Current Change in Public Transport - Public Procurement and the Transition to Electric Buses

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VENDELA ÅSLUND
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Current Change in Public Transport

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Vendela Åslund

LUND
UNIVERSITY

DOCTORAL DISSERTATION

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Title and subtitle: Current Change in Public Transport − Public Procurement and the Transition to Electric Buses

Abstract: This thesis examines how the transition to electric buses in urban public transport unfolds within a system organised through public procurement by competitive tendering. The aim is to increase knowledge on the dynamics between the transition to electric buses in public transport and public procurement. While previous research on electrification has largely centred on technological optimisation, cost modelling, and operational performance, less attention has been paid to the institutional and organisational dynamics that influence how electrification of buses is implemented in practice. Addressing this gap, the thesis adopts a sustainability transitions perspective and conceptualises public procurement as a dynamic structure composed of actors, institutions, and material components, through and within which the transition is negotiated. Empirically, the thesis draws on interviews with actors involved in the transition, such as Public Transport Authorities (PTAs) and Public Transport Operators (PTOs), as well as document analysis of tenders from Sweden, Norway, and the Netherlands. The analysis is guided by three research questions: (1) How does public procurement influence the introduction of electric bus technology? (2) How does the introduction of electric bus technology influence the roles, responsibilities, and strategies of actors involved in public procurement?, and (3) How does the introduction of electric bus technology influence changes in public procurement instruments?

The results from the four included papers show that ownership of buses, depots, and charging infrastructure reflects established norms, but is gradually renegotiated due to electrification. While buses have traditionally been owned by PTOs, the expected longer technical lifespan of electric buses and the need to ensure continuity across contract periods have prompted an increased use of takeover clauses and considerations of public ownership. Depots are increasingly publicly owned or developed through public-private arrangements due to the longevity of investments, need for strategic location, and updates to the electrical grid. Divisions of ownership are thus shaped by expectations of the future system, as well as by practical considerations and existing norms. Second, the transition is influenced by procurement principles, in particular fair competition, technology neutrality, and public value. These principles frame which technological choices that are seen as acceptable or legitimate. Fair competition motivates public ownership of infrastructure to avoid undue advantages for established operators, and technology neutrality remains an important ideal in procurement, yet is challenged as PTAs specify charging strategies, infrastructure configurations, and sustainability requirements that implicitly favour certain technologies. In parallel, the principles of public value frames appropriate technological choices, with procurers needing to not only ensure technological feasibility, but also to work towards system-wide sustainability and ensure that societal goals and goods are addressed.

Third, electrification reshapes responsibilities and strategic actions among actors. New technology introduces new actors and dependencies, requiring PTAs to assume expanded roles as long-term planners, coordinators of infrastructure, and to set sustainability criteria. PTOs adapt operational practices to electric buses and seek new capabilities, while municipalities and energy companies play a central role in planning and permitting infrastructure. Fourth, electrification both broadens the scope of procurement and also narrows down technological choices. Tenders evolve from the contracting of bus services to the procurement of integrated systems that include depots, chargers, batteries, and lifecycle sustainability. At the same time, when infrastructure is established, later procurements must become more specific to ensure compatibility and operational continuity, making other technologies less plausible. This dual dynamic reflects the role of procurement in both accommodating and directing technological change.

In sum, this thesis demonstrates that procurement is not merely a policy instrument nor an organisational circumstance in the transition to electric buses, but rather a dynamic structure that configures the transition and is reconfigured because of it. The interplay between technology, institutions, and actors results in procurement practices that are continually reinterpreted and reshaped as electric buses become the new norm in urban public transport.

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MADE IN SWEDEN

Abstract

This thesis examines how the transition to electric buses in urban public transport unfolds within a system organised through public procurement by competitive tendering. The aim is to increase knowledge on the dynamics between the transition to electric buses in public transport and public procurement. While previous research on electrification has largely centred on technological optimisation, cost modelling, and operational performance, less attention has been paid to the institutional and organisational dynamics that influence how electrification of buses is implemented in practice. Addressing this gap, the thesis adopts a sustainability transitions perspective and conceptualises public procurement as a dynamic structure composed of actors, institutions, and material components, through and within which the transition is negotiated. Empirically, the thesis draws on interviews with actors involved in the transition, such as Public Transport Authorities (PTAs) and Public Transport Operators (PTOs), as well as document analysis of tenders from Sweden, Norway, and the Netherlands. The analysis is guided by three research questions: (1) How does public procurement influence the introduction of electric bus technology? (2) How does the introduction of electric bus technology influence the roles, responsibilities, and strategies of actors involved in public procurement?, and (3) How does the introduction of electric bus technology influence changes in public procurement instruments?

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Third, electrification reshapes responsibilities and strategic actions among actors. New technology introduces new actors and dependencies, requiring PTAs to assume expanded roles as long-term planners, coordinators of infrastructure, and to set sustainability criteria. PTOs adapt operational practices to electric buses and seek new capabilities, while municipalities and energy companies play a central role in planning and permitting infrastructure. Fourth, electrification both broadens the scope of procurement and also narrows down technological choices. Tenders evolve from the contracting of bus services to the procurement of integrated systems that include depots, chargers, batteries, and lifecycle sustainability. At the same time, when infrastructure is established, later procurements must become more specific to ensure compatibility and operational continuity, making other technologies less plausible. This dual dynamic reflects the role of procurement in both accommodating and directing technological change.

In sum, this thesis demonstrates that procurement is not merely a policy instrument nor an organisational circumstance in the transition to electric buses, but rather a dynamic structure that configures the transition and is reconfigured because of it. The interplay between technology, institutions, and actors results in procurement practices that are continually reinterpreted and reshaped as electric buses become the new norm in urban public transport.

Populärvetenskaplig sammanfattning

Elbussar har blivit en allt vanligare syn i stadstrafiken de senaste åren. På kort tid har utvecklingen gått från enstaka fordon och testprojekt till elektrifiering av en betydande del av den svenska bussflottan. Elektrifiering av busstrafiken anses vara en viktig del i att nå mål om minskad klimatpåverkan och nollutsläpp, och kollektivtrafiken har kommit längre än andra delar av transportsektorn vad gäller elektrifiering. Omställningen har drivits av både teknisk utveckling och politiska mål och realiseras framför allt genom offentlig upphandling. Eftersom 90 procent av svensk busstrafik upphandlas under konkurrens är detta en viktig del i omställningen till elbussar, där upphandlare kan initiera och driva tekniskiftet genom exempelvis olika typer av krav eller mål i upphandlingsunderlag.

Mycket av den tidigare forskningen om elbussar har präglats av ett teknikfokus och har varit inriktad på hur denna omställning kan åstadkommas på ett så energi- och kostnadseffektivt sätt som möjligt. Den här avhandlingen visar att organisatoriska och institutionella frågor är minst lika avgörande. När en så stor och komplex verksamhet som kollektivtrafiken byter teknisk grund ändras inte bara fordonen som rullar mellan hållplatser som ändras utan även ansvar, roller och arbetssätt för aktörer som planerar och utför busstrafiken.

Denna avhandling fokuserar på att förstå dynamiken mellan elektrifiering och upphandling av busstrafik. Elektrifiering innebär att nya delar av systemet behöver byggas upp, så som laddinfrastruktur, nya sätt att planera trafik, och nya sätt att ställa teknik- och miljökrav i upphandling. Samtidigt så finns det tydliga ramverk och strukturer som styr hur upphandling fungerar, exempelvis normer kring ägarskap av depåer, formella aktörsroller och principer om rättvis konkurrens. Detta skapar en dynamik där omställningen till elbussar och upphandling växelvis påverkar varandra, tekniken som introduceras och aktörers olika roller och arbetsuppgifter.

Genom en djupdykning i svenska upphandlingar av elbussar, med internationella utblickar till Norge och Nederländerna, följer denna avhandling den snabba omställningstakten i kollektivtrafiken, där elektrifierade bussar gick från att utgöra endast två procent av alla svenska stadsbussar år 2018 till 40 procent år 2025. Omställningen medför inte bara att en ny typ av buss sätts i drift, utan även att normer inom upphandling av busstrafik har utmanats, att ändrade former för ägarskap och ansvar för infrastruktur har krävts, att nya hållbarhetsparametrar

behöver hanteras inom ramen för offentlig upphandling samt att både beställar- och utförarkompetens behöver utvecklas för den eldrivna busstrafiken. Exempelvis visar resultaten att frågor rörande miljö och social hållbarhet för batterier har blivit viktiga de senaste åren, vilket då kräver att kravställningen i upphandlingen måste spegla detta. Detta ställer i sin tur krav på beställarens kompetens att både utforma och utvärdera sådana typer av krav, men också att det finns resurser för uppföljning och kontinuerlig utveckling av kravprofilen. Dessutom ser vi att kravställningen för fordon och laddinfrastruktur blir alltmer specifik i takt med att elektrifieringen fortgår och det nya systemet etableras. Både laddinfrastruktur och elbussar har en (förväntad) teknisk livslängd som sträcker sig längre än kontraktstiden, och resultaten pekar på ett ökat användande av övertagandeklausuler samt specifika krav på fordon för att dessa ska kunna passa med befintliga laddare och elsystem.

Åt andra hållet har även regelverk och normer inom upphandling och förväntningar på teknikutvecklingen och framtiden påverkat vilken typ av elbussteknik som har införts och hur denna har hanterats inom upphandlingsramverket. Konkurrens- och teknikneutralitet och normer kring detta har format vilken aktör som anses bäst lämpad att ta ansvar och ägarskap för nya delar av bussystemet. Avhandlingen pekar på att det finns en trend mot ökat offentligt ägande av depåer och laddinfrastruktur för att säkerställa att konkurrensen inte blir snedvriden i framtida upphandlingar och för att säkerställa kostnadseffektivitet av investeringarna i infrastruktur. Därtill har normer kring teknikneutralitet och vilken typ av krav som ställs i upphandling haft inflytande på vilka laddstrategier som införts. Operatörer ansågs ha bättre marknadskunskap om vilken strategi som kan fungera bäst i olika kontexter och har även ansvar för den dagliga driften och handhavandet av laddinfrastruktur. Därför ansågs det tidigt i omställningen lämpligt att operatörer ansvarar för en del av teknikvalen som rör laddare. Däremot är laddstrategier i senare upphandlingar alltmer förutbestämda av beställaren, och genomgående verkar depåladdade batterielbussar vara den föredragna tekniken.

Elektrifiering av bussar i kollektivtrafiken genom offentlig upphandling innebär alltså inte bara ett teknikskifte, utan kan beskrivas som en dynamisk utveckling där ny teknik och etablerade arbetssätt och normer växelvis påverkar varandra och tillsammans formar det nya systemets ramverk. Detta gäller både för det ramverk som utgörs av ny fysisk infrastruktur och teknik och för ramverk för aktörers ansvar och roller och vilka normer och värden som prioriteras i omställningen.

Popular Science Summary

Electric buses have become increasingly common in urban public transport systems in recent years. In a short time, developments have progressed from single vehicles and test projects to the electrification of a significant share of the Swedish urban bus fleet. Electrification of buses is considered an important step towards reduced and zero emissions, and public transport has come further in this transition than other parts of the transport system. This transition is driven both by technological development and advancement, as well as political ambitions and societal goals, and in Sweden it is primarily realised through public procurement by competitive tendering. Because over 90 per cent of Swedish bus services are procured in this way, it is an important arena for the transition to electric buses, where procurers can initiate and advance through, for example, different types of requirements or goals.

Much previous research on the transition to electric buses has focused on technology and optimisations of cost and energy efficiency. This thesis shows that organisational and institutional aspects of the transitions are equally important. When such a large and complex system like public transport changes driveline technology, it's not just the vehicles that drive between stops that are changed, but also responsibilities, roles, and ways of working.

In this thesis, the focus is on understanding the dynamics between electrification and public procurement of bus services. Electrification means that new parts of the system need to be established, such as charging infrastructure, new ways of planning services, and new ways to set technical and environmental requirements in tenders. At the same time, there are frameworks and structures that influence procurement, for example, norms regarding ownership, formal role descriptions, and principles of fair competition. This creates a dynamic where the transition to electric buses and procurement influence each other as new technology is introduced.

Through a deep-dive into the procurement of electric buses in Sweden, together with insights from Norway and the Netherlands, this thesis follows the fast-paced transition in Swedish public transport, where the share of electric buses in urban services increased from only two per cent in 2018 to 40 per cent in 2025. The transition involves more than a new type of bus; it challenges procurement norms, alters how ownership of infrastructure is managed, introduces new sustainability aspects to be addressed, and means that actor competencies need to be developed for electrified bus services. For example, the results show that the social and

environmental sustainability of batteries has gained importance, which needs to be reflected in the design of requirements in tenders. In turn, this raises the bar for the necessary competencies of procurers to both design and evaluate such requirements, but also requires that there are resources for follow-up and for continuous development of the requirements. In addition, requirements for vehicles and charging infrastructure are becoming increasingly specific as the new system becomes more established. Both charging infrastructure and electric buses have an (expected) technical lifespan that extends beyond the contract period, and the results point to an increased use of takeover clauses and specific requirements for vehicles so that they fit with existing chargers and electrical systems as a way to manage this.

On the other hand, regulations and standards within procurement, as well as expectations of technological and future developments, have also influenced the type of electric bus technology that has been introduced, and how this has been managed within the procurement framework. Competition and technology neutrality, and norms surrounding this, have shaped which actors are considered best suited to take responsibility and ownership for new parts of the bus system. For example, the results show a trend towards increased public ownership of depots and charging infrastructure to ensure that competition is not distorted in future procurements and for cost-effectiveness. In addition, norms around technology neutrality and the type of requirements set in procurement have had an influence on which charging strategies have been introduced. Operators were considered to have better market knowledge of which strategy can work best in different contexts, and are also responsible for the daily operation and management of the charging infrastructure. Therefore, early in the transition, it was considered appropriate for operators to be responsible for some of the technology choices related to chargers. However, the results show that charging strategies in later procurements are increasingly predetermined by the procuring authority, and depot-charged battery electric buses consistently emerge as the preferred technology.

Thus, electrification of buses in public transport through public procurement does not just involve a technological shift, but can be described as a dynamic development where new technology and established ways of working and norms alternately influence each other. Together, this dynamic shapes the framework of the new system. This applies both to frameworks consisting of new physical infrastructure and technology, and to frameworks influencing the responsibilities and roles of actors, as well as which norms and values are prioritised in the transition.

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As I write these acknowledgements, I am overcome with feelings of relief and joy, as this was to be written the very last, and this must mean that I actually did make it, and some sadness, as it means that my time as a doctoral student is coming to an end. Bittersweet! These six years have been a time of immense growth, both as an academic and personally, and whilst I have spent countless hours on my own, with my own thoughts, behind a closed door reading, analysing, writing and editing, this has by no means been a lonely feat. I have been so lucky to have had strong supporters in my colleagues, friends, and family along the way that it feels like a collective achievement. Thank you to everyone who played a part in that.

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Vendela
Lund, May 2026

List of Publications

Paper I: Åslund, V., & Pettersson-Löfstedt, F. (2023). Rationales for transitioning to electric buses in Swedish public transport. Research in Transportation Economics, 100, 101308. https://doi.org/https://doi.org/10.1016/j.retrec.2023.101308

Paper II: Åslund, V., & Pettersson-Löfstedt, F. (2025). Institutional perspectives on public procurement in the electric bus transition. European Transport Studies, 2, 100036. https://doi.org/https://doi.org/10.1016/j.ets.2025.100036

Paper III: Åslund, V. (2026). Navigating electrification in public transport: the role of public transport authorities. Urban, Planning and Transport Research, 14(1), 2641587. https://doi.org/10.1080/21650020.2026.2641587

Paper IV: Åslund, V. & Nikoleris, A. (202X). When principles meet practice: dynamics of technology neutrality in electric bus adoption. [Manuscript submitted].

Author Contribution

I am the corresponding lead author of Papers I, II, and IV, and led the conceptualisation, data collection, analysis, writing, and editing for these papers. I am the sole author of Paper III.

Related Publications

Åslund, V., Pettersson, F., & Danielson, H. (2021). *Elbussen är här! Lärdomar och kunskapsluckor i forskning om elbussar* [The electric bus is here! Learnings and research gaps in electric bus research]. (K2 Outreach; Vol. 2021, Nr. 2). K2 − The Swedish Knowledge Centre for Public Transport.

Åslund, V., Pettersson, F., & Danielson, H. (2022). *Omställning till elbussar i svenska städer: Lärdomar om affärsmodeller, ägarskap och upphandling* [The transition to electric buses in Swedish cities: Insights on business models, ownership and procurement]. (K2 Working paper; Vol. 2022, Nr. 3). K2 − The Swedish Knowledge Centre for Public Transport.

Pettersson-Löfstedt, F., Danielson, H., Åslund, V. (2022) *Energikostnad för depåladdade respektive tilläggsladdade elbussar: De ekonomiska konsekvenserna av att ladda elbussar nattetid eller dagtid vintern 2021-2022* [Energy costs for depot and opportunity charged electric buses: The economic consequences of night and daytime electric bus charging in the winter 2021-2022] (K2 Working paper; Vol 2022, Nr. 4). K2 − The Swedish Knowledge Centre for Public Transport.

Åslund, V., Pettersson-Löfstedt, F. & Danielson, H. (2023) *Omställning till elbussar: Lärdomar, erfarenheter och rekommendationer* [The transition to electric buses: Learnings, experiences and recommendations]. (K2 Outreach; Vol. 2023, Nr. 4). Lund: K2 − The Swedish Knowledge Centre for Public Transport

Åslund, V. & Pettersson-Löfstedt, F. (2024) *Elbussar ur ett stadsplaneringsperspektiv* [Electric buses from an urban planning perspective]. K2 Working Paper; Vol. 2024, Nr. 3). Lund: K2 − The Swedish Knowledge Centre for Public Transport.

