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Research paper

Rationales for transitioning to electric buses in Swedish public transport

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ABSTRACT

Public transport systems in different parts of the world are currently undergoing a change characterised by the introduction of battery-powered electric buses in everyday operations. The introduction of electric buses brings new challenges such as high investment costs and technology concerns, as well as new forms of collaboration between both established and new actors. The aim of this paper is to disentangle different actors' rationale for the transition, identifying underlying interests in and expectations of the electric bus system. With a focus on the Swedish context, we found that whilst common rationales exist, these are influenced by collective expectations and different underlying interests for the actor groups. We found that the interests of the actors are grounded in expectations of future developments, but also relate to the experience that the transition is occurring faster than previously anticipated. The results show a high degree of consensus regarding the transition to electric buses, although the actors have varying resources and action spaces with which to influence the transition, which is largely determined by the institutional and local context.

1. Introduction

The environmental and climate advantages of the operating electric bus, compared to other alternatives, are often considered a main driving force behind the transition to electrified bus fleets (Lajunen & Lipman, 2016; Li et al., 2018). Electric buses are placed in the category of zero-emission buses, meaning that they produce no local emissions during operations. This technology can realise a number of potential benefits, such as improved energy efficiency, reduced climate impact, and less noise and local air pollution in the urban environment where electric buses operate. Electric buses can thereby contribute to achieving societal goals, e.g., those concerning an improved local environment and reduced climate impact from the transport sector (Aldenius et al., 2022; Borén, 2020; Correa et al., 2019).

Previous research on the introduction of electric buses has often focused on the development of electric bus technology, identifying several uncertainties and barriers that potentially impede the rate of transition to electric buses. Such barriers include high investment costs for vehicles and infrastructure (Li, 2016; Li et al., 2018; Moataz et al., 2018); uncertainties when investing due to rapid technological developments concerning improved battery capacity; and increasing the efficiency of charging infrastructure (Li et al., 2018; Moataz et al., 2018). In combination, this means that there are risks associated with investing in a technology that may, in a few years, be outdated.

Several studies have also identified barriers in the organisation of public transport. In their study of electric bus demonstration projects, Xylia and Silveira (2018) found that issues in aligning the perspectives of different actors were considered difficult related to further implementation. They conclude that the complexity of the electrification of public transport requires collaboration and that the alignment of the many involved actors' perspectives is of key importance. Similar conclusions are drawn by Aldenius et al. (2022), who highlight the importance of a well-functioning collaboration between actors involved in the transition. Bakker and Konings (2018) further argue that the main barriers to a transition are institutional, and that an institutional lock-in due to the regulative, normative, and cognitive frameworks regarding how public transport is planned, procured, and operated discourages the transition to electric buses.

In practice, however, many cities across the world are transitioning to electric buses. In European countries, the rapid technological development of electric buses combined with political ambitions to reduce transport system emissions (e.g., greenhouse gases, NOx, and particulate matter) have contributed to the pace of the transition from fossil fuels to renewable fuels in general, and electrification in particular (UITP, 2017). Formerly, battery-powered electric buses mainly featured as part of test and demonstration projects (Aldenius et al., 2016; UITP, 2016),

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but during the course of just a few years, there has been a shift from test and demonstration projects, with a small number of vehicles, to a wider introduction of electric buses into the regular public transport fleet (ITDP, 2021; Lundström et al., 2019). The share of new registrations of electric buses in Europe increased from 12% in 2019, to 22% in 2021 according to the UITP (2022), and this is expected to steadily increase due to EU policies such as the Clean Vehicles Directive, which stipulates that 22.5% of procured buses in public tenders must be zero-emission between 2021 and 2026 (UITP, 2022).

The reason why actors within the public transport sector are investing in a technology that is still characterised by uncertainties, both in relation to the present conditions and future developments, is not yet fully explored. In addition, in some cases, such as in Sweden, electric buses are replacing other fossil-free alternatives. In 2021, over 90% of vehicle kilometres in the Swedish public transport sector were run on renewable fuels, primarily biofuels (The Swedish Public Transport Association, 2021). As such, buses in Swedish public transport are already well on the way to becoming fossil-free. At the same time, the number of electric buses in Swedish public transport has seen a strong increase in recent years. In 2017, there were 54 electric buses in operation, while at the end of 2022 the number had increased to 763 (The Swedish Public Transport Association, 2023; The Swedish Bus and Coach Federation, 2021). Based on the results of recently completed, or ongoing, tendering processes for new contracts, it is clear that the number of electric buses will continue to increase in coming years (The Swedish Public Transport Association, 2020).

This raises the question as to why actors are willing to take on the risks that are associated with electrification, at least at this stage of the transition, if they have already made investments to replace fossil fuels with other fossil-free alternatives. Furthermore, the transition to electric buses encompasses more than a transition to a new fuel. The transition to an electric bus system is characterised by the previous system undergoing changes, both in terms of technical artefacts and organisational structure (Aldenius et al., 2022; Bakker & Konings, 2018; Xylia & Silveira, 2017).

The aim of this study is to disentangle different actors' rationales for transitioning to electric buses[1] in urban public transport, with a focus on the Swedish context. We approach the issue from a socio-technical transitions studies perspective, based on Bakker's (2014) conceptual framework developed to explain actors' rationale for supporting a transition. Through interviews with key actors in six Swedish cases – public transport authorities, public transport operators, and municipalities - the ambition is to identify the actors' interests in and expectations of the transition to electric buses in order to explain the actors' rationales. We pose the following research questions.

- What are the interests and expectations of different actors in the transition to electric buses in the case studies?
- What are the differences and similarities in the interests and expectations among the key actors?

Beginning with a review of previous literature in Section 2, we then present the analytical framework in Section 3. This is followed by a description of the context of the study and method in Section 4. Results and analysis are presented in Section 5 and then discussed in Section 6, followed by conclusions in Section 7.

2. Previous research on the transition to electric buses

Electric buses have gained increasing popularity in public transport systems due to environmental benefits and potential cost savings over time. Previous research on electric buses has largely focused on electric bus technology and the implementation of said technology in the existing public transport system, where minimising the total cost of operations (TCO) and the optimal location for chargers is a well-researched topic. In addition to a focus on the technology, other research also addresses organisational aspects of electric bus implementation and operations.

Electric bus technology is considered to bring environmental benefits on both the local and global level, which is often considered a main argument for electrification. Locally, the electric driveline produces no emissions during operations, contributing to improved air quality in urban areas (Holland et al., 2021; Quarles et al., 2020). The electric engine also reduces noise pollution, which can increase the attractiveness of the urban environment (Borén, 2020). On a global scale, electric buses are more energy efficient compared to alternatives and reduce the emission of green-house gases (Manzolli et al., 2022). In turn, moving away from fossil-fuel dependency is a reason to electrify the transport sector in general, and this is therefore also a reason to electrify public transport (e.g., Aldenius et al., 2022; Blynn & Attanucci, 2019). It is, however, important to consider that the environmental impact of an electric bus is also determined by factors aside from the operations of an electric bus fleet. To assess the total environmental impact of an electric bus, one must consider the environmental impact over the lifetime of the bus, from production to the end of the technical lifetime. For example, this includes the extraction of raw materials for both battery and vehicle, how the electricity used to charge the battery is produced (Newbery & Strbac, 2016; Rupp et al., 2019), and recycling or re-using materials at the end-of-life stage (Manzolli et al., 2022).

