The SYÖKSY Research Project – Electrically-Powered Vehicles in Ring Rail Line Feeder Traffic and Short-Distance Travel

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INTRODUCTION AND PROJECT DESCRIPTION

1.1 Background

The SYÖKSY Research Project began in April 2010 and involved studying and developing solutions for electrically-powered feeder traffic and short-distance travel in connection with the Ring Rail Line which is currently under construction. As the Ring Rail Line will perform an important cross-traffic role in the Helsinki metropolitan region, it will become a significant element of the metropolitan traffic system. As the Ring Rail Line will connect the main railway line with the Vantaankoski railway line through Helsinki-Vantaa Airport, it will connect the airport not only to the metropolitan region, but also to Finland's national railway network. Metropolitan traffic systems consist not only of railway lines, but also roads, streets and the parking systems associated with stations. Both Marja-Vantaa and Aviapolis, districts adjacent to the Ring Rail Line, are important for developing business and housing in the metropolitan region. The Ring Rail Line will operate as an efficient city rail resource, transporting some 200,000 passengers on a daily basis and significantly reducing the amount of time people spend travelling to and from work. Regular traffic on the Ring Rail Line will begin in 2014. In connection with feeder traffic, the most important location in the Marja-Vantaa neighbourhood will be Kivistö Station, and the most important locations in Aviapolis will be the areas surrounding Aviapolis Station and Helsinki-Vantaa Airport Station.

There are several reasons why new low-emissions service models are required for feeder traffic and short-distance travel. Finland is committed to achieving reductions in CO_2 emissions from burning fossil fuels. Currently, the contribution to total emissions from traffic sources is large. The use of public transport and vehicle-sharing schemes should therefore be promoted in order to offer attractive alternatives to users of private cars. The Ring Rail Line is a major investment that will improve the level of service provided by public transport systems. To benefit from this investment, the emphasis in station surroundings must be placed on feeder traffic and short-distance travelling for personal reasons. Doing this will improve the attractiveness of stations and also improve mobility in the metropolitan region.

Figure 1 Ring Rail Line. Copyright Ring Rail Line Project

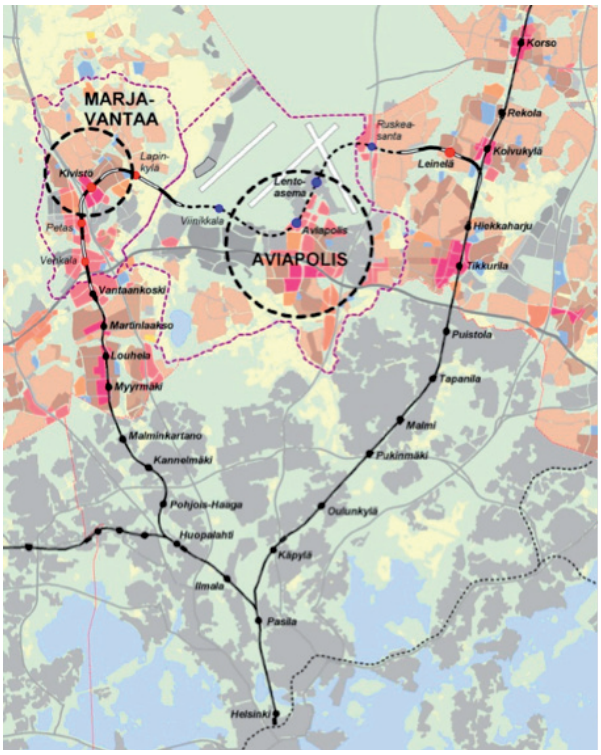

Figure 2 Marja-Vantaa and Aviapolis in relation to the Ring Rail Line. The areas studied in the project are shown as dotted circles. Copyright City of Vantaa

1.2 Objectives, Themes and Participants

The primary objective of the SYÖKSY Research Project was to develop public transport service solutions for Ring Rail Line feeder traffic which are suitable for residents, commuters and other visitors to the Aviapolis and Marja-Vantaa districts. Such solutions should exploit different types of electric vehicle as well as other vehicles with a low-CO_2 emissions profile. The proposed solutions represent an intermediate stage between public transport and private car use.

After assessing user needs in connection with the provision of new passenger transport services, transport services based on electric-vehicle technology in station areas were developed. Assessments of the prerequisites for implementing transport services and electric-vehicle technology are also provided in this report, together with views regarding their effects on infrastructure planning. Small pilot projects were used to test solutions considered to have the greatest potential in the near future.