Pettersson-Löfstedt, F. & Åslund, V. (2024) *Lärdomar från omställningen till elbussar* [Learnings from the transition to electric buses]. In *Kollektivtrafik som medel för hållbara städer och regioner– det vet vi efter tio års forskning*. Lund: K2 − The Swedish Knowledge Centre for Public Transport.

Åslund, V., & Pettersson-Löfstedt, F. (2025). *The Transition to Electric Buses in Public Transport: Lessons learned from Sweden, Norway, and the Netherlands.* (K2 Outreach; Vol. 2025, Nr. 1). Lund: K2 − The Swedish Knowledge Centre for Public Transport.

Table of Contents

1 Introduction

Electrification of the transport sector is regarded as an important step towards sustainable transport and mobility systems. Replacing combustion engines with electric drivelines can reduce greenhouse gas emissions, improve air quality, and reduce noise pollution, creating more liveable urban environments (Dulce et al., 2024; Rodrigues et al., 2025). Environmental benefits are often cited as a primary reason for electrification, aligning with global and national climate targets and local ambitions for more attractive cities (Avenali et al., 2024; Paskett et al., 2025). However, the effects of electrification extend beyond environmental performance. Electrification introduces new technological artefacts, such as charging infrastructure, battery systems, and grid connections, that alter operational and organisational processes and principles of transport systems (Behnia et al., 2024; Manzolli et al., 2022).

One segment of the transport sector that has made significant progress with electrification is public transport, and specifically the urban bus system. Globally, the adoption of electric buses in public transport has increased from 0.2 per cent to nearly 5 per cent, with China leading the way and Europe emerging as the second-largest market (International Council on Clean Transportation, 2025). Within the European Union, almost half of new city bus sales in 2024 were zero-emission, and several member states have set ambitious targets for full electrification of urban bus fleets by 2030 (International Energy Agency, 2024). Sweden mirrors this trend. From only 54 electric buses in 2017, the Swedish fleet grew to over 1,500 by 2025, and projections indicate that electric buses will dominate urban fleets by 2030 (Transport Analysis, 2024a, 2024b). This rapid uptake is driven by a combination of policy instruments, technological maturity, and market developments, as well as regional and municipal ambitions for climate neutrality.

The operation of electric buses requires new competencies, planning processes, and investment strategies. Electric bus technology, the vehicle, battery, and charging infrastructure, has different characteristics compared to combustion engine technology. Therefore, electrification introduces some challenges. Public transport systems are complex socio-technical configurations, comprising physical infrastructure, institutional frameworks, and actor networks. These elements have co-evolved with combustion-engine technology over the decades. Introducing electric buses challenges this configuration, requiring adjustments in planning,

operations, and governance. For example, charging strategies affect route planning, timetabling adjustments, and grid capacity (Rizopoulos & Gkiotsalitis, 2025; Varghese & Pradhan, 2025); ownership models for buses and infrastructure influence risk distribution and investment decisions (Bakker and Konings, 2018; Orbea et al., 2019); and procurement processes must accommodate new technical specifications and sustainability criteria (Ammenberg & Dahlgren, 2021; Jagiełło et al., 2023). These changes ripple through the system and influence actors' roles and responsibilities, procurement strategies, and institutional frameworks. Electrification is not merely a technical upgrade, but a socio-technical transition that challenges established structures and practices.

In Sweden, public procurement is the primary mechanism through which the transition to electric buses is realised. Over 90 per cent of bus services are organised through competitive tendering, where Public Transport Authorities (PTAs) define services, set environmental requirements, technical standards, and contract private public transport operators (PTOs) to provide the services. Electrification challenges the procurement of public transport, as practices have been designed for combustion engine technology and are often inadequate in handling the uncertainties and infrastructural demands of electric bus systems. Questions arise about who should own and operate charging infrastructure, how risks and responsibilities should be distributed, and how to balance technology neutrality with the need to steer toward sustainability goals.

These questions are not merely procedural; they reflect deeper institutional logic and normative expectations about the roles of public and private actors in delivering public transport services. As such, public procurement is not only an instrument for implementing electrification but also a structural force that shapes the trajectory of the transition.

The interplay between electrification and procurement is dynamic. On the one hand, procurement influences the transition by setting requirements, allocating responsibilities, and signalling directionality. On the other hand, the transition influences procurement by introducing new technologies, altering roles and responsibilities, and challenging established practices and norms. This mutual shaping calls for an analytical lens that goes beyond viewing procurement as a policy instrument or a static context. In this thesis, I employ a sustainability transitions perspective and conceptualise public procurement as a structure, with material, actor, and institutional components, that both constrains and enables action, and that itself undergoes reconfiguration in response to the electrification of urban bus fleets.

1.1 Research Contribution

This thesis adds a new dimension to the growing body of research on electric buses by shifting attention from technical and economic optimisation towards the organisational and institutional context of the transition. Whilst previous studies have focused on cost modelling, charging strategy optimisation, and lifecycle assessments, this work examines how actors and institutional frameworks shape the transition in practice. Empirically, the thesis provides a comprehensive analysis of how electrification interacts with procurement practices. With a focus on Sweden and the organisation of public transport in this context, with complementary insights from other European contexts, and analysing real-world procurement processes and actor strategies, this thesis provides insights into how electrification unfolds within established systems rather than in isolated technical domains.

This research further advances understanding of public procurement as a mechanism for and of technological change in public transport. It demonstrates how procurement practices evolve during a transition, highlighting tensions between established norms and practices and new technology. The findings emphasise how ownership models, technical requirements, and normative expectations are renegotiated in response to electrification, offering guidance for procurement processes that balance the need for sustainable long-term strategies and aspects of a developing technology.

The purpose is not to contribute to developing theory; however, this thesis can contribute insights to sustainability transitions through the conceptualising of public procurement as a dynamic structure in the public transport system. The approach moves beyond procurement as a static context or policy instrument by highlighting how the structure is reconfigured through interactions between actors, institutions, and materiality. This illustrates the duality of structures in transitions, providing empirical examples of how structural change accompanies technological shifts in established systems.

The following section outlines the overall aim of the research and the specific questions that guide the inquiry.

1.2 Aim and Research Questions

This thesis aims to increase knowledge on the dynamics between the transition to electric buses in public transport and public procurement. It does so by applying a sustainability transitions perspective, and with a focus on Sweden, where this technological shift takes place both through public procurement and where public procurement sets the contextual conditions for the transition.

The findings are grounded in empirical evidence, comprising interviews with actors involved in the public procurement of public transport, as well as analyses of procurement documents. The thesis addresses the following research questions:

Research question 1 (RQ1): How does public procurement influence the introduction of electric bus technology?

Research question 2 (RQ2): How does the introduction of electric bus technology influence the roles, responsibilities, and strategies of actors involved in public procurement?

Research question 3 (RQ3): How does the introduction of electric bus technology influence changes in public procurement instruments?

The thesis comprises this cover essay and four papers, with each paper contributing to answering several research questions. Together, the papers and cover essay address the aim of this thesis. Table 1 provides an overview of the focus of the included papers and the research questions addressed.

Paper I explores actors' rationales for electrification in six Swedish cities. Based on expectations of and interests in the electrification of buses in public transport, this study disentangles motivations for electrification to better understand actors' strategies and roles in the transition.

Paper II analyses how institutional frameworks in public procurement influence the transitions to electric buses, and how regulative, normative, and cognitive frameworks are influenced by the transition. Based on seven cases in Sweden, Norway, and the Netherlands, the focus is on technological requirements and divisions of ownership as procurement instruments.

Paper III examines the changing role of Public Transport Authorities following electrification, and is based on interviews with Swedish, Norwegian, and Dutch actors. This study deals with the PTAs' multiple assignments as both procurers of services and long-term strategic planners.

Paper IV studies the dynamics of technology neutrality in public procurement of electric buses. Based on tender documents from 45 procurements in Sweden over a seven-year period, this study uncovers both temporal and hierarchical dynamics of technology neutrality.

Table 1 – Focus of the papers in relation to thesis research questions.
Orientation of the four included papers in the thesis and which of the three research questions that the papers contribute to answering.

	Paper I	Paper II	Paper III	Paper IV
Focus	Disentangle actors' rationales for transitioning to electric buses, identifying expectations and interests	Examine the role of public procurement in the transition through the influence of and influence on regulative, normative, and cognitive frameworks	Analyse how the role of the PTA, as planner and procurer of public transport, changes due to the transition to electric buses	Explore dynamics of technology neutrality in public procurement during the transition to electric buses in Sweden
RQ1	X	X		X
RQ2	X		X	
RQ3		X	X	X

1.3 Terminology and Research Boundaries

By **public transport**, I mean "*passenger transport services of general economic interest provided to the public on a non-discriminatory and continuous basis*" as per the definition in the EU regulation on public passenger transport (Regulation 1370/2007). Public transport thus includes buses, trains, and other forms of transport that are available to the public, charge set fares, and often run on fixed routes. In this thesis, I focus on public transport by bus, on fixed routes, and on a fixed timetable.

This thesis focuses on the electrification of buses in **urban public transport**. In the Swedish context, this means that only so-called Class 1 buses are included. Class 1 buses are designed for both seated and standing passengers, allow frequent passenger transfers (The Swedish Public Transport Association, 2023a), and are often referred to as city buses[1] (The Swedish Bus and Coach Federation, 2024).

Electrification refers to the transition from combustion engines to electric drivelines. I use the term **electric buses**, referring to buses with electric drivelines. In the included papers and in this cover essay, the term electric bus mainly refers to battery electric buses. When the term zero-emission bus (ZEB) is used, this includes

[1] Class 2 buses refer to those designed primarily for seated passengers and equipped with seatbelts, with standing passengers allowed in the aisle, usually used for inter-urban services. Class 3 buses are designed exclusively for seated passengers and equipped with seatbelts, usually referred to as coaches, and are used for long-distance services.

both battery electric buses (BEBs) and fuel cell electric buses (FCEBs). Both are electric bus technologies.

Whilst the majority of **the empirical material is drawn from a Swedish context**, the organisational form of public procurement of public transport also exists outside Swedish borders. Whilst Sweden serves as the main empirical context, the thesis treats the **organisational form as the subject of analysis**.

1.4 Structure of Thesis

The thesis begins with a background chapter describing the context in which this research has taken place. The first part of this chapter presents real-world developments of the electrification of public transport, both internationally and in Sweden. This is followed by a description of the organisational context in Sweden, and an outline of the public procurement process. This chapter aims to provide an understanding of the setting of this thesis and begins to outline the motivation to focus on public procurement in electrification.

Chapter 3 presents previous research on the electrification of buses in public transport, highlighting the need to address organisational aspects of the transition. This chapter also presents research on public procurement of public transport, both as a policy instrument and as an organisational context. The chapter concludes with the positioning of the thesis in relation to these research fields, setting the foundation for the research.

The theoretical framing and analytical approach are presented in Chapter 4, with a presentation of foundational principles of sustainability transitions research and interpretations of structure in transitions research. The second half of the chapter describes how I operationalise transitions concepts in order to conceptualise public procurement as a structure as the analytical approach in this thesis.

Chapter 5 covers research design, descriptions of the empirical material, and methods. It explains how the included papers evolved during the research process, how they inform each other, and how the modes of inquiry respond to the aim and research questions. Chapter 6 summarises the four included papers.

A synthesis of the results from the four papers is found in Chapter 7, illustrating the mutual shaping between public procurement and the transition to electric buses. Chapter 8 answers the research questions, discusses the results in relation to the theoretical framework, presents the thesis contributions and recommendations, and ends with suggestions for further research.

2 Background

The purpose of this background chapter is to provide an understanding of the context in which my research has been conducted, and to anchor the research approach in practical, real-world developments. For an understanding of the research process in this thesis, it is important to note the dynamic and fast-paced nature of bus electrification, resulting both from the policy setting and the maturation and availability of electric bus technology. Section 2.1 illustrates these developments, describing the electrification of urban bus fleets on international and Swedish scales. Further, an insight into the organisational setting of public transport in Sweden is important, as this explains the roles, processes, and systems within which actors and technology exist and operate. This is addressed in Section 2.2. Lastly, as the electrification of buses in Sweden is now primarily realised through public procurement, Section 2.3 outlines the procurement process and gives an account of regulations and principles guiding public procurement of public transport in Sweden.

2.1 Developments in the Electrification of Buses in Public Transport

Electricity has been used to power trains, tramways, and metros for decades, and it could be claimed that electricity as a driveline for buses in public transport is not novel. As early as 1907, a battery electric bus operated in the UK between London's Victoria Station and Liverpool Street Station (The Economist, 2007). A fully charged battery could drive the bus up to 40 (English) miles, after which it returned to the depot to change the empty battery for a fully charged one. However, the weight and inefficiency of the battery meant that it was soon replaced by other propulsion technologies. Since then, major developments in both technology and the transportation sector have influenced public transport systems. Public transport has seen shifts in fuel and engine types, from petrol and diesel to biodiesel, gas and ethanol, and combustion engines, and most recently electricity and hydrogen. What contributes to the novelty of the current transition to electric buses is the widespread implementation and pace of adoption.

Globally, the share of electric buses increased from 0.2 to 4.9 per cent between 2014 and 2024, outpacing the transition in the private car and heavy freight vehicle markets (International Energy Agency, 2024). China is the frontrunner in terms of share and number of electric buses in the transport sector, with over 70 per cent of the global electric bus fleet (International Council on Clean Transportation, 2025; International Energy Agency, 2024). The second largest market is Europe (International Energy Agency, 2025). In the EU-27, electric buses comprised 3.7 per cent of the share in 2024,[2] and this number might not come across as significant; however, almost half of new city bus sales were zero-emission in the EU-27 in 2024 (International Energy Agency, 2024), and in three member countries (Finland, Iceland, and the Netherlands), all new city bus sales were zero-emission (Molliere, 2025). City buses have a strong potential for electrification due to their fixed routes and daily driving distances (International Energy Agency, 2022; Magnusson & Berggren, 2018; Mulholland, 2023; Xylia, 2018). Within this sector, battery electric buses dominate among the available electric bus technologies (Molliere, 2024; Mulholland & Rodríguez, 2022).

The share of electric buses is expected to increase steadily and rapidly in the EU in the coming years, as all EU member states have targets for the public procurement of alternative-fuelled buses (including electric buses) through the Clean Vehicles Directive (Directive 2019/1161). Other EU-level policies, such as the Alternative Fuel Infrastructure Regulation (Regulation 2023/1804) and the EU Green Deal, also influence this development. In early 2023, the European Commission published a press release proposing new CO_2-emission targets for heavy-duty vehicles, and to "*stimulate faster deployment of zero-emission buses in cities*", it was proposed that all new city buses should be zero-emission by 2030 (European Commission, 2023), and over half of European capital cities strive to operate fully electrified bus fleets by 2040 (Mulholland & Rodríguez, 2022).

In the earlier stages of the transition (ca 2015), demonstration projects were launched around Europe to test new electric bus technology to assess the operational potential and organisational needs (UITP, 2016, 2017). These demonstration projects were part of formal, but not formalised, processes, where established actors gained experience and competence, and new actors and technologies were introduced into the public transport system, forming new relationships, connections, and areas of responsibility (Aldenius et al., 2016). Since then, electric buses have been introduced into regular operations on a larger scale, moving from introduction by way of demonstration projects to introduction through formalised planning and procurement processes (UITP, 2021, 2022).

[2] Including both city and inter-urban buses.

Sweden is no exception. Several test and demonstration projects in the early stages provided actors in the Swedish public transport system with technical experience and assessment of the operational requirements of electric buses. Many of these projects involved both public actors, such as Public Transport Authorities and municipalities, and private actors from the vehicle and infrastructure industry, as well as research centres and energy companies (Aldenius et al., 2016; Lundström et al., 2019). In 2017, only 54 electric buses operated in Swedish public transport (Transport Analysis, 2026).

Since then, the sector has moved from demonstration projects towards fully electrified urban bus fleets. In the past five years, the share of electric buses in Sweden has increased from three per cent to over 16 per cent of the total bus fleet (Transport Analysis, 2026). The share of electric buses is even higher if considering only urban bus fleets, which is where electrification has made significant progress in recent years. In 2018, the share of electric buses was just two per cent. In 2025, 40 per cent of urban buses (Class 1 buses) were electric, as shown in Figure 1 (Transport Analysis, 2026).