Another area of research on electric bus technology addresses the economic impacts of the electrification of buses. The introduction of electric buses is associated with a higher initial investment cost compared to buses with combustion engines (Blynn & Attanucci, 2019; Li, 2016; Xylia & Silveira, 2018). Higher costs are a commonly mentioned barrier for the large-scale deployment of electric buses (Bakker & Konings, 2018; Moataz et al., 2018). These higher costs derive both from the purchase of the actual electric bus, where the battery comprises a large part of this cost (Manzolli et al., 2022; Rodrigues & Seixas, 2022), and costs relating to establishing and upgrading a charging system for the electric bus, such as charging infrastructure and establishing grid connections at charging points (Blynn & Attanucci, 2019; Xylia & Silveira, 2018). Studies have shown that electric buses can be cost-effective over their lifetime, despite higher upfront costs (Manzolli et al., 2022). This is due to both lower maintenance costs and lower costs for fuel, in combination with a longer expected technical lifetime of the bus and increased energy efficiency (Hensher et al., 2022; Holland et al., 2021; Lajunen, 2018; Quarles et al., 2020). Altogether, these parameters can make the TCO of electric buses competitive compared to other fuel alternatives (Grauers et al., 2020; Kim et al., 2021), meaning that there may also be economic incentives for transitioning to electric buses. There are, however, some uncertainties regarding the cost, for example, how it will be influenced by future technological development, and uncertainties regarding the price of electricity and alternative fuel (Moataz et al., 2018; Xylia & Silveira, 2018).

In addition to uncertainties regarding future cost and technological developments, transitioning to electric buses and introducing them in everyday operations requires that actors make decisions and deal with new issues. Another stream of research deals with the implementation issues of electric buses, where models for decision making in the choice of charging strategy, localisation of chargers and charging and timetabling optimisation are aimed to aid decision-makers in these choices. The deployment of charging infrastructure goes hand-in-hand with the deployment of electric buses. The location of charging infrastructure can be optimised based on cost or energy efficiency (Hsu et al., 2021; Xylia et al., 2017) or to ensure that the current bus network or scheduling is not disrupted by the introduction of electric buses (Lin et al., 2019; Wei et al., 2018). There is a debate on the most suitable charging strategy for electric buses in public transport. Previous research highlights that the

[1] This paper is solely focused on battery-electric buses. Trolleybuses and hybrid buses are not included.

charging strategy, and the impact this can have on the cost and energy efficiency of operations, is dependent on the local urban context as well as the operational characteristics of the public transport network (Grauers et al., 2020; Harris et al., 2020; Jefferies & Göhlich, 2020; Kim et al., 2021). There is no "one-size-fits-all" in the choice of the charging strategy or location of chargers.

The charging needs of the electric bus also requires that the operational planning of the traffic is adjusted to encompass the charging parameter. Studies by Häll et al. (2019) and Perumal et al. (2022) show that current planning procedures, which have been designed for combustion engine buses, will not be sufficient for electric bus operations. This also means that actors involved in the planning of the bus network require additional or new competence as the transition to electric buses progresses. Given the technological developments, e.g., improved battery capacity or improved efficiency of charging, and the way this affects planning, continuous adaptations to planning procedures is necessary.

Research on the transition to electric buses that pertains to cost and energy efficiency mostly concerns single cases or is based on either data from test or demonstration projects, or forecasts and assumptions on the future pricing of fuel and technology (Manzolli et al., 2022; Rodrigues & Seixas, 2022). Whilst this research is important to demonstrate the feasibility and potential benefits of electrification, research based on data from regular operations or from a transition on a larger scale is scarce at this point in time, due to both the availability of such data (operators with this type of data may be unwilling to share it due to questions regarding business strategy or competition) and the fact that electric buses may not have been operated in everyday traffic long enough for this data to be collected. There are still uncertainties regarding the technology, both in regard to how the electrification of buses will affect day-to-day operations on a larger scale (Häll et al., 2019; Rodrigues & Seixas, 2022) and how the technology will continually develop in coming years (Aldenius et al., 2022; Moataz et al., 2018; Xylia & Silveira, 2017).

Besides the technological perspective on how to implement electric buses, recent research also addresses implementation issues from an organisational perspective. For example, the way in which risk and responsibility has traditionally been divided between actors may not be suitable for this transition given the uncertainties that outline the deployment of electric buses (Aldenius et al., 2022; Bakker & Konings, 2018; Hensher, 2021). Similarly, depending on which actor is subject to them, higher investment costs may also affect the proportion of barrier (Li et al., 2018; Moataz et al., 2018). It is therefore also important to emphasise how realised benefits as well as barriers affect different actors in different ways depending on the organisational and institutional context. The outcome of electrification, whether a benefit or a barrier, profits or burdens actors differently depending on the particular actor's competence, resources, and role in the transition (Bakker & Konings, 2018). There also is a need for policy and financial support from governments to encourage the adoption of electric buses and overcome some of the barriers to their widespread use (Cardoso, 2022; Li et al., 2018; Rodrigues & Seixas, 2022).

In sum, previous research suggests that electric buses have the potential to transform public transport systems, but successful implementation requires a coordinated effort from involved actors. While previous research has identified numerous barriers and challenges associated with a transition to electric buses, there is so far little knowledge explaining the current upsurge in the introduction of electric buses in everyday operations, as seen in the Swedish cases. Furthermore, there are a number of often cited benefits of electrification, such as improved air quality, reduced noise pollution and increased energy efficiency. How and why these benefits are actually realised and achieved in practice is not yet entirely documented. We address this knowledge gap by focusing on how expectations of and actors' interests in the transition to electric buses underlies the rationales and how these may shape the development of introducing electric buses in everyday operations in urban public transport.

3. Analytical framework – conceptualising rationales for transitions

The point of departure for the analysis in this study is a conceptual framework for explaining actors' rationales for supporting a transition, described by actors' interests and expectations, as presented by Bakker (2014). In Bakkers' study of the transition to electric automobility in the Netherlands, he outlines how positive expectations and interests may explain an actors' support for a transition. He distinguishes between collective and individual expectations, and short-term and long-term interests.

Expectations of the emerging technology or system, in this case the electric bus system, guide actors in their decision-making regarding how to engage in the transition. Positive expectations are considered crucial to the development of a technology and its market success (Borup et al., 2006; Budde et al., 2012). An actor's decision making will be influenced both by their own individual expectations of what the emerging socio-technical system will be able to provide, as well as the dominant collective expectations of wider society (Bakker, 2014). Advocating for a certain technological solution will depend on whether the collective expectations are high or low, regardless of the actor's beliefs.

Bakker (2014) writes that the interests of an actor can be defined by their most basic objectives, and while plain survival is the most basic objective of any actor, more pronounced interests can be attributed to individual actors or groups of actors. The interests can also refer to long-term or short-term interests. Long-term interests and individual expectations guide the actor's decision-making process, and whether they are inclined to influence the configuration of the system. Short-term interests may guide the actor to engage in a transition to gain experience, or to understand the transition's potential impacts on long-term interests.

The interests of an actor can be defined by their goals, capabilities, resources, and the institutional context in which they operate (Bakker et al., 2014). As these factors change during the emergence or development of a new system, interests may change as the new system evolves or becomes more established, and actors are assumed to try to influence the configuration of the new system in order to align it with their interests (Avelino & Rotmans, 2009; Farla et al., 2012). Therefore, interests can help to understand an actor's strategy in a transition, what goals said strategy aims to achieve, and what resources and capabilities the actor has at their hand to deploy said strategy.