SYÖKSY is a joint research and development project coordinated by the Helsinki Metropolia University of Applied Sciences. The participants in the research consortium were:

- The School of Industrial Engineering at the Helsinki Metropolia University of Applied Sciences
- The Centre for Urban and Regional Studies (YTK) at Aalto University
- The EDGE Research Laboratory at the Verne Traffic Research Centre in Tampere University of Technology

The project content was divided into three complementary themes:

- Technologies and solutions required for implementing traffic systems and new service concepts
- Traffic system planning and the assessment of feasibility and possible effects
- User-centred traffic planning

Two levels of planning were used in the project:

- Short timeframe: using current technology / solutions implementable by 2014 (the date when the Ring Rail Line will be completed), and
- Long timeframe: visions of future (2030–2040) solutions which could help in handling issues connected with urban planning phases

Cooperation with companies and organisations representing the local community is important in an applied research project such as SYÖKSY. Funding was provided by the Tekes Sustainable Community technology programme and the companies participating in the project. Financial contributions were made by Ensto Finland Oy, European Batteries Oy, Helsingin seudun liikenne HSL (Helsinki Region Transport), the Jumbo Shopping Centre, LAK-Lentoasemakiinteistöt Oyj (Airport Real Estates Plc), Vantaan Energia Sähköverkot Oy (Vantaa Energy Electricity Networks Ltd.), the Itella Corporation and Vantaan Innovaatioinstituutti Oy (Vantaa Innovation Institute Ltd). The project steering group consisted of representatives of the above-mentioned companies and Aalto University, Green Net Finland, Hermia Oy, the Tampere University of Technology, Helsinki Metropolia University of Applied Sciences and Tekes' Sustainable Community technology programme. Gilbert Koskela, a project engineer from the City of Vantaa, chaired the steering group.

Researchers working on the project were Sirkku Wallin and Sanna Ahonen from the Centre for Urban and Regional Studies (YTK) at Aalto University, Hanna Kalenoja, Erika Kallionpää, Kimmo Ylä-Anttila and Antti Moisala from Tampere University of Technology, and Heikki Torvinen and Markku Haikonen from the School of Industrial Engineering at Helsinki Metropolia University of Applied Sciences. Mr Haikonen was also the project manager. Suvi Häkämies and Arto Haakana from Green Net Finland supplied expertise and communication/information services for the Helsinki Metropolia University of Applied Sciences. Risto Salminen, Director of the Helsinki Metropolia University of Applied Sciences, held overall responsibility for the project.

1.3 Content of the report

This report on the research project has three sections: a general description of the project, separate reports on each of the themes investigated and a summary of the research results and recommendations. Section 2 deals with themes such as:

- Low-emissions-technology solutions for traffic and their technical prerequisites in an urban environment and the results obtained from pilot projects.
- New service models based on electrically-powered traffic technology with an assessment of their feasibility and their effect on urban infrastructure and levels of CO_2 emissions.
- User needs in new feeder traffic, short-distance travel and other journeys on personal business together with proposals for planning measures which will promote sustainable mobility in new residential areas.

The prerequisites for electrically-powered feeder traffic and short-distance travel are therefore handled in a wide-ranging manner. A condensed version of the project conclusions and recommendations is provided in Section 3. A list of the data sources and publications resulting from project work can be found at the end of the report.

RESEARCHED AND DEVELOPED ELECTRICALLY-POWERED FEEDER TRAFFIC AND SHORT-DISTANCE TRAVEL SOLUTIONS

2.1 Technologies and solutions required for the implementation of traffic systems and new service concepts

The research tasks assigned to the Helsinki Metropolia University of Applied Sciences consisted of a literature review, feasibility and usability studies, in both normal-traffic and laboratory conditions, of a hybrid bus, an electric car, an ethanol-powered plug-in hybrid car, and charging solutions. The studies of applied research included also interviews with consumers and test users of electrical vehicles.

The research revealed several methods for expanding the use of electrically-powered vehicles in feeder traffic and short-distance travel. These methods can be linked to the Ring Rail Line in the Aviapolis and Marja-Vantaa districts, and thereby lead to a reduction in levels of CO_2 emissions. Some of them can be adopted immediately, others may only be possible in future decades and will require further research.

A short description of the outcomes of the technical solutions studied and their prequisities follows. A full account of the results obtained by the Metropolia University of Applied Sciences is presented in Appendix 1.

Hybrid buses, electric buses, buses using alternative fuels - ProBus

According to a feasibility test using a Chinese hybrid bus, there is justification for the adoption of hybrid technology, including buses that use biomass-based fuels, in the City of Vantaa's internal traffic as well as in feeder traffic linked with the Ring Rail Line. The quantity of fuel consumed would be reduced by some 30%, and noise levels would be lower than with traditional diesel engines. The use of biomass-based fuels would also significantly reduce the quantities of CO_2 emitted.