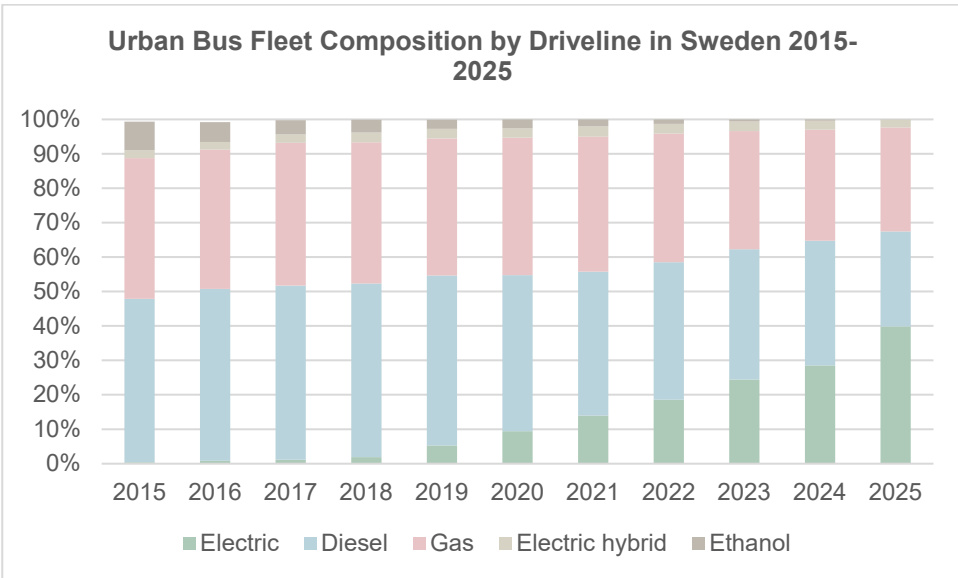

Figure 1 – Urban bus fleet composition by driveline 2015-2024 in Sweden.
Bar chart showing the increase in the share of electric buses (in number of buses) in Sweden between 2015 and 2025, indicating the share (number of buses) of Class 1 buses per fuel type. From 2019, the share of electric buses has been increasing relatively fast, from two per cent to 40 per cent between 2018 and 2025. Adapted from Transport Analysis (2026) and the International Energy Agency (2024).

Sweden's goal is to reach net-zero emissions by 2045, with a milestone to reduce emissions from domestic transport by at least 70 per cent by 2030 compared to 2010 (SFS 2017:720; Skr. 2023/24:59). In public transport the shift is driven by both national and regional targets for full-scale electrification in the near future, as well as market developments and the maturation of electric bus technology.

Domestic transport accounts for almost a third of Sweden's total greenhouse gas emissions, and emissions from road traffic dominate (The Swedish Environmental Protection Agency, 2023; Transport Analysis, 2024b). Electrification of road transport is therefore considered an important step in decarbonising the transport sector. Electrification of road transport, primarily private vehicles and public transport, is also considered a way to free up fossil-free fuels for use in other transport segments and sectors where electrification is considered more complicated (The Swedish Public Transport Association, 2023b; SOU, 2024:97).

The public transport sector has taken large strides towards fossil-free transport services in the past 20 years. In 2005, only seven per cent of vehicle kilometres ran on fossil-free and renewable fuel; in 2023, that number was 95 per cent (The Swedish Bus and Coach Federation, 2024; Transport Analysis, 2024a). As such, emissions from the public transport sector have already been substantially reduced.

Whilst electrification and increased use of fossil-free fuels significantly reduce greenhouse gas emissions from vehicles, from a lifecycle perspective, emissions need to be limited as well as resource use minimised. This is one of the reasons why measures other than merely changing fuels or driveline technology are needed. Transport efficiency, referring to both reducing the need for transport and replacing energy-intensive modes of transport with more energy-efficient ones, is also key in reducing the climate impact from domestic transport (The Swedish Environmental Protection Agency, 2023). Electrification of buses in public transport is therefore an important contribution to the achievement of climate goals, and as public transport emissions are low, the greatest climate impact is achieved by also increasing the market share of public transport (The Swedish Public Transport Association, 2023b). From an operational perspective, this means it is vital that the alternative driveline technology chosen to improve environmental performance does not negatively impact the service of the urban bus, which would counteract the desired modal shift to public transport (Guida et al., 2021).

The number of electric buses in Swedish public transport has increased drastically over the past 10 years, with a 12-fold increase in five years between 2018 and 2023 (The Swedish Public Transport Association, 2023c). In 2025, over 2,300 electric buses were operational in the Swedish public transport system (International Energy Agency, 2025; Transport Analysis, 2026). The Swedish Transport Administration predicts that by 2030, electric buses will be the most common bus type in urban bus fleets (Transport Analysis, 2024b). Figure 2 shows the increase in the number of electric buses in Swedish public transport over the past decade. Whilst urban

services have constituted a significant part of electric bus traffic, recent developments, especially since 2024, show progress has been made for regional traffic with Class 2 buses.

Sweden's three regions with the three major cities (Stockholm, Gothenburg, and Malmö) have the largest electric bus fleets and have set targets for fully electrified urban bus fleets by 2030 and 2035 (Region Västra Götaland and Region Stockholm, respectively), and have goals to improve the energy efficiency of public transport through electrification (Region Skåne) (Skånetrafiken, 2025; Storstockholms lokaltrafik, n.d.; Västtrafik, 2021).

This shift takes place through public procurement; therefore, the remainder of this chapter presents how public transport is organised in Sweden. By describing the organisation of public transport and the public procurement process, and the principles and regulatory frameworks that guide interactions and practices, the goal is to provide an understanding of the context within which Sweden's transition to electric buses takes place.

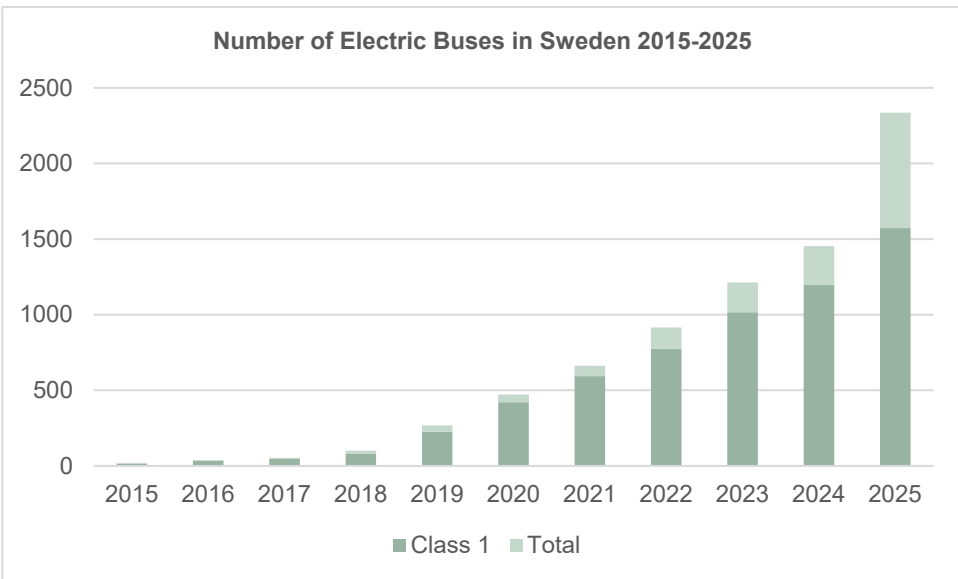

Figure 2 − Number of electric buses in Sweden 2015-2025.
Bar chart showing the rapid increase in the number of electric buses between 2015 and 2025, from only 20 to over 2,300 buses, including all bus types, as shown by the lighter top bar. Of these, the majority are so-called Class 1 buses that operate urban public transport, as shown by the darker bottom bar. Adapted from Transport Analysis (2026) and The Swedish Public Transport Association (2023c).

2.2 Organisation of Swedish Public Transport

The public sector has traditionally played an important role in the planning and provision of public transport in Sweden. Prior to 1960, public transport was primarily organised through market-driven initiatives, operated either by private or public entities (Ringqvist, 2016). Onwards, public funding of public transport through taxes increased and shifted more responsibility to the public sector, and in 1978, the first national legislation assigning formal responsibility for public transport to the public sector was introduced. Later developments and further legislation have allowed the market to play a larger role; one significant shift was the opening up for competitive tendering of services in 1989 (Ringqvist, 2016; van de Velde & Hirschhorn, 2021). Since then, competitive tendering has become the most common way to organise public transport in Sweden. Today, over 90 per cent of Sweden's bus services are publicly procured in a competitive tendering process (The Swedish Bus and Coach Federation, 2024).

The Public Transport Act (2010:1065), introduced in 2012, aimed to update public transport regulations to align them with EU legislation and opened up for further deregulation by allowing open access to the market. This deregulation was expected to increase competition in the market, grow the supply of public transport, and improve cost efficiency. The Public Transport Act also stipulates that each of Sweden's 21 regions should have a Regional Public Transport Authority (hereinafter referred to as PTA), composed of the region or municipality, or both. PTAs are responsible for long-term strategic planning of public transport and the development of regional transport supply programmes that outline goals for the services. The transport supply programmes align public transport with broader societal and environmental goals and strategies, and whilst national policies have influence, PTAs have considerable autonomy in setting their own objectives and direction (2015/16:RFR14).

The Public Transport Act therefore assigns substantial responsibility and autonomy to PTAs for the planning and provision of public transport. In terms of planning, the regional transport plan and alignment with regional developmental policies position the PTAs as long-term strategic planners. In terms of the provision of public transport, PTAs are positioned as procurers of services and the design, execution, and evaluation of tenders. However, the planning and operation of public transport in Sweden also involves other actors from both public and private sectors, such as regions, municipalities, and public transport operators.

Regions are tasked with regional development, for example, promoting environmental sustainability, reducing climate impact, and supporting energy transitions, formalised in regional development plans. Sweden's 290 municipalities hold significant influence over land-use planning through the municipal planning monopoly, which can affect public transport infrastructure, such as depots and

charging infrastructure, and as such are also partly responsible for public transport (Swedish National Board of Housing, Building, and Planning, 2025).

The degree of individual actors' responsibility for public transport varies across and within regions, depending on strategies and design of tenders in public procurement. In the next section, I outline the process and principles of public procurement of public transport in Sweden.

2.3 Public Procurement Framework in Sweden

Public procurement refers to the purchase of goods and services by government or state-owned organisations, where the public organisation acts as the client and private companies perform the service or provide the goods. Public procurement can be used as a policy instrument to ensure that the service procured is performed at the best price and as a means to steer towards public goals.

Several regulations guide the process and circumstances of public procurement. In Sweden, both EU and national legislation instruct the procedure, such as the Public Procurement Act (2016:1145) and the EU Green Public Procurement Criteria for Road Transport (European Commission, 2019). Nationally, the Public Procurement Act and Procurement of Services in the Utilities Sectors (2016:1146) further set the regulatory framework. Also, the National Agency for Public Procurement ("Upphandlingsmyndigheten") and the Swedish Competition Authority ("Konkurrensverket") instruct and guide the public procurement process.

For the public transport sector specifically, advice for the public procurement for public transport is provided by the Swedish Public Transport Association ("Svensk Kollektivtrafik"), where guidelines and tools have been developed as recommended standards for the tendering process. These include, for example, models of contracts, recommendations for technical specifications, and environmental requirements. Whilst not obligatory, these instruments have been adopted by the sector, and their usage is increasing (The Partnership for Improved Public Transport, 2020).

There are different ways to organise the procurement of public transport. In this thesis, I focus on procurement models where a PTA tenders out the operation of the bus system to a PTO. This is a widespread and increasingly common procurement model, and usually entails that the PTO in turn procures, owns, and operates buses (Guida et al., 2021; van de Velde, 2004). As such, normative frameworks, reflecting norms and standardised practices, also guide the procurement of public transport, alongside the abovementioned regulatory frameworks.

Procurement of public transport is a multi-year process, typically divided into planning, procurement, and contract phases. It begins with a public announcement by the PTA, inviting operators to an initial meeting for an exchange of information

and input on the upcoming procurement. Approximately one year later, the comprehensive tender documents are presented, where the services are described, technical specifications and environmental requirements are set, and the evaluation criteria are described. An open forum Q&A where potential tenderers can submit questions, ensuring equal access to any clarifications and amendments, follows. Circa one year after the publishing of tender documents, tenders are submitted confidentially by operators and subsequently evaluated by the procurer. The tender is awarded publicly, and after there is a period during which the decision can be appealed. Typically, the new contract begins about a year after the award decision and lasts eight to 12 years. Figure 3 depicts an outline of the process.

The focus of this thesis is the second stage of the procurement process: the design of tender documents. This is for two reasons. First, this is the stage of the procurement process where the direction for the services is communicated through, for example, environmental and technical requirements or descriptions of the characteristics of the procured services. Second, previous research has shown that the design of such requirements needs to be adjusted and changed due to electrification and that the use of different procurement mechanisms at this stage of the procurement process is important for initiating change and introducing new technologies, as will be presented in the next chapter.

The size and frequency of public transport procurement vary across regions. For example, larger PTAs (e.g. Västtrafik and Skånetrafiken), may have continuous ongoing procurement processes in a 10-year period for services with large fleets, while smaller regions may procure services once in the same time period and at a smaller scale. Therefore, the procurement experience, competence, and relevant market knowledge necessary to plan, design, and evaluate tenders also vary. The market is diverse, with over 200 operators in the field; however, it is dominated by 10-20 larger PTOs (The Swedish Bus and Coach Federation, 2024).

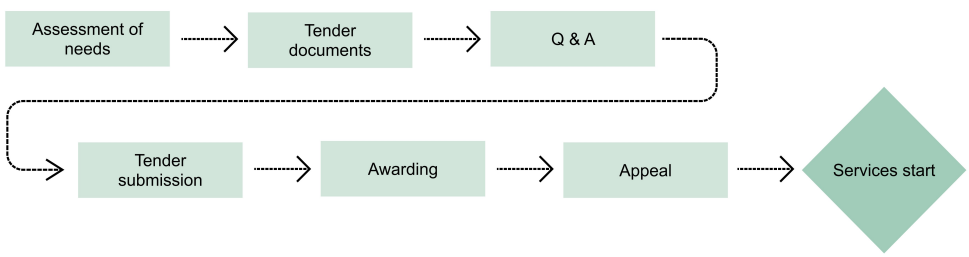

Figure 3 – Procurement of public transport process
Illustration showing the six steps of the procurement process before the services start. The focus of this thesis has been on the second step − tender documents. Adapted from Swedish Competition Authority (n.d.); Lidestam et al. (2016); The Partnership for Improved Public Transport (2020).

Previously, procurement of bus services included the procurement of services performed by vehicles; electrification also necessitates the procurement of charging infrastructure. As this transition is still in relatively early stages, there are not yet any standards or standardised models for how to procure this infrastructure, who should procure it, and who should own, operate, and maintain it. This adds complexity to the procurement process.

3 Previous Research and Positioning

This thesis draws on research from several fields. The empirical focus is on electrification of buses in public transport, reviewing previous research within this field has been important to identify research gaps, narrow down the scope, and determine the focus of this thesis. Section 3.1 gives an account of current research on this topic and outlines the motivation to focus on organisational and institutional factors of the transition to electric buses. Section 3.2 presents research on public procurement of public transport, and outlines the two main ways, as I interpret it, that public procurement is conceptualised in public transport research. First, as a policy instrument, where research focuses on the results of the procurement process, as in the effect or efficiency of procurement. Second, as the organisational context, where regulatory and normative frameworks influence and determine actors' actions, action space, and relations. Section 3.3 explains how I position my research within these fields.

3.1 Electric Buses in Public Transport

Research on the transition to electric buses is a relatively young but quickly growing area of study. As a field, the focus thus far has primarily been on supporting initiation and acceleration of the shift to electric buses to achieve global and local environmental goals in a cost effective and environmentally efficient manner.

The environmental benefits of electric bus services are cited as a main motivation for transitioning from combustion to electric engines, contributing to international and national targets for reduced emissions and fossil-fuel dependence, and improved local urban environments (Dulce et al., 2024; McCluskey et al., 2025; Paskett et al., 2025). Operating electric buses in public transport can reduce greenhouse gas emissions from the sector (e.g. Rodrigues et al., 2025; Say et al., 2023) and improve air quality locally through reduced tailpipe emissions (e.g. Holland et al., 2021; Zhou et al., 2023). The local environment further benefits through reduced noise pollution due to the quiet electric engine (Glebe et al., 2024). These benefits could increase the attractiveness of public transport and potentially influence a modal shift from private to public transport (Avenali et al., 2024; Giagnorio et al., 2024; Liu et al., 2024; Sunitiyoso et al., 2022).

Electric buses may be tailpipe emission-free during operations; however, for the total climate and environmental impact of electrification, one needs to consider the lifecycle of the bus and not only Well-to-Wheel or Tank-to-Wheel. The full environmental impact also depends on how the electricity powering the buses is produced, and therefore varies with the energy mix and source, and between cities and countries (Farzaneh & Jung, 2023; Panta et al., 2024; Rodrigues et al., 2025), and may also vary locally with daily and seasonal variations in the electricity mix (Rupp et al., 2019). The total energy consumption is also determined by local conditions such as topography (Avenali et al., 2024), temperature (Giagnorio et al., 2024; McGrath et al., 2022), battery production, degradation and recycling (Nordelöf et al., 2019), and the operational characteristics of the services (Ager-Wick Ellingsen et al., 2022; Wang et al., 2025).

Even with these variations, transitioning to a partially or fully electric bus fleet in public transport offers climate and local environmental benefits compared to combustion engine buses (Dulce et al., 2024; Nordelöf et al., 2019). As a result, much of the research on electrification of public transport aims to initiate and accelerate the transition, and is addressed in several different disciplines and through diverse perspectives; for example, the development of vehicle and battery technology (Manzolli et al., 2022; Varghese & Pradhan, 2025), the design and planning of operations with a charging configuration (Hsu et al., 2021; McCluskey et al., 2025; Zhang et al., 2025), cost analysis (e.g. Dulce et al., 2024; Rodrigues et al., 2024; Xiao et al., 2024), sustainability and social effects (Giagnorio et al., 2024; Holland et al., 2021; Ku et al., 2021; Lajunen, 2018), and organisation and collaboration (Aldenius et al., 2022; Borén & Grauers, 2019; Gasparre et al., 2025; Orbea et al., 2019).