Together, interests and expectations guide an actor on how to engage with a new technology and to what extent they support a transition. If the individual expectation on the emerging system aligns with the actors' interests, they are likely to support the transition. Even if the expectations do not align with the actors' interests, they are assumed likely to support the transition in order to influence the transition and align the emerging system with their interests. Also, positive collective expectations can push actors whose interests are not aligned with the transition, or who have negative individual expectations, to still support the transition in order to "secure their seat at the table" (Bakker, 2014).

Bakker applies the framework to an emerging transition and uses it to explain actors' rationales in supporting a niche. The present study is, however, geared at a transition that is more mature, as the introduction of electric buses currently occurs on a wide scale, across geographical and organisational contexts. We are interested in the *why transition on a large scale*, as opposed to *why support a specific niche*. The way that the framework has been interpreted for the aim of this study is shown in Fig. 1.

As explained in Section 2, the transition to electric buses in Sweden mostly occurs within procurement through competitive tendering. As the institutional context has been recognised to influence actors' interests, this means that the transition occurs when the actors' mutual relationships are defined by both formal and informal conventions.

Interests are considered to be dependent on the eventual configuration of the emerging system, and involved actors are likely to attempt to

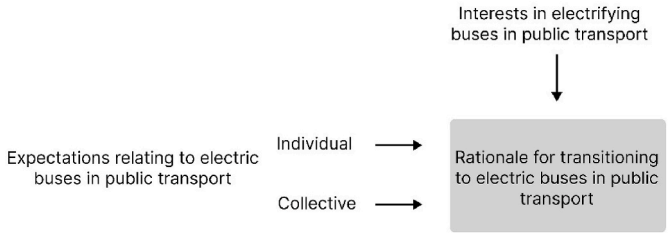

Fig. 1. Conceptual framework for explaining actor rationales, adapted from Bakker (2014).

influence this configuration so that it aligns with their interests (Bakker et al., 2014). The strategies that actors may employ to influence the transition can both refer to the actors' specific goals, and to the resources and capabilities they deploy to achieve these goals (Farla et al., 2012). In the Swedish cases, the capabilities and resources an actor has to act on their goals is largely based on the contract design, as it defines what action space the contractual parties have. The procuring actor, usually the PTA, can steer the development in their desired direction through the contract design, for example, by requiring a certain technology or solution. With a more flexible, or open requirement, often by use of functional requirements, the operators are given larger action space to influence the transition to align with their interests (Camén et al., 2020).

While the specific tender documents and contracts are not included in the empirical material of this study, it is important to consider how this context may influence actors' interests. In this study, we focus on the interests in relation to the actors' goals. Since the empirical material did not allow for a distinction between long-term and short-term interests, we have not included such a distinction in the analysis. Actors have, or are perceived to have, different goals that may be difficult to align (Bakker, 2014). Public actors such as the PTA and municipality often have a variety of societal goals to relate to within the framework of a financial restriction, and while the operator may also have multidimensional goals, the financial restriction is often more absolute than the one on which actors in the public sector operate. In terms of expectations, we view collective expectations as expectations held by a group of actors, such as PTAs or PTOs, or wider society, and individual expectations as those held by a specific actor, for example, a specific operator or specific municipality.

4. Introduction of the Swedish case and methodology

4.1. Public transport governance and the transition to electric buses in Sweden

The governance structure of Swedish public transport highlights the role of regional public transport authorities (PTAs). There are 21 PTAs in Sweden, typically with the responsibility to procure public transport services in a competitive tendering process in which operators submit tenders to win the contract. Ninety percent of regulated bus traffic is exposed to competitive tendering (The Swedish Bus and Coach Federation, 2021). As such, PTAs play an important role in the transition to electric buses through contracting and tendering. PTAs are, however, by no means sovereign – they have to act together with local municipalities, public transport operators, and in the case of electrification, electricity grid owners, manufacturers of vehicles and infrastructure and other actors, both in the private and public sectors. In this paper, we focus on three actor groups specifically: the public transport authority (PTA), the public transport operator (PTO), and municipalities.

Around 240 private sector bus operators exist in the Swedish market, a majority of which can be categorised as small companies with less than 50 employees. Two percent of the companies have over 500 employees, of which four larger companies control a majority of the market (The Swedish Bus and Coach Federation, 2021).

There are 290 municipalities in Sweden, and while tendering and procurement are typically the responsibility of a regional public transport authority, a few municipalities operate public transport under their own management or are responsible for the procurement of services. Municipalities in Sweden are also responsible for land-use planning, meaning that they play a role in the localisation of depots and charging infrastructure, and in some cases, they are also important actors in the energy system as owners of electricity infrastructure or biogas production facilities. Local public transport networks are a result of dialogue and interaction between municipalities and PTAs. Municipal level goals, e.g., local climate objectives, urban development plans, and objectives regarding urban qualities also define the context in which the transition to electric buses takes place.

In order to reach the target of carbon neutrality by 2050, Sweden has a goal to develop a fossil-fuel independent vehicle fleet by 2030 (SOU, 2013:84). As mentioned previously, the public transport sector has already made substantial moves towards fossil-free or low-carbon alternatives (Aldenius, 2018; Xylia & Silveira, 2017). In 2021, 92% of vehicle kilometres in public transport ran on renewable fuel (primarily various biofuels, hydrogen fuels and electricity) (The Swedish Public Transport Association, 2021). In a survey study of what aspects affect the attractiveness of renewable fuel from the Swedish PTAs perspective, Xylia and Silveira (2017) found that environmental aspects (e.g., reduced emissions, improved energy efficiency) were the main priority when choosing new fuel. Fuel availability and the availability of infrastructure associated with a specific fuel type was also found to be of importance. At the time of the study, electric buses were only at the demonstration stage in Sweden, but electricity was found to be the most attractive fuel alternative for the future by survey respondents, with the full scale implementation of electric buses estimated to take at least 10 years (Xylia & Silveira, 2017). However, for the past 5 years, the number of electric buses in Swedish public transport has increased, as shown in Fig. 2. In 2022, 763 battery-electric buses were in operation in Swedish public transport, corresponding to just under 6% of the total bus fleet (The Swedish Public Transport Association, 2023).

Prior to 2017, electric buses in Swedish public transport were mostly part of test or demonstration projects, where the involved actors had an opportunity to evaluate and test the technology (Aldenius et al., 2016; Lundström et al., 2019). In recent years, electric buses have been introduced in regular operations, both within ongoing contracts and later through competitive tendering. The transition to electric buses has therefore occurred both within an arena of collaboration as well as competition. In both cases, the role of individual actors' interests as well as their expectations, held both by individual actors and collectively as partners in contracting and collaboration, become important. Conventional contracting assumes that actors act in pursuit of their own interest rather than the interests of a common goal (e.g., Gilson et al., 2015; Pinto et al., 2021). Collaborative governance, on the other hand, (e.g., Ansell & Gash, 2008; Thomson & Perry, 2006) presupposes actors agree on a common goal, not with the intention for the actors to resign their own interest, but instead to consider their interests in the context of achieving said shared goal. We find this potential tension between competitive tendering and procurement, on the one hand, and the need for collaboration between actors in implementing the transition to electric buses on the other, very interesting. This is the justification for the inquiry into the rationales of different actors involved in the current transition to electric buses.