According to a research report produced by Tampere University of Technology (Appendix 2.), the ProBus solution – a new transport service model – could be taken into service on a fast-track timetable to link the hotels in the Aviapolis area with Helsinki-Vantaa Airport. By using a scheduled and partly on-demand timetable, the ProBus solution would provide transportation for commuters to and from local office complexes and the Jumbo Shopping Centre. In addition to passengers, costs of the service could be covered by hotels and office complexes, as well as other local operators.

Automatic vehicles as elements in public transportation – the Opt10 / CyberCities project

A survey of commuters conducted by the Centre for Urban and Regional Studies (YTK) at Aalto University (Appendix 3.), revealed that automatic vehicles were considered to be fairly interesting . Automatic vehicles could be used in limited areas for delivering personal transportation services. They could also reduce operating costs, as they do not require drivers and control-room personnel can monitor several vehicles at the same time.

Future possibilities for using automated vehicles in new transportation services are however connected with several legal requirements for which solutions at EU level should be found. Passenger safety and associated responsibilities must also be carefully evaluated. Moving forward at only national level is not possible. Even though the initial investment

costs are higher than with traditional bus operations, the operational costs associated with remotely-controlled driverless electric vehicles are significantly lower than in operations that require a driver. Salaries represent more than 50% of the total cost of operating bus services.

Vehicles currently using the road and city streets network should be investigated and tested more extensively in the new EU-level CyberCities project. The City of Vantaa could be one of three European locations for trials of new public transportation solutions. Potential test routes are from Kivistö Station to the Keimola district or the housing fair area, or from Aviapolis Station to the Jumbo Shopping Centre.

Environmentally-sound shared vehicles – AviaMobil and eMobil

Hybrid technology is already available in private cars, and plug-in hybrids will be available in a few years time. If biomass-based fuels are used in this type of vehicle, levels of fossil-fuel-based CO_2 emissions can be reduced to the targets set for 2050 – just 20-30 g/km in the case of private cars. The test vehicle was a plug-in Toyota Prius hybrid which uses ethanol as fuel. Hybrid technology allows vehicles to make short journeys using electrical power and longer journeys using a fuel-driven engine or generator. In this way, vehicle operating range is not limited as in electric cars. Several models of electric passenger car will be launched by different manufacturers in the beginning of 2011. Consumer research carried out by the project indicates that only after 2020 will the majority of people be willing to make such a purchase.

An electric shared-use passenger car (Volkswagen Passat) was tested on business journeys made by people working at Technopolis in Vantaa and by residents of the Pakkala district. Interest was expressed, but as typical daytime working trips involved distances of 60 km or more, the operating range of approximately 100 km on a fully-charged battery limited use of the vehicle to only one journey per day. This makes the delivery of a commercial service unprofitable at the present time.

The use of electric and plug-in hybrid vehicles should however be promoted by providing parking and charging facilities.

Charging electric vehicles and electricity grids

The charging technology used in electrically-powered vehicles can cause undesirable harmonics and voltage dropouts. In well-designed charging technology, the standardisation of charging devices, soft-start operation and active power-factor correction, among other methods, can reduce the effects of vehicle-charging activity on the quality of grid supplies and keep fluctuations from the norm within acceptable limits.

In Finland, the charging of electric vehicles will be easiest when performed in courtyards and covered areas such as parking garages, and in similar locations such as current service stations or specialised roadside rapid-charge stations. In housing areas and workplace parking lots, a full charge will require about 10 hours. In business premises, a medium-speed charge will require 1.5-3 hours, while specialist electrical vehicle facilities will offer rapid (15–30 minutes) and ultra-fast charging (6 minutes). New buildings should be equipped with adequate cabling and charging connection points. The cables laid to courtyards should be installed in ducts so that new or additional cables can be added without extensive excavation work. Upgrades to connection box hardware should also be permitted to reduce their cost when compared to completely new connection points. The chosen charging technology should allow control of the charging process, regardless of whether the control impulses are transmitted by local building automation systems, the electricity supplier or the electrical grid in connection with the current electricity generation situation.

The term 'Smart Grid' refers to an intelligent network which incorporates fixed generation facilities powered by renewable energy resources such as the wind and solar radiation, some of them small-scale. The problem with both wind and solar power production is that the synchronisation of output with consumer demand is not always possible and large quantities of energy should therefore be stored for use when required. Electricity grids themselves cannot provide this storage function and one of the alternative proposals is the use of batteries in electrical vehicles for this purpose. In smart grids, the charging of electric vehicles can, as with other controllable loads, be controlled in an optimal manner

in relation to network usage and electricity generation, electricity sales, emissions trading and other influential factors. Payment could be made using fixed-price text messages or call-based mobile telephone charging systems. By exploiting RFID and NFC technology, text-message and call-based payments can be made easier to use. Similar preselections can be made by using 2D barcodes. The corresponding technology and its interfaces should not be decided on a case-by-case basis - it should be easy to understand and use and also implemented by both telephone operators and electricity suppliers in accordance with standards.

