrastructure that these vehicles need, both via incentives and legislation.

The function of FCS's are mainly two; extending the range of EV's as well as creating the psychological security to overcome what now is called "range anxiety", the fear of being stranded without "fuel". There is however a lot of question marks that do not have any precise answer. With such a fast evolution in technology, will a major investment now be outdated before it has paid off? The cars, batteries and FCS's are all integrated; a technological leap forward on either part could change the game. Once people have overcome their psychological barriers, will they perhaps optimize their behaviour, planning in slow charging at all points making an infrastructural FCS investment obsolete?

If one is looking for reasons not to act you will find them. On the other hand denying global warming is nowadays way beyond reason. Perhaps one does not need to look for immediate return on an investment when it comes to the establishment of FCS or even buying an EV. It is clear that the ease of legislation from government and municipals surrounding the establishment of charging stations, strive to push the public over the threshold to a more sustainable fleet. The official Swedish target is to have a fossil fuel free transport sector by 2030. On the level of the EU, we are soon to se legislation harmonizing standards and giving well-needed guidance to how the FCS's should be distributed over Europe. For now we still have a quite complicated situation with a race for first place between different standards, legislation still lagging behind the technical development. Permits need to be issued by a variety of authorities. In this report we hope to bring clarity to how to navigate through all this and facilitate the building of a fast charging infrastructure.



Picture 1*: Global temperature rise and CO2 rise over the last 150 years*

Source: http://www.climatechoices.org.uk/pages/cchange3.htm

2.1 AIM

This report is a part in the EU project, North Sea Electric Mobility Network (E-mobility NSR). It has an overall goal to facilitate the introduction of a charging infrastructure by presenting plans, decision support and guidelines to bring light to the matter for the benefit of decision makers and other relevant actors within the NSR.

The aim of the project is to guide and inform interested parties in drawing the right conclusions when it comes to building an infrastructure of FCS´s, marketwise as well as from a very "hands on" perspective. We get into rules & regulations that outline definite boundaries as well as the question of feasibility from a practical and economic view. The report includes aspects of installation, demand, function, safety, maintenance, user-friendliness and construction. Simply put; on how to introduce FCS's.

The targeted readers are officials within the private and public sector, as well as road maintenance and city planners. In all our readers are people involved in planning a fast charging infrastructure.

2.2 Report boundaries

This report covers the path to have a FCS up and running. It provides a basis for planning and purchasing the complete FCS; it does not cover the projecting, building and running of the FCS.

The report is mainly based on the Swedish market and laws however the conditions of other EU countries are very similar why most of the report is relevant beyond the Swedish boarders.

FCS's are most valuable for full electric vehicles, that is what this report is focusing on and does not cover plug in hybrids (although a few models are equipped with fast charging) The hybrid models have solved the problems addressed by fast charging stations by being precisely HYBRIDS.

3. Background and current situation of e-mobility

3.1 Context of e-mobility (Electric-Mobility)

E-mobility is a new word that describes how to reform the transport infrastructure from oil-based to electricity-based. This includes the vehicles, the charging infrastructure and the support systems[1]. The advantages of electric vehicles (EV's) are a very efficient driveline in the cars with zero local emissions, very low noise, a smooth ride and low maintenance demand. Other advantages are that charging is done when the car is parked and that the cost of driving is low. The main disadvantages is; a short (or very short) driving range, long charging times in between, high initial investment for the consumer when buying the electric car and finally a cost for the cars battery degeneration.

For the electric vehicle to run it needs electricity from the electric grid. The general trend is a vast change in the structure of the electric grid due to new small local power plants and intermittent CO2-friendly energy production as well as a fast technological evolution making it possible to control both production and consumption as well as distributing power in a more efficient way (Smart Grid-concepts). In context of a mass introduction of electric cars, they will be a part of these changes. One side of it is the increasing need for electric power; the other side is the opportunity/possibility to control when an electric car shall be charged.

To overcome some of the disadvantages with the short range of electric cars, the public infrastructure can provide charging opportunities, both via slow, medium and fast charging. Even if these charge spots perhaps are not used so often, they give a feeling of security to the driver. He or she can always get back home! This is an especially important function of a FCS.

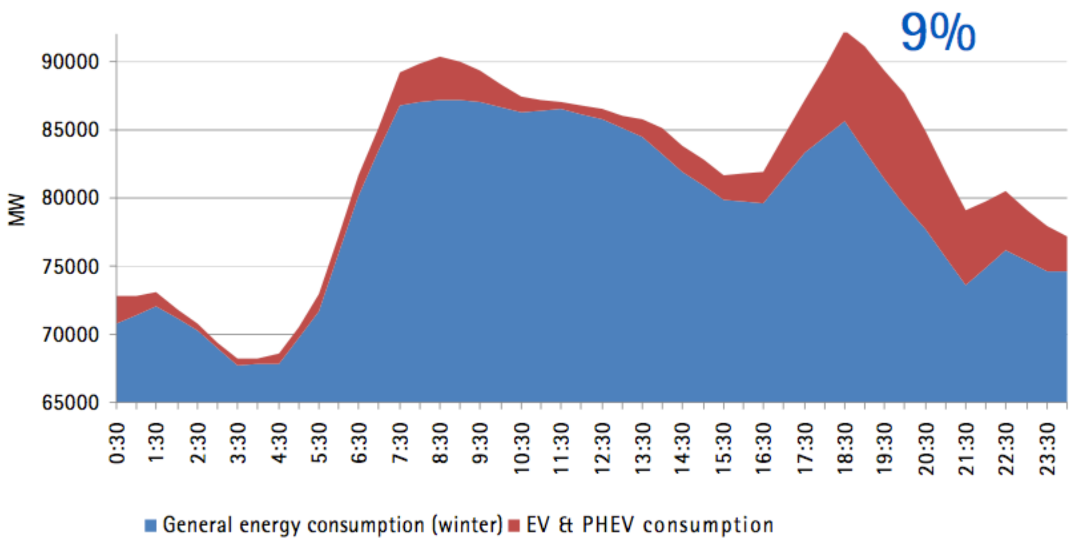
3.2 Electric Infrastructure

The charging infrastructure is still in its infancy, and the rate of development is fast but not well planned in all cases. In a near future this will be changed, as new directives from the EU will come into play. These directives cover the

[1] Facilitating payment, locationdisplays, roaming functions etc.

complete electro mobility infrastructure; private and public normal chargers, fast charging networks and even inductive charging.

If the total road transport fleet would be electrified to 50 %, the additional electricity demand in Sweden will be in the neighbourhood of 15 TWh. This is approximately 10% of Sweden's electricity production today. The general opinion is that it will take 15-25 years to reach this extent of electrified fleet, thus giving the electricity grid plenty of time to gradually adapt.



Picture 2: Simulated energy demand for EV's

Increase in energy demand on an average workday by 2025 (prediction). It is interesting to notice the major increase being early morning just when arriving at work and evening time after getting home. One can challenge this prediction arguing the electric fleet will have built in low-tariff timers that will optimize charging and partly fill in the "dip

Source: Better place

Fast chargers are mainly a daytime solution. This in contrast to slow charging predicted to be used to a large extent in morning and afternoon, before going to work and after coming home from work as can be seen in the above diagram. The expected impact of fast chargers on the electricity grid is therefore small on the large geographical scale. Establishing a Fast Charging "centre" can however locally have a considerable impact why grid connection and planning around this is another of this reports focus areas.