This study is based on cases of six Swedish cities where electric buses have been introduced into regular operations. The cases were selected based on how far in the transition to electric buses they have come and the way in which the transition was initiated. This selection made it possible to include cases where electric buses had been introduced following a test or demonstration project as well as those where electric buses were introduced in regular operations following a procurement process or within existing contracts. The difference in these processes

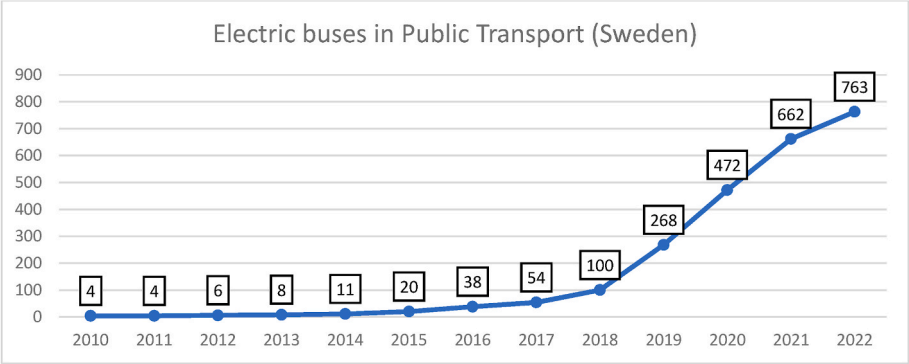

Fig. 2. Number of electric buses in Swedish public transport 2010-2022 (The Swedish Public Transport Association, 2023).

and how it may affect the actors' interests and expectations was important to capture, by which account this case selection is appropriate.

In three of the cases, Jönköping, Malmö, and Gothenburg, the transition to electric buses was initiated through test or demonstration projects, through which involved actors gained experience with the technology prior to procuring electric buses. In Jönköping and Malmö, the PTA and the municipality initiated the test projects, involving the PTO, vehicle manufacturer, charging infrastructure manufacturer, and electricity grid owner in the project. In Gothenburg, the vehicle manufacturer acted as initiator, inviting both private and public actors to the test project. In the other three cases, Ystad, Piteå, and Stockholm, the transition was not preceded by a test project. In Ystad, electric buses were introduced within an existing contract by initiation of the PTO. In Piteå, electric buses were introduced through procurement. In Stockholm, electric buses were introduced in an existing contract by initiation of the PTA. An overview of the process and number of electric buses in the cases at the time of the study (2021) are presented in Table 1. The cases differ both in terms of fleet size and size of the city. Sweden's three largest cities, Stockholm, Gothenburg and Malmö, are at different stages of transition, with Gothenburg and Malmö having come further than Stockholm. Jönköping is a medium-sized city, whereas Piteå and Ystad are smaller cities in opposite ends of the country (north and south). The geographical variation and the variation in fleet size depicts the varying contexts in which the transition takes place, which is important to capture in the study.

4.2. Method

The empirical material was based on 20 semi-structured interviews with 24 interviewees from PTAs, municipalities, and PTO's that have been involved in the electrification of buses (see Appendix A for compilation of interviewees). These interviews were conducted as part of a larger research project on the transition to electric buses in Sweden, and as such the interviews covered a wider range of topics than the ones immediately in the scope of this study. An interview guide was used to capture the interviewees' comments on the topics of (a) how and why the transition to electric buses was initiated, (b) the collaboration between involved actors, and (c) barriers/enablers in the transition process. For this study, the topics (a) and (b) have been in focus.

Table 1
Overview of the process and number of electric buses in the cases.

	Process in which the transition to electric buses was initiated	Number of electric buses[a]
Ystad	Existing contract	5
Piteå	Procurement	13
Jönköping	Test project and Procurement	51
Malmö	Test project and Procurement	112
Gothenburg	Test project and Procurement	150
Stockholm	Existing contract	15

[a] This indicates the number of electric buses in everyday operations at the time of the study (2021).

The choice to conduct semi-structured interviews is to allow for the interviewees to talk about their experience with and attitude towards the transition to electric buses in a freer manner compared to a structured interview-approach. The semi-structured approach also appropriate as all interviews follow the same interview guide, ensuring that all interviews touch upon the same topics, but there is freedom to adjust and ask follow-up questions depending on the interviewee's perspective and knowledge (Brinkmann & Kvale, 2015).

The interviewees for the organisations are employed on both a managerial and operational level. This allows for a variety of perspectives on the transition to be expressed. Nine of the interviewees represented PTOs, of which five were in managerial positions and four in operational positions. Eight of the interviewees represent PTAs, five of which held managerial positions and three of which held operational positions. Within the seven interviewees representing municipalities, five held managerial positions and two operational positions. The selection of interviewees was based on both initial desktop research to ensure that relevant representatives for the organisations were included, as well as snowball sampling in an iterative process. The interviews were carried out via videoconferencing between March and November 2021 and lasted between 30 and 90 min. All interviews were recorded and transcribed verbatim, and then coded using NVivo. Quotes from the interviews have been translated from Swedish to English by the authors.

The point of departure for the analysis derived from understanding that a rationale can be described by both interests and expectations. The first step of the analysis was to identify the actors' rationales for transitioning to electric buses. This first step of coding was done on a case-by case basis. Upon initial coding, these rationales were compared across actor groups and cases. For each rationale, sub-categories for interests and expectations were added for the second round of coding, and the material was subsequently coded according to both interests and expectations expressed explicitly by the interviewees, and interests and expectations as interpretated by the authors. Distilling and disentangling the rationales therefore included some degree of interpretation by the researchers. The identified interests and expectations were then compared across actor groups and between cases to allow for similarities or differences to be identified.

5. Results and analysis

The analysis of the actors' rationales showed that they have similar rationales for engaging in the transition. Disentangling these rationales into interests and expectations on the transition showed that whilst the actors had similar rationales for engaging in the transition to electric buses, the underlying interests and expectations that formed the rationales were different between the actor groups. In addition, comparison

between the actor groups on a case-by-case basis showed that actor groups' interests and expectations did not differ between cases; PTAs across cases had similar interests and expectations, as did PTOs and municipalities across cases. Subsequently, the following section presents the interests in, and expectations of, the transition to electric buses in public transport, first for each of the three actor groups separately in Section 5.1, answering the first research question. This is followed by differences and similarities between the actor groups in Section 5.2, answering the second research question.

5.1. Interests and expectations of different actors in the transition to electric buses

5.1.1. Public transport authorities – direction and reaction

The benefits to both local environment and public health are referred to as a major reason to transition to electric buses by PTAs. It is in their interest to invest in technology that will contribute to reaching regional goals of reduced emission and improved air quality, with the expectation that electric buses will provide these benefits.

In their role as procuring actor, the PTA has the potential to steer the development in their desired direction, as expressed through the requirements in the contract. In order to do so, the PTA needs to have up-to-date knowledge, both concerning what technology is available on the market, and how this technology will influence the public transport system when in operation. To secure this competence, the PTAs have an interest in partaking in test and demonstration projects and introducing electric buses within existing contracts. This provides experience with the new technology, which is considered a key component in the PTAs' assignment in planning and procuring public transport services.

The interest to gain more experience with electric buses is also related to a collective expectation that the transport sector and the bus market is heading towards full-scale electrification. Larger PTAs in the big urban regions (Stockholm, Gothenburg, and Malmö) note that they expect the availability of non-electric buses to be in low supply, and therefore need to know what technology to require in the upcoming procurements. In addition, in interviews Q and N, they reason that they can only follow developments on the market and that it is the automotive industry and bus manufacturers that have a significant influence on the development going forward, as exemplified by the following quote:

> "We can see that the benefits are many, apart from the lower emissions and noise pollution and such, the reality is that the whole market is investing in electrification. So of course, we also want to electrify because it aligns with our goals, but also because of the market. We can't have a completely different input … we are not that big on the market to be able to drive the vehicle development in a different direction that the vehicle manufacturers themselves are not interested in." (Interview Q, Gothenburg, PTA)

Market developments, also within private transport, are referred to as a reason to electrify. Electric buses are considered necessary to both maintain and improve the image of public transport as a modern and forward-thinking alternative to the car, as expressed by the following quote:

> "The region of Scania, the whole of Sweden, the whole world, is transitioning to electricity for private cars. If public transport is to have attractiveness to the car, which we need in order to have market shares, we can't be driving with combustion engines. It's an outdated technique compared to electricity." (Interview N, Malmö, PTA)

Market developments have also improved both the efficiency and the cost of electric buses, a trend which is expected to continue. It is in the PTAs interest to establish and work towards a cost- and energy-efficient public transport system. In terms of cost-efficiency, PTAs expect that electric buses will become competitive in terms of investment costs compared to alternatives in just a few years. In addition, the interviewees express that electricity is considered a "safe" alternative in the future compared to alternative fossil-free fuels such as HVO or biogas. Concerns regarding the cost and availability of these fuels in the future cause them to be regarded as uncertain options by the interviewees. As there are also strong collective expectations that the whole transport system will be electrified in the future, electrification is regarded as a less uncertain option in comparison.

Amongst the PTAs there is an expectation that the operators are keen on electric buses as it aligns with their interests of lower operational costs and the ability to build an image around electrification (to show that they are modern/innovative/responsible) (Interview H, N and R), and gain experience with the technology (Interview C, Q and W).

> "They [the PTOs] are very interested in electrification, they can see all the benefits and perhaps build their image and brand based on it … but also that it entails lower cost of operations and energy costs, that is very much in favour of electrification." (Interview N, Malmö, PTA)

The same interviewee also highlighted that PTOs seem to have a preference for electric buses, which makes the transition different from the previous introduction of biofuels in terms of an alignment of interests. Electrification is expected to contribute to goal-fulfilment for more than one actor, whereas the transition to biogas was in part characterised by a resistance from the PTOs:

> "The difference we can see between electricity and biogas [previous fuel] is that the operators never liked biogas, we had to force it into the contracts. If we didn't require biogas in the contract, we would have had diesel buses. We had to have requirements [in order] to meet our goals of fossil-free public transport. […] There is a lot in favour for electrification. We can see that the operators initiate and accelerate the transition, in part to perhaps get rid of biogas … There have not been any discussions like we had when we had biogas, but then again, we have a consensus that may not have existed with biogas." (Interview N, Malmö, PTA)

Whilst the full scale electrification of electric buses in urban public transport is expected and in line with national and regional policies and goals, PTAs express that the transition is occurring at a faster pace than initially expected. Electric buses have been offered in tenders where they have not been required, resulting in a larger part of the fleet being electrified than the PTAs may have assumed in their electrification strategy. This is in contrast to the transition to biogas in Swedish public transport, as expressed by interview N. The PTA not only has a role in setting the direction of the transition but is also reacting to developments that cause the transition to electric buses to happen faster than anticipated. This may cause possible tensions between electrification and strategies for the previous energy carrier.

In municipalities where public transport is an important market for regional biogas production, the PTA may need to consider the municipalities interests and expectations of the impact of electrification on the energy sector (Interview H and N). For example, in both Malmö and Jönköping, electrification has led to discussions about the future of biogas as fuel for urban public transport, and electrification outrivals an already renewable fuel. In interview N, these developments are referred to as "unfortunate but inevitable" for buses in urban public transport.

5.1.2. Public transport operators – efficiency and strategy

PTOs are responsible for executing the traffic as it is specified in the contract with the PTA. It is in their interest to submit tenders that will award them the contract, and as such their interests are strongly related to the institutional context. While they may not adhere to regional and local goals that pertain directly to the environment, they do so through their relationship with both the PTA and municipalities, which dictates the conditions within which they operate. The local conditions therefore become important factors when considering the interests of PTOs.

Municipal goals regarding noise pollution and air quality mean that the PTOs have an interest in operating traffic that will contribute to

reaching such goals, where electric buses are expected to provide these benefits. All the interviewed PTOs refer to either regional or municipal goals when discussing their interest in electric buses (Interview A, F, O, S, T and X).

> "It's not just about the bus journey from A to B, it's about the total environment; the living environment, the urban environment, noise pollution and such things. We can see benefits in being part of the sustainability journey, and also to be a partner in [achieving] it" (Interview T, Gothenburg, PTO)

In the local context, there is also an expectation amongst the PTOs that electric buses will provide them with access to other urban spaces due to the quiet and zero-emission technology. This means that electric buses could access zero-emission zones in a city if such were to be established. Larger PTOs also speak of an expectation that urban centres may become car-free in addition to zero-emission zones, giving electric buses access to those spaces as well. Not only does this give the PTO a competitive advantage in terms of an expected increase in ridership, it also contributes to the attractiveness of public transport. There is an expectation that introducing new technology will improve the attractiveness of the services and improve customer satisfaction. For both smaller and larger PTOs, operating electric buses are expected to help with their branding and image.

The PTOs have environmental interests in the transition, namely that they will have access to other urban spaces and increase the attractiveness of public transport, thereby gaining a competitive advantage derived from their expectations of the municipality within which they operate. These interests are significant due to the municipality being involved in the transition. Environmental requirements in tenders, set by the PTA, are also important, but the involvement of the municipality, and the arena that municipal goals and strategies set as the scene for the operations of public transport, are also of importance to consider.

From a market perspective, it is also in their interest to invest in a technology that they expect the PTAs are interested in. Alongside the PTAs' expectations that operators are keen on electrification, there is a collective expectation amongst the PTOs that electrification is "inevitable", both due to market developments as well as an assumption that all PTAs/municipalities want to electrify and therefore will require electric buses in procurement.

Investing in electric buses thereby also provides PTOs with experience of the new technology, which improves their ability to submit tenders and win upcoming procurements. The operation of electric buses differs from non-electric buses. In terms of service planning, one needs to consider charging time and location, battery capacity, and driving schedules, which is often the responsibility of the PTO. Experience with this gives the PTO access to knowledge and competence. Smaller PTOs expressed an expectation that investing in electric buses will help them become more established on market (Interview A and F), whilst larger PTOs with electric bus fleets in several cities have an interest in expanding their business (Interview O, T and X).

The contracts are usually awarded on various criteria, where cost is one such criteria; it is one of the PTOs goals to operate cost-efficient public transport services within the framework of the contract. Electric buses have previously been characterised by high investment costs; however, this is expected to change. In addition, electric buses have a lower Total-Cost of Operation (TCO) as they are more energy-efficient than other alternatives and require less maintenance. This means that the economic interest in the electrification of buses is further strengthened. In addition, there is an expectation amongst the PTOs that electric buses will have a longer technical lifetime compared to buses with a combustion engine (Interview B, G, I, O, and T). This affects the Life Cycle Cost (LCC), positioning electric buses as a competitive alternative compared to other drivelines for the future.

All PTOs expect both that the technology for electric buses will develop rapidly in coming years, and that the wider transport sector will soon be electrified. As such, they are keen to be part of these developments in the early phases of a transition to strengthen their position on the market through experience and competence. There is also a collective expectation that development in battery technology will allow for depot charging even in larger cities, and for longer routes, which are currently dependent on opportunity charging along the route.

5.1.3. Municipalities – urban qualities to increase attractiveness

> "We [the municipality] have goals to increase travel by bike and by public transport and to reduce our impact on the climate and environment […] and electric buses contribute to more sustainable and attractive urban environments, with reduced CO2 emission, better air quality and reduced noise pollution. In our guiding documents we see these as the benefits of electrification, and that it is our responsibility to achieve this." (Interview R, Gothenburg, municipality)

As exemplified by Interview R above, the benefits to the local environment – reduced noise and pollution, and improved air quality – are at the forefront when municipalities account for their interests relating to electric buses in urban public transport. There is an expectation that reduced emissions and quiet electric bus technology will contribute to establishing attractive urban spaces and improve the image of public transport. Another municipal official described it in the following way:

> "The nuisance that could be caused by the bus exhaust fumes and noise when you drove past cafes and such, you avoid that with electric buses. We will receive less complaints of the kind. And it will give an [improved] image of public transport. Those who thought negatively of public transport," it's always late, it emits fumes, take them [the buses] away", they can't say that anymore. They are quiet, clean, and nice things that transport us in a good way" (Interview M, Malmö, PTA)

There is an expectation that electric buses will have access to more urban spaces than buses with a combustion engine. The technology means that bus routes are expected to be possible to locate closer to schools, parks, and other sensitive areas where attempts are made to improve urban qualities (Interview A, O and T). The possibility to allow for the allocation of indoor bus stops was also mentioned (Interview O and S). Altogether, this is expected to improve the attractiveness of buses as a public transport mode, thereby increasing ridership, and ultimately, improving urban qualities.

Based on the information from the interviewees, the electrification of buses may cause additional indirect costs for the municipality. This includes, e.g., resources for additional legislative processes for planning and building charging infrastructure in the urban space, and/or for upgrading power grids in existing bus depots. They may not see an economic upside, as do the PTA or PTO, who may benefit from the expected lower operational costs of electric buses. However, they do see the advantages on a local scale, which can result in other benefits that may not be expressed in monetary value to the same extent as investment or operational costs, for example, improved public health (due to, for example, reduced noise pollution, improved air quality) and improved urban qualities.

Municipalities share the PTAs' and PTOs' expectation that the transport sector as a whole will be electrified in the future. The municipalities have an interest in ensuring that this process takes place in dialogue with urban planning, for example, ensuring that depots and charging infrastructure are strategically placed. This is in part to secure that investment in this infrastructure, which the municipality is sometimes responsible for, is planned from a long-term perspective as opposed to only with the current contract period in mind. Infrastructure for opportunity charging, in addition to requiring strategic placement to secure efficient operations, is also an aesthetic element in the urban environment. The municipalities have an interest in ensuring that the aesthetics of such infrastructure do not come into conflict with the

desired urban qualities.

Investing in electric buses is also expected to portray the municipality as forward-thinking and improve the image of public transport, as well as the image of the municipality. Similarly to PTAs, municipalities refer to developments within private transport as a reason to electrify public transport, as expressed by Interview P:

> "Before one could see an electric car and think "Wow, they're driving an electric car", now we see a non-electric car and think "Oh, are they still driving a diesel-fuelled car!?", it will be the same with cities that don't have electric buses – "No electric buses? What are they thinking, why don't they have electric buses?" (Interview P, Malmö, municipality)

5.2. Comparison of the actor groups

Disentangling the actors' rationales and considering each actor group separately provides understanding for the perspective on the transition. In order to also explore how they might engage in the transition, a comparison between actor groups and relating this to the organisational context was needed. We found that despite different interests, electrification can contribute to mutual goal fulfilment for the actors. Further, the actors' perception of the fast pace of the transition ought to be seen in light of the timeline of the procurement and tendering process that influences the PTAs' and PTOs' considerations during the transition. Finally, the role of the municipality in realising the potential benefits of electrification is a significant one. The organisational and local urban context are of equal importance when regarding the actors' interests.

5.2.1. Differences and similarities in interests and expectations between the actors

Environmental interests are prominent amongst actors in the public sector. Electric buses have benefits compared to alternatives in the local context: zero-emissions during operations means improved air quality, and the electric driveline reduces noise pollution. For municipal actors and PTAs, these reasons are at the forefront. These environmental reasons are applicable on the local scale, whereas environmental reasons on a global scale are less pronounced. This is perhaps due to uncertainties relating to negative externalities connected to production and disposal, for example, the extraction of raw materials for battery production and the electricity-mix impacts on the life-cycle emissions (e.g., Hensher et al., 2022; Tong et al., 2017), which require more research to determine the total environmental and climate impact. This is also perhaps due to the fact that a fossil-free urban public transport had already been achieved prior to electrification in all except one of the studied cases (Piteå), and in a comparison between the old fuel and electricity, it is the local benefits that are eminent.

When stating environmental interests, the public sector actors, municipalities and PTAs, express their role in the transition as an active leader in addressing issues connected to the local environment. They also discuss to what degree a strategy to operate electric buses might contribute to reaching local and regional goals related to air quality and noise pollution. Private sector actors, the PTOs, also express environmental interests when investing in electric buses, but phrase it in terms of a contribution to other actors' goals and strategies, not necessarily their own.

Alongside the expectation that electric buses will contribute to reaching goals pertaining to noise pollution and improved air quality, the same qualities are expected to contribute to an attractive urban environment and make new parts of the urban environment accessible for public transport. For PTOs and municipalities, this is expected to increase ridership and an improved image for buses as a public transport mode locally. Increasing the attractiveness and market share of public transport is also in the PTAs' interest. Increasing the attractiveness of public transport and increasing the market share compared to private transport is considered a key interest for all actors but stemming from different rationales. For PTAs and municipalities, this interest is linked to an environmental reason to electrify; for the PTO, it is linked to an economic reason – to maintain or establish a competitive advantage.

There are also economic interests in the transition. For PTOs, the expected lower TCO of electric buses make them cost-competitive compared to alternatives. The expectation that electric buses will have a longer technical lifetime means that the life-cycle costs of an electric bus is also considered competitive. This is also in line with the PTAs' interest in procuring cost and energy efficient public transport services. Other economic interests exist as well: societal benefits stemming from reduced noise pollution and less emissions contribute to better public health, which is in the interest of municipalities from a welfare-economics perspective.

5.2.2. Pace of transition in relation to organisational context

All three actor groups refer to market developments, both within public and private transport, and there is a collective expectation that the whole transport sector is moving towards electrification. The transition is also occurring at a faster pace than expected. To keep up with these developments, gaining experience with electric buses is considered important by all actors. Rapid technological developments and the large-scale electrification of the wider transport sector are expectations collectively held by all actors. There is also a sense of urgency when reflecting on how the developments in public transport are expected to play out in the coming years. All actors express positive expectations related to electrification, but also state that electrification is not without its challenges.

Considering that the transition is occurring faster than expected, the actors have varying resources and capabilities with which to pursue their interests. That the transition is progressing at a faster pace than the actors initially anticipated highlights a temporal component that underlies the actors' interests and influences the strategies and resources that are available for them to engage in, and use to influence, the emerging system. For example, it has previously been necessary for PTAs to require specific technologies to transition to a fossil-free fleet (Aldenius et al., 2021; Xylia & Silveira, 2017). However, in this transition to electric buses, electrification is happening even without setting requirements to do so. There is therefore a sense of urgency underlying the interests of the PTA. In their study from 2017, Xylia and Silveira found that Swedish PTAs expected that full-scale implementation of electric bus technology would take at least 10 years. Strategies to operate electric buses are already in motion as present developments in practice highlight. The PTAs reflection that it is happening faster than anticipated indicates that current developments are not in line with previous expectations, requiring PTAs to take action to ensure their interests are protected. As a procurer of public transport, relevant knowledge, and competence of the technology available on the market, are crucial to set and fulfil both internal strategies and meet goals set on a national or regional level. The results indicate that the PTAs consider that they, at this time, need more competence in order to set the direction of development, and not only follow the direction set by the market.

> "The world is in constant change. We [the PTA] never thought it would go so quick, that suddenly electrification is happening and that all the forces are pulling in the same direction. That from a national level they want authorities to facilitate electrification for the operator … all of a sudden it happened, and this is a paradigm shift that is taking place over just a few years" (Interview N, Malmö, PTA)

Similarly to the PTA, there is a sense of urgency amongst the PTOs about gaining experience and knowledge with the electric bus technology in order to maintain or establish a competitive advantage for future procurements. That electric buses have been offered in, and won tenders, even where electric buses have not been required, is also an indication of the expectations concerning how the technology will advance as well as how the price of said technology will develop. A strong

positive collective expectation that the electrification of buses lies in the future, almost regarded as an inevitable fact, influences the actors in, despite uncertainties and barriers, electrifying in order to gain access to the resource of experience and competence. This in turn establishes what is at the moment considered an advantageous position going into the future. This can be interpreted as safeguarding current interests and also setting oneself up to maintain a strong position going into the expected future.

This faster-than-anticipated development should also be seen in light of the timeline of the procurement and tender process. In Sweden, public transport is procured in 10-year contracts with tenders being submitted and the contract awarded a couple of years prior to the traffic starting. Considering how electric bus technology has developed thus far, and how it is expected to develop in coming years, this timeline implies that the contractual parties must handle uncertainties and risks that are not yet fully known when entering the contract (Hensher, 2021). Because the transition to electric buses in the studied context mostly occurs within procurement, the PTOs and PTAs action space is largely defined by the contract design. While our results indicate that both contractual parties are "heading in the same direction" in terms of the large-scale electrification of buses in public transport, the strategies to do so and the desired configuration of the system may differ depending on their interests. The PTA has the ability to steer the developments by stating more specific requirements. Or, if they do not have the resources to do so, leave more decisions to the PTO by the use of functional requirements, who in turn has more action space (Camén et al., 2020). A larger PTA that procures (electric) bus traffic regularly, for example, the PTAs in Stockholm, Gothenburg and Malmö, has more experience and competence with which to detail these requirements in order to align it with their interests compared to a PTA that procures the services in ten-year intervals. Similarly, a large PTO has more experiences to draw on when submitting tenders than a small PTO. As such, the electrification of buses may have long-term impacts on the public transport market that, so far, are hard to foresee.

5.2.3. *Municipalities' role in the realisation of expectations*

Municipalities have an important role in realising some of the expected benefits and other actors' interests of electrification. For example, municipal environmental requirements relating to air quality may act as a catalyst for electrification, as other technologies may not meet set standards if low-emission zones in cities are established. In addition, without the municipality establishing expected low-emission zones, electric buses may not access new urban spaces, and thereby the expected increase in the attractiveness of public transport or increased patronage may not be fulfilled. These are interests that, according to the results of this study, are important for the PTA and PTO to realise. Municipalities hold a key role in realising the potential benefits of electrification and should be considered as such in the transition. It is therefore not only the contracts design that influences the PTAs and PTOs possibilities to pursue their interests; rather, consideration of municipal strategies and interests are equally important.

6. Discussion

The aim of this study was to disentangle actors' rationales for engaging in the transition to electric buses in public transport, and to describe these rationales in terms of interests and expectations. The analysis shows that the different actor groups have different interests, and that they prioritise between these differently. For PTAs, electrification can contribute to reaching regional goals of reduced emission and improved air quality, and in order to achieve this, the PTAs have an interest in gaining competence and steering the development in a direction such that these goals are fulfilled. For PTOs, economic rationales, stemming from interests in gaining competence and experience to establish a competitive advantage together with expectations of lower costs, are prominent. For municipalities, interests in improving urban qualities in the local environment, by reducing noise and local air pollution, and ensuring that the electrification of buses in public transport aligns with this interest, is identified as important. However, the transition to electric buses can contribute to mutual goal fulfilment, despite these differences.

The interests of the PTAs and the municipalities are well aligned with the interests of the PTOs based on their market knowledge. Alongside this alignment of interests, there are strong collective expectations regarding the electrification of the bus fleet that guide the actors in their decision-making. The actors refer to developments both inside and outside the public transport sector that influence their individual expectations. Apart from expectations on future technological developments, actors also hold expectations regarding other actors assumed strategies and interests. We interpret the results as there being a consensus regarding electrification that has not existed in previous transitions to a new fuel in public transport.

6.1. *Access to material and immaterial assets*

As presented in Section 5.2, the interests of PTAs, PTOs, and municipalities align with the transition to electric buses. Bakker (2014) writes that actors are likely to try and influence the transition and the configuration of the emerging system in order to align it with their interests. All actors refer to an investment in electric buses as a means to access a particular resource that could be used to influence the system and steer the development in their desired direction. From a PTA's perspective, investing in electric buses and engaging in the transition supplies the actors with competence and experience, an immaterial resource that could be utilised to improve their role as procuring part and know what technology to require in upcoming tenders. Experience and competence are also valuable resources for PTOs, as an improved market and operational knowledge increases their ability to win tenders and expand their business. For municipalities, these resources have to do with their ability to influence the choice of charging strategy, the location of depots, and the location and design of charging infrastructure, in order to secure that the electrification of public transport does not go against any urban planning strategies.

Access to competence and experience as an immaterial asset in the transition to electric buses in everyday operations is considered important by both PTAs and PTOs. Furthering their competence on procuring and operating electric buses is necessary to both instruct the developmental direction and maintain or establish a certain position in the procurement process. The interest to gain further competence may indicate that the knowledge and experiences gathered through test or demonstration projects need to be complemented with experiences from regular operations. Whilst test projects are important for experience with the technology, experience of how to handle such technology on a larger scale, and within the context of public procurement, is of importance as indicated by the results of this study.

New phases bring about new questions. As the transition to electric buses progresses, moving from test projects to electrifying parts of the fleet and then to entire bus fleets, new questions arise or change character. A key question highlighted when electrifying parts or whole bus fleets is how to balance different sustainability goals. Interests in achieving targets for improved air quality and less noise pollution are set against ethical and moral considerations surrounding the environmental impact of the extraction of raw material for batteries or social impacts such working conditions in other parts of the world. In their role as public procurer, the PTA has an important role to play here. There is ongoing work from several PTAs in Sweden to address this and develop guidelines for how to handle ethical and social responsibility in the production of batteries and electric vehicles. This is one example of how PTAs are taking a governing role to steer the development in the desired direction.

6.2. Pace of transition requires action

The interest in gaining further experience and competence should also be seen in light of the expectations of rapid technological developments and the observations that the transition is progressing faster than expected. There is a sense of urgency in gaining said competence, not only for the actors to be up to date with relevant technology as it is introduced, but also to have the ability to lead or direct the transition in order to align it with their goals, not solely following the developments in a direction as set out by a different actor. Uncertainties regarding technological developments is by previous research considered a barrier to transition (Blynn & Attanucci, 2019; Moataz et al., 2018; Xylia & Silveira, 2018). In this study, uncertainties also seem to stem from the pace with which existing technology is introduced, not the technology in itself.

In her study on the influence of the organisation of bus transport with respect to the introduction of renewable fuel, Aldenius (2018) found that functional requirements in tenders resulted in exclusively biodiesel, and for the introduction of biogas and electric buses' specific requirements, it was necessary for the PTA to set specific requirements. Based on the interviews and cases in this study, we see a potential break from this, as electric buses are being offered and winning tenders where electric buses are not a specific requirement. This trend may influence the role of the PTA and the strategies they employ when procuring bus traffic through competitive tendering. Previously, the PTA were required to take a leading and directional role to bring about a transition, but our results indicate that aside from leading, their interests as identified in this study also indicate a reactional approach to the transition. This could come to affect their role in the transition, and by extension, also the roles of other actors involved. This is in line with reasonings from Hensher (2021) and Bakker and Konings (2018), who argue that the established or current organisation of public transport in terms of tendering and planning may not be suitable for the transition to electric buses, requiring involved actors to employ new strategies.

6.3. The role of expectations in the transition

That electrification can contribute to mutual goal fulfilment despite different interests, and the consensus between actors that the interviewees highlight, are partially based on expectations of the transitions rather than established knowledge. For example, there is an expectation that electric buses will have a lower TCO, which influences the PTOs expectation that electric buses will be economically interesting, in turn influencing the PTAs expectation that the PTOs will want to electrify the bus fleet. Previous research on the TCO of electric buses indicate that whilst electric buses can be cost-competitive compared to conventional buses, there are a number of parameters that influence this (Grauers et al., 2020; Kim et al., 2021). Some of these parameters, such as the future pricing of fuel or cost of technology, are yet unknown. Just recently, a large Nordic PTO released a statement that the costs of operating an electric bus fleet have been grossly underestimated based on their data from operations of electric buses, which suggests that the expectations of the economic benefits of electrification may not be as substantial as expected (Bussmagasinet, 2023).

Another expectation is that electric buses will have access to other urban spaces, based on an expectation that municipalities will establish zero- or low-emission zones, influencing the interests of both PTA and PTO. However, whether these expectations will actually be fulfilled is not yet conclusively proven. The consensus that we interpret the results indicate is therefore something that may be altered during the course of the transition.

6.4. Considerations for future research

The resources that the actors wish to gain access to, as discussed previously, can consist of both material and immaterial assets. It is not just the access to these assets that determine whether the actors can use them to steer the development, but also what capacity the circumstances allow. It is important to highlight how the local context to a large extent establishes this playing field. The role of the municipality in fulfilling some of the expectations is a point to be highlighted yet again. Given the importance of the local context and local policy goals pertaining to urban planning and urban qualities, as a key arena establishing the playing field for the transition to electric buses – more research is needed on how a transition to electric buses interacts with urban planning.

In addition to the local urban context being of importance to bring further understanding to the transition, how actors employ the tools they have at hand to influence the emerging system is also of importance, which relates to the organisational context. For the PTA and PTO, this has largely to do with the procurement process and contract design. More research is therefore needed on the role of procurement in the transition and how this limits or enables the possibilities of different actors to influence the development.

Is electrification a goal in itself, or a strategy an actor can pursue in order to achieve other goals or pursue their interests? Many countries and cities now have goals for electrified bus fleets in place (ITDP, 2021; Mulholland & Rodríguez, 2022). From the perspective of this study, where rationales for electrifying is described by actors' interests and expectations on the transition, electrification can be regarded as both a strategy and goal. Regardless of the perspective, what interests and whom these interests serve is important to consider. The role of expectations, both on the transition and how these influence actors' interests, is of equal importance. In this study, we found examples of interests that largely rely on expectations rather than established knowledge. These dynamics will be of interest to pay further attention to as the transition progresses.

7. Conclusions

The aim of this paper was to disentangle different actors' rationales for transitioning to electric buses in public transport. With a conceptual framework based on actors' interests and expectations of the emerging electric bus system, we identified several different rationales for the transition to electric buses in public transport, such as improving the local urban environment, increasing the attractiveness of public transport, reducing cost of operations, gaining experience and building competence.

We conclude that whilst the actors have different interests, the transition to electric buses can contribute to mutual goal-fulfilment for the involved actors. The interests of the regional public transport authorities and the municipalities, such as improved urban environment and increased attractiveness for public transport, which the electrification of bus fleets can contribute to, are well aligned with the interests of the operators, where interests in operating cost efficient traffic and gaining competence with new technology can be met by operating electric bus fleets. We interpreted the results as there being a consensus regarding electrification that has not existed in previous transitions to a new fuel in public transport. Whilst there is a consensus, the actors have varying resources and action space to influence the transition, which is largely determined by the institutional and local context.

We found that the interests of the actors are grounded in expectations of the future developments, but also related to the experience that the transition is occurring faster than previously anticipated. These affect the actor's possibility, with the resources at hand at this stage, to influence the development and the transitions going forward. As such, we also found that the actors have an interest in gaining both material and immaterial assets to be able to influence the emerging system. Competence and experience, as well as the ownership of physical infrastructure, are examples of such assets. Further, we found that, in addition to considerations for procurement and contract design, attention should be paid to the municipality's role in the transition, as they have an important role in realising the expected benefits of electrification.

CRediT author statement

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Compilation of interviews

List of interviews	Actor (Position within organisation)	Interview date
Interview A	Ystad, (PTO)	2021-03-30
Interview B	Ystad, (PTO)	2021-03-30
Interview C	Ystad, Skånetrafiken (PTA)	2021-05-19
Interview D	Ystad, Ystad municipality	2021-04-13
Interview E	Jönköping, Jönköpings municipality	2021-07-08
Interview F	Jönköping, PTO	2021-08-30
Interview G	Jönköping, PTO	2021-08-30
Interview H	Jönköping, Jönköpings Länstrafik (PTA)	2021-09-30
Interview I	Piteå, PTO	2021-09-13
Interview J	Piteå, Piteå municipality	2021-10-05
Interview K	Piteå, Piteå municipality	2021-10-05
Interview L	Piteå, Regionala Kollektivtrafikmyndigheten Norrbotten (PTA)	2021-10-29
Interview M	Malmö, Skånetrafiken (PTA)	2021-10-01
Interview N	Malmö, Skånetrafiken (PTA)	2021-10-12
Interview O	Malmö, PTO	2021-10-12
Interview P	Malmö, Malmö municipality	2021-11-04
Interview Q	Gothenburg, Västtrafik (PTA)	2021-11-08
Interview R	Gothenburg, Västtrafik (PTA)	2021-11-19
Interview S	Gothenburg, PTO	2021-11-08
Interview T	Gothenburg, PTO	2021-11-08
Interview U	Gothenburg, Gothenburg municipality	2021-10-25
Interview V	Gothenburg, Gothenburg	2021-11-01
Interview W	Stockholm, Trafikförvaltningen (PTA)	2021-11-04
Interview X	Stockholm, PTO	2021-11-08

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