Regardless of the varying approaches to the study of electric buses in public transport, a common theme is the presence of barriers to, and complexities associated with, full-scale adoption. These complexities are considered to derive from introducing buses powered by an electric engine and associated charging infrastructure into a system planned and designed for buses powered by a combustion engine and fuelling stations. A common point of departure is that the transition is unlikely to unfold in a straightforward manner but will require that the established system evolves and is altered or adjusted to the specifics of electric bus technology.

Technical and infrastructural complexities in the transition to electric buses primarily stem from the integration of charging infrastructure and the alignment with operational characteristics such as timetables, routes, and grid capacity. Research has largely focused on developing optimisation models to determine ideal charger locations and operational strategies that balance cost, energy efficiency, and service reliability (Behnia et al., 2024; Häll et al., 2019; Paskett et al., 2025; Rizopoulos & Gkiotsalitis, 2025). Different charging strategies, for example, depot-based slow charging and opportunity fast charging along a route, require different

planning approaches and have implications for grid capacity, urban space availability, and operational flexibility (Manzolli et al., 2022; Rodrigues & Seixas, 2022; Varghese & Pradhan, 2025). These changes require adjustments to established systems. In addition, due to range and charging constraints, electric bus fleets are expected to be larger than combustion engine fleets (Othman et al., 2024).

Further, many of the studies aiming to optimise and model the transition base input data on assumptions of future costs and limited operational experiences (e.g. Frieß & Pferschy, 2024; Lu et al., 2023). Whilst such studies can provide indications of the transitions expected progress, the fast-paced developments in practice are not fully mirrored in research. Despite the growing body of technology-focused research, a key research gap lies in the contextual variability of these solutions. What works in one city may not be suitable in another due to differences in geography, infrastructure, and policy priorities. Moreover, while optimisation models offer valuable insights, they do not fully account for the decision-making processes of actors who weigh technical performance against sustainability goals, costs, and market conditions.

Economic complexities in the transition to electric buses revolve around high initial investment costs for vehicles, batteries, and infrastructure, contrasted with lower operational costs over time (Blynn & Attanucci, 2019; Mohamed et al., 2018; Paskett et al., 2025; Rodrigues et al., 2024; Say et al., 2023). The Total Cost of Operations (TCO) framework is commonly used to assess feasibility (e.g. Harris et al., 2020; Holland et al., 2021; Jefferies and Göhlich, 2020; Kim et al., 2021; Ku et al., 2021; Quarles et al., 2020; Tong et al., 2017) and show that electric buses are increasingly cost-competitive compared to combustion engine buses. However, the distribution of costs across different actors, such as public authorities and private operators, creates imbalances. While one actor may benefit from reduced operational expenses, another may bear the burden of infrastructure investment. Several studies call for subsidies, grants, and public funding to mitigate these barriers and support long-term transition efforts (e.g. Giagnorio et al., 2024; Li et al., 2018; Thorne et al., 2021; Xiao et al., 2024; Zhou et al., 2024).

Despite growing evidence of the economic viability (e.g. Ghotge et al., 2025), a gap remains in understanding how financial responsibilities are negotiated and shared among actors. Current models often overlook the institutional and organisational undercurrents that influence investment decisions. Further, this research states that economic and institutional support is necessary (e.g. Aldenius et al., 2022; Bakker and Konings, 2018; Gasparre et al., 2025), yet there is limited research to date on how this support is designed and implemented in practice. There is a need for more research on how these tools, like procurement strategies, are applied in practice, and how they interact with evolving market conditions, technological maturity, and policy frameworks.

This thesis focuses on addressing these research gaps on institutional and organisational parameters of the transition to electric buses, with a particular focus on public procurement. The following section provides an overview of the literature on organisational and institutional factors in the transition to electric buses and outlines the motivation to focus on public procurement.

3.1.1 Addressing Institutional Complexities and the Importance of Organisational Context

Institutional complexities arise from the organisation of public transport and from the way the system has developed and been designed for previous technology. Established planning processes, financial strategies, relations and responsibilities among actors and the physical system have evolved in unison with combustion engine technology, and, as summarised in previous sections, are not compatible with electric bus technology. Research in this area highlights and problematises the lock-ins in the current system, ranging from inflexible operational planning models (Paskett et al., 2025; Zhou et al., 2024) to calls for increased political and authority support for electrification (Avenali et al., 2024), altered divisions of risks (Giagnorio et al., 2024) and relations between actors, and alterations to procurement processes and strategic planning (Borén & Grauers, 2019; Orbea et al., 2019). It can be argued that both economic and technical complexities and constraints to the transition derive from the established institutional context, and that addressing institutional complexities can cause a chain reaction, so to speak, minimising or erasing other barriers to the transition.

Political and authority willingness and support, through targets, goals, and funding, are necessary for the transition and to realise the global and local benefits of electrification (Avenali et al., 2024; Mohamed et al., 2018). By setting targets and near- and long-term goals for public transport, authorities can indicate the desired trajectory. Several studies conclude that the transition is dependent on authorities and other public actors taking on a leading role in setting the conditions for the transition through requirements and targeted procurements, minimising uncertainties and increasing willingness and incentive to invest in a technology that currently might be perceived as immature or risky (Bakker & Konings, 2018; Hensher, 2021; Mohamed et al., 2018; Orbea et al., 2019).

As new actors and technology are introduced in the system, relationships between actors are changed, new roles may be created, and new responsibilities allocated. This alters established practices. For example, Bakker & Konings (2018) suggest that authorities take on responsibility for investment and establishment of infrastructure, and Rodrigues et al. (2025) and McCluskey et al. (2025) conclude that authorities ought to re-evaluate current incentives and subsidiary support.

There are also calls for adjustments to procurement and contracting, for example, the consideration and inclusion of electric bus characteristics in tender requirements (e.g. Ammenberg and Dahlgren, 2021; Gadepalli et al., 2022; Jagiełło et al., 2023), and altered forms of contracting to handle division of risk and responsibility (e.g. Hensher, 2021; Orbea et al., 2019). These studies conclude that current practices and established ways of working in procurement and contract design are inadequate to manage the technical characteristics of electric bus technology and the uncertainties and difficulties that the transition entails. As concluded, the technical characteristics of electric buses differ from previous technologies, and therefore the tools used to introduce these into the system must be adapted to the new technology.

Bakker & Konings (2018) call for institutional change to remove barriers to electric bus adoption, involving transport authorities taking an active role in the transitions through, for example, new business models, investments in infrastructure, and assuming more risks in contracting. Their study highlights how authority initiatives and new strategies have the potential to minimise barriers to the transitions. Recent research by Gasparre et al. (2025) brings to light how the institutional context influences the transition to electric buses by analysing organisational dynamics in electrification in Italy. The authors highlight how PTAs navigate changes associated with electrification and bring attention to how institutional pressure and technological developments cause PTAs to act and modify existing routines and processes by, for example, adjusting routes due to charging constraints, and investing in new infrastructure as technology develops (Gasparre et al., 2025).

There is consensus that political support, authority initiative, and new strategies and processes in policy and procurement are necessary to overcome barriers to electrification and realise a technological shift. Yet, there is limited research on whether and how current practices have changed, or on how policy tools such as procurement have been used and altered in this transition. This research aims to fill that gap.

Whilst this consensus exists, it is important to acknowledge that the level of political support, the policy landscape, the organisation of public transport, and the processes within which such measures are to be included, vary from context to context, both on an international and national scale. As such, the focus on Sweden in this thesis places public procurement of public transport in the forefront, as it is through this process that the transition to electric buses takes place, as well as establishing the organisational context, the relationship between actors, and the boundaries of action. Therefore, the next section presents previous research on public procurement of electric buses.

3.1.2 Public Procurement of Electric Buses

Electrification introduces technological uncertainty, altered cost parameters, and complex infrastructure demands regarding the procurement of public transport, requiring procurement and tendering of buses to undergo changes to accommodate and manage this. Simultaneously, research calls for policy support and targeted procurement strategies to actualise the transition and to manage the above-mentioned complexities. I understand this as procurement both influencing and being influenced by the transition to electric buses.

Research on tendering and the procurement of electric buses highlights that existing practices are inadequate for managing the new technology that electrification entails. Rodrigues & Seixas (2022) and Li et al. (2018) emphasise a need for new mechanisms for contracting and procurement in order to overcome cost and risk barriers to the implementation of electric buses. Similarly, Hensher (2021) writes that significant unknowns of electric bus fleets and future developments may require that current practices be altered to better reflect and manage the risks and responsibilities that operators and authorities face during the course of the transition to a zero-emission fleet.

In their study on tender criteria for electric and diesel buses in Poland, Jagiełło et al. (2023) found that there was no significant difference in the tender criteria for the two technologies, thus concluding that organisations that had processes and procurement patterns for diesel buses in place have transferred these to tenders for electric buses. This results in tenders not sufficiently considering both the advantages and disadvantages of electric bus technology. Difficulties in procuring new technology are also highlighted in a Swedish study, where Ammenberg & Dahlgren (2021) developed a multi-criteria assessment framework for comparison between different bus technologies in public procurement. Technical maturity, the total cost of ownership, and the need for investments in infrastructure are discussed as characteristics of electric buses that differ from other technologies, and where current procurement practices are inadequate for addressing these aspects (Dahlgren & Ammenberg, 2021).

In terms of infrastructure, both Orbea et al. (2019) and Borén & Grauers (2019) suggest that procurement models be adapted to electric buses, but to separate the procurement of buses and services from the procurement or establishment of charging infrastructure. According to Borén & Grauers (2019), procurement of charging infrastructure prior to services ensures that any permits for grid connections are secured before services start, and procuring this separately is also economically favourable as the infrastructure has a depreciation period longer than contractual periods (Orbea et al., 2019). Such strategies would divide the procurement of the electric bus system into two different tenders − one for services, and one for infrastructure.

In her thesis, Xylia (2018) explores early electrification efforts of buses in Stockholm, concluding that a new institutional set-up is necessary, and also suggesting changes to procurement. For example, stricter procurement standards for electric buses are necessary to steer technological choices, as well as adjustments to ownership models, investment incentives for infrastructure, and extensions of contracts.

3.2 Public Procurement of Public Transport

Public procurement is an important tool for transitioning to more sustainable societies, as it sets sustainability requirements and shapes supplier and market behaviour (Brammer & Walker, 2010; Sönnischsen & Clement, 2020). Criteria set through public procurement can stimulate innovation, increase public welfare, and contribute to sustainability goals, depending on the purpose of the procurement (Edquist & Zabala-Iturriagagoitia, 2020). There is a vast body of research on public procurement; I concentrate specifically on the procurement of public transport by delineating the two major focus areas of the research that are significant for this thesis. First, research that analyses public procurement as a policy instrument in the provision of public transport, and second, research that conceptualises public procurement as an organisational context.

3.2.1 Public Procurement of Public Transport as a Policy Instrument

Procurement of public transport, particularly through competitive tendering, is widely utilised as a mechanism to achieve various policy goals and societal values. Public procurement through competitive tendering is considered to foster innovation and competition in the market (van de Velde et al., 2008), improve the efficiency of public transport (Nash & Smith, 2020), and reduce costs (Hensher & Stanley, 2010). Thus, it is seen as a way in which the public sector can drive technological change, sustainable outcomes, and innovation (Hansson et al., 2023). Public procurement of public transport is as such recognised as a powerful demand-side policy instrument for achieving environmental and societal goals, in which case it is often referred to as Green Public Procurement or Sustainable Public Procurement (e.g. Aldenius, 2021; Testa et al., 2016; Timm et al., 2025).

As the focus of this thesis is the procurement phase, specifically the design of tender documents, it deals with the planning and initial design of procurement, and not the evaluation of the outcome of the procurement. The efficiency and monetary value of a procurement process deal with the ex-post results of the procurement, placing focus on the outcome of the procurement and, as such, will not be described here. The focus is on the mechanisms of procurement and tender documents that can be

designed by procurers to achieve various societal and environmental goals. Research on how public procurement as a policy instrument functions and how authorities can translate environmental targets into practice emphasises the role of technical and environmental requirements or criteria, and the award mechanisms included in tenders.

The design and formulation of tender requirements play a pivotal role in steering technological transitions and advancing environmental objectives in public transport. Technical and environmental requirements in tenders establish the minimum compliance criteria that all bidders must meet. This defines the required standards and characteristics for the services being procured, for example, performance, energy consumption, material sourcing, and vehicle and driveline specifications (Lindfors & Ammenberg, 2021; Testa et al., 2016). In the bus sector, these are categorised into functional or specific requirements, and how they are designed and formulated impacts the flexibility, innovation potential, and cost-effectiveness of the procurement (Aldenius et al., 2021; Camén et al., 2020; Timm et al., 2025).

Aldenius et al. (2021) show that Swedish tenders increasingly employ functional requirements specifications, such as emission and energy efficiency targets. This allows operators flexibility in technological choices, and can promote innovation towards, for example, low-emission solutions. On the other hand, specific requirements, such as mandates for biogas or electric buses, have been instrumental in accelerating infrastructure development for alternative fuels, albeit at the cost of reduced flexibility and higher procurement complexity (Aldenius et al., 2021; Aldenius & Khan, 2017). Camén et al. (2020) also highlight that specific or overly prescriptive contract design can hinder adaptive responses to emerging technologies. Aside from environmental requirements, their study also highlights how operational and technical requirements, such as timetables, bus design, and age requirements, as well as the use of technical standards, influence the flexibility of a contract and the cost, efficiency, and quality of the services procured.

The procurer's competence to design and evaluate technical and environmental requirements is crucial for the use and effectiveness of these mechanisms (Aldenius & Khan, 2017). Knowledge of how to translate goals and targets into tender requirements, and up-to-date technical and market knowledge, is necessary to set relevant and targeted requirements (Lindfors & Ammenberg, 2021). This competence, and the resources to develop such competence, might not be fully established during periods of uncertainty or in the face of technological change, (Hensher, 2021). Therefore, the use of different public procurement mechanisms and their effectiveness may vary in the face of, and during the course of, technological change.

This literature also mentions the relationship between authority and operator (e.g. Aldenius et al., 2021), as they, as a result of the procurement process, are contractual

partners; it is important to acknowledge how authorities' governance and strategies in procurement influence the performance of operators (van de Velde & Hirschhorn, 2021). This calls for research that also addresses the organisational context and how this influences procurement and tendering.

3.2.2 Public Procurement as an Organisational Context

Attention to organisational aspects of procurement highlights that, in addition to being a policy instrument, procurement also functions as an organisational context. The organisation of the supply of public transport in Europe is categorised into two groups by van de Velde (1999): *authority initiative* and *market initiative*, as illustrated in Figure 4. In a market initiative, the supply of transport services is based on autonomous market entry at the transport supplier's initiative, based on the profitability of the service. In an authority initiative, a public transport authority has the power to define the services, and market entry is based on the authority's initiative.

Authority initiative is further categorised into public ownership and private concession, where public ownership entails that the services and associated assets are run and owned by the authority or delegated to a private operator. Private concession involves a private operator being selected by the authority. In this thesis, I focus on contexts where a public transport authority organises public transport services and assigns temporary rights to an operator, i.e. authority initiative through private concessions. In such contexts, there is direct competition between operators periodically when they submit bids for tenders for temporary operational rights of services (van de Velde & Hirschhorn, 2021). This is referred to as public procurement through competitive tendering.

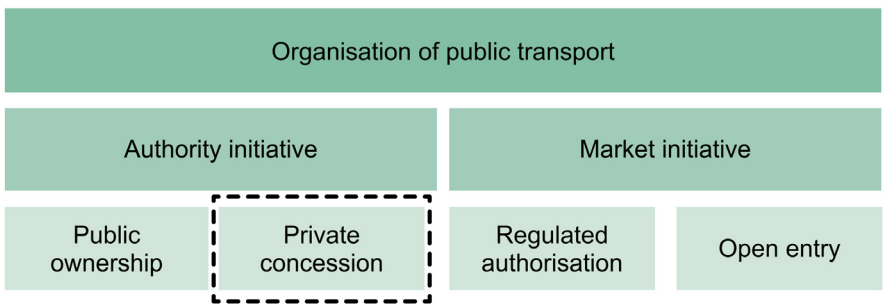

Figure 4 – Organisational models in public transport.
Figure showing different ways to organise the supply of public transport services, divided between authority initiative and market initiative. In this thesis, the focus is on authority initiative and private concessions, where services are publicly procured through competitive tendering. Adapted from van de Velde (1999).

Public procurement plays a pivotal role in shaping the institutional landscape of public transport systems (Aldenius et al., 2021; Hansson, 2011) as it determines how services are delivered, and defines the roles, responsibilities, and strategic capacities of actors (Canıtez & Çelebi, 2018). Canıtez (2019) argues that all actors and organisations in the public transport system are embedded in an institutional environment. Such institutional environments involve regulatory and normative dimensions that define roles and procurement strategies (Veeneman, 2018). This includes both formal rules, such as politics and legislation, and informal frameworks or paradigms, such as norms and customs (Canıtez & Çelebi, 2018; van de Velde, 2004). This shapes the interests and actions of actors, and the context within which they can pursue strategies and their action space. Previous research also highlights that the efficiency of procurement and performance of public transport is highly reliant on the institutional context (Canıtez & Çelebi, 2018; Guevara et al., 2025; Hirschhorn et al., 2019).

The organisational context is, therefore, important to acknowledge in public transport studies as it guides actors and determines the operational context of public transport. This research highlights differences between more mature, "stable" institutional environments, and contexts with more informal or immature organisation and operation of public transport services. Gwilliam (2008) writes of the regulatory cycle in bus transport, which reflects shifts between market liberalisation and regulation, where weak institutions and fragmented markets often lead to instability and underdevelopment of public transport services. This can prompt state intervention and, over time, mature institutional environments emerge with legal frameworks, defined actor roles, and professionalised contracting rules and relationships, increasing the efficiency of services (Gwilliam, 2008). Furthermore, Costa & Fernandes (2012) point out that technical changes, such as electrification, can reinforce the maturation or formalisation of institutional environments due to the need for cost-intensive investments in infrastructure and coordinated planning, contributing to a shift towards defined roles and regulatory frameworks.

Institutionally strong public transport settings are characterised by shared norms and political vision, public transport regulations and legal frameworks, strategic directions, competent and defined authorities, and the existence of professional contracting and tendering mechanisms (Canıtez & Çelebi, 2018). Sweden, and several European contexts, such as Norway, Germany and the Netherlands, can be considered to exhibit these characteristics (Hirschhorn et al., 2020; Longva & Osland, 2010; Veeneman, 2018).

As previously noted, this thesis focuses on authority initiative through private concessions, in particular, what is sometimes referred to as the Scandinavian model, where public authorities are responsible for designing and procuring public transport services and then purchasing them from private companies, via a tendering

process (Hansson, 2011; Longva & Osland, 2010; van de Velde, 1999). Canıtez & Çelebi (2018) write that, "*The transactional relationship between operators and authorities in any public transport system occurs not in a vacuum, but in a particular institutional environment*" (p. 116). In particular, the organisational form under study leads to the transactional and contractual relationship between authorities and operators (Camén et al., 2020; Canıtez & Çelebi, 2018; Hansson, 2011; Longva & Osland, 2010; Molander et al., 2018). Most notably, Public Transport Authorities emerge as central actors with the introduction of competitive tendering, especially in the so-called Scandinavian model, which legally positions the PTA as responsible for the planning and procurement of public transport (Hansson, 2011; van de Velde, 1999).

As such, public procurement through competitive tendering distributes strategic, operational, and financial risks and responsibilities between actors, with PTAs traditionally bearing strategic risks and uncertainties, and operators bearing operational risks. This distribution influences the actors' priorities and interests. In terms of responsibilities, the division of risks further requires actors to hold specialised competences to manage their roles, bringing to light the resources and capabilities that actors consider necessary to function in this organisational context. For example, PTAs hold various responsibilities that combine regulatory, entrepreneurial, and financial functions. They authorise operators, design and award tenders, set and enforce market rules, and subsidise services to meet societal goals (van de Velde, 2004). These responsibilities, and in turn the roles and logics of actors (e.g. Aldenius, 2018; Camén et al., 2020; Hansson et al., 2023), shape the organisational context and the power dynamics between actors in public transport systems.

Viewing procurement as an organisational context thus shifts attention from outcomes to processes: how institutional logics, actor strategies, and material artefacts co-evolve. It underscores that procurement is not static; it is reconfigured during transitions as new technologies, competencies, and expectations emerge.

3.3 Positioning and Contribution

This thesis positions itself at the intersection of research on electric bus adoption and studies on public procurement of public transport, addressing a critical gap in understanding the organisational and institutional dimensions of the transition to electric buses in public transport.

While research on electric buses has expanded in recent years, a substantial share of this research carries a normative orientation, where electrification is framed as an unequivocally positive development, with a predominant focus on how this transition *ought* to occur. Much of this research assumes that environmental and

economic optimisation will drive adoption, which has led to a focus on technological solutions, modelling approaches, and prescriptive policy recommendations. Relatively little attention has been paid to institutional factors, role negotiations, and organisational adjustments. This thesis responds to this gap by offering empirically grounded analyses of *how* electrification unfolds within a procurement-based organisation of public transport, and examining structural reconfiguration. This complements the predominantly normative literature with insights into how this transition interacts with existing structures.

Similarly, studies on public procurement often conceptualise public procurement as either a policy instrument for achieving sustainability goals or as the organisational context. Whilst it is acknowledged that the two are interdependent, and the role of public procurement in initiating technological shifts has been established, the influences of such technological change on procurement itself are less developed. In addition, in contrast to perspectives that conceptualise public procurement as primarily a market mechanism for fostering competition and efficiency, this thesis moves away from a market-based logic. I approach procurement as an institutionalised structure, rather than an instrument operating on the assumption of well-functioning markets and rational actors. This shifts the focus from market performance to institutional and material conditions within which procurement decisions are made and enacted.

The theoretical framework and analytical approach are presented in the following chapter.

4 Theoretical Framing and Analytical Approach

This chapter presents the field of sustainability transitions, which serves as the theoretical point of departure for this thesis. Research on sustainability transitions focuses on how socio-technical systems change, evolve, transform, and restructure to meet new needs and functions in the light of sustainability challenges. Section 4.1.1 serves to outline the fundamental principles and ideas in this field of research, leading into Section 4.1.2, outlining the debate on agency and structure in this research. 4.1.3 describes different conceptualisations of structure and how it is interpreted in transitions research. In Section 4.2 I present how sustainability transitions and structure are understood and operationalised in this thesis.

4.1 Sustainability Transitions

4.1.1 Fundamentals and Characteristics of Transitions

Socio-technical change; how new technology is used, accepted, diffused, or rejected, can be studied from a variety of perspectives, one of which is socio-technical transitions (Sovacool & Hess, 2017). Socio-technical transitions involve change to a socio-technical system (e.g. energy system, transport system, healthcare system), where technology and insitutions are changed fundamentally. Whereas studying technological change may only include the changes in the technological dimension, socio-technical transitions also encompass changes in institutional structures, meaning that, for example, cultural, regulatory, organisational, and cognitive changes are also conceptualised as part of the transition (Zolfagharian et al., 2019).

In light of the many and vast sustainability challenges that we face today, incremental change is not sufficient to break with old, unsustainable systems and transition towards more sustainable ones. Markard et al. (2012) highlight that the issue of how to promote and govern toward sustainability is of key importance to address, and act against, these challenges with radical changes. With a basis in socio-technical transitions, they describe this as sustainability transitions, defined as

"*long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption*" (Markard et al., 2012, p. 956).

Köhler et al. (2019) present several characteristics of sustainability transitions that set this field apart from others where technological change is studied. First, the characteristic of multi-dimensionality and co-evolution. As the socio-technical system consists of multiple, connected elements, changes in one dimension involve changes in another. Sustainability transitions are not linear processes but involve multiple developments in many directions. Secondly, sustainability transitions are multi-actor processes, and each actor has a specific set of resources, capabilities, beliefs, interests, and strategies (Farla et al., 2012; Fischer & Newig, 2016).

Further, transitions are a long-term process. Innovations need time to mature and achieve market readiness, and the destabilisation of existing systems to allow innovations to emerge also takes time. Because of the multiple possible transition pathways, sustainability transitions are also characterised by values, contestation, and disagreement. Different actors may have different notions of sustainability and different strategies for achieving it (Kemp & van Lente, 2011; Smith & Stirling, 2010). Lastly, Köhler et al. (2019) write of the normative directionality of sustainability transitions. Central to sustainability transitions is the role of public policy, shaping the direction of the transition through regulation, subsidies, and taxes (Farla et al., 2012; Markard et al., 2012). This, then, requires a normative statement of what it is that the transition should achieve (Fuenfschilling, 2019).

Long-term goals often guide the direction of a sustainability transition. Markard et al. (2012) phrase it as a transition being purposeful and intended. Kemp & van Lente (2011) state that sustainability transitions involve additional challenges compared to other types of transitions, as sustainability not only involves a change to the system but also a change in the criteria used to determine whether the new system is appropriate in addressing sustainability challenges. It may be required that such criteria change drastically so that they align with sustainability concerns and not economic benefits (Kemp & van Lente, 2011; Smith et al., 2010).

A key characteristic of transitions is the dynamics between stability and change. Fuenfschilling (2019) argues that the dynamics between the established system and the change generated both inside and outside of this system could be the most defining feature of sustainability transitions research. It is therefore of interest to study the nature and source of certain changes, but also the persistence and stability of existing systems. Sustainability transitions and the characteristics of the process of socio-technical change have been addressed through a variety of different analytical frameworks. Strategic niche management, transition management, and the multi-level perspective on socio-technical transitions are considered to be core frameworks in transition studies (Zolfagharian et al., 2019).

4.1.2 Agency and Structure in Transitions

Whilst different in scope and focus, there are common assumptions amongst the three dominating frameworks of sustainability transitions research, one of which is that the persistence of stability of the existing system can be explained "*through the embeddedness of actors in structural environments*" (Fuenfschilling, 2019, p. 221). Within the transitions literature, there is a debate on agency and structure, and the role of these in transformational change. Agency and structure are considered conceptual counterparts; together, "*they (re)produce societal dynamics through their mutual entanglement and interaction*" (Kok, 2023, p. 1). The debate on agency versus structure centres around how individual and collective actions (agency) interact with, are constrained by, or transform the stable socio-technical systems that define societal functions (structures) (Duygan et al., 2019; Fuenfschilling, 2019).

Early transitions studies have received critique for a "systems-bias" that analytically prioritises socio-cognitive rules as regime stability and technological dependencies, and neglects the role of actors, whilst more recent literature has sought to integrate theories of agency and institutional change (e.g. de Haan & Rotmans, 2018; Fischer & Newig, 2016; Schürer, 2025; Sorrell, 2018; Svensson & Nikoleris, 2018). Consequently, recognising the co-evolution of actors, institutions, and materiality has become central to understanding how stability and change unfold simultaneously. This has produced more nuanced conceptualisations of structure and agency, ranging from socio-cognitive rules and expectations to highly material elements such as infrastructure, that generate both path dependence and possibilities for change.

Whether structure and agency should be understood as inseparable or analytically distinct varies. Drawing on structuration theory, some transitions scholars argue for a duality in which structures both enable and constrain action while being reproduced through routine practices (e.g. Avelino, 2017; de Haan & Rotmans, 2018). Other perspectives, however, argue for analytical dualism, contending that structures and agency possess distinct causal powers that operate on different timescales and should therefore be examined separately to understand transition outcomes (e.g. Sorrell, 2018). Across these perspectives, a common insight is that agency is always exercised within structural conditions shaped by rules, norms, and material arrangements, while actors' strategic actions can gradually transform those same conditions (Koistinen & Teerikangas, 2021; Schürer, 2025; Wittmayer, 2026). Schürer (2025) presents three common perspectives on agency and its relation to structure in transitions research, of which the most relevant to this thesis is the notion of embedded agency. This approach perceives agency as being shaped by the agent's strategies, as well as the socio-technical system the agent is embedded in, the norms and expectations suggested by the structural context, and the resources

the structure allows for the agent (Schürer, 2025). From this perspective, structure directly influences agency as it forms the conditions of it.

The debate on agency and structure highlights that while agency enables change, it is shaped and often constrained by structural conditions, whether understood as stable rules and routines, or as fluid, relational configurations. Building on perspectives that conceptualise structure as the constellation of rules, norms, and material technologies that condition actors' capacity for change, my analytical focus turns to structure because I understand it to provide the configurations through which actors operate and where procurement decisions acquire meaning and consequence. In this thesis, this approach enables a clearer understanding of how electrification reconfigures the enabling and constraining environment for action, rather than interpreting procurement outcomes solely through individual or organisational agency.

4.1.3 Conceptualising Structure in Transitions

The concept of structure in transitions research is complex and subject to various interpretations drawn from different theoretical traditions (Kok, 2023; Svensson & Nikoleris, 2018), including structuration theory, institutional theory, and systems thinking.

Structuration theory posits that social systems are constituted through the duality of structure and agency; structures constrain and enable action, while actions reproduce or transform structures (Giddens, 1984). This perspective informs transition studies by emphasising that actors operate within structural contexts, but also have the capacity to enact change. Institutional theory contributes the notion of structure as a set of regulative, normative, and cognitive pillars that stabilise social systems (Scott, 2014). These pillars manifest in laws, standards, cultural norms, and shared beliefs that coordinate behaviour. In addition, systems thinking adds another layer, viewing structure as the configuration of different elements, technologies, institutions, and practices, which co-evolve over time (Zolfagharian et al., 2019). These foundations frame structure both as a constraint to and an enabler of sustainability transitions.

Transitions research demonstrates a plurality of interpretations and conceptualisations of structure; one influential conceptualisation is structure as socio-technical regimes, which are embedded configurations of technologies, infrastructures, user practices, and cultural meanings (Geels, 2002). Regimes are stabilised through the mutual interdependencies among these elements, creating an inertia to change. This highlights the co-evolutionary nature of structure, where technological artefacts, institutional arrangements, and social practices reinforce each other over time. Therefore, regimes are considered to exhibit resistance to

change because alterations in one element often require changes in others, making transitions highly complex and multi-dimensional (Geels, 2010; Turnheim, 2023).

Another interpretation of structure in transitions research emphasises rules, norms, and institutions that govern socio-technical systems. This includes regulations, standards, and informal conventions that guide actor behaviour and maintain system stability (Fuenfschilling & Truffer, 2014). This interpretation draws on institutional theory, viewing structure as a set of regulative, normative, and cognitive pillars that shape actors' (inter)actions. Such structures create path-dependencies and lock-in effects, making transitions challenging by reinforcing existing practices. However, institutional structures are not seen as static, but evolve through a process of institutionalisation and deinstitutionalisation (structuration) (Fuenfschilling & Truffer, 2014). This change is often incremental as institutions are embedded in organisational processes and societal norms. This conceptualisation underscores why sustainability transitions require attention to institutional frameworks.

The concept of structure can also extend to include power and power dynamics in transitions. This portrays structure as not-neutral; it embeds asymmetries of influence that shape transition trajectories (Avelino et al., 2016). This interpretation foregrounds the political dimension of structure, emphasising that transitions involve contestation and negotiation rather than purely technical or institutional change.

As shown, there are different ways to conceptualise structure in transitions studies. Kok (2023) presents paradoxical sets of interpretations of structure in transitions research, underscoring the multitude of different approaches to the concept. Of particular interest for this thesis is the different conceptualisations of the concreteness of structure, how active it is in its own right, and how structure is considered to influence action.

An elusive conceptualisation of structure stresses the different rules that coordinate actions, such as normative and cognitive frameworks. Such intangible and abstract conceptualisations of structure are manifested through the actions of actors, from which changes to the structure are considered to derive. The conceptual counterpart would be a concrete conceptualisation of structure, where physical artefacts and infrastructure are highlighted as influencing the dynamics of transitions (e.g. Geels, 2002). Attention to materiality can deepen the understanding of the role of the physical manifestations of a system in transformational change (e.g. Svensson & Nikoleris, 2018). There exists a span of conceptualisations of structures, ranging from elusive to concrete, or as Kok (2023) phrases it, the different structures considered in transitions research can be "*concrete as a coal plant, or as elusive as societal expectations regarding the future of sustainability*" (p. 2).

The activeness of structure in transitions may also be open to interpretation. It can be argued that structures shape transitions, exercising power through institutions, norms, and practices (e.g. Huttunen et al., 2021). In this sense, structure is active

and can influence behaviour and practices, but not act deterministically (e.g. Fuenfschilling & Truffer, 2014). A process of structuration can therefore be seen as institutionalisation or regime-coherence. Separating process from structure renders structure something to be engaged with and acted upon, and avoids attributing any agency to the structure. This conceptualises structure as something more passive, but still a determinant of how transitions unfold. Another key question is how structure is considered to influence action. Interpretations differ on whether they function as a medium for action, shaping the environment within which actors operate, or as a condition for actions, constraining and enabling agency (Kok, 2023).

The concept of structure in transitions research is, as described, multifaceted and encompasses institutional rules, socio-technical regimes, networks and power relations. The different interpretations and conceptualisations do, however, converge on the idea that structure both constrains and enables change, shaping the pace and direction of transitions, albeit with different analytical priorities.

4.2 Analytical Approach: Public Procurement as Structure

My approach for this thesis is that public procurement of public transport can be conceptualised as a structure that influences how actors in public transport manage technological change. I understand structure as something that gives "structure to actions" – that is, something that influences or provides conditions for actions, and that, in turn, can be influenced by actions.

Conceptualising public procurement of public transport as a policy instrument in a technological shift or a transition mainly focuses on the effect of this tool, that is, the outcome of specific procurements in replacing old technology or introducing new technology, as described in the previous chapter. This creates a seemingly one-way influence from the actions of actors (how they procure) and the resulting materiality (what they procure), with a focus on the effect or effectiveness of these actions. The conceptualisation of public procurement as a structure allows for the idea that the materiality itself affects actions; a two-way influence instead of one.

The perspective of public procurement being the condition for action is, as previously mentioned, also a common approach in public transport studies. The perspective of public procurement as only the condition for action entails that this phenomenon is regarded as a constant or perpetual, solely providing the circumstances for actions, but not changing, even during the course of technological shifts or changes. Conceptualising public procurement as a structure opens up the idea that the structure itself is influenceable and may undergo changes through a reconfiguration of components.

Conceptualising public procurement of public transport as a structure further allows for attention to institutions and how these influence action. Whilst both the approach of public procurement as a policy instrument and as a condition for action acknowledge regulative institutions, for example, legislation on the process of public procurement and its influence on actions, normative and cognitive institutions are also influential. Given that normative and cognitive institutions affect action through the way they influence how actors understand their reality and what actions are deemed appropriate or possible, it is essential to also pay attention to these institutional frameworks.

Therefore, conceptualising public procurement as a structure, one that both influences and is influenced by actions, provides me with the concepts necessary to explore the dynamic influence between public procurement and the transition to electric buses. I understand this structure to be composed of actors, materiality, and institutions, whose interdependencies and dynamics have developed to provide a specific societal function; in this case, the provision of public transport services. Figure 5 depicts a conceptual diagram of the components and the dynamics. I argue that this configuration has developed and been established in unison with combustion engine technology. For the purpose of this research, I assume that due to the introduction of new technology (materiality), this configuration and its components (actors, materiality, institutions) undergoes changes, thus altering the structure itself.

Materiality refers to tangible and intangible resources in the system, which includes physical technology and infrastructure and can also include non-material elements such as knowledge and experience. In this thesis, the primary focus is on charging infrastructure, vehicles, and batteries as physical components of the electric bus system, collectively referred to as electric bus technology.

I understand actors as being able to pursue strategies. Strategies refer to goals actors want to achieve as well as the activities they pursue and the resources they deploy to achieve those goals. Resources can be tangible as well as intangible, as noted above (Farla et al., 2012). There is a wide range of actors who operate in and influence the public transport system, for instance, politicians, national-level policy-makers, actors in the automotive industry, charging infrastructure manufacturers, and passengers. In this thesis, I focus on actors involved in the public procurement process directly; as such, those are PTAs and PTOs, as noted in Section 3.2.

Institutions refer to regulative, normative, and cognitive frameworks. Cognitive frameworks can be regarded as the lens through which reality is constructed, e.g. visions, expectations, and mental paradigms. Examples of these in public procurement of public transport can be expectations of future technologies and visions for the future transport system. Normative frameworks refer to informal rules that have come to be accepted following socialisation and socially desirable

expectations, e.g. values, responsibilities, and duties. Examples in this thesis are, for instance, normative roles, formal but not formalised procurement practices, and procurement values and principles, guiding how actors approach procurement. Regulative frameworks determine the "rules of the game", constrain behaviour, and regulate interactions; most often, these are legislation, policies, and regulations. In this thesis, examples are the Law of Public Procurement, climate policy goals, and the European Clean Vehicles Directive.

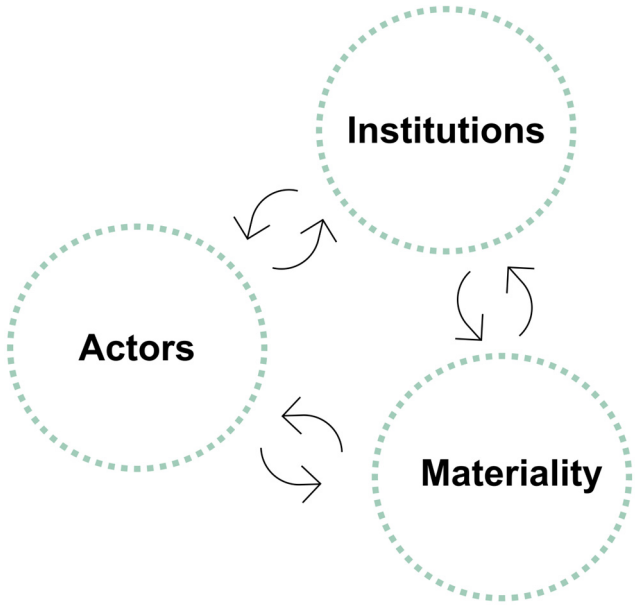

Figure 5 − Components and dynamics in the structure
Structure, as the configuration between institutions, actors and materiality, and the dynamic influence between these components, is assumed to change due to the introduction of electric buses.

5 Research Design, Empirical Material, and Methods

In this chapter, I explain the research design and how I have approached the four studies included in this thesis. I begin by describing the research design, first addressing theoretical considerations and implications to the research approach, then mapping how the papers are connected and how they contribute to answering the research objectives. For an understanding of the chosen modes of inquiry and methods, I detail the data collection process and the motivation to use interviews and documents as empirical material, along with methods for analysis. Reflections on the reliability and validity of this research approach bookend this chapter.

5.1 Research Design

The research design outlines how various aspects of the study, such as objectives, methodological approach, and data collection and analysis, align to address the aim of the thesis and research questions (Hölscher et al., 2021). This is of particular importance to explain when adopting a transitions perspective, as these aspects should reflect the complexity and multi-dimensionality of socio-technical change (Zolfagharian et al., 2019). In this thesis, the focus is on the dynamic between the transition to electric buses in public transport and public procurement, explored through a transitions lens. While the theoretical framing is discussed in the preceding chapter, this section elaborates on how those theoretical choices shape the research design and process, including the selection of materials and methods.

5.1.1 Normative Orientation and Reflexive Methodology

Transitions research is inherently normative, aiming not only to understand change but to contribute to sustainability-oriented transformation (Kemp & van Lente, 2011; Loorbach et al., 2017; Susur & Karakaya, 2021). This means that research should begin from real-world challenges, critically interrogate existing systems, and support pathways toward sustainable change. Consequently, the research design must reflect this by incorporating considerations of societal relevance, knowledge

co-creation, and reflexivity (Ampe et al., 2026; Susur & Karakaya, 2021; Zolfagharian et al., 2019). In this thesis, these principles are addressed through the selection of cases that are situated within ongoing transition processes, and through methodological choices that allow for engagement both with actors and the particular context of the transition under study.

To support this, the research adopts an interdisciplinary and qualitative approach, which is necessary to capture the multi-dimensional nature of socio-technical change, allow for adaptability of methods to fit the particular study, and capture the embedded actors' perspectives and their own understanding of electrification (Douglas, 2017). Reflexivity is embedded throughout the research process, with attention paid to my role as a researcher, the evolving context of the transition, and the implications of methodological choices. This includes adapting methods in response to emerging insights and maintaining a critical stance toward the assumptions and boundaries of the research (and researcher).

Moreover, recognising the value of actors' perspectives not only as data but as sources of situated knowledge is important. The interview, interviewees, and the documents that together form the material are influenced by their contexts and do not emerge from an objective void. Further, recognising this material as situated knowledge also acknowledges the partiality of the data (Thompson, 2001). Individually, the interviews and documents provide a partial perspective, but together they can be used to portray experiences in the transition to electric buses, which I, as a researcher, piece together in the design of the research and in the interpretation and presentation of the findings. Thus, it is important to provide not only thorough descriptions of the context of the studies (Chapter 2) and what previous knowledge informs my analytical lens (Chapters 3 and 4), but also the process, conditions, and practicalities guiding the inquiry, and the situational circumstances out of which the knowledge was produced (Background and Methods in included papers, and the remainder of this chapter).

5.1.2 Process and Orientation of the Included Papers

The work with this thesis began with a literature review of research on electric buses in public transport and the state of transition in public transport systems across the world. This review identified the importance of considering the organisational context and the processes through which the transition takes place. As a result, a focus on the Swedish context entailed addressing the role of public procurement in this transition, laying the foundation for this thesis.

A closer look at the state of transition in Sweden revealed that substantial efforts to transition from fossil to renewable fuel have been made in the public transport sector, from 20 per cent renewable fuel in 2010 to over 90 per cent in 2020 in procured bus services (Transport Analysis, 2024a). The literature review has also

highlighted the many barriers to electrification (as noted in Chapter 3). I was curious to understand why, in the presence of so many barriers and technological uncertainties, and with most public transport services already operating on renewable fuel, PTAs and PTOs in Sweden are transitioning to electric buses, from which the scope of Paper I emerged.

The findings from Paper I highlighted how changes in the physical infrastructure affected actor strategies, and this inspired the scope of Papers II and III, addressing and delving deeper into the effects electric bus technology has on actors and procurement practices (Paper II), and the role of actors (Paper III). Papers II and III were developed in parallel. In both Papers II and III, ideas and norms of the role of the PTA as a technology-neutral procurer arose as a topic for further consideration, which inspired the focus of Paper IV. Figure 6 shows the association between the papers.

Developing the papers was an iterative process, informed both by findings in previous papers, and the quickly changing empirical context. During the time these studies were conducted, from 2020-2025, the number of electric buses in Swedish public transport more than tripled, and the share of electric buses in urban public transport increased from just over 10 per cent to over 35 per cent (Transport Analysis, 2026). This called for a reflexive and dynamic approach to the design and focus of the included papers – aiming both to study and follow the transition, and to recognise emerging queries and research gaps, whilst also addressing the aim and research questions of this thesis. Together, the papers address the research questions and contribute to the overarching aim of the thesis, whilst the focus and scope of the individual papers are different. In the following section, I describe in more detail the scope and empirical material of the papers, with reflections on how these choices influence the thesis as a whole.

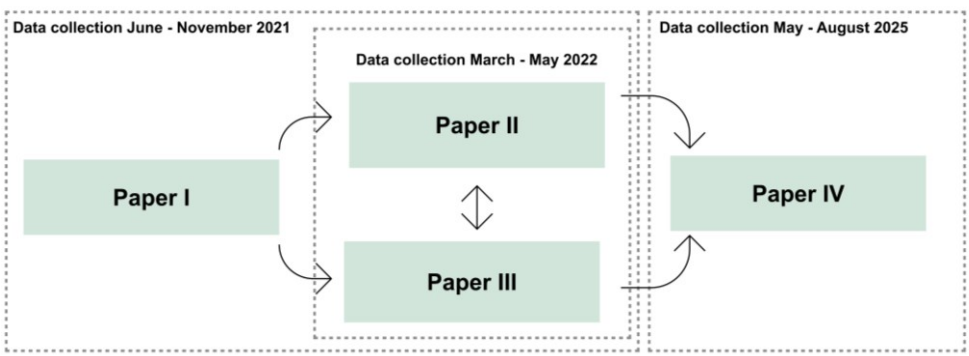

Figure 6 – Association of the papers included in the thesis
Flowchart showing the process of data collection for the four included papers, and the association between the papers. Paper I informed the scope of Papers II and III, and these results informed the scope of Paper IV. The dates for the separate rounds of data collection for the papers is indicated as a dotted line.

5.2 Empirical Material

In this thesis and in Papers I-III, I use the term "case" to refer to instances of public procurement of electric buses by a public authority. Each case includes interviews with select interviewees and procurement documentation, and is to be regarded as one example of the organisational form and procurement process that is in focus in this thesis. This empirical material was gathered in three rounds between 2021 and 2025.

The first round commenced in June 2021, and the scope of this round was planned in conjunction with the need to gather material for the research project e(+)bus. As such, the material collected in Round 1 has also served as the base for reports and analyses conducted for that project (see list of related publications). Round 1 includes six cases in Swedish cities. The case selection was based on two main factors: (a) the stage of the transition, and (b) the size of the bus fleet. In addition, a variance in geographical conditions, the way in which the transition had been initiated, and actors involved (e.g. PTAs, PTOs, municipalities) were considered.

The three largest cities as cases were predetermined through the project. This was motivated by the fact that these cities are located in the regions with the largest bus fleets in Sweden, and procure services in large contracts regularly. Whilst the cities were already decided upon, I selected which procurement or contract to include. This resulted in: Stockholm (early stages of transition, transition initiated in existing contract), Gothenburg (large electric bus fleet through procurement), and Malmö (large electric bus fleet in a short-term contract). Jönköping was selected as a medium-sized city with heavy involvement of public actors in the transition process; Piteå was selected both to include a different geographical context and due to the role of the municipality as procurer (as opposed to a PTA); and finally Ystad was chosen for the small size of its bus fleet and the introduction of electric buses within an existing contract by initiative of the PTO. This variance in case characteristics allowed for a broad analysis and consideration of many different factors of electrification, corresponding to the aim of Paper I.

As mentioned, some of the material in this thesis has also been analysed for other purposes, namely within the research project e(+)bus, where reports, presentations, and policy recommendations have been produced. The material and preliminary results within that project have also been discussed, presented, and reviewed by project participants. This has proved valuable input for understanding the status of the transition as it progresses, and giving insights into the considerations of actors and what practical benefits the research can contribute. As such, using the same basis of material for both the project and the thesis has allowed me to use alternating and diverse approaches to the analysis of the material. Parts of the material gathered in Round 1 recur in three separate papers, and this has allowed for a deep and close understanding of the material, what results can be extracted, and any limitations.

The choice to also look at international cases was motivated by the focus being on a particular organisational form; including cases outside of Sweden allows for a closer look into which factors and results were country-specific, and which relate to the organisational form under study. The understanding of the material from Round 1 led to the need to supplement with material from a second round, this time broadening the scope to include international cases.

Round 2 was completed in collaboration with another research project. The case selection for Round 2 relied heavily on the characteristics of the cases from Round 1. To complement the material from Round 1, the international cases in Round 2 needed to have the same organisational form as a selection of the Swedish cases, and be in similar stages of transition. This narrowed case-selection down to the European context, focusing on Norway and the Netherlands. Striving for further similarities in organisation and transition, with consideration to the aims of Papers II and III, the selection was further narrowed down to cities and procurements where both depot and opportunity charging via pantograph were implemented, meaning that the material components of the cases were similar (Paper II), and that the role of PTAs and PTOs could be studied (Paper III). This resulted in the inclusion of three cases from Norway (one in Trondheim and two in Oslo) and one in the Netherlands (Eindhoven). Table 2 details the contracts and procurements included in each case.

Round 3 of data collection was solely for Paper IV, and included tender documents from all public procurements of urban public transport services by bus in Sweden between 2018 and 2024. Tender documents from four of the procurements included in Round 1 were transferred to Round 3 (Piteå, Jönköping, Göteborg, and Malmö).

Table 3 details the dates, scope, and material for each round.

Table 2 – The scope and material of the three rounds of data collection.
This table shows what material was collected and when, divided into the three rounds of data collection. The majority of the interviews were conducted in Round 1 during 2021, and complemented with interviews and further tender documents in Round 2 in 2022. The final round only included tender documents and was completed in 2025.

	Round 1 June-November 2021	Round 2 March-May 2022	Round 3 May-August 2025
Scope	Sweden [Ystad, Piteå, Jönköping, Malmö, Göteborg, & Stockholm]	Sweden [Jönköping, Malmö, & Göteborg]; Norway [Trondheim & Oslo]; the Netherlands [Eindhoven]	Sweden [All regions]
Material	Semi-structured interviews [23 interviews/27 interviewees] & documentation for six procurements	Semi-structured interviews [six interviews/nine interviewees] & documentation for four procurements	Procurement documentation for 48 procurements

Table 3 – Cases.
This table shows the included cases, displayed according to which round the material was gathered, and which papers each case was included in. As shown, some cases in Round 1 are included in Papers I-III, and from Round 2, some cases are included in both Papers II and III.

	Case	Contract/procurement	Interviews	Included in Paper
Round 1	Stockholm	E22 Busstrafik Innerstaden och Lidingö – Tilläggsavtal till Uppdragsavtal [E22 Bus Services Inner City and Lidingö – Supplementary Agreement to Contract]	PTA, PTO	I
	Göteborg	Trafik 2020 Göteborg, Mölndal, Partille [Services 2020 Gotheburg, Mölndal, Partille]	PTA, PTO, Municipality, Energy company	I, II, III
	Malmö	Malmö Central 2021	PTA, PTO, Municipality, Energy company	I, II, III
	Jönköping	Stadsbusstrafik Jönköping [Urban Bus Services Jönköping]	PTA, PTO, Municipality, Energy company	I, III, III
	Piteå	Kollektivtrafik med buss 2020 [Public Transport by Bus 2020]	PTA, PTO, Municipality	I
	Ystad	Trafikuppdrag Ystad stad – Tilläggsavtal Elbuss Ystad [Traffic Assignment Urban Ystad – Supplementary Agreement Electric Bus Ystad]	PTA, PTO, Municipality, Energy company	I
Round 2	Trondheim	Bussanbud Stor-Trondheim 2019-2029 [Bus Tender Larger Trondheim 2019-2029]	PTA, PTO	II, III
	Oslo (a)	Transporttjenester Oslo sør 2021 [Transport Service Oslo South 2021]	PTA, PTO	II, III
	Oslo (b)	Transporttjenester Indre By 2023 [Transport Services Oslo Central 2023]	PTA, PTO	II, III
	Eindhoven	Concessie Zuidoost Brabant [Tender Southeast Brabant]	PTA	II, III

5.2.1 Semi-structured Interviews

To address the aim of this thesis it was important to gather and understand the actors' perspectives on the transition to electric buses and to get insights into their experiences of the procurement process and outcomes. Qualitative interviews place the interviewee's perspective at the forefront and are also a means to explore new and emerging phenomena where other types of material are not yet available (Brinkmann & Kvale, 2015), corresponding well to the considerations of transitions research. Brinkmann (2020) describes qualitative interviews as ranging from structured to unstructured. In the middle of this range, one finds the semi-structured interview. Brinkman & Kvale (2015) define the qualitative, and specifically the semi-structured, interview as "*an interview with the purpose of obtaining descriptions of the lifeworld of the interviewee in order to interpret the meaning of the described phenomena*" (p. 60).

The purpose of the qualitative interview is to produce knowledge. Semi-structured interviews have higher knowledge-producing potential compared to structured interviews (Brinkmann, 2020), allowing the researcher to choose an angle and ask follow-up questions depending on what emerges as important during the course of the interview, and the opportunity to focus the dialogue on the issues important for the research (Harvey-Jordan & Long, 2001). Further, Brinkmann (2020) claims that semi-structured interviews also allow the researcher to be a knowledge-producing participant in the interview process, rather than an outsider extracting information from an interviewee. The role of the researcher in semi-structured interviews and the perception of the interview as a knowledge-producing process set criteria for the reflexivity and transparency of the researcher, which is why, in the remainder of this section, I describe the interview process and how I approached it practically.

At the time of conducting these studies, the cases presented in Table 3 were all at early but different stages of the transition, and the interviewees therefore had varying experiences of the transition. It was important both to capture this variation and to acknowledge it; therefore, the interview guide was tailored to the specific case and each interviewee, whilst maintaining the core structure and common themes to enable comparison and analysis of the material in a consistent manner.

The main topics of the interview were decided after a review of previous research and literature on the transition to electric buses, and before the process of interviewing started. The interviews served dual research purposes. The primary purpose was to gather empirical material for this thesis, while the second was to obtain input and material for the research project e(+)bus. Therefore, the interview guide was designed to cover both topics relevant to the project deliveries as well as the thesis. This influenced the design of the interview guide, which was divided into the following thematic sections: (a) Background and decision-making processes; (b) Procurement, contracts, and collaboration; (c) Experiences from operations; and (d)

Electrification, the transport system, and the city. Paper I primarily used material from sections (a), (b) and (c), and Papers II and III from sections (b), (c) and (d).

Finding and selecting interviewees was an iterative process based on desk-top research and through referrals from interviewees themselves. The number of interviews was not determined beforehand; the interview process concluded when a degree of saturation had been reached. All interviews were conducted through videoconferencing via Teams or Zoom as there was limited opportunity to perform in-person interviews due to the COVID-19 pandemic and for geographical reasons. All interviews were recorded and transcribed verbatim.

PTAs were interviewed for all cases, and PTOs for most cases. Municipalities and electricity grid owners or energy companies were interviewed for the Swedish cases where these actors had been involved in the studied procurement. After each interview, a memorandum was written detailing key takeaways. This was shared with co-authors and the interviewee(s) directly after the interview. Interviewees were also offered the opportunity to view the transcripts if any business-sensitive information was discussed, for example, upcoming procurement strategies or details about costs, to ensure that these were not shared as results or with other interviewees.

Table 4 shows an overview of the number of interviews per organisation, and in which paper the material was included. For more details on the material used in each study, please refer to the individual papers.

Table 4 − Overview of interviews.
Table showing which organisation the actors interviewed represented, which cases these were applicable to and the number of interviews and interviewees per organisation. For all cases, the PTA was interviewed, and for the cases from SE and NO the PTOs were interviewed. In the SE cases, the municipalities and grid owners were also interviewed.

Organisation	Case	Number of interviews (interviewees)
Public Transport Authority	Ystad, Piteå, Jönköping, Stockholm, Göteborg, Malmö, Trondheim, Oslo, Eindhoven	10 (12)
Public Transport Operator	Ystad, Piteå, Jönköping, Stockholm, Göteborg, Malmö, Trondheim, Oslo	9 (12)
Municipality	Ystad, Piteå, Jönköping, Göteborg, Malmö	6 (6)
Electricity grid owner/Energy company	Ystad, Jönköping, Malmö, Göteborg	4 (4)

5.2.2 Documents and Document Analysis

Procurement documents: tenders, contracts and other documentation play important roles in this thesis. The documents provided both data and a deeper understanding of the context and processes under study, serving both as empirical material and as a means to interpret empirical findings and uncover insights during the research process (Bowen, 2009).

Prior (2008) presents a typology of how documents can be used in research, making a distinction between two approaches to their analysis: the approach to documents as a resource and the approach to documents as a topic. Within these two approaches, focus can be on the content or the use and function of the document. In this thesis, documents are positioned as resources with a focus on both content and the use and function of documents, and how these are "*used as a resource by actors for purposeful ends*" (Prior, 2008, p. 825). This positioning of documents mirrors the theoretical approach to procurement as a structure that influences strategic actions.

Procurement documents were used in two ways in this thesis: as a complement to interviews in Paper II and as the only empirical material in Paper IV. In Paper II the focus was primarily on the contents of procurement documents, both supplementing and validating material from interviews as a means of triangulation (Bowen, 2009). For Paper II, tender documents from seven international cases were collated, compared, and analysed using qualitative content analysis. The use of documents from both Swedish and international cases broadens the empirical material and scope, from a Swedish perspective to a more overall perspective on the organisational form, and provides the opportunity for generalisability and insights into the procurement process dynamics across geographical contexts.

In Paper IV the focus was primarily on the use and function of the documents. In this study documents served as stand-alone material. The selected documents cover all procurements of urban bus services in Sweden in the studied time frame, complementing the other papers by providing depth and a thorough understanding of the studied context, as well as offering insights into temporal transition dynamics.

These two approaches to the study and positioning of documents and the variety of the included material serve the purpose of this thesis well. Using document analysis as both a complement to other material (Paper II) and as a stand-alone method (Paper IV) provides both breadth and depth to the aggregated results and serves as a means to increase the validity and generalisability, which is described in more detail in Section 5.4.

5.3 Methods of Analyses

Earl Rinehart (2021) writes that analysis is the "*active and interpretive process researchers undertake with research evidence during a study*" (p. 304); where and when this analytical process begins may depend on when the researchers consider the study to start. I consider the process of gathering empirical material, as described in the previous section, the process of familiarising myself with the material, and outlining the scopes of the included papers and this thesis as important parts of the analytical process. As some of the material is also included in several papers, the thesis' overall analytical process and the separate papers' analytical processes are closely linked.

For the thesis in general, I employed an abductive analytical approach due to the dynamic research context. An abductive approach allows for an emergent research design, meaning that I could respond to developments and empirical insights along the way during the research process (van Hulst & Visser, 2024). This meant that the analytical process was iterative rather than linear, and involved a back-and-forth approach between the empirical context and material, analysis, theoretical engagement, and reporting of results. Through these cycles, and by repeatedly applying different analytical frameworks and procedures, I advanced my insights and understanding progressively, the material was revisited and assumptions challenged, and interpretations of results were refined. Revisiting the phenomenon under study allows for reflection and understanding of changes to the relevance of certain occurrences or concepts over time (Timmermans & Tavory, 2012). This allowed me to adjust the subject and scope of the included studies.

The abductive approach further fosters theoretical sensitivity (Earl Rinehart, 2021). With each iteration and return to the material and "double-fitting" between the material and theory (Timmermans & Tavory, 2012), preliminary interpretations were tested against theory, and in turn, guided how I engaged with the material in subsequent studies. Iterations and going back and forth between material and theory are also necessary with regard to the analytical procedures and conceptual frameworks selected for the individual studies. For qualitative content analysis (Paper II) and thematic analysis (Paper III), this means movement between specific units of meaning and the material as a whole (Vaismoradi et al., 2013, 2016).

The specifics of the analytical process for each included study are found in the methods sections in the appended Papers I-IV.

5.4 Validity and Reliability

The principle of credibility refers to the robustness of the findings and that the sources of knowledge are dependable (Belcher & Claus, 2025). In other words, the data collection, methods, analysis, and results meet criteria for validity and reliability. Credibility is sometimes regarded as the possibility of another researcher replicating a study; however, Brinkmann & Kvale (2015) write that this is not feasible for a qualitative study, and especially for studies based on interviews and documents. As such, credibility in such instances involves describing the process of data collection clearly, defining the role of the researcher in the data collection, and the chain of evidence connecting the material to the research claims is clear.

Reliability involves assuring the accuracy and inclusiveness of the material (Peräkylä, 2021). Thorough case descriptions in the included papers, together with accounts of how and when the material has been gathered, improve reliability, as do extensive background sections, both in the Papers and the cover essay, as this provides explanations for the scope of the material and the chosen data collection methods. Validity is also constructed through thorough case descriptions in the papers, creating a chain of evidence and transparency about the origin of the claims made. Through a description of the analytical process and conceptual framework and how I have arrived at the scope of each paper also increases the validity.

Validity is further ensured by the use of multiple sources of material (Yin, 2014), both in the separate papers and for this thesis as a type of triangulation. Interviews with actors in various roles within and across organisations in the cases contribute to this. Different perspectives on the same topic or theme from different actors, both in other organisations and within the same organisation, mean that I have been able to create an overall picture of how the transition to electric buses has unfolded, informed by multiple perspectives and sources of material. This is especially relevant for Papers I-III, where the use of both interviews and documents validates the findings in the respective material and ensures that the interpretations made are reasonable. I have strived to use different sub-sets of the interviews in the different papers, and all papers include different combinations of the material. Using a different set of materials for Paper IV further strengthens the validity of the thesis findings.

The way in which results are presented is also an important way to improve credibility. I have aimed to create a connection between the analytic claims and the material by presenting the findings in Papers I-III with quotes from the interviews (Nylén, 2005). Further, the use of quotes also creates a distinction between the voice of the interviewees and the material, and my voice as a researcher, making the boundaries between interpretations and the material clear (Douglas, 2017). This strengthens the credibility of the analytical claims by constructing a chain of evidence and a description of the research process (Peräkylä, 2021).

The role of the researcher in qualitative studies is also important to reflect upon in the context of research credibility. Through addressing my approach to the research and my perspective on the methods and materials in the sections above, I have strived for a clear and transparent approach to my role in the studies.

Finally, generalisability and limitations should be addressed. This thesis is primarily based on Swedish cases, complemented by a small number of cases from Norway and the Netherlands. These contexts may share institutional characteristics such as strong public transport authorities and competitive tendering regimes, which may limit the generalisability of the findings to settings with different organisational forms. I have included distinct descriptions of the studied contexts and the selection and criteria of cases and interviewees to clearly demarcate the boundaries of this context, aiding in addressing the limitations (Graneheim & Lundman, 2004; Nowell et al., 2017).

Further, the material was gathered from 2021 to 2025, a time period during which both technology and regulatory frameworks were evolving, meaning that findings should be interpreted as situated in the early-to-mid stage of the transition to electric buses. New regulations regarding vehicles and batteries came into play, and government subsidies, such as the electric bus subsidy ("elbusspremien") and urban environment agreement ("stadsmiljöavtal"), were redesigned or removed. Furthermore, external factors, such as the COVID-19 pandemic, affected patronage and revenues, electricity prices soared, and political priorities affected supply chains. These changing factors make it important to situate the findings in their temporal context and acknowledge how this evolving empirical setting also required flexibility and continuous reflection on case selection and analysis.

6 Summary of Papers

6.1 Paper I − Rationales for Transitioning to Electric Buses in Swedish Public Transport

The point of departure for Paper I was to bridge the gap between previous research on electric buses, where barriers and difficulties in adoption have been highlighted, and observations from real-world developments both globally and in Sweden, where the transition had been initiated and progressing at a relatively fast pace (compare Chapter 2.1 and Chapter 3.1). This dissonance between what was highlighted in the research and what is observable in practice raised the question as to why, in the presence of so many barriers (according to research), actors in Sweden are pursuing this transition at this stage. This question was compounded by the fact that over 95 per cent of bus services in Sweden were already fossil-free, bringing to light the often-stated environmental motivations to transitions: Swedish public transport has already seen major investments in achieving fossil-free services.

We delved into this question by aiming to disentangle actors' rationales for transitioning to electric buses through a transitions perspective, based on a conceptual framework by Bakker (2014) in which rationales can be understood as interests and expectations on a technology or transition.

We found that the transition is occurring rapidly and outpaces initial expectations, and that the shift is not solely driven by environmental benefits, but also by strategic positioning by actors, by technological developments and maturity, and institutional dynamics. Disentangling interests and expectations into long-term and short-term interests, and collective and individual expectations, this study highlighted how actors' engagement with the emerging electric bus system is based on their expectations of future developments as well as their interests in shaping this system to align it with their goals and objectives. As such, actors' actions are not only a reaction to technological change, but are strategically targeted to influence the configuration of the emerging system.

We found consensus among actors regarding the desirability of electrification, which is somewhat in contrast to previous transitions (e.g. to biogas), which were more contentious. This consensus is largely built on shared expectations rather than established and realised outcomes. For example, there were expectations that

electric buses would be more cost-effective and environmentally beneficial, even though empirical data on their performance were still limited.

An important result was that actors seek to access both material (e.g. infrastructure) and immaterial assets (e.g. competence and experience) in order to influence the transition and align the emerging systems design with their individual interests. This highlights how the institutional context, i.e. procurement structures, plays a critical role in shaping the action space available to each actor, and their opportunity to act on these interests.

In sum, the transition to electric buses in Sweden is shaped by a complex interplay of interests, expectations, and institutional structures. Public procurement was not the focus, but this study brings it to the forefront as the arena for the transition. The results emphasise the concept of procurement as not only a tool through which the transition takes place, but also as the context and structure that shape expectations on possible actions and actors' roles. Whilst actors share expectations on electrification, their strategies and actions differ based on their roles, resources, and perceived opportunities within the structure. These results were taken further into Papers II and III, where we further analysed institutional aspects of this transition (Paper II) and actor roles (Paper III).

6.2 Paper II − Institutional Perspectives on Public Procurement in the Electric Bus Transition

Building on the results from Paper I, Paper II delved deeper into institutional dynamics and regulative, normative, and cognitive frameworks. We explored the mutual shaping of public procurement and the transition to electric buses in European transport systems, focusing on seven cases from Sweden, Norway, and the Netherlands. Employing a sustainability transitions perspective, we analysed how regulative, normative, and cognitive frameworks influence procurement strategies. Specifically, we looked at the division of ownership and technical requirements in tenders, and how these influence and are influenced by electrification.

Regulative frameworks (legislation, regulations, policies) set the agenda for procurement and define and formalise the role of PTAs. They enforce principles such as fair competition and technology neutrality in procurement, reflected in the use of technical requirements. Normative frameworks (social norms, values, and roles) shape perceptions of which actors should make which technical decisions, and which actors should own infrastructure. The introduction of charging infrastructure and technology has changed existing norms, and we found tendencies to increased public ownership of depots and charging infrastructure. This division

of ownership is motivated by strategic planning needs, cost efficiency and the longevity of such infrastructure, and may alter normative role expectations and responsibilities of actors.

Cognitive frameworks (visions, expectations, mental paradigms) guide actors' strategic decision-making and shape procurement logics. We found that the transition to electric buses is perceived as inevitable, which, on the one hand, creates a consensus on the general directionality. On the other hand, these expectations on future directions and technological developments influence expectations of actors' competencies and responsibilities in the future system. This can, for instance, be reflected in the use of technical requirements and PTAs deferring technical decisions to operators based on the assumption that they should have better knowledge about the market. However, we found that across actor groups, competence is evolving as all gain experience and technical know-how, which suggests a reconfiguration of cognitive frameworks.

This study underscores that public procurement, and the strategies used in procurement with regard to ownership and technical requirements, are not only policy instruments but structural forces that influence the emerging system and the actors in it. The dynamic influence between procurement and electrification shows that these strategies both reflect and drive institutional change. This is visible through the adaptations to technical requirements to better reflect the characteristics of new technology, how ownership of infrastructure is organised, and shifting normative role expectations.

To summarise, electrification is causing a reconfiguration of institutional frameworks guiding the procurement of public transport, whilst these frameworks also provide a logic and directionality for the transition. We found that normative and cognitive frameworks are being renegotiated, in particular concerning actor roles and responsibilities. Of particular interest is the role of the PTA, whose dual assignment as long-term planner and procurer of public transport can be a source of tension in the transition to electric buses, which is further unpacked in Paper III. Also, the analysis of technological requirements and the expectations regarding which actor should make which technological choices brings forth the principle or ideal of "technology neutrality", which inspired the focus of Paper IV.

6.3 Paper III − Navigating Electrification in Public Transport: The Role of Public Transport Authorities

Paper III draws on the findings in Papers I and II and places focus on the PTA and their (evolving) role with electrification. In this study, I drew on a conceptual framework by Wittmayer et al. (2017), where role change during a transition is conceptualised as qualitative (re-interpretations or changes in the prominence of activities or attitudes) and quantitative (new, changed, or removed responsibilities or activities) changes to the activities and duties of an actor. I found that the introduction of new technological artefacts alters actors' roles and also challenges procurement strategies.

The study distinguished three key parts of the role of the PTA that undergo change: the role of the PTA as a technology-neutral procurer, the role of the PTA as a long-term planner, and the role of reacting to the transition. Each of these is associated with certain activities or attitudes that have changed due to the transition to electric buses.

First, as the technology-neutral procurer, I found that there is a lack of consensus among actors on what constitutes a technological choice in the electric bus system, and thereby a lack of understanding of what technology neutrality is in this system. As such, the perception of which actions or strategies are perceived as technology-neutral is up for negotiation and interpretation. Procurement strategies can be framed as either technological choices or strategic choices, in particular concerning new technological artefacts. This is closely tied to the activity of ensuring just competitive conditions, which is also altered during the transition due to the introduction of new infrastructure and its ownership.

Second, ownership also changes the role of the PTA as long-term strategic planner, as altered ownership models and increased public ownership influence their assignment. The division of ownership further adds to the duties of the PTA, as they establish interfaces between actors and their responsibilities and therefore also determine the role of other actors in the emerging system.

Third, the PTA's role is also one of reaction to and guidance of the transition. Valuation and prioritisation of new questions indicate attitudinal changes. I found that re-interpretation and increased prominence of certain aspects of the public transport system, such as social sustainability of battery production and sourcing, are indicative of attitudinal changes. In addition, the pace of the transition requires (re)action from the PTA. Electrification is increasingly seen as the norm, which calls for the PTA to ensure that the transition is aligned with societal goals, compared to early stages, where they needed to ensure that the transition was initiated.

The findings outlined above show changes to both activities and attitudes associated with the role of the PTAs, and indicate both qualitative and quantitative role change.

New responsibilities and activities are associated with the role of the PTA, which is conceptualised as a quantitative role change. Reinterpretations of some activities, such as technology neutrality, and the prominence of activities or attitudes towards them, such as ensuring the sustainability of batteries, also indicate qualitative role change. With the role of the PTA changing in the transition, it follows that other actors' roles in the system also change, and further implies changes and reconfiguration of the structure.

Papers II and III were worked on in parallel, and the results of both direct attention to technology neutrality and technological choices, which informed the design of Paper IV.

6.4 Paper IV − When Principles Meet Practice: Dynamics of Technology Neutrality in Electric Bus Adoption

Paper IV explored the dynamics of technology neutrality in the electric bus transition and built on the results from Papers II and III. Drawing on a framework of technology hierarchies (Schmidt et al., 2016), we analysed all procurements of urban bus services in Sweden from 2018 to 2024 with regard to how requirements for zero-emission services and vehicle and driveline technology are designed, as well as how technologies such as chargers, depot set-up, and batteries are procured. The results illustrated how regional public transport authorities balance sustainability targets of implementing zero-emission vehicle fleets with the idea of adopting a technology-neutral approach in public procurement.

We found that the definitions used and technical requirements set stabilised zero-emission buses as the sectoral standard. Procurements early in the studied time frame allowed for a mix of technologies; however, as the transition progressed, requirements for fully zero-emission fleets became common, and the terminology shifted from a flexible "emission-free" definition to legally anchored definitions of a "zero-emission bus" in industry procurement templates, moving specificity downwards in the technology hierarchy. This showed that whilst requirements on higher technology hierarchy levels were open to several different technologies, requirements on lower hierarchy levels increasingly specified a particular technology.

Increasing specificity in vehicle and driveline requirements enforced the trend. Increased use of takeover clauses for buses and chargers extends the influence of a single procurement as technological decisions made in one procurement cycle shape the feasible and rational choices in subsequent ones. We also found that battery-electric depot-charged buses emerged as the preferred technology across the regions

and the studied time period. These two developments together meant that available technological choices became narrower, even if requirements on higher hierarchy levels are technology-neutral.

As the transition progresses, new questions and priorities emerge, and with a full-scale introduction of electric buses, the social and environmental sustainability of batteries has gained prominence. This is reflected in more specific requirements on the composition, traceability, and social sustainability for batteries. These considerations introduced additional selectivity, which, in practice, meant that certain suppliers or technologies were excluded.

The findings illustrate how technology neutrality in public procurement is not static, but evolves over time and across levels of technology hierarchies. While neutrality was maintained on higher hierarchy levels, requirements became specific on lower levels as the transition progressed. Striking a balance between multiple sustainability objectives and principles of neutrality or specificity in a transition is important; this study showed how this is negotiated in practice.

7 The Dynamics Between The Transition to Electric Buses and Public Procurement

This chapter synthesises findings from the four papers and illustrates the mutual shaping between public procurement and the transition to electric buses. The findings show that procurement is not only a mechanism for implementation, but also enforces certain principles and norms, and frames expectations on technology and on actors, influencing how electric bus technology is managed and interacted with. In turn, the characteristics of this technology challenge some of these norms and principles, causing redefinition, reprioritisation, and renegotiations of institutional frameworks and actor roles, responsibilities, and strategies.

The following points are made: (a) procurement norms regarding ownership and expectations of the functions of the future system influence how ownership of electric bus technology is managed; (b) ownership and technological choices are also shaped by procurement principles, most notably principles of fair competition and technology neutrality, but also the public value orientation of public procurement; (c) in turn, the introduction of electric bus technology requires changes to actors' roles and responsibilities, and these changes to roles further challenge established procurement principles, calling for reprioritisation in procurement; and (d) the introduction of electric bus technology has triggered changes to procurement practices, with both increased technological and environmental specificity and a broader scope that now includes the externalities of electrification and addresses social sustainability aspects in more detail.

The following sections describe these dynamics and the connection to the included papers (referenced with I, II, III, and IV).

7.1 Ownership of Depots, Chargers, and Buses Reflects Established Norms and Future Expectations

Electrification of urban bus services means that electric buses are introduced in tandem with the establishment of charging infrastructure, building of new or retrofitting of existing depots, establishment of grid connections, and ensuring enough capacity both in terms of effect and spatially. New physical elements need to be managed in procurement. Some of these bear no similarity to the previous technology, for example, chargers and batteries, and some are similar, but with new characteristics, such as buses and depots.

- *Ownership of buses and depots is based on norms and established practices, but is up for renegotiation*

In the studied context, buses are traditionally owned by PTOs, as is also the case for electric buses. However, given that electric buses have other characteristics than combustion engine buses, this division may not be the optimal way to manage bus ownership as electric buses have an (expected) longer technical lifetime compared to combustion engine buses (I) and also a longer than the contractual period (II and IV).

A longer technical lifetime of buses could motivate a shift towards public ownership, and in turn use leasing agreements during the contractual period. However, the daily handling of vehicles, PTOs' market competence, and operational experience, motivate continued operator ownership of buses (I and II). The increased use of takeover agreements, where buses are sold back to the PTA, or directly to the new PTO at the end of a contractual period (IV), is a strategy to negotiate this; still following the traditional ownership structure, but with new additions to procurement to ensure longevity and cost efficiency of investments.

For depots, the results indicate tendencies towards increased public ownership due to electrification (II, III, and IV), due to the longevity of investments, establishing a grid connection, the need for strategic localisation of depots, fair competition, long-term strategies, and harmonising with urban planning. The results show that where depots are already owned by public actors, these continue to be so and are retrofitted to accommodate charging infrastructure and increased capacity, with grid connections and installations being prepared prior to procurement. Where new depots are built, these are also publicly owned and leased to operators to safeguard strategic location and capacity. Further, where depots have previously been privately owned by operators, the findings show that PTAs are taking action towards public ownership of depots in the future (II and III). This tendency towards public ownership of depots may not solely be due to electrification, but the transition to electric buses may accelerate and amplify the trend due to the investments and long-term strategic actions necessary to adapt depots for electrification. These

arrangements may, on the one hand, reduce uncertainties about the desired trajectory; on the other hand, this reinforces standardisation and limits flexibility for future technologies (IV).

- *Expectations inform ownership of new electric bus technology*

How new elements are managed is largely based on expectations of the new technology and expectations of actors' roles in the future system (I and III). Chargers are new technological artefacts in the system, and the way that these are chosen and which actor owns them is based on expectations of the future system and of actors' future capabilities (I and II), as well as normative frameworks such as traditional divisions of ownership and responsibilities (III). These expectations are thus most influential at the initial stage of this transition, because once procured and the charging strategy established, the infrastructure will be in place and actors will gain experience with a particular set-up. These experiences will inform ownership models and technology choices in upcoming procurements, and either reinforce the division of ownership and technological choices, or experiences and technological developments will call for new arrangements (IV).

Ownership of electric bus technology, be it chargers or buses, is therefore influenced both by normative frameworks and expectations that influence the transition to electric buses. Public ownership and takeover clauses cement technological choices across contract cycles, reinforcing established configurations, and may reduce future flexibility. Further, ownership becomes a strategic lever for actors, as it influences both long-term interests and competition in procurement.

7.2 Principles of Competition, Neutrality, and Public Value Frame Technological Choices for Electrification

The results show that technological choices in the transition to electric bus technology are shaped by norms, principles, and ideals of public procurement deriving from the organisation of public transport. Two principles have been especially formative in the studied contexts: fair competition and technology neutrality. Both aim to ensure openness to innovations and market efficiency, yet the results show that they are interpreted and acted upon differently with electrification and the introduction of new technologies.

- *The principle of fair competition motivates public ownership*

The principle of fair competition influences ownership, as discussed in the previous sections, and also who is expected and capable of making technological choices.

Established procurement practices aim to avoid giving certain operators competitive advantages in procurement, and electrification and new infrastructure have thus motivated increased public ownership (II). The rationale for this is that future tenders compete on a level playing field, rather than operators in possession of crucial elements gaining competitive privileges. Such strategies may improve competition and support operational continuity, but may also narrow down future technological choices (IV).

- *Technology neutrality is renegotiated due to the introduction of electric bus technology*

Technology neutrality is a second principle that has influenced the introduction of electric bus technology. The use of both "neutral" and specific requirements in procurements, for instance, requiring zero-emission services but specifying that they should be slow-charged overnight at depots, illustrates how PTAs reconcile the principle of technology neutrality with the need for system integration (IV). Whilst technology neutrality is considered a guiding principle in the transition (III), the results show that it is negotiated and redefined as the transition progresses and the systems become more established.

Technology neutrality also reframes decisions on technological choices. Choices on charging strategy and technology are understood as strategic planning decisions, rather than technology-specific approaches (III). This positions choices on what electric bus technology to implement, requiring coordination of costs, urban space constraints, grid readiness, and system integration, not as technological preferences in procurement but rather as planning instruments (IV).

- *Public-value orientation frames appropriate technological choices*

The public value orientation of public procurement also emerges as a procurement principle that has influenced the introduction of electric bus technology, and legitimises what is considered "appropriate" technology. The results show that while procurement initially focused on narrower environmental sustainability criteria, such as tailpipe emissions, tenders have evolved to also address social sustainability and externalities of electrification (IV). These developments reflect evolving regulative and normative expectations and what the procurement of electric buses ought to include. Procurers not only need to ensure technological feasibility but also to work towards system-wide sustainability and ensure that societal goals and good are addressed.

Therefore, the principles of fair competition, technology neutrality, and public value not only influence the introduction of electric bus technology, but also define who owns what, who makes technological choices, and which externalities are internalised in procurement. In sum, these principles create the conditions under which certain technologies become practically implementable and legitimate.

7.3 Electrification Entails Shifting Responsibilities and Strategies

Procurement defines the interfaces between actors, and electrification redistributes and adds responsibilities for actors. Decisions on charging strategy and depot ownership determine which actor assumes strategic or operational duties, and the interfaces between actors are dynamic and renegotiated as the transition progresses (II and IV).

- *New actors and technologies involve altered responsibilities for established actors in the electric bus system*

Electrification introduces new actors into the public transport system. This calls for new and altered roles, division of responsibilities, and changes to relationships between both new and established actors in the system (I and II). New actors introduce new dependencies and coordination needs, expanding the organisational and contractual landscape. For example, for the establishment of chargers in the urban environment, planning permits and processes with municipalities need to be engaged with, grid connections secured with energy companies, and additional procurement of chargers and installations from manufacturers need to be made. These duties may be divided between PTAs and PTOs, or the sole responsibility of one. For instance, when PTAs specify depot charging and assume ownership of depots, PTOs' responsibilities shift toward operational integration rather than planning and establishing depots and charging infrastructure. These evolving interfaces illustrate how procurement mediates power relations and role negotiations within the emerging electric bus system.

Focus on the PTA shows that their role is particularly affected by electrification, with new additional responsibilities and expectations on them (III). They take on new responsibilities such as managing infrastructure ownership, coordinating grid connections (II), and ensuring compliance with sustainability requirements for battery supply chains (IV). New technology also entails that normative principles such as technology neutrality are reinterpreted, and decisions on charging strategies are framed as strategic choices necessary for cost efficiency and urban planning, rather than technological choices. This means that actions and strategies pursued by PTAs are reinterpreted, and illustrate the dynamics of roles and the PTA as both facilitators of change and keepers of a certain order, balancing the need for fair competition with long-term infrastructure planning.

- *Actors seek new resources to align the transition with their interests*

These changes bring to light actors' capacities and resources (economic, time, competence, infrastructure), and how these are deployed to influence the transition, but also how these need to develop for actors to be able to deploy them in the new

configuration. Public and private actors alike seek to gain assets, both material and immaterial, to have resources to align the direction of the transitions with their interests and goals (I and III). Physical assets can constitute a competitive advantage for PTOs, thus meaning that the playing field in competitive tendering is skewed. Physical assets owned by public actors mean that these aspects of the electric bus system are not subject to competition, which could adversely affect the cost and efficiency of the resulting services and system.

In addition to physical assets, immaterial resources, such as experience, market knowledge, and technical know-how, are important for actors to acquire in order to be able to design, procure, and evaluate tenders (PTAs), and submit bids and operate attractive and profitable public transport (PTOs) (II and III). As such, it is in an actor's interest for all actors to gain such experience and knowledge, as this, in theory, would mean competent procurers and reliable bidders. However, strategic actions are also based on the expectations of the future electric bus system and on how technologies will develop (I). This, in turn, fosters expectations on the role of one's own and other actors' responsibilities in this emerging system (I, III).

In sum, actors seek resources to influence the configuration of the emerging system. This strategic positioning underscores the interplay between expectations and materiality, as actors act not merely in response to technological change but to shape the trajectory.

7.4 Electrification Both Broadens the Scope of Procurement and Narrows Technological Choices

Electrification requires not only the procurement of services. Tenders include requirements for charging infrastructure, battery sustainability, and grid integration. This shift introduces new contractual interfaces and risk and responsibility allocation, requiring alterations to procurement practices to manage these new parameters. At the same time, the electric bus system is expected to fit or be integrated into the already existing system. Routes, infrastructure, and other system requirements are, as such, already in place as the result of previous procurements (I and II). The transition to electric buses thus entails fitting into the existing system, whilst also defining and achieving the new system (III and IV).

This is reflected in the use of technical requirements (II and IV), how institutional frameworks inform the way the new system is procured (II), and what is considered to be part of this new system (IV). What was once a process focused mainly on contracting bus services now encompasses the procurement of complex systems, including vehicles, chargers, batteries, and grid connections. Requirements have

become increasingly detailed, extending beyond technical and environmental performance to address lifecycle and social sustainability (IV).

- *Electrification necessitates more specificity in procurement to safeguard operations and ensure the sustainability of the system*

In the procurement of electric bus services, consideration must be given to the existing system. Electric buses are expected to fit into the existing system in terms of routes, frequency, patronage, and sometimes timetabling. These requirements create the conditions for the planning of electric bus services and narrow down the possible technologies. For example, opportunity charging may be difficult to establish on a route where there are limitations to where chargers can be established (II). At the same time, electrification narrows down technological choices once the system becomes established. Once a particular charging strategy or depot configuration is implemented, subsequent procurement must align with these "legacy" decisions to ensure operational continuity and cost efficiency. Procurements later in the transition to electric buses, therefore, adopt more specific requirements to fit the existing system (IV).

The results also point to increasingly specific and strict requirements for batteries; requirements for sustainable sourcing of raw materials, exclusion of certain materials, tracking the supply chain, and also the reuse and recycling of batteries (IV). These developments illustrate how new technology both brings new questions to light and triggers reinterpretation or reprioritisation of existing questions, generating changes to normative frameworks (I and III), and how procurement practices evolve as regulative frameworks change. While the use of functional, technology-neutral requirements has been advocated for (II), the findings indicate that specificity is necessary to ensure that (a) the electric bus system matches the operational characteristics of the established system, and (b) that the implementation is sustainable and scalable.

- *Electrification involves new considerations and prioritisations that broaden the scope of procurement*

Whilst requirements on the electric bus system are becoming more specific, electrification also broadens the scope of what public procurement of bus services ought to address and secure. As electrification introduces new electric bus technology into the procurement process, this shift extends the system boundaries beyond vehicles and operations to also include infrastructure and upstream supply chains. Whilst at first, reflections were mostly on the importance of addressing this in the transition (II) these considerations are now also implemented in procurement practices (IV). Tenders increasingly address lifecycle impacts and social sustainability of electrification, such as sourcing of critical materials, working conditions in the supply chain, and end-of-life management. Procurement of electric

buses is not only about ensuring attractive and efficient public transport services, but also about safeguarding wider societal and environmental objectives.

These results show that procurement practices and institutional frameworks themselves undergo significant transformation during the transition to electric buses. Electrification both broadens the scope of the procurement, extending the systems boundaries, but, as the transition progresses, also narrows down the technological possibilities as the electric bus system is established.

7.5 Synthesis

Public procurement of bus services and electrification have mutually shaped each other in the transition to electric buses in the studied context. The design of tenders and associated requirements sets the conditions and signals directionality for how and which electric bus technology is adopted. The findings show that ownership and the use of technical requirements as procurement mechanisms, and norms and established ways of working with these, influence the introduction of electric bus technology. Expectations on the developing electric bus technology also influence how these instruments are used by actors in a procurement process.

In addition, normative principles, especially the notion of technology neutrality and the ideal of fair competition in procurement, further influence the transition and the introduction of electric bus technology in the public transport system, changing technical configurations and redefining the roles and responsibilities of actors in the public transport system. Procurement is a key arena where these changes are manifested, as decisions on ownership, charging strategies, and infrastructure shape the interfaces between actors and redistribute responsibilities. These interfaces and roles are not static but evolve and are negotiated and adjusted as the transition progresses, reflecting changes to both norms and strategic considerations.

8 Concluding Discussion

This chapter situates the findings within the theoretical framework of sustainability transitions and the conceptualisation of public procurement as a dynamic structure composed of actors, materiality, and institutions. Through this, I aim to highlight how the transition to electric buses is not just about technological substitution but entails a reconfiguration of established structures. Section 8.1 revisits the research questions and answers them, and Section 8.2 connects key empirical insights to the theoretical framework, elaborating on the roles of materiality, and regulative and normative frameworks in shaping transition dynamics. Section 8.3 presents the contributions of the thesis and practical recommendations, and Section 8.4 outlines avenues for future research emerging from this work.

8.1 Answering the Research Questions

The findings answer the thesis research questions. First, the findings demonstrate that procurement influences the adoption of electric bus technology not only through requirements and ownership strategies, but also by signalling directionality and embedding expectations about the design of the future system and division of responsibilities (RQ1). Second, the introduction of electric bus technology reconfigures actor roles and responsibilities, particