

Strategisk utveckling

PM
2019-02-25

Ärende
SL 2014-2911

Handläggare

Infosäkerhetsklass
K1 (Öppen)

Transition to electric buses in Stockholm County

Summary

By analysing electric bus technology and impacts of a switch to electric drive-trains, this study proposes how buses in the region could gradually be fully electrified with a limited and acceptable amount of risk and cost.

The proposal is that new investments in infrastructure are primarily allocated to depots and terminals where the electric buses will charge their batteries. Further requirements for infrastructure can be considered based on the goals and needs and included within transport procurement contracts. This strategy allows the continued exploitation of existing investments in CBG (biogas), and supports the continued use of 100 % renewable energies in SL-traffic.



The aim of the transition to electric buses is to contribute to better air quality, reduced noise, increased energy efficiency and an attractive and climate-neutral Stockholm region. Electric buses can also help strengthen the SL brand.

Background

On request of the Transport Committee, the transport department in Stockholm County performed a study on the transition to electric buses within the county. The study was performed in 2017 and 2018. The study built on previous trials and pilots with plug-in hybrids and charging infrastructure.

Since 2018 five electric buses run services in Norrtälje local traffic and three autonomous electric minibuses run a service in Barkarbystaden (since October 2018). There are plans to introduce more electric buses in the county in the future. In 2018, SL procured electric buses services to run from start of contract for the first time; five buses will start to run in local service in the summer of 2019 in Sigtuna/Märsta. A further four possible bus service contracts which could include electric buses will be decided during the coming year. These contracts relate to services that will start running in 2021

Electric buses have the largest positive impact when introduced in dense urban areas where today's buses contribute to noise and air pollution that negatively affect people's health. Analyses in this study therefore focus on these dense urban areas, and specifically within the Stockholm context this relates to Stockholm city centre and Lidingö.

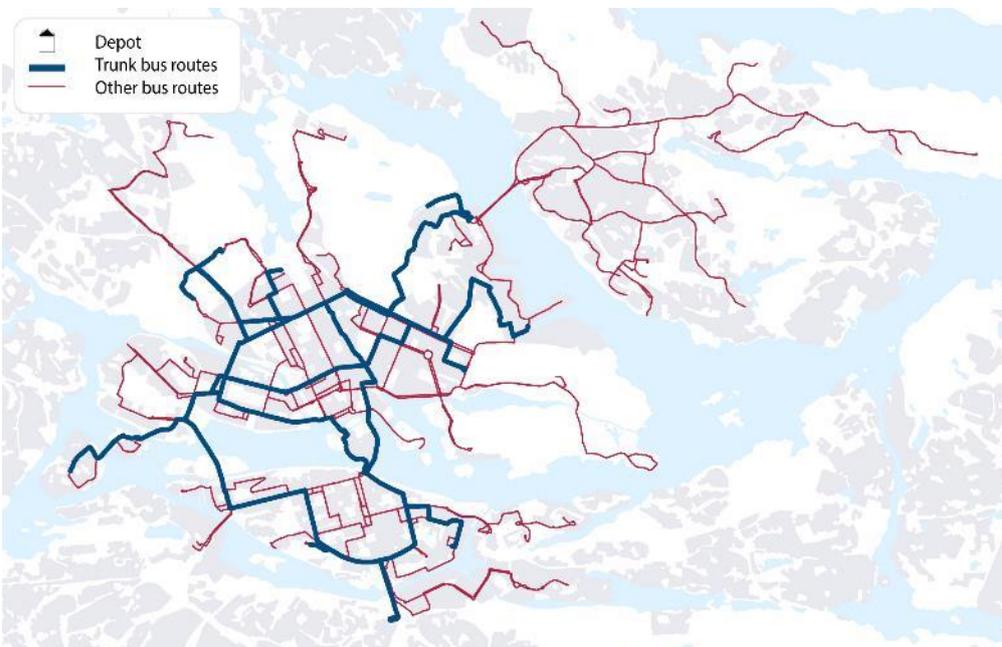


Figure 1 The bus line network and depots in Stockholm city center and Lidingö.