3.3 Road Infrastructure

Fast chargers have two main functions on electro mobility; to allow electric cars a longer range and to relive drivers of so called “range anxiety”, the fear and uncertainty of running out of power. The increase in range can either be the ability to use the electric vehicle for a longer period in a limited area (city) or the ability to travel longer distances.

To relieve drivers of electric cars of range anxiety, it is important that the car can be charged if there are unforeseen events. In order for this charge to be reasonable in time, FCS’s are needed. To have FCS’s in the neighbourhood gives the driver a feeling of security. For the FCS’s to act as range anxiety reliever’s, they must be places in areas where a lot of electric cars are driving, i.e. around the major cities. Studies in Japan show that the average driver uses more of the available energy if there is FCS nearby.

To use FCS as range extenders on longer trips is tricky. The placement must be in almost perfect distances related to the specific vehicles range. With the current range FCS’s should be placed about 70 to 90 km from the starting point and slightly less between the following stations. If the placement is successful, the next bottleneck could be that the station only can serve one to two vehicles per hour. We therefore want to underline the necessity of careful studies on where to put FCS’s along the major highways and when planning, have grid capacity in mind.

Should FCS’s come to serve heavy commercial traffic, fast charging may be of interest in cities, at well-defined routes for bus lines or intercity logistics. These stations may be the same as for electric cars (as described in this report), but they may also be proprietary of the vehicle manufacturer.

Lately experts have discussed whether the future structure and use of electric cars at all will be intercity. One side argues the questionable economics of establishing the intercity network in relation to the believed minimal future use of electric cars for these purposes. Resting on the fact that today’s use of cars in general is 90% local (less than 50km) despite the lack of technical limitations on range or psychological restraints.

On the other hand one can take a stand in the question; what needs to be done in terms of cutting down on the use of fossil fuels. The follow-up question then will be; what competition does electromobility have when it comes to solving the equation long range transports without fossil fuels. Perhaps it after all is a viable solution...

3.4 Market and timing

As the e-mobility infrastructure is in its early stages of development, there are many thoughts on how the market will develop. We don't know how fast the electric car fleet will grow; variables as the economics and status of driving an electric car as well as incentives both to private owners and to companies and municipals are sporadic and not so clear today. An important provision to growth is that there are popular car models in all segments available and that the infrastructure is built at a good pace to not inhibit electric car sales.

Sweden has adopted a plan to have a transport sector free of fossil fuel by the year 2030 [2]. To reach this goal, a great effort must be put into renewable fuel and electromobility. There is no agreed strategy today regarding how this will be implemented, but the introduction of a fast charging infrastructure is a step in the right direction.

3.5 Development direction

In the next few years it seems there will be a very rapid development of all aspects of e-mobility. New car models are being released with continuously improving technology. They have better efficiency, better regeneration when braking, and better batteries supplying longer range, lower energy consumption and safer cars. The infrastructure will also improve when different actors will act on the increased need and business opportunities.

The rate of development is however dependant on the volume and structure of incentives that national and local government provide. The very rapid growth in electric car numbers in Norway is greatly due to a massive volume and variety of incentives such as removed car tax, free parking with free charging, free use of bus lanes, no road toll and more. The other factor of the high sales was the introduction of attractive electric cars, starting with Nissan Leaf in 2012.

In Sweden the incentive for environmental cars, the super-environmental car "bonus" of 40.000 SEK, is based on CO2 emissions, and the limit covers both pure electric vehicles and hybrid vehicles. In consequence the majority of cars

[2] http://www.regeringen.se/

receiving the funds are significantly cheaper hybrids rather than the more expensive pure electric cars.

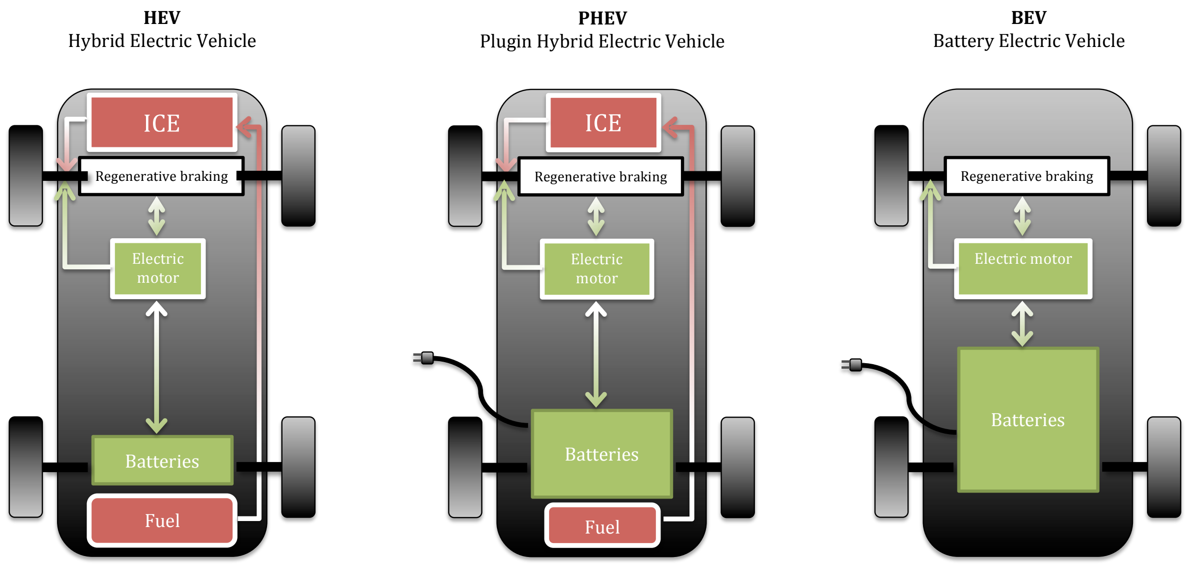
At present, the majority of electric car sales in Sweden are to companies and municipalities, the motive being a mix of financial capability, fulfilling environmental policies as well as, through the ownership of the electric vehicle, marketing and profiling their stand to the public.

Picture 3*: Electric truck*

A typical case of mixed motives; economic capacity, branding towards the public, corporate value fulfilment and hopefully also an honest will to drive technology in the right direction and taking environmental responsibility seriously.

Source: http://www.mynewsdesk.com/se/renova/images/elbil-i-test-hos-renova-93292

In Sweden so far the interest in plug-in hybrids has been much stronger than the interest for full electric vehicles. The reason could be that they are functionally more similar to our standard cars and the need for adapted human behaviour (user pattern) is close to none. As mentioned earlier the economic incentives from Government and municipalities do not differentiate between hybrid and electric cars which most probably also comes into play.



Picture 4: *Difference between HEV, PHEV and BEV electric cars.*

Source: Peter Lindgren, Lindholmen Science Park

The Hybrid disadvantage is that they carry around two drivelines with added cost and complexity. Since these cars always have an alternative to the electric drive there is (usually) no need of fast charging. The Hybrid solution of a car is addressing the same problems as Fast Charging Stations. One can question how a dual driveline car can be cheaper than a car with a single driveline. In the long run, when differences in production volumes are not so drastic perhaps this no longer will be true. If so, let's hope infrastructure is ready to handle the shift.

Another possible technical direction of development is increasing the electric cars range, speed of loading, possibility of loading when tariffs are low etc., by having exchangeable whole battery packages, This method was first implemented by the company "Better place" establishing a network of battery exchange stations in Israel and Denmark Unfortunately the company went bankrupt in mid-2013.

Electric cars can also have so called range extenders; today they are usually combustion engines with generator. The range extender can also be a fuel cell, which runs on hydrogen. This technology is developing fast, but there are no vehicles commercially available at present. This will also need a refuelling network of hydrogen stations, which also is in its infancy.

A futuristic scenario is to charge electric cars while driving by inductive charging. This technology is already demonstrated on trams and busses, but to have it on highways for the public to use is far away from implementing.

4. Prestudy on fast charging establishment

4.1 Feasibility in general

We think it's a reasonable assumption that the general public recognizes the need to make the shift from fossil to renewable fuels. The uncertainty of how such a shift will impact our everyday life practically and economically extends to the potentially commercial beneficiaries.

Human nature, hazy rules and regulations, uncertainty of how the grid will be adapted, sales volume estimates, different standards battling for first position, different technical solutions trying to solve the problem of fast charging, competing solutions to overall green transports and the hole of e-mobility waiting for clarity in how the structure of governmental or even parliamentary incentives will be played out during the next ten years. The uncertainties are many. In the light of this there are no facts to present as a base for a feasibility study.

Another probable assumption is that fast charging infrastructure as an economic self-supporting entity needs to climb a quite high threshold before reaching the frequency that can facilitate charging of a fleet. Could be the function of FCS's never will be in the commercial range considering the competition from slow charging. Perhaps FCS's main purpose is to assist electric car users in feeling safe and "in range" or assisting potential buyers in overcoming mental barriers.

So to whom is it feasible to set up a FCS? As mentioned before the mixed motives scenario (page 9) is the most probable and economic coverage may be accomplished by either car sales or by the much larger environmental Cost/Benefit balance to which we all are responsible.

4.2 Cars

The number of electric cars is increasing fast, however from a very low starting number. In Sweden the number of electric cars and vans has gone from about 1500 to 3000 in one year (December 2012 to December 2013), including both battery electric cars and plug-in hybrid cars.

The number of different types of electric cars is also increasing fast; today (December 2013) there are about a dozen types available. Not all of them are adapted for fast charging. Basically there are the siblings Mitsubishi i-

MiEV/Peugeot iOn/Citroen C-Zero and the Nissan Leaf that are adapted for the CHAdeMO fast charging system. However in a near future there are a number of new and updated types planned to be introduced. These include the Renault Zoe, Volkswagen eUp and BMW i3, all small and modern cars. (See Appendix 6.2)

The range of a pure electric car typically is 140-200 km under ideal conditions, and these are the conditions of the NEDC (New European Driving Cycle) test. The NEDC-range is what manufacturer presents as range, but as with conventional cars' consumption figures, the figure presented is not totally realistic. With the different systems in the car operating, as heating and cooling, the range is typically 20-30% less. And under hard conditions, as in wintertime with dropping temperatures, the range can come to be only 50 % of the presented range. This should be communicated to customers to give them a possibility to manage their expectations and adjust their driving patterns.

Current and near future electric cars and hybrids with fast charging potential to be launched on the Swedish market:

Car type	Type	On market (Sweden)	Normal charging	Fast charging system	Semi fast charging
Think!	FEV	1999	Schuko	-	-
Tesla Roadster	FEV	2008	Tesla	-	Tesla
E-Car 500 EV EV-adapt 500	FEV	2010Q1 2013Q1	Schuko	-	-
Mitsubishi i-MiEV	FEV	2010Q4	Type 1	CHAdeMO	-
Peugeot iOn	FEV	2011Q1	Type 1	CHAdeMO	-
Citroën C-Zero	FEV	2011Q2	Type 1	CHAdeMO	-
Volvo C30 electric	FEV	2011Q2	Type 2	-	-
Renault Kangoo ZE	FEV	2012Q1	Type 1	-	-
Nissan LEAF	FEV	2012Q1	Type 1	CHAdeMO	-
MB Vito E-cell	FEV	2012Q1	Type 2	-	Type 2
Opel Ampera	PHEV	2012	Type 2	-	-
Volvo V60 Plug-in hybrid	PHEV	2012	Type 2	-	-
Volvo C30 electric generation2	FEV	2013Q2	Type 2	-	Type 2 22kW

Tesla S	FEV	2013Q3	Type 2	Type 2 (Tesla)	Type 2 43 kW
Renault Fluence ZE	FEV	2013Q3	Type 1	-	Type 2* Chameleon
Mitsubishi Outlander	PHEV	2013Q3	Type 1	CHAdeMO	-
Ford Focus Electric	FEV	2013Q4	Type 1	-	-
BMW i3**	FEV PHEV	2013Q4	Type 2	CCS	-
Citroën Berlingo El	FEV	2013Q4	Type 1	CHAdeMO	Type 1
Peugeot Partner El	FEV	2013Q4	Type 1	CHAdeMO	Type 1
Volkswagen e-up!	FEV	2013Q4	Type 2	CCS	-
Nissan e-NV200	FEV	2014	Type 1	CHAdeMO	-
Tesla Model X	FEV	2014Q1	Type 2	Type 2 (Tesla)	Type 2
Volkswagen e-Golf	FEV	2014Q2	Type 2	CCS	-
Renault Zoe	FEV	2014Q2	Type 2	-	Type 2 Chameleon

Table 1: *Current and near future electric cars*

** future upgrade, ** can be ordered as a FEV or a PHEV,*

In this table the difference between normal- semi-fast- and fast-charging power provided:

- Normal charging one/three phase 2kW-15kW
- Semi fast charging three phase 20kW-40kW
- Fast chargingDC 40kW-120kW

4.3 Batteries

The electric cars battery technology has quickly improved over the last years. The early cars had lead batteries but where quickly replaced by NiCd and NiMh batteries. These batteries have then been replaced by the latest technology, Li-Ion batteries, based on Lithium. The charging infrastructure and fast chargers in particular all are adapted to the technical specs of the new batteries. The lifespan of Li-Ion batteries are dependent on operating temperature, rate of charge and discharge and the number of charging cycles. It is not fully determined exactly how fast charging deteriorates the battery, but heavy use of fast charging is not healthy for the battery pack in an electric car.

4.4 Chargers

Electric vehicles can charge either with AC or DC current, alternatively one can also use the method of inductive charging. In the early stages of electric car development the different manufacturers made their own charging systems, and they were usually made for connecting to **standard Schuko AC-outlets**. These are the same as standard outlets for car heaters in Sweden, but facilitating a higher current (10 Amp. to 16 Amp. vs. the normal 8 Amp).

Later new and dedicated connectors where developed enabling the charging current to be much higher, and these where fitted to the new electric cars. The charging infrastructure was and is, at this point not yet adapted to the new connectors. Therefore the Schuko connector is still what is most frequently available at public charge spots.

The CHAdeMO Fast charging system was developed in Japan in/during 2009, and has spread around the world in a few years. It is today the main fast charging technology with over 2600 installations worldwide, and serves over 70.000 CHAdeMO compatible vehicles. In Sweden there are about 17 stations installed and many more are planned due to Nissan supplying FCS's to dealers and fleet owners. Chargers and methods of charging for electric cars are defined in a few different ways.

"CHAdeMO Association aims to increase quick-charger installations worldwide and to standardize how to charge the vehicles."
Source: http://CHAdeMO.com

- Type of charging: AC, DC and inductive charging.
- Speed of charging: normal, semi-fast, fast charging
- Type of connector: Type 1, Type 2, CHAdeMO/CCS
- Type of communication between vehicle and the electric supply. The types are referred to as Mode 1, Mode 2, Mode 3 and Mode 4.

In the following listings the difference of present and future charging systems are described.

Connectors:

<u>AC outlets, charger in car (OnBoard Charger- OBC):</u>

- Schuko: standard outlets for outdoor use for example car heat outlets. Can be used for currents up to 16 A, but it is not recommended to use this for a long period of time due to risk of fire.

Picture 5: *Schuko connector and outlet*

Source: www.elfa.se/elfa3~se_sv/elfa/init.do?item=43-206-53&toc=20043 www.elfa.se/elfa3~se_sv/elfa/init.do?item=36-738-29&toc=20115

- Type 1: also called Yazaki and can be used at currents up to 32 A

Picture 6: *Type 1 connector*

Source: http://carstations.com/types/j09

- Type 2: also called Mennekes, can be used at currents up to 70 A (one phase) or 63 A (three phase).

Picture 7: *Type 2 connector*

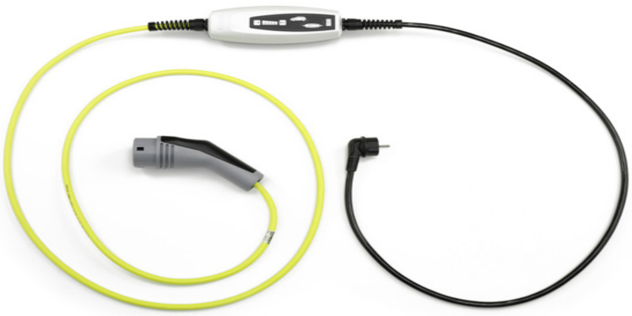
Source: http://www.mennekes.de/en/latest0.html?tx_ttnews%5Btt_news%5D=543&cHash=8a3a075b1f16cae5ddc9c7f51f647a99

- Tesla: Tesla motors have their own connector system in the USA, but in Europe they will use a modified Type 2 connector, that can handle both AC (one and three phase) and DC fast charging. The DC fast charging will only be for the Tesla Supercharger system.

Picture 8: *Tesla EU connector*

Source: http://www.teslamotorsclub.com/showthread.php/8173-Europe-Future-Charging-for-Model-S-1-phase-or-3-phase-(Part-2)/page42

The connectors of the charging cord are combined in different ways depending on the car and outlet configuration. Most cars are supplied with a cable equipped with the car connector (Type 1 or Type 2) in one end, and the other end is adapted to the charging infrastructure available (in Sweden a Schuko connector). These cables are usually prepared for a low power (10 A), and are not using the full capacity of many car chargers.



Picture 9: *Charging cord with Schuko connector*

Source: http://emobility.volkswagen.de/int/en/private/cars/components/06/components/0/tab2components/0/text1_files/file/document.jpg

Power supply used on dedicated parking spaces is often fixed to the wall (wall box) with the suitable car connector (Type 1 or Type 2) on the other end.

Picture 10: *Charging cord with a wall box*

Source: [http://nyheter.schneider-electric.se/news_livesite.asp?newsID=102508& show=1](http://nyheter.schneider-electric.se/news_livesite.asp?newsID=102508&show=1)

DC charging, charger outside car:

- **CHAdeMO**: This system was developed in Japan so it is mainly used in Japanese cars. This connector only supports DC charging, it is therefore used in conjunction with a Type 1 AC connector.

Picture 11: *CHAdeMo socket connector (left) and Type 1 connector (right)*

Source: http://www.electroyou.it/image.php?id=10027

Picture 12: *CHAdeMO glove connector*

Source: http://charge.yazaki-group.com/english/product/quick_outlet.html

- **CCS**: Combined Charging Standard. Uses a Combo T2 connector to the car that contains both the AC and DC connectors. The AC part of the connector is the Type 2 described above, and it is combined with a separate DC connector. This means that the same connector is used for both fast charging and standard charging, and that the car can switch automatically from fast charging to standard charging when the charging level reaches 80%.

Picture 13: *CCS plug and connector*

Source: http://www.volkswagen.co.uk/new/e-up-nf/home

- **Tesla Supercharger**: As described before, Tesla has different connectors for Europe and the USA. The modified Type 2 connector used in Europe is adapted to fast charging without the need of a dedicated DC-part. The pins used for three phase AC charging is switched to DC charging when the vehicle is connected to a Tesla supercharger. Therefore it cannot be used with CCS fast chargers.
  There is a converter available for the connector to also use CHAdeMO fast chargers, it is however doubtful if this adaptor is legal to use in Europe.

Inductive charging:

- To charge an electric car with inductive charging, all that is needed is to simply park the car above the charger. Necessary equipment for inductive charging is a Base unit on the ground (or perhaps "in" the ground) and a Car unit in the car; these use resonance frequency to transfer energy to the car. In order to work together they must be standardized, a process just recently initiated by the EU. Until the standard for inductive charging is in place, this will inhibit manufacturers to release systems.
  Inductive charging is today viewed as a complement to conductive charging (charge with a cord), and will not replace normal charging.

Communication:

There are four main ways for the car and charger to communicate. In the following illustrations *(Source: Infrastruktur för Snabbladdning av elfordon, Länsstyrelsen Västra Götalands län, link: http://www.lansstyrelsen.se/vastragotaland/Sv/publikationer/2013/Pages/2013-41.aspx)* the black line symbolizes current and the red line communication of charging information.

- **Mode 1**: No communication. The OBC is connected directly to the outlet via standard Schuko connector. If the current demanded from the OBC is too high, the fuse will be released on the outlet side.

Mode 1
No communication between charge port and car

- **Mode 2**: Communication between car and EVSE (Electric Vehicle Supply Equipment), a safety box on the charging chord. The EVSE checks that the power demand does not exceed what the outlet can give and a basic earth protection breaker is also included.

Mode 2
Communication between the charge cord EVSE and car. Safety with earth breaker for charge cord and car

- **Mode 3**: Communication between the charge spot and car. An EVSE is placed in the charge spot or wall box, communicating with the car. This enables the charger to give exactly the current the car needs with a high degree of security against faults. The connector is either Type 1 or Type 2 to the car and to the wall it is either fixed or a Type 2 connector. These chargers are not common yet but it's suggested that all new cars shall comply with this standard.

Mode 3
Communication between the charge pole and car charger. Safety with earth breaker for charge pole and car

- **Mode 4**: Fast chargers have dedicated communication systems, as the chargers communicate with the car to find the optimum current to charge with. The three systems have their own protocols, but as they also have dedicated connectors, there is no risk of mix up. Today there are FCS's that are equipped with two cords with both CHAdeMO and Combo T2 connectors thus being able to handle both the CHAdeMO protocol as well as the CCS protocol.

Mode 4
Extern fast charger is connected directly to the car battery. Communication with the battery management system (BMS) in the car. Very high security for charger and car

	Type	Phase	Current (max)	Voltage (max)
Mode 1	AC	Single	16	250
		Three	16	480
Mode 2	AC	Single	32	250
		Three	32	480
Mode 3	AC	Three	32	480
Mode 4	DC	-	400	1000

Table 2: *Differences between the Modes of charging*
Source: C Milton 2011

In the EU a new directive is suggested that states that the connection for AC charging shall be Type 2. To our knowledge the decision of approval of this new standard is very probable, but the final decision is yet to be taken. We expect a decision during 2014. Such a decision will also include an effort to give guidelines of the density of charge spots in each country both for AC and DC (FCS), i.e. how many public charge spots there should be in a specific area.

In short, for Europe the fast charging system shall be CCS. It is however a good idea to look at combo-FCS's that can handle both the CCS and the CHAdeMO systems plus 43 kW AC. This because there are a great number of electric cars already equipped with the CHAdeMO system, and many new cars will have the capability of high power AC charging (and without CCS).

4.5 Legal requirements

The rules and regulations regarding FCS's are not very well harmonized as of today. The legal aspects can be divided into a few main areas; first the framework of having the right to dispose of a geographical area for your purposes. Secondly under what circumstances you are allowed to connect to the grid and what possibilities are they're considering the supply-capacity for electricity. Thirdly one must line up with the regulations stating what configuration of equipment you are allowed to use at your FCS. Finally you must consider the legal right to commercialization. The problem is that most of these aspects are in different ways integrated into each other and since the field of business is fairly new, standards and harmonisations are lagging and precedential cases are few. Bottom line being that the legal framework differs from case to case depending on location. So with this said and as far as we can come; here are the legal considerations we would like to make you aware of.

4.5.1 Grid connection

A recommendation is to start with contacting the local grid company to find out what their recommendation is on the question of geographical location since they have many of the crucial answers; How far to nearest transformation-station, what electrical capacity does the grid have in the specific area. There probably is a fair chance that they will know all about the general development plans for the area in question. We are not alone when recommending the grid company as a starting point.

The grid company will also give you a cost-estimate on the FCS-to-grid connection, which most probably is a substantial part of the overall cost to establish a FCS. Should the grid owning company give you a quote on the cost of your connection that, to you seems “out of the ballpark” it is possible to appeal to The Swedish Energy Markets Inspectorate (Energimarknadsinspektionen) and have your connection fee examined and possibly overruled and lowered.

4.5.2 Territory of concession “Markupplåtelse”

To establish a FCS you are not required to have a building permit since it is classified as an “automatic payment device” and not a building. Depending if the charging station is going to be established on land dedicated for building or land dedicated for street, different permits are needed.

In Sweden the rules & regulations define and differentiate between three type of “areas; Outdoors Street, Outdoors Land and Indoors. These legal entities give different rules for the establishing of FCS´s.

Grounds

To install a FCS on land dedicated to buildings (“Tomtmark: enskild plats, privat mark, generellt avgränsade markparkeringar och p-hus/garage” http://www.pmalmo.se/P-info/Gatumark--tomtmark/), you are only required to have the property owner’s consent. To establish a FCS in cities and in connection to ordinary parking places, it is common practice that the city (municipality) owns the ground and leases it to a parking company with whom you in this case must have an agreement with.

Street

To establish a FCS by a street, the road traffic act (Vägtrafikförordningen) and Transport Administration (Trafikverket) come into play. Permits are required and are issued by the municipality. Decisions with consideration to the traffic administration are made at the city's police authority. The municipality has a veto right and could overrule. (Elforsk- Laddningsinfrastruktur, 2010; A.Thorén, 2012). Worth mentioning is that the municipality has the possibility to reserve parking lots for electrical vehicles.

Indoors

To establish a FCS indoors as for an example a parking house, you need the permission from the building holder (owner or leaseholder). The rules regulating safety issues for indoors FCS came into power while the prevailing car batteries where still lead (Pb-acid). As mentioned the new batteries are mainly Ni-Mh and Li-ion batteries that have other types of safety issues than the Pb-acid batteries. The current applicable regulations are unfortunately out of date.

4.5.3 Parking lots for electric vehicles in Sweden

The Swedish Transport Agency (Transport-styrelsen) has made it possible to reserve parking lots for a special type of vehicle such as electric vehicles. In consequence one can specifically dedicate a parking lot for electric vehicles and equip it with a FCS. The rule also applies to "street area" parking, however the parking lot in this case **must** have external charging equipment intended for common use. An electrical vehicle is however not obliged to charge while parked on such a parking lot.

Picture 14: *Parking for cars with external charging capability.*

Source: *http://www.transportstyrelsen.se/*

4.5.4 Electricity Concession (Nätconsession enligt Ellagen 1997:857)

Much of the electricity act (Ellagen (1997:857) is relevant when it comes to introducing FCS's.

Until 2012-06 it was only possible to build or use the power line without the electricity concession if the activity was;

A) Within a well-defined and limited area,
B) Only used for an internal purpose
C) Modestly limited in its distribution
D) Or were placed in an industrial area.
E) The owner had to use an internal net on his own account (Elforsk 2010; document 10:59)

The electricity concession is a permit allowing the building of a grid for high voltage transfer as well as using or selling high voltage electricity. When you apply for an electricity concession you must do so referring to a specific stretch of the grid or within a defined area. (*http://sv.wikipedia.org/wiki/N%C3%A4tkoncession#N.C3.A4tkoncession*). It is important to keep in mind that all electrical consumption somewhere down the line "rests" on a party that has an Electricity Concession; a net owner with whom you must have an agreement in one way or another.

Exception from the electricity concession

If an activity is not subject to the electricity concession, it is possible according to the constitution (SFS 2007:215) to apply for exception. This specific regulation defines under which conditions an exception can be made. From 2012-06-01 the regulations have been changed benefiting owners of FCS's. Ordinance (2012:163). The change adds one more exception from the Electricity concession regarding the charging of electricity vehicles.

This new regulation says:

"An internal low-voltage network which is intended mainly for automotive electricity needs may be built and used without a network license." Ordinance (2012:163) "Förordning 2007:215 om undantag från kravet på nätkoncession enligt ellagen" (1997:857) 2012.

In this text there we want to highlight;

"Low-voltage network"- FCS's using < 1000 voltage are hereby an exemption (> 1000 voltage = high voltage).

In the same regulations, there is another paragraph that says that it now is possible to transfer electricity on behalf of others, which supports the possibility for the owner of a FCS to bill a customer for the charging of their vehicle.

(K. Lindholm, Svensk Energi, 2012-05; SFS 2007:215; SFS 2012:163).

4.5.5 Laws and regulations regarding the connectors

Today you are required to have one subscription (abonnemang) per 1000 V of charging poles. Should your charging area include several charging stations that all together amount to more voltage you are required to have one subscription per 1000/ V.

4.5.6 Safetymatters FCS

A foundation protecting the FCS from being hit by a car is important. This shall be a concrete foundation of at least 15 cm in height or a steel beam (this is the same as for petrol stations gas pumps).

Regulations suggest that an outlet socket shall have a 1,7m clearance from the ground, alternatively a lid that is lockable or other equivalent blocking device, for child safety. The socket should be secured from overloads such as short circuits. (see SS 423 40 00, 41A.2.6), and so on. Similar restrictions should apply for the connectors on a FCS.

The protection of the FCS itself (short circuit, temperature etc.) shall be provided by the manufacturer, but it is good to have this specified in the offer.

4.5.7 Restrictions and regulations concerning FCS's.

This report is focused on Swedish laws and regulations, therefore the names in the list are in Swedish.

Laws, ordinance standards and directives	Comments
Laws	
(SFS 1997:857) Ellag	(The electricity law) Definitions of high/low current, and when the electric concession is or is not applicable, everything that concerns the electricity for the fast charging stations.
(SFS 1998:808) Miljöbalken	(The environmental Code), the rules of consideration, regulations that protect the nature, Regulations for The Environmental Impact Assessment, and similar.
Ordinance	
(SFS1990:806) Elinstallatörsförordningen	(The electrical ordinance). This ordinance regulates who may perform the electrical installations.
(SFS 1993:1068 Förordningen om elektriskt materiel	(The ordinance about electrical materials) Rules on the electrical materials, obligations regarding electrical materials, safety rules and conditions to be met before allowing market access.
(ELSÄK-FS.2000:1) Elsäkerhetsverkets författningssamling	(The Swedish National Electrical Safety Board of Statutes) Rules regarding electrical equipment for a potentially explosive environment.
(SFS 2012:163) Förordning om ändring i förordningen (2007:215) om undantag från nätkoncession enligt ellagen (1997:857)	(Ordinance amending the Ordinance concerning exception from the network license under the Electricity Act)
(SFS 2007:215) ”Förordningen om undantag från kravet på nätkoncession enligt ellagen”	(Regulation for exception from the requirement of network license under the Electrical Act)
(ELSÄK-FS 2006:1, 2008:1,	(Heavy current regulations) These regulations are for

2008:2, 2008:3, 2008,4) Starkströmsföreskrifterna	professional activities on or near electrical power installations and electrical devices.
(SFS 2009:22) Starkströmsförordningen	(The Heavy current ordinance) "This Regulation relates to the Electricity Act and concerns electrical safety in relation to electrical systems and devices that are intended to be connected to such systems."
Standards and directives	
(2006/95/EG) Lågspänningsdirektivet	(The Low Voltage Directive) The directive is a harmonization of rules within the definition of low currency apparatus for the European market and aims at "people, property and pets" that should be "protected from damage caused by electrical products".
(SS-EN 60439) Elinstallationsstandarder	(Electrical Installation Standards) Applicable standards concerning electrical installations.
(SS 4364000) Elinstallationsreglerna. Elinstallationer för lågspänning – Utförande av elinstallationer för lågspänning.	Applicable standards concerning electrical low voltage installations.
(SS 4364000 avsnitt 751) Elinstallationsstandarder rörande kapslingsklasser.	Standards concerning encapsulation classes for electrical installations.

Table 3: *Laws, ordinance standards and directives concerning installation and use of fast charging stations in Sweden*

Source: Vattenfall, 2010; Elforsk: rapport 10:59; *www.notisum.se; http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/_sfs-1998-808/; http://www.elsakerhetsverket.se/Global/F%C3%B6reskrifter/%C3%84ldre%20f%C3%B6reskrifter/1999-5.pdf; Wikipedia.org*; SEK Svensk Elstandard.

4.6 User requirements and commercial adaption

In Tokyo FCS's have been installed since many years. Interesting statistics have been presented (E. Sunnerstedt, The city of Stockholm, the environmental Department, 2012-09). Before the introduction of fast charging stations, the users of electric vehicles came home with an average of 40% power remaining in the batteries. After the introduction of fast charging stations, the same users came home with 10% power remaining. The study also showed that the drivers increased their driving range, which leaves us with the conclusion that the mere existence of fast charging stations reduced their "range anxiety". It also turned out that when users knew that they were close to fast charging stations, they also drove over a longer distance than before. Even if they theoretically never should use the fast charging stations, they knew that it was possible to charge their vehicle. The same conclusion was drawn in a report from Viktoria Swedish ICT; User Requirements (Dr. M.Nilsson, 2012).

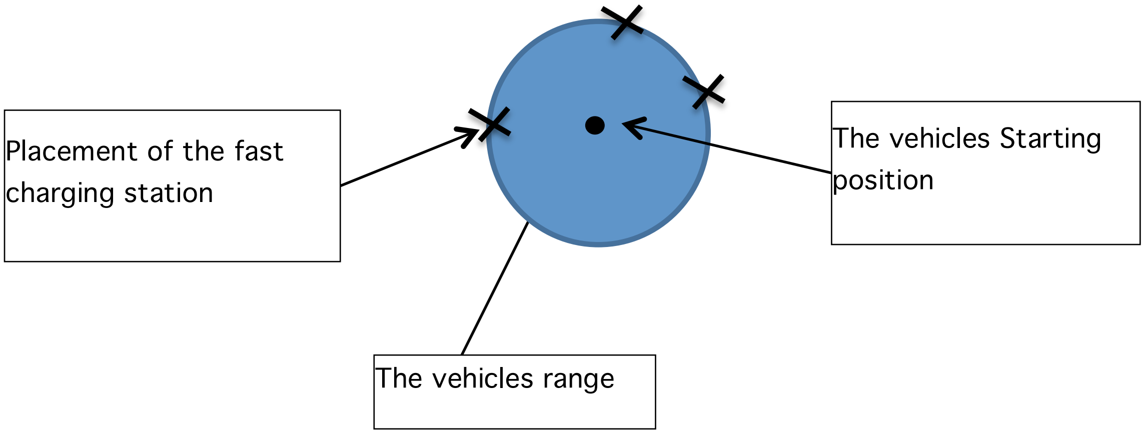
4.6.1 Initial users of fast charging stations

One potential group of users is commercial intercity transports such as taxi and delivery vans since their range is most often regular and well defined. The vehicles mentioned above have frequent pauses from driving as well as regular routes yielding good opportunities to recharge without interfering with their core purpose.

If the energy consumption performance becomes obvious by the amount of recharges per day it is perhaps also probable that the recharging routine will encourage the drivers to excel in "miles per charge" completing as many tasks as possible on one charge.

The placement of the stations affects how much they are used. The FCS will be most effective if it is placed on the edges of the vehicles range area, thus increasing the EV's range with up to 80% to optimize the increase of its range. If the FCS is placed too close to their starting position, it will have a functional overlap since one could expect an electrical vehicle to have a recharging opportunity at its start and end destination. (Dr. M.Nilsson, Viktoria Swedish ICT, 2012), see

Picture 15: *Suitable placement of FCS's*. The distance to the FCS is however difficult to decide since different cars have different range and the range differs very much between summer- and wintertime. A good assumption for the distance between FCS's can be between 50 km and 80 km.



Principal placement of the fast charging stations in relation to the vehicles starting position.

Picture 15: *Suitable placement of FCS's*

Source: Maria Nilsson, Viktoria Swedish ICT

4.6.2 Practical Security/Safety issues and weather adaption

Due to our northerly location and many hours of darkness during wintertime, it would be plausible to install some kind of lighting device to simplify the connection between the vehicle, cable and electrical outlet. One solution could be to have a light connected to the cable glove as to guide the user to a correct "plug-in". (Dr. M.Nilsson, Viktoria Swedish ICT, 2012)

Placing a FCS in a not so frequently populated place increases the risk as well as the fear of assault or robbery. The psychology of the intended user and the actual risk of becoming a crime victim both will affect the frequency of usage of the FCS.

The FCS should be possible to use comfortably in all kind of weather conditions, which should be taken into account when designing or selecting a supplier of a FCS. A placing and user designed area with consideration to possible rain, snow, ice and darkness should be a good starting point for user friendliness. Perhaps a roof with lighting is a good solution.

Location temperature is another factor to consider. It is known that it is both harder and takes longer time to charge your car in a cold climate. One aspect is vehicle design, batteries have a hard time recharging when they are too cold. Some car producers have a built in battery-heating device, but not all do. Charging times can increase drastically when cold. The charging effect with a very cold battery can be around 10 kilowatts, while under normal conditions should be 50 kilowatts. As a consequence charging time can go from 20 minutes to over a hour, interfering with the drivers transport planning and can also contribute to “Range anxiety”.

Weather can create a lot of problems. With this in mind it could be good advice to install lighting/roof above the FCS or make sure to include the station area in a nearby snow clearance contract.

Picture 16: *FCS’s must function in all weather conditions*
Source left picture: http://www.funny-potato.com/blog/category/cars/page/2
Source right picture: http://www.greenhighway.nu/

4.7 Installations requirements

4.7.1 Considerations on geographical position

Before getting into digging and building it is important to have studied the entire infrastructure in the area; water, sewage, power cables, communication etc. Nowadays it is possible to get support from https://www.ledningskollen.se/ who's function is to work as an information coordinator between an entrepreneur and owners of the above mentioned infrastructure. (Meeting notes 9 oct. 2012, Göteborg Energi)

It is also important to keep in mind the possibility that companies or private persons can have installed "add ons" or extensions that they have not reported to the authorities or owners of infrastructure, hence they will not be represented in the information generated by www.ledningskollen.se.

As for now, there are no clear regulations covering FCS's. Depending on the geographic positioning the regulations vary from case to case. As mentioned before it is strongly recommended to get in touch with local authorities to get an orientation to which rules apply in the specific case at hand.

For territory of concession you have to apply for a permit from the local police authority that in their turn must include the consensus of the landowner before issuing a permit.

When planning a project it is recommendable to consider an approximate area for locating a FCS rather than prematurely fixating a specific spot. The cost of establishment is strongly dependent on how far from the closest grid transformer station the FCS is placed. Our recommendation is to pick up a discussion with the grid owner about the cost of different locations within an area, immediately after defining an area in which one wants to place a FCS.

When installing fast charging stations, it could be of value to consider the following aspects (H.Kenamets 2012)

- Recommended distance between FCS along the road is 40 – 60km Access to 400 volt and 32 Ampere current.
- Distance should not be more than 500 meters from the main road.
- Possibilities for 2 cars to park.
- Opportunity for the user of the electric vehicle to go indoors.
- Permission from the landowner to use the property.

4.7.1 Who is legally qualified to install

The authorities actually have not specified qualifications necessary to work with installations of FCS's, however the common practice is to seek specialist electricians qualified and educated specifically on FCS installations.

4.8 Operation and maintenance

4.8.1 Service of the fast charging station

We strongly recommend reaching an agreement with a service company making clear the division of responsibility. Parameters that should be considered when drafting the agreement are the following:

- How and to whom is a FCS failure communicated?
- Which is the accepted response time/repair time?
- Cost definition for service car and hourly rates.
- Frequency of overall survey of the FCS.
- Are there crucial spare parts? Who will have them in stock?
- Investigate general corporate hygienic factors such as financial stability, responsibility insurance etc.

Wireless solutions where the FCS reports directly to the service company with a malfunction code should be an obvious solution to save a lot of time and money. Frequent overall surveys, especially in the beginning of operation, should still be carried out until one is confident that the wireless malfunction reporting really works as intended.

4.8.1 Different payment structures

Payment structures

At present, there are several FCS's that are free, as the customer base is very small, and there are few FCS's around. This must of course change over time and different payment methods must be considered.

How to set up payment system for an FCS is dependent on the purpose of it. An FCS can have different purposes beside fast charging electric cars, it may be to attract customers to a commercial site, to promote electromobility in general, to show environmental awareness or it may be a completely commercial enterprise. In the light of varying purpose both pricing and model of payment should be adapted to the situation.

Generally it is expensive to have a dedicated payment system for a single FCS why it is recommended to, if possible, integrate payment in conjunction with existing payment systems such as close by cafés, restaurants, gas stations or other commercial units.

The billing unit is another issue; time spent at the FCS, actual energy (demands measurement) or a fixed fee. If the FCS is a part of a network of charging stations, an option is to have a subscription that takes care of the payment.

5. NSR countries and Finland, Estonia

5.1 Norway

In September 2013 Norway's count of EV's was close to 19.000 (source: www.Gronnbil.no), which is impressive in comparison with Sweden´s 1500 cars and light vehicles. (source: http://www.powercircle.org/). That makes Norway the leader of implementation of EV's. They have initiated several projects to increase the amount of EV's on the market. One plausible reason for Norway's success in the Electrification car project is that they have introduced free parking in public places, no car tax as well as permission for EV's to utilize the bus-lanes in Oslo. The EV's are also relieved of the burden of road tolls in Norway. Norway and Sweden are since 2009 cooperating to promote the electrification of the road traffic. Norwegian authorities also invested 4 million NOK in building 400 charging stations, mostly in the cities. (*Förslag till Nationellt Program för utvärdering av Elfordon och Laddinfrastruktur NATUREL,*ELFORSK, Power Circle, Test Site Sweden, S.Bergman, *July 2010)*

To establish a FCS in Norway the cost is between 300.000 and 1.000.000 NOK. The charging box costs about 150.000 – 200.000 NOK. The rest is to cover the costs of connecting to the grid. There is a website mapping all the FCS's in Norway. The plan is that the same website will have information of any malfunction of a specific FCS.

5.2 Denmark

A Danish company; Clever, is building charging stations and FCS's in Denmark, from north to south. When all stations are implemented, there will be in total 20 stations all over Denmark. On their website, it is possible to see exactly where the stations are and if it is a fast or a normal charge station.

The homepage also shows general information about driving an electric vehicle and a support number for charging your electric vehicle. (*http://www.clever.dk/find-forhandler/*, 2012-09-07)

Denmark has also focused on establishing battery replacement stations, run by the Israeli company Better Place. Robots simply remove the emptied battery and replace it with a fully charged one; the operation takes about 5 minutes and is a complementary solution to fast charging. Only the Renault Fluence Z.E. is adapted to this, but unfortunately Better Place went bankrupt in 2013.

5.3 Finland

Finland has approximately the same amount of EV's as Sweden There is not as much information about the fast charging situation in Finland as there is for the rest of the NSR countries.

5.4 Estonia

Estonia has installed charging stations in a network that covers the entire country. Tallinn currently has 51 DC fast charging systems. 200 more fast charging stations have been promised to be installed by the autumn of 2012. One of the aims of installing the quick charge stations in Estonia is to enable the electric vehicle to drive all over the country with the possibility to be able to charge your car everywhere. "This will make Estonia the first country in the world with a nationwide infra-structure." (Estonia offer the buyers of an electric vehicle 50 percent for the purchase and maximum 1000€ to construct Mode 3 AC charging equipment for cars). The government is using the 507 Mitsubishi i-MiEV in their own fleet. *(http://unnamedharald.hubpages.com/hub/Estonias-Electro-Mobility-Program-Nation-Wide-Electric-Vehicle-Service*; 2012-09-07) and *(http://www.mkm.ee/electric-mobility-programme-for-estonia/*; 2012-09-07)

5.5 Holland

In the province of Noord-Holland a subsidy for the implementation of fast chargers are in place. This subsidy is for fast chargers placed on other places than along the national highways of the province. It must be open to the public 24 hours per day, use green power and have more than 20 kW of charge power. The subsidy is determent of installed power, 20 kW (AC) amounts to €5.000, 40 kW (DC) amounts to €25.000 and 40 kW (AC) and 40 kW (DC) amounts to €30.000. The recipient then agrees to have a price for a charge turn in conformity with market prices, maintenance the charger and report of the use for a period of three years.

http://www.noord-holland.nl/psstukken/openbaar/OBAS/OBAS-PB2013-32.pdf

The Interreg IVB North Sea Region Programme
Investing in the future by working together for a sustainable and competitive region
European Union
The European Regional Development Fund
VÄSTRA GÖTALANDSREGIONEN
LINDHOLMEN SCIENCE PARK

5.6 The United Kingdom

One of United Kingdom's driving forces for introducing infrastructure for the Electro Vehicles is contributing to a global climate change and a lower carbon energy supply through the electricity system.

The Government of the United Kingdom has invested in eight pilot projects on the subject of installing trial recharging infrastructure. A study in the United Kingdom recently showed that drivers of Electro Vehicles "range anxiety" was drastically reduced from 100 to 35%, after approximately three months of driving.

6. Conclusion

6.1 Cost drivers

The cost for establishing a fast charging station varies and depends on several aspects; where it is placed, how far it is to the closest electrical transformer station, and what type and brand of FCS that is selected. The cost for the most powerful FCS fast charging station which means a charged car in 20 minutes with an effect at 50kW will cost in Sweden approximately 200 000 – 300 000 SEK. (P.Morath, OKQ8, 2012, meeting notes 9 oktober). Worth noting is that Tesla now has a FCS that delivers 120 kW.

Putting up a "fast-charge" sign at the main road will of course do a lot of good. Keep in mind that you have to apply for a permit to do so. Depending on where you would like to raise your sign, different authorities' issue the permit. The following webpage can guide you as to which authority you should approach. http://www.lansstyrelsen.se/gavleborg/Sv/samhallsplanering-och-kulturmiljo/infrastruktur-och-it/Pages/reklamskyltar-utmed-vagar.aspx

We suggest exploring this aspect in the evaluation phase of a project.

6.2 CHECKLIST

A. First decide the FCS purposes besides fast charging of electric vehicles.
   a. Profiling
   b. Attracting customers to a commercial site
   c. General promotion of E-mobility
   d. Running a business on Fast Charging

B. Where shall the station be placed roughly?
   a. Near main roads in the city, for maximizing range in the city proximity and reduce range anxiety
   b. At a sufficient distance from a city for added range of electric cars
   c. Shall it be near other facilities, as restaurants, shopping mall etc.

C. Legal and Financial assessment
   a. Check with powergrid company for possibilities, geographic/financial.
   b. Check for other infrastructural plans for the area
   c. Check with local authorities about permits and legal aspects.

D. Appearance, physical outline and preparation for future upgrade?
   a. Include more parking places
   b. Added signs
   c. Sun panel roof
   d. Space for additional FCS's if the capacity becomes to small

E. How to set up payment system
   a. What to charge for
   b. How to charge

F. Which fast charging system to use
   a. CHAdeMO
   b. CCS
   c. CHAdeMO and CCS combo, this is of course the one to choose as soon as the are available (and if the cost is acceptable)
   d. Medium charging should also be included (up to 43 kW three phase), for Renault and Tesla cars

G. After the placement and general appearance of the FCS s set, it is time to do detail planning.
   a. Pin-point the exact placement of the FCS, check with the power company on the cost for different locations
   b. Apply for permits by the municipality and road administration if necessary
   c. Shall the parking be restricted to electric cars only,
   d. Apply for signs.
   e. Request quotes from a few suppliers of FCS's, preferably installed and tested on site
   f. Decide and request quotes on the ground works, foundation, fences, roof, lighting etc.
   g. Request quotes on maintenance and support of the FCS
   h. Decide on cleaning and winter maintenance

7. Appendix

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7.2 Examples of Fast Charging Stations

The FCS's presented below is not a complete list, it is some examples of manufactures on the market in late 2013.

ABB

Source:
http://www.abb.com/

GARO

Source:
http://laddstation.verkstad.org/

EFACEC

Source:
http://www.efacec.pt/

EVTRONIC

Source:
http://eric.stempin.free.fr/

Schneider Electric

Source:
http://download.schneider-electric.com/

Fuji

Source:
http://www.americas.fujielectric.com/

Eaton

Source: http://www.eaton.com/

Tesla

Source: http://www.teslamotors.com/supercharger

7.3 Car Models

Think!

Top speed: 110 km/h, range: 160 km.

Source: http://www.etron.se/nya_fordon/THINK/think.html

Tesla Roadster

Top speed: 201 km/h, range: 394 km.

Source: http://www.teslamotors.com/roadster

E-Car 500 EV

Top speed: 120 km/h, range: 120 km.

Source: http://ecarsweden.com/?page_id=189

Mitsubishi i-MiEV/Peugeot iOn/Citroën C-Zero (Basically the same car)

Top speed: 100-130 km/h, range: average: 70-100 km, max 150 km

Info at: http://mitsubishimotors.se/bilar/i-miev

Volvo C30 Electric Generation.II

Top speed: 130 km/h, range:164 km

Source: http://www.volvocars.com/

Renault Kangoo Z.E.

Top speed: 130 km/h, range: 168 km

Source: http://www.renault.se/bilar/elbilar/kangoo-ze/kangoo-ze/

Nissan Leaf

Top speed: 145 km/h, range: 199 km

Source: http://www.nissan.se/SE/sv/vehicle/electric-vehicles/leaf.html

Mercedes Benz Vito E-cell

Top speed: 89 km/h, range: approx. 130 km

Source: http://www2.mercedes-benz.se

Tesla S-Model

Top speed: 193-209 km/h Range: 335-426 km.

Source: http://www.teslamotors.com/models

Renault Fluence ZE

Top speed: 193-209 km/h, Range: 185 km

Source: http://www.renault.com/

Mitsubishi Outlander PHEV

Electric top speed: 120 km/h, electric range 50 km

Source: http://mitsubishimotors.se/bilar/outlander-phev

Ford Focus Electric

Top speed 137 km/h, range 162 km

Source: http://www.ford.se/Personbilar/Focus-Electric#primaryTabs

BMW i3

Top speed: 150 km/h, range: 130-160 km.

Source: http://www.bmw.se/

Citroen Berlingo Electric

Top speed 130 km/h, range 120-170 km

Source: http://www.citroen.se/citroen-berlingo-skap/#/citroen-berlingo-transport/electric/

Peugeot Partner Electric

Top speed 130 km/h, range 120-170 km

Source: http://www.peugeot.com/en/news/new-partner-electric-100-partner-100-electric

Volkswagen e-Up!

Top speed 130 km/h, range 160 km

Source: http://emobility.volkswagen.com/int/en/private/cars/e-up.html

Nissan e-NV200

Top speed 140 km/h, range 120-170 km

Source: http://www.nissan.se/SE/sv/vehicles/lcv/e-nv200.html

Tesla X-Model

Top speed: 193-209 km/h, range: 335-426 km.

Source: http://www.teslamotors.com/models

Volkswagen e-Golf

Top speed 140 km/h, range 190 km

Source: http://emobility.volkswagen.com/int/en/private/cars/eGolf.html

Renault Zoe

Top speed 135 km/h, range 210 km

Source: http://www.renault.se/bilar/elbilar/ZOE/ZOE/

Volvo V60 Plug-in hybrid

Electric top speed 120 km/h, electric range 50 km

Source: http://www.volvocars.com/

Opel Ampera (Same as Chevrolet Volt)

Electric top speed Not available, electric range 80 km

Source: http://www.opel.se/

NORTH SEA REGION ELECTRIC MOBILITY NETWORK
e-mobility NSR

About E-Mobility NSR

The Interreg North Sea Region project North Sea Electric Mobility Network (E-Mobility NSR) will help to create favorable conditions to promote the common development of e-mobility in the North Sea Region. Transnational support structures in the shape of a network and virtual routes are envisaged as part of the project, striving towards improving accessibility and the wider use of e-mobility in the North Sea Region countries.

http://www.e-mobility-nsr.eu

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