Park and ride

The construction of parking facilities for passengers using the Ring Rail Line is planned to take place in two phases. Consideration should however be given to the construction of these parking facilities on an accelerated timetable, and with larger numbers in the initial phase, at least near Kivistö Station. Currently, local parking authorities are mainly responsible for arranging parking facilities for connection traffic. Later, as connection-related parking will benefit other parties, every player who benefits should contribute to the associated costs.

Investment and operational costs associated with connection parking should be divided between users, users' municipalities, the municipalities to which journeys are made, companies who are providing transportation services, the state and local businesses.

The most important element in bicycle parking facilities is to ensure that the distance to station platforms is short. Another important element is the security of such parking facilities. Safe locations for bicycle racks should always be equipped with locking arrangements, preferably the possibility of securing the bicycle frame. Bicycle parking facilities should always be situated in busy locations which have a roof and are well lit.

Primary recommendations concerning technology solutions and their prequisities:

1. Hybrid buses should be used in feeder traffic and in bus services in the City of Vantaa
    a. biomass-based fuels should be employed
2. In the ProBus model, hybrid or electrically-powered buses should be established in the Aviapolis district to serve airline passengers, hotel customers, office workers, consumers and the Flamingo entertainment centre. In connection with this:
    a. A distinct brand should be created.
    b. Provision of an electric bus service could be the City of Vantaa's contribution to the World Design Capital 2012 event
    c. Funding from the Tekes EVE – Electric Vehicle Systems 2011–2015 programme should be applied for.
3. In the Opt10 model for automatically-controlled vehicles, the City of Vantaa should participate in the joint European research programme which will assess the usability of such vehicles. Test environments offered to the programme should include Kivistö Station, the Marja-Vantaa housing fair area and the Keimola residential district, as well as connections between Aviapolis Station, the Jumbo Shopping Centre and the Flamingo entertainment centre.
4. In Aviamobil and eMobil, the car sharing model of sustainable plug-in hybrid and electric cars should be promoted by installing parking and charging solutions in public locations. The same considerations apply to electric scooters, electric bikes and similar devices.
5. Preparations should be made for the provision of user-friendly controllable charging facilities for plug-in hybrid and electric cars:
    a. By building completely-new charging poles/points or converting existing engine-heating points into charging points. When constructing new buildings, ducts that can be used for the future installation of charging cabling should be a minimum requirement. Engine-heating points should be upgradable to avoid the need to replace them.
    b. The dimensioning of electricity grids and transformers, and smart grids, should be arranged so that charging operations are controlled in an optimal manner. Payments for electricity consumed should be made by exploi-

ting RFID or NFC technology.

6. Additional park and ride facilities for cars and bicycles should be constructed at all stations which will handle connection traffic, especially in locations close to the Hämeenlinna and Tuusula highways.
    a. Investment and operational costs associated with parking for connection traffic should be divided between service users, users' municipalities, the municipalities to which service users are travelling, the state, companies that provide the services chosen by users and local businesses.
    b. In some locations, facilities for charging electrically-powered equipment such as electric bicycles, electric scooters and electric cars should be provided.

2.2 Implementation of a traffic system based on new transport services and an assessment of the expected effects

The objective in research activity conducted by by Tampere University of Technology was the planning of alternative transport services that will meet the needs of different user groups in the target areas and to assess the impact of such services. The research task included assessments of the technological and economic costs of the transport service models and their effects on mobility, travel behaviour, urban infrastructure and land use. In the developed transport services, the overall goal is to offer users a low-emissions mobility system which is so competitive that the majority of residents and commuters do not need to use a private car on a daily basis. By developing transport services, the aim is to keep car ownership in the area at a low level and ensure that households do not need to own more than one car.

Transport service models were divided into four service-model alternatives based on on-demand public transport or vehicle sharing. Opt10 is an open-access, on-demand public transportation system, ProBus is a public transportation service for defined groups and AviaMobil and eMobil are shared-vehicle service models designed for connection traffic along the Ring Rail Line, for residents of the Marja-Vantaa district, for working people and for visitors to the Aviapolis district. Short-term planning targets include offering these service concepts within the next few years, long-term plans extend to 2040. While short-term solutions are based on currently-available technology, the emphasis on vehicle automation is greater in the 2040 solutions. Results achieved in the long-term scenario will also be extensively applicable in similar areas.

- Opt10 is an open-access public transportation service model which anyone can use as part of the public transport network. In the short term, this service model will be implemented using small buses with drivers. In the longer term the vehicles employed will be smaller and, and after the initial phase, driverless and remotely controlled (2015-2020 research/demonstration phase, 2020-30 extended implementation). In the final phase (2030-40) the system will be fully automated. Routes will consist of trunk lines complemented by additional lines offered on a flexible and on-demand basis.
- The ProBus service model is an on-demand public transportation model which offers transport services to defined groups such as employees of specified companies, people visiting shopping centres, customers using connection traffic facilities, train travellers, airline travellers, hotel residents and students. Routes are based on fixed route maps. The vehicles employed can accommodate 1-2, 3-5 or 5-10 people.
- AviaMobil and eMobil shared-use vehicles can be electric cars or electric bicycles. In this service model, the target is to provide transportation both within the Aviapolis and Marja-Vantaa districts and also outside these areas without the need to own a car.

Forecasts indicate that transport service models can increase the popularity and attractiveness of public transportation and reduce the levels of CO_2 emissions. The results indicate that transport services will expand the transportation-oriented influence of railway stations to neighbourhoods located further away than is generally considered an acceptable walking distance or bicycle journey. A station's area of influence usually extends to 1-2 kilometres and the desire to make journeys longer than this on foot or by bicycle diminishes significantly beyond this threshold. On the other hand, from the viewpoint of energy efficiency and space utilisation, using a traditional passenger car for a trip of 2-4 kilometres is an inefficient choice for connection traffic. In the open access, on-demand service model for public transportation investigated, the number of passengers generated by station neighbourhoods in 2040 will be approximately one fifth larger than the so-called "basic alternative" – the situation in which transport service models are not implemented.

Correspondingly, in the AviaMobil and eMobil models, the number of passengers using public transportation is forecast to be some 15% higher than in the basic alternative. In overall terms, the number of journeys completed by private cars will be reduced by 4-12% when using the alternative service models. These models therefore introduce new and attractive forms of mobility for short distances, and their implementation will reduce the number of trips made on foot and by bicycle.

Also, the implementation of service models will reduce traffic-related CO_2 emissions in the case study areas by 3-9% compared on the basic alternative. In the on-demand model, CO_2 emissions are 9% smaller than in the basic alternative. The introduction of shared-use vehicles also reduces CO_2 emissions. Calculations indicate that implementation of the ProBus service model for defined groups will result in a 3% reduction in CO_2 emissions compared to the basic alternative.

When adapting urban areas and urban construction for electric vehicles, factors which must be taken into consideration include not only parking space but also space for vehicle operation such as the dimensioning of traffic lanes and service stations. Since the new electric vehicles and service models presented here are well suited to the current dimensions of roads and urban spaces, the changes in land use planning required are fairly minor. For example, charging points can be implemented using minimal technology when installed in existing urban structures by adding electrical connections which correspond to the engine-heating points or connection boxes already in use. The introduction and general adoption of small electric vehicles in urban environments also opens up opportunities for innovation in the design of parking facilities and charging stations.

From the viewpoint of the wider urban structure, the service models proposed here open up new possibilities in land use and traffic planning. The introduction of light electric vehicles and their proposed service models also allows a reappraisal of traffic network hierarchies and the classification of cycle and pedestrian tracks. Future possibilities include the integration of different land-use zones and improved connections via pedestrian and cycling routes which could also be used by light electric vehicles.

Stations and their surroundings will be important centres for rail-dependent neighbourhoods. The majority of journeys made by local residents will be directed to stations and channelled further through them. The planning of stations and their immediate operational surroundings is one of the most important tasks in urban planning and building construction. From the viewpoint of transport services, it is important that stations are designed to be intermodal centres, in which transfers by passengers from one mode of transportation to another take place smoothly and information regarding upcoming connections is immediately available. In urban planning, it is recommended that traffic-related stops, platforms and parking spaces are located in the immediate vicinity of terminal or station buildings or even inside them. Other services should also be placed in nearby locations, for example inside station premises, to allow a smooth chain of travelling connections.

Compared to transport service models and their immediate technological prequisities, factors of much greater significance are the mobility environment and the careful and high-quality planning of important ”connection interfaces” such as stations, stops, traffic-mode transfer points, parking spaces and buildings. To support new traffic models, the number of such connection surfaces will certainly increase. Specifically, intermodality between different forms of traffic and the integration of services into a consistent whole (hybrid buildings) is one of the most important tasks in planning activities.

2.3 User needs and adoption of service solutions in user-driven traffic planning

The research objective in work conducted by the Centre for Urban and Regional Studies (YTK) at Aalto University was the generation of information concerning the mobility needs of potential users and the prequisities for benefiting feeder traffic and short-distance travel connected with the Ring Rail Line. This information is necessary for the planning and implementation of electrically-powered feeder traffic and short-distance travel facilities in new urban areas located in the Aviapolis and Marja-Vantaa districts. The research offers an in-depth view of the user needs of commuters and local residents (Appendix 3.). Commuting journeys were studied via a survey of employees at Vantaa Technopolis,

while journeys undertaken by residents were investigated through workshops arranged in the Pakkala neighbourhood in the Aviapolis district. In addition to data collection, this research theme offered users an opportunity to assess the suitability and future implementation of transport service solutions developed by the Tampere University of Technology. The service solutions proposed were on-demand buses, shared electrically-powered vehicles and shared electrically-assisted bicycles.

