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D5.2.7 The potential of park-and-ride systems

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Contents

Introduction

Vantaa is in the middle of large traffic junction points. The ongoing infrastructure project Ring Rail Line will soon open a new train connection to Vantaa-Helsinki airport. Vantaa aims for large implementation and usage rates of public transportation. Smooth, extensive public transportation with better sidewalks and bicycle paths are main goals of Vantaa city traffic planning. To increase the usage of public transportation and make it more appealing Vantaa integrates effectively park-and-ride areas to its traffic structures. Most of the capital city region park-and-ride facilities are free of cost. In Vantaa all park-and-ride areas are free. [1] [2]

The increasing interest toward electrification of public and private vehicles has highlighted the question of free or affordable plug-and-ride possibilities. Plug-and-ride is a term used for the opportunity to drive part way with your own full electric or hybrid electric vehicle and plug it in for charging while you head for work with a bus or train.

This work will assess the opportunities and prospects of developing the plug-and-ride concept in the Vantaa city area. The need for charging points should be estimated through the increase of traffic and the anticipated penetration levels of electric vehicles.

Charging of electric vehicles

Good access to charging points for electric vehicles (EVs) is as essential as the availability of gasoline stations for vehicles with internal combustion engines (ICEs). Charging of an electric vehicle can happen in several facilities or places. Depending on the location and estimated parking time, it can be considered whether fast or slow charging is more suitable. Electric vehicle owners must be capable of charging their vehicles at home. If the work place offers a charging possibility, influences that straight on the behavior of the vehicle owner. The more there are charging places for EV drivers, the more confident they feel driving their vehicles. Range anxiety is one of the problems EVs face. However, building heavy charging infrastructure networks is extremely expensive.

Among others charging points can also be built on streets (e.g., curb-side) and parking garages. At least here, one should establish a functioning system for billing and metering of the charging event. Several EV drivers using same charging poles requires an intelligent system with clear payment arrangements.

Finally, park-and-ride areas provide a great basis for EV charging as well. The existing park-and-ride areas could be separated into parking lots for common ICE cars and EVs. The need of charging poles, of course, could be determined through the usage of electric vehicles.

Depending on the time requirements the charging of electric vehicles can happen on several voltage and current levels. The right power levels for charging should be estimated in the implementing place separately. Charging levels are classified mainly by the voltage level. With a mode 2 (one-phase) charging pole it takes around two hours to recharge an EV with a 26 kWh-battery. The charging of a similar vehicle battery would take over seven hours from a home plug (one-phase, 16 A). Table 1 presents the preliminary IEC standardization work for EV charging modes (2010).

Table 1: Charging levels, IEC 61851-1 [3]

Mode	A max	Phases	V	AC or DC	P (kW)
1	16	1	230	AC	3.7
	16	3	400	AC	11
2	32	1	400	AC	13
	32	3	400	AC	22
3	32	1	690	AC	22
	70	1	690	AC	48
	32	3	690	AC	38
	63	3	690	AC	75
	250	1	690	AC	173
	250	3	690	AC	300
4	400	-	1000	DC	400

Considering that the common working hours are enough to charge a typical EV battery to full, most of the park-and-ride area charging points could be implemented as slow charging or mode 2 charging. This would also minimize the cost effect of plug-and-ride.

There are some Finnish manufacturers producing charging points in Finland (e.g., Ensto, Finpilar, SLO, UTU). Ensto slow charging points are based on Schuko plugs. Ensto EVT150.12 charging point has two socket outlets (16 A) and two kWh-meters on DIN-rails. At present SLO sells the Ensto EVT150.12 for 2096.18 euros per piece. SLO's own charging unit with less expensive technology and more limited functions is sold for 634.40 euros per piece. Prices contain value added tax. [4] [5]

Above mentioned charging systems could be sufficient in plug-and-ride use. Chargers with higher capacity would incur greater costs. Probably they would not even create extra value for the users or the provider because there is basically no need for quicker charging in the park-and-ride areas. Additionally, the price of fully usable charging system does not limit to the cost of the charging device itself. Ground or wall mounting of the charging unit creates notable costs.

Park-and-ride to plug-and-ride

The most important objectives for park-and-ride areas are decreasing the amount of private car driving and strengthening public transportation as a mode of travel. Park-and-ride areas provide commuters an option to drive part way with their own vehicles and then change to public transportation – i.e., bus or train. Partly due to the population growth in the capital region the demand for park-and-ride car parks is envisioned to rise during the next ten years. At the moment the capital region park-and-ride lots number around 9000 parking spaces for cars. Until 2020, the amount is suggested to be increased with another 9000 parking spaces. Most of the new park-and-ride lots would locate next to the railway connections (e.g., Ring Rail Line). [6]

In Finland, there are some specific characteristics related to the park-and-ride areas. Common problem with park-and-ride concept has been the lack of state funding. Political willingness to improve the circumstances for park-and-ride area utilization should be enforced. This would, for instance, create a springboard to efficient utilization of plug-and-ride. Park-and-ride area usage should be integrated to the public transportation ticketing system for practical operation. Advisory information systems for notifying the location and free capacity of park-and-ride areas should be developed to help commuters navigate their way through the traffic to available park-and-ride lots. Park-and-ride areas should be developed in cooperation with communities and in order to fulfill the objectives of the Helsinki area traffic systems plan (HLJ 2011). [6]

There still remains a lot of room for the future development of park-and-ride systems. All the above-mentioned can be proportioned to the prospects of plug-and-ride. Electric vehicle drivers would certainly benefit from mobile and internet solutions for real-time plug-and-ride guidance. Helsinki Region Transport (HRT) has already recommended broader use of internet-based and mobile applications, as well as stationary road posts for presenting information on park-and-ride car parks to commuters and other traffic [7]. Information such as the availability of charging points could be transferred through telecommunication channels to the passengers' mobile equipment. Reserving a parking lot or charging point via mobile devices would facilitate the usage of and improve the user experience of plug-and-ride parking. [6]

Recently published final report of the SYÖKSY project speaks for electric vehicle charging on park-and-ride areas. SYÖKSY project (2010 – 2011) aimed for determining the possibilities of integration of EV traffic into the upcoming feeder system and train connection built from east to west in Vantaa (i.e., Ring Rail Line). The work stated a need for providing park-and-ride areas with an option for later installation of EV charging equipment. When the basic piping for cables is done in beforehand, a lot of money is saved in later mountings. The SYÖKSY project described EV charging poles to have a good image value which contributes to the profitability demonstration projects and willingness of different companies to

participate in such projects. Shopping center Jumbo has already opened the first six free EV charging points contributing to the Ring Rail Line project in its parking area. [8]

SYÖKSY project also showed that there is a need to pay attention to the passive and active filtering of harmonics for improving power quality. Harmonic components occur from the non-linear loads like EV charger. However, power quality is not an issue that would impede the penetration of EV chargers. Some problems might come from the winter conditions in the Finnish cities but with good planning and positioning of EV charging devices climate does not create too big a threat for EV chargers. Mainly, the difficulties could relate to the heavy fall of snow. [8]

Main risks possibly hindering the development of park-and-ride systems are known. The most demanding necessity is the cost allocation. Who will pay and what? Who will be the winner? Building parking space in cities is not free of costs. It is recommended that companies from the industry and commerce sectors should take part in the development of park-and-ride systems. For certain compensation, car parks other than the actual park-and-ride areas could participate by providing commuters with parking space. Secondly, careless planning of land use can impede the successful implementation of park-and-ride areas, especially around the stations. Finally, the lack of commitment and failures of cooperation are risks to be taken into account. [6]

Internationally, there are some projects where plug-and-ride concept is in use for first EV owners. For instance, Seattle, Washington, in the United States has four park-and-ride areas offering altogether 39 plug-and-ride parking lots for EV owners who have enrolled in a specific trial. The Level 1 (1.92 kW) charging points utilize NEMA (National Electrical Manufacturers Association) 5-15R and 5-20R plugs for maximum of 15 and 20 ampere charging. Three of the charging points are Level 3-equipped (300 – 600 V DC; >100 A). In 2008, it was estimated that the plug-and-ride Level 1 charging points would occur costs of around $ 10,000 USD for the first two devices and thereafter $ 2,000 USD per each additional device. This estimation included engineering, permitting, hardware costs, weather-proofing and service costs. [9] [10]

Park-and-ride in Vantaa

In Vantaa there are currently around 1280 park-and-ride lots. In the first phase of the Ring Rail Line construction project, Vantaa will gain an extra 500 park-and-ride lots on four train stations: Kivistö, Aviapolis, Airport and Leinelä. More park-and-ride lots to these stations are built when necessary. The Ring Rail Line will later receive four more stations and possibly more park-and-ride space. Regarding this input and other assumed increase of park-and-ride lots, there could be approximately 2000 park-and-ride lots in Vantaa in 2020. Utilizing the predicted penetration levels of electric vehicles in 2020 (see Figure 1) a reasonable requirement for EV charging points on park-and-ride stations can be assessed. As seen in the IEA scenario, the market penetration of EVs will be moderate but clear until 2020. In Figure 1 yellow color stands for electricity-based vehicles, plug-in hybrids (dark red) are shown separately. Based on the IEA BLUE Map scenario, one can say that also the Vantaa region will have room for demonstrations and development of plug-and-ride during the next five to ten years. [2] [11]

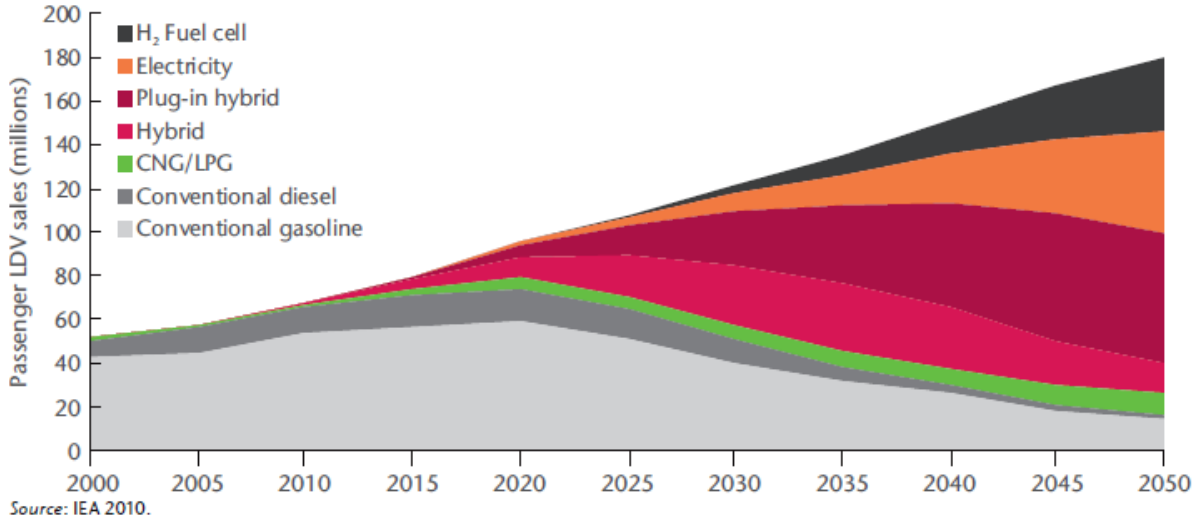

Figure 1: Annual light-duty vehicle sales by technology type, BLUE Map scenario [11]

Vantaa city has done traffic counts on all park-and-ride areas. The volume of a specific weekday from 2010 showed that the average parking lot usage on park-and-ride areas was around 72 percent. Thus, nearly three quarters of the available lots were reserved during the working hours. There was some unbalance between locations as some of the park-and-ride areas were full and others were clearly more vacant. However, the usage rate is rather high and it can be said that continuous population growth on the area will require establishing of more parking space to park-and-ride stations. [12]

Case: 10 % of EVs

Demand side control of loads is an increasing trend. From the electricity network point of view controllable loads provide control potential that can be used for leveling the consumption peaks. On large scale, it is possible to utilize demand side response for balancing the grid's power production fluctuation – e.g., in case of wind energy.

After a couple of years the amount of park-and-ride lots in Vantaa may reach 2000 units. Let us consider that 10 percent of all the private vehicles were operated on electric energy, thus requiring an EV charging point. Now, if 200 out of those 2000 Vantaa park-and-ride lots were equipped for plug-and-ride and the usage rate would remain in 72 percent (according to the volume count in 2010), we would have 144 EVs parked in Vantaa plug-and-ride lots every weekday.

Consider every vehicle in a plug-and-ride lot would be charged for three hours during the time staying in the lot – assume it eight hours. 144 vehicles with slow charging (3.7 or 11 kW) would draw maximum power of around 600 kW (3.7 kW charging) or 1.6 MW (11 kW charging). The daily energy consumption would reach nearly 1,600 kWh or 4,800 kWh, respectively. These volumes of power and daily energy consumption are based on a 10 percent share of EVs only. Whether the electrification of private vehicles is going to happen quickly or not, there will be a clear need for controllability of plug-and-ride power and energy consumption in the future. Intelligent charging systems with load measurement and system load leveling options are required at least in larger charging systems.

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