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The potential to electrify buses in all 11 of the county's bus transport **service** contracts was analysed. The analysis includes different technologies for charging: depot charging, opportunity charging and in-motion charging. It also includes status of depots as well as investment requirements. Currently only city buses (Class 1) can be procured as electric buses; this means that the most densely built up areas have the largest potential for electrification. It is possible that as the technology develops and matures, this will change.

A step closer towards zero-emissions

This study supports the transport department in moving a step closer towards zero-emission local bus services. Taking a holistic perspective to the topic, the study provides an important input to strategic decision making. The study shows how bus services are likely to be affected depending on different choices of technology and levels of electrification. Scenarios for different technologies and levels of electrification have been looked at in application to the bus service contracts in Stockholm city centre and Lidingö. No matter which level of electrification is introduced, an increase in the number of electric buses will require the transport department to change their own internal processes regarding for example procurement and monitoring of contracts.

From a climate perspective, a switch to electric buses (from biofuels) is also strategically important because it frees up limited amounts of sustainable biofuels to other sectors of society which cannot so easily be electrified. During the study period, climate issues have risen in importance, and have received increased focus in Sweden. Analyses show that a large proportion of Sweden's bus services should be electrified by 2030 in order for Sweden's national climate goals to be reached.

Overarching goals

The region of Stockholm has ambitious goals for renewable fuels, energy efficiency and reduction of local emissions (nitrogen oxide and particulate matter) based on the regional transport plan and the County's environment plan. SL's bus services currently run on 100 % renewable fuels. In order to reach goals regarding energy efficiency, the transition to electric drive trains is a good alternative since electric motors have approximately three times higher efficiency compared to combustion engines. Electric drive trains also have zero tail-pipe emissions (except for complementary heating which is often powered with biodiesel to warm the inside of the bus). Electric buses also result in

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considerably lower levels of urban noise and can free-up biofuels to different parts of the transport sector. Hybrid technologies, eco-driving and transport planning are other tools that should be used to reach environmental goals.

On the national level, Sweden's goal is to have a fossil-fuel independent vehicle fleet by 2030. To achieve this, it is important that the right energy sources and fuels are used in the appropriate cases. It is important that electricity is used whenever possible in order to reduce energy use in all sectors, given that carbon-neutral electricity can be produced.

The EU is working to support the adoption of clean and energy-efficient vehicles and their policies include goals related to public procurement. Several cities within Europe have agreed to only procure electric buses from 2025. Among these cities are: Barcelona, Copenhagen, Heidelberg, London, Milan, Paris and Rome. Copenhagen has the goal to only have zero-emission buses by 2025 and Paris plans to electrify 80 percent of their bus fleet by 2025.

There is no goal relating to zero-emission bus services in the regional transport plan for Stockholm. This study proposes that such a goal be included in order to simplify the requirements in forthcoming bus service procurements. The study also proposes the allocation of resources to start adapting existing and planned infrastructure, particularly depots and terminals, so that investments are done in time so that electric bus services can start to run.



Figure 2 Depot charging bus in Norrtälje. Foto: Maria Övergaard.

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Figure 3 Illustration of buses with opportunity charging at Moa Martinsson torg.



Figure 4 Illustration of buses with in-motion charging at Valhallavägen.

The potential for electric buses

The study shows that there is potential to introduce electric buses in several forthcoming bus service contracts. Depot charging should be considered as the primary charging alternative, while the possibility to opportunity charging also should be considered. This strategy gives the possibility to continue using biomethane, and to wait for further technology maturity and standardisation of electric drive trains. If the aim in the longer term is to have 100 % zero-emission vehicles in urban traffic in the county, then the discussion of in-motion charging needs to be initiated in order to enable the electrification of trunk bus routes.

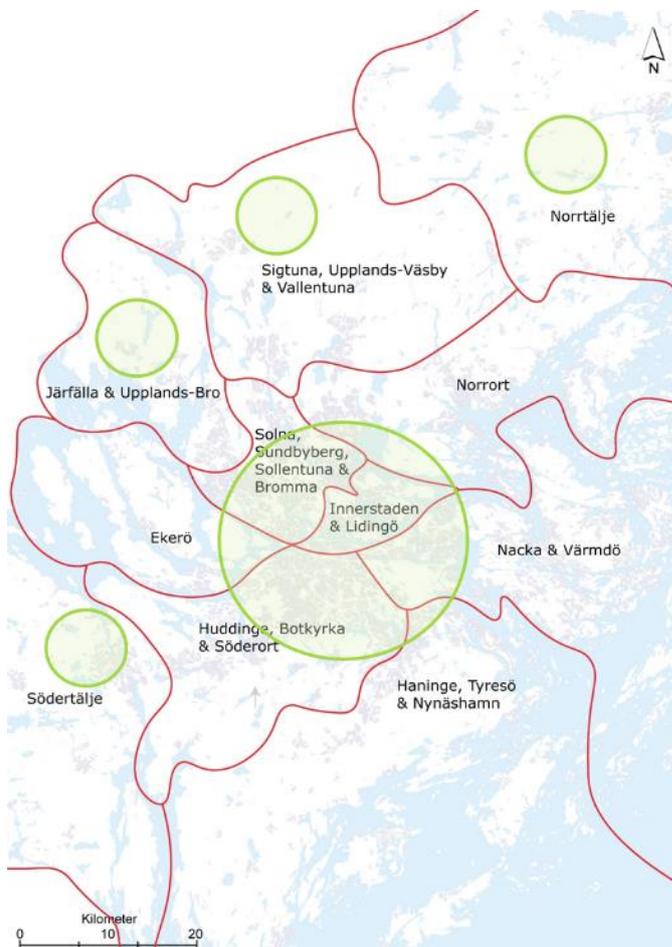


Figure 5 Contract areas for bus traffic in Stockholm County. Green circles illustrate areas where the potential for electrification is good.

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K1 (Öppen)**Electric buses and the environment**

The environmental benefits of electric buses are primarily in terms of reduced energy use, lower levels of local noise and air pollution. The buses are assumed to run on renewable electricity. A positive climate impact is that biofuels which are used in buses today will be freed up and made available for other actors.

Based on current levels of technological maturity and methods of analysis, the assessment is that energy use in the whole county can be reduced by about 19 percent by 2030. This is based on a transition to electric buses on those lines that do not require Class II buses. The calculation assumes that the buses from 10 lines that run in Stockholm city centre and on Lidingö are depot-charged. With these assumptions, it is possible to electrify about 690 buses (32 percent of the approximate 2100 buses in the region). The analysis needs to be regularly updated based on changes in both technology and analysis methods.

If the focus of analysis is only on buses in the city centre and Lidingö, a possible reduction of energy use is in the region of 70 percent. This calculation supposes the switch of all buses to electric drive trains from biodiesel and biomethane. The reduction in energy use in these central areas would be about 20 percent if charging is done only at depots in which case 40 percent of the buses can be electrified.

Battery production and break-down of minerals have environmental consequences that must be addressed. The study's proposal is to extend the requirements written in procurement contracts to include battery's production, traceability, recycling and re-use. In order to reduce environmental problems related to batteries, it is important not to use batteries that are too big.

Social consequences

Electric buses are likely to result in locally positive social consequences. An area or a street with quiet and clean buses is more attractive. Results regarding increased attractiveness of urban areas following introduction of trams can also apply to the case of electric buses if they are introduced together with measures to support unhindered accessibility for the vehicles. Electric buses also improve conditions for bus drivers since they provide a considerably better working environment. There are risks related to battery production that contribute to negative social consequences in mining / extraction processes. Requirements for social sustainability should be made (for example that minerals in the supply chain should be traceable) in bus service procurements.

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K1 (Öppen)**Cooperation necessary for cost-effectiveness**

The study's analysis and input from several sources show that electric buses are often more expensive than conventional buses. Depending on the specific conditions, the introduction can be cost-neutral for the transport department. An important consideration is that today's electric buses have a considerably higher capital cost compared to conventional vehicles, but in the long-term have lower operational costs. Technical solutions that are run efficiently have the potential to save money in the long run. The solution must be optimised from a system perspective, and in this respect transport suppliers and asset managers are important actors for the transport department to cooperate with.

A transition to electric buses will be a cost both for the transport department's investment budget and operations budget, depending on where the boundary of responsibilities lies. This boundary and appertaining share of risk should be decided in an early stage before each bus service procurement. A recommendation is that a dialogue with the market should be developed. In connection to a procurement, it is recommended that zero-emission buses are required, in the cases where it is practically applicable, in a clear dialogue with the market actors. When a transport service provider leaves a bid, the possibilities to charge the buses batteries within the geographic area specified in the contract should be clear.

The proposed possible solutions in this study include charging at depots and terminals. This means that, in principle, the transport department can maintain its current business model whereby the service provider owns the buses. If electrification with in-motion charging becomes a reality, then current guidelines need to be changes since the transport department would probably have to own the vehicles in order to enable a write-off of the capital costs over a longer time period than is covered by the contract. Another possibility is to include special clauses in the contract regarding ownership and takeover.

Different forms of co-financing could improve the economic picture. In 2019, several grants are available for application. It is unclear the status of these grants in the future, and these should be seen mainly as a bonus source of financing. Municipalities and asset managers can also contribute through e.g. measures for improved efficiency which can reduce operational costs. Dialogue and cooperation are needed in order to find cost-neutral and attractive solutions that support a good passenger experience.

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K1 (Öppen)**The method for socio-economic assessment can be developed**

The cost-benefit analyses of bus traffic in Stockholm city centre and Lidingö show that benefits are not higher than costs. The economically-valued benefits of air pollution and climate are relatively small compared to running costs for the buses. The reason for this is that the fuel mix is already fossil-fuel free and that the buses are of high environmental standard. The running costs of electric buses depend on the level of electrification. The cost-benefit analyses regarding for example reduced noise levels in and outside the bus cannot be valued using current methods. It is possible then that there are clear positive effects that are not clearly valued in the analyses. Sensitivity analysis shows that the vehicle costs have a significant effect on the result. If the vehicle costs are assumed to be the same as for a conventional bus, then the cost-benefit ratio will be positive.

New technology entails new risks

The introduction of new technology in existing environments is always done with uncertainties and accompanying risks for the technology, project and organisation. Electrification of buses in Stockholm results in a change in risk assumptions compared to current solutions.

The largest technical risks relate to uncertainty regarding functioning of batteries and charging infrastructure which are not fully tested. The consequences of this are the robustness and attractiveness of the buses can be negatively affected. With regard to the batteries, there are social and environmental risks regarding production and recycling. Through requirements in procurement contracts, traceability in production and routines for recycling can reduce these risks.

The safety-related risks related to the introduction of electric bus charging are considered to be low. The emergency services and other actors are preparing for the introduction of a large number of electric vehicles in Sweden. A lack of capacity in the Swedish electricity network is not judged to be a large risk, but capacity in the local grid network must be assured. During operation, there may be a risk for electricity power outages, which could result in consequences for electric buses.

In summary, the study advocates a gradual transition to electric buses which is related to relatively low risks. A transition to depot-charged buses at the outset is – seen through a risk perspective – the approach that requires only small changes in guidelines and internal processes. In line with the increase in

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technological and organisational capabilities, further steps towards electrification can be made.

Recommendations from the study

- Develop policy goals for electrification of the bus transport system that do not require more buses than today, and which can be expanded in line with requirements for capacity.
- Develop cooperation and co-financing solutions with municipalities and other actors.
- Analyse the possibilities for electric drive trains for every bus service procurement and develop the requirements in such a way as to adapt to new possibilities and risks.
- Work to electrify buses during current bus service contract periods in the cases where the contracts allow it.
- Maintain the possibility of using a combination of renewable fuels.
- Prepare for electric drive in new and redevelopment of strategically important facilities and ensure continued central location and space for them.
- Adapt the transport department's organisation, policy documents and guidelines for a gradual electrification of bus services.
- For forthcoming bus service procurement contracts in Stockholm city centre and Lidingö, charging in depots is recommended.

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Participants

The following have mainly participated in the study (PT=Public Transport Administration, Region Stockholm).

Project management

Anna Forsmark, Project leader (PT)

Johan Böhlin, Assistant Project leader (strategist fuel and energy, PT)

Steering committee

Jens Plambeck, Sponsor (Head of Department, Strategic development), Niclas Blomqvist (Strategic Development, Section Manager for Business Development), Stefan Wallin (Strategic Development, Section Manager for Sustainable Development), Mattias Wäppling (Strategic Development, Section Manager for Transport and Infrastructure Development), Sofie Enander (Strategic Development, Section Manager Planning), Anna Mostert (Transport Department, Section Manager for Bus traffic), Anna Melin Berglund (Investment Projects, 2017-2018), Roger Taringer (Section Manager for Investment Projects, autumn 2018)

Extended meetings have been held with Stockholm City.

Investigation leaders

Erik Sjaunja (Trivector)

Astrid Buhre (until June 2018, Trivector)

Project group

Anna Forsmark, Project leader, (PT), Johan Böhlin, Assistant Project leader (strategist fuel and energy, PT), Maria Övergaard (strategist bus PT), Erik Sjaunja (Trivector), Astrid Buhre (Trivector, until June 2018), Cecilia Wallmark (Sweco), Jenny Widell (Sweco), Tom Strandberg (Syntell)

Editors final report

Erik Sjaunja (Trivector), Karna Zerne (Trivector)

Business model and procurement

Jenny Widell (Sweco), Christian Arntzen (Business strategist TF), Elof Winroth (Prospero)

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Battery

Maria Xylia (Sweco), Marie Swenman (Sweco)

Energy supply

Harpal Dhuper, (strategist electricity, PT), Kenneth Domeij (specialist depot and terminal, PT), Cecilia Wallmark (Sweco), Kajsa Roxbergh (Sweco), Mikael Andersson (Sweco), Maria Xylia (Sweco), Anton Sjögren (Sweco), Bror Lundbergh (WSP), Sara Anderson (2050, until dec 2017)

Economic assessments (infrastructure and operation)

PG Andersson (Trivector), Hannes Englesson (Trivector), Maria Xylia (Sweco), Kajsa Roxbergh (Sweco), Erik Sjaunja (Trivector), Astrid Buhre (Trivector/TF), Cecilia Wallmark (Sweco), Peter Svahn (TF)

Electric bus technology and traffic planning

PG Andersson (Trivector), Hannes Englesson (Trivector), Sebastian Fält (Trivector)

Vehicle

Maria Övergaard (strategist bus, PT), PG Andersson (Trivector), Werner Nuchterlein (PN Consult)

Planning process

PG Andersson, (Trivector), Niklas Tengheden (Trivector), Martin Öhrblom (Sweco)

Risk analysis

Tom Strandberg (Syntell), Maria Övergaard (Fordonsstrateg Buss TF)

Socio-economic assessments

Sesselia Arnadottir (PT), Stina Hörtn (Trivector), Astrid Buhre (Trivector/PT)

Social and environmental consequences

Johan Böhlin (strategist fuel and energy, PT), Martin Almgren (strategist noise, PT, until mars 2018), Helen Maalinn (social strategist, PT), Lovisa Indebetou (Trivector), Christian Fredriksson (Trivector), Maria Xylia (Sweco)

Successive analysis process leader

Per-Olov Karlsson (PO Karlsson Projektstyrning), Ulrika Westgren (Tyréns)

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Visualization

Carl Johan Rydell, (Sweco), Chris Webb (Sweco)

Other participants from Public Transport Administration (PT)

Pauline Sedin (Mobility strategist), Mikael Eriksson (strategic bus planning), Eric Hörnfeldt (Business manager for Traffic and Revenue Assurance), Nadica Orac (Business Manager for Mobility), Lisa Svennberg (until may 2018), Rickard Ehn (Urban Planner), John Gustaf Almquist (Business Manager for Vehicle Fleet), Magnus Johansson (Property Strategist), Thomas Fylkehed (Strategic Planner for Bus traffic , until march 2018), Malin Lindberg (Planning Coordinator), Niclas Saptovic (Business Manager for Transport Safety), Kerstin de Potocki (Communications Officer), Erik Dunkars (Energy Strategist)