From a user perspective, the implementation of new electrically-powered transport services is affected by many structural factors:

1. Existing physical and operational structures in urban areas have a significant influence on mobility needs and possibilities of choosing modes of transportion.
2. The resources available for public transportation - especially whether new services will complement existing services or replace them.
3. The successful provision and implementation of new electrically-powered transport services (for example services developed during the SYÖKSY project), are dependent on the availability of related support services such as reservation, booking and payment routines and also on service-levels connected with journey durations, routes and overall attractiveness.

The results of user-group and case-study analyses were as follows:

The Aviapolis district

For Aviapolis, the challenge lies in the district's segregated urban structure. Housing, recreational and workng areas have been separated from each other. This causes car-dependency, long commuting journeys and biased user needs in transportation services. Currently, interaction between residential and employment areas in Aviapolis is minimal. People who work in the area live elsewhere, while those who reside in the area work in other places. Also, Aviapolis is home to the Jumbo Shopping Centre, which does not have proper access in terms of public transport. The situation is unlikely to improve in the future without feeder traffic that supports the Rail Ring Line.

Once constructed, the new Aviapolis Station neighbourhood, which includes residential and commercial areas, will have a positive effect on the currently separated nature of urban functions in the Aviapolis district. There will then be a specific need for light traffic lanes and routes along which individuals can conduct their business. Responsibility for the implementation of these lanes and routes should be divided between employers and service companies operating in the area. Even if this is achieved, arranging transport services for existing residents, for example people living in the Pakkala district, remains a challenging task.

Of the service models presented, **on-demand buses** clearly generated the highest levels of interest. Such vehicles would benefit users on routes to and from their hobby activities, and would also provide fill-in services during quiet periods (for example transporting airline passengers travelling on night flights). There is still a clear need for regular bus routes which serve short-distance travel requirements between residential areas and the Jumbo Shopping Centre, as well as Aviapolis Station. For the uses just mentioned, quiet time feeder traffic will rely heavily on the Ring Rail Line, while route plans for other uses should be designed from the perspective of other user needs. Commuters considered on-demand buses to be the most interesting service model of those proposed. The need for such services will depend on whether employees commute by car or not. It should be noted that providing public transportation services which only improve journeys in the Aviapolis district, at one end of the travel chain, will not be enough to encourage people to move from using private vehicles to public transport. All stages in the travel chain must be easy to access and use.

Interest in **shared-use vehicles** was lower than in the case of on-demand buses. Methods of using shared-use vehicles were limited to occasional events, since as a primary mode of transportation such a service is unlikely to have an adequate level of service combined with a competitive price. On the other hand, the prerequisites for demand for electrically-powered shared-use vehicles exist in the Aviapolis district. Companies and their employees located there

are technology-literate and willing to use new technology such as electrically-powered vehicles. In connection with shared-use vehicles, Aviapolis also has a good ”operational structure”. Residents mainly use vehicles in the evenings and at weekends, and employees´ needs for cars are restricted to office hours. Consequently, the new service models can be piloted without major investments and the associated risks. The development of electrically-powered shared-use vehicles should be supported as this will introduce new technology to new people, dispel associated prejudices and accelerate the adoption of electrically-powered modes of transportation.

Only a marginal group of users were interested in **shared-use bicycles**. The evidence indicated that people already have their private bicycles, and that user needs are focused on having better cycle tracks and the provision of bicycle parking facilities.

The new service models presented also encountered resistance, often for reasons that did not relate to services developed in the project. Public transport planning for the Aviapolis district is ongoing and residents feared that their direct bus connections to Helsinki would be under threat. For this reason, people’s attitudes towards new plans were reserved. In addition, proposals for new transportation services were subject to the normal resistance that comes with proposals for change, as people are unwilling to change their mobility habits. In overall terms, it is difficult to make predictions regarding future transportation needs, especially in an area in which significant changes are taking place.

In the Aviapolis district:

1. It is important that existing transportation services be maintained.
2. It should be noted that the introduction of electrically-powered transportation services will not by itself increase the use of public transport. The level of public transportation service provided in the Helsinki Metropolitan Area should be improved in a broad-ranging manner using traditional service models.
3. Arranging new electrically-powered services makes most sense in new residential areas located around Aviapolis Station.

The Marja-Vantaa district

Marja-Vantaa differs from Aviapolis in many ways. Because of its location, the majority of the district’s mobility needs will be directed naturally through the station along the railway line to the south. As Marja-Vantaa’s commercial and business centre is located by the Ring Rail Line and especially Kivistö Station, the routing of feeder traffic and short-distance journeys is easier to plan than in multi-centred areas. The situation in the Aviapolis district would be simpler if the station was located in Pakkala, close to commercial services and extensive residential zones.

There are also good social preconditions for providing sustainable transport services in Marja-Vantaa. An additional factor is that newly-arrived residents are more ready to adopt new ways of living. The electrically-powered feeder transportation services proposed in this report will be able to deliver residents to the station and then back home. The need to acquire a second car, or a lifestyle which supports such a purchase, is then less likely.

Measures to be taken in the Marja-Vantaa district:

1. Transport services should be taken account of in both the planning phase as well as during the construction phase. Routes for light traffic and attractive station surroundings should be completed and ready for use when residents move into the area. Once adopted, mobility habits are difficult to change.
2. When planning feeder traffic and short-distance travelling, local facilities that people use in their hobbies should be taken into consideration so that appropriate routes and service quality are provided.
3. A mobility centre should be established at the station which offers not only transportation services but also information regarding sustainable transportation and everyday living.

The central thrust in new urban areas should be on pedestrians, light-vehicle traffic and public transportation, even though travellers will continue to rely on traditional service models. In this way, user habits will support the use of transportation services based on electrically-powered vehicles in the future.

Prequisities for user-centred traffic planning

1. Sustainable transportation is not just the design of technology or services, it requires that rail solutions be integrated into urban neighbourhoods and that transportation services become an essential part of individuals' daily lives. The existence of a rail connection to Marja-Vantaa will make public transportation options more attractive. In the case of Aviapolis, separated functional areas and multiple centres ensure that the planning of public transportation services remains a challenge.

2. Transport services are only as effective as their support services allow them to be. The provision of electrically-powered feeder traffic and short-distance travel services will not alone be sufficient to cure the dependence on private cars. New transportation services will require support to make unfamiliar services easy and pleasant to use.

3. From a user perspective, the availability of on-demand buses tackles the need for second cars among those for whom current public transport services appear inadequate. In order for shared vehicles to become common, it is essential to provide support services which are both versatile and visible. Specific recommendations include Internet-based reservation services and mobility centres.

4. User resistance to attractive service models and service renewal can be countered by constructing attractive urban environments in which car-free lifestyles are possible. People's understanding and recognition of public transport and shared-use vehicles should be fostered. The conclusions outlined above are not only mutually supportive, they represent preconditions for the widespread adoption of electrically-powered feeder traffic and short-distance travel services.

PROJECT CONCLUSIONS, MAIN RECOMMENDATIONS AND VISION

3.1 Conclusions

In this research project, several ways were developed in which Ring Rail Line feeder and business traffic in both the Aviapolis and Marja-Vantaa districts can be advanced while levels of CO_2 emissions can be reduced. Electric-vehicle technology makes transportation methods which generate low levels of emissions possible in an urban environment. The use of electrically-powered vehicles is recognised as the most ecological solution among currently-known methods of transportation. To a certain degree, arrangements of this type are already possible, but the wider adoption of electrically-powered transportation technology is likely to begin at the beginning of the 2020s.

In order to make electrically-powered vehicles more common in public transportation systems, new types of partnership are necessary when providing new service models. Investments by different parties, subsidies from public funds and innovative models of public procurement will be required. All of these must support the implementation of new solutions. Also, the use of electrically-powered vehicles in public transport service models must be profitable for commercial operators. If this is not the case, the new technology will be ignored.

According to the research studies, the emphasis in both the Aviapolis and Marja-Vantaa districts should also be on urban development which is less car-dependent and more reliant on everyday feeder and business traffic. This requires good footpaths and routes for light traffic.

Traffic planning should take account of the needs of both residents and employees in an area. There are specific prequisities for user perspectives when designing new electrically-powered feeder and business service models and their implementation in new urban areas.

With the help of the service models investigated, areas influenced by a railway station can be expanded to offer travellers more functional journey chains which combine different forms of transportation.

3.2 Recommendations

The SYÖKSY Research Project recommends preparations for new transport and mobility services by getting people accustomed to using them;

- Implementing electrically-powered transportation technology involves both challenges and new opportunities. The starting point should be proactively accustomising people to new types of mobility solutions, not passive waiting for something to happen.
- Preparation for the implementation of electrically-powered transportation technology also means simultaneous development of the infrastructure and services for new transport service models and vehicles. In other words, it is necessary to plan traffic lanes and routes, and charging services and payment systems for the electricity used, as well as other services connected with new electrically-powered transportation technology.

Measures associated with preparation activity include: 1) guaranteed service levels and 2) the development of existing transport service models. When building new urban districts, service levels should be stable throughout the construction phase. Traffic safety aspects should also be given due consideration. It is important that residents moving into new neighbourhoods become accustomed to use public transport. Private cars will not be a primary choice if the public transportation system provides excellent services. Current transport service models should be reconfigured in ways that they support the new service models proposed. Public investment should target not only the development of new technology but also the full-scale provision of current services. In addition to accustoming users to new forms of transportation and creating associated commercial prerequisites, this will facilitate further traffic-related research

Transport service models and urban planning solutions in the Aviapolis and Marja-Vantaa districts

The starting point for transport service models in the SYÖKSY project was the creation of functional, low-emissions transportation systems which offer travellers the best possible services. It is essential that new solutions are developed for future traffic systems to improve public transportation and thus attract new users. This is also the case in the Aviapolis and Marja-Vantaa districts through which the route of the new Ring Rail Line passes.

The new transportation service models proposed in this report are based partly on public transport facilities provided on an on-demand basis, which adds to the range of transportation services available and can increase the number of users.

As the new electrically-powered vehicles and their proposed service models are suitably dimensioned for current road, street and urban spaces, changes in land use requirements are relatively small. For example, the majority of charging points can be implemented using minimal technology in installations that are added to existing urban structures. The introduction of electrically-powered vehicles and their widespread adoption should be viewed as a positive challenge and an opportunity for innovation in the design and planning of parking facilities and charging stations.

From the perspective of land use and traffic planning and the wider context of urban structures, electrically-powered vehicles also open up new opportunities. The advent of light electric vehicles and their associated service models make possible a re-evaluation of the lane classifications used in traffic networks, especially in connection with pedestrian and light traffic. Possibilities that arise include different types of integrated land-use areas and improved connections using routes for light traffic which can also be used by electrically-powered vehicles.

Recommendations for the Marja-Vantaa district:

- All the service models presented: Opt10, Probus, AviaMobil and eMobil should be considered.
- Opt10 would be a particularly suitable choice as it can link trunk lines with flexible routes to travellers' destinations.
- A central requirement is to develop feeder traffic and short-distance transportation services and initiate their implementation at the earliest possible stage.
- It is important that light-traffic routes are constructed in good time, as doing this will make living and moving around in the area more enjoyable. This will also be beneficial for the introduction of electric bicycles as a method of providing mobility according to the eMobil service model.

Recommendations for the Aviapolis district:

- All the service models presented: Opt10, Probus, AviaMobil and eMobil should be considered.
- Traffic considerations in the forthcoming commercial zone are important if people in the area are to use and rely on the facilities provided by Aviapolis Station.
- A ProBus-type on-demand service model for public transport could be created to serve airline passengers and hotel customers and people visiting office complexes.
- The Jumbo Shopping Centre area should be linked with Aviapolis Station by using an on-demand ProBus transport service model.
- Smooth journey chains and connections from Aviapolis Station must be guaranteed, and routes such as the one to Helsinki via Kartanonkoski should be preserved so that the level of public transport service experienced by tra-

vellers on these routes is not adversely affected. Organising public transportation in the new Aviapolis residential areas will be an important element in providing links to the Ring Rail Line. The ProBus service model is suitable for this – and in future decades the Opt10 service model will be an even better choice.
- Both the AviaMobil and eMobil shared-use vehicle service models should be introduced.

3.3 A common vision for further measures

The Marja-Vantaa district should adopt Opt10 with the simultaneous aim of making it an automatic-vehicle solution.
- This development work is being progressed through the European CyberCities project, which the City of Vantaa should join and attempt to become one of the three locations in Europe in which automated public transportation is being developed.
- In the initial phase, Opt10 should be driverless and remotely-monitored (2015 research/demonstration phase, 2020-2030 commercial phase). It should eventually become fully-automated (2030-2040).

The Aviapolis District should adopt ProBus with the simultaneous aim of making it an open-access, on-demand service using buses which employ new hybrid or all-electric technology.
- As hybrid and electric buses already exist, the investment required is not large. Additional funding for the establishment of public transportation between the airport, hotels, office complexes and the Jumbo Shopping Centre should be applied for from the Tekes EVE programme. This project could also be linked with Vantaa's contribution to the World Design Capital 2012 event.
- ProBus can be implemented on a rapid timescale and could play an important role in Ring Rail Line connection traffic once construction of the railway is completed.
- Opt10 could also be a suitable future application for the Aviapolis District.

Parking and charging points for the electrically-powered shared-use AviaMobil and eMobil service models (cars, bicycles, mopeds, scooters, etc.) *should be constructed in railway stations and public locations.*

Preparations should be made for the general adoption of electrically-powered vehicles in both private and public traffic systems. This means both creating the required charging infrastructure and introducing smart grids. The needs of private car owners and public transport vehicles are different. Technologies for both exist, but new generations of battery and charging technology are being developed on a continuing basis. To make the correct technological and investment decisions, both companies and the public sector must be active participants in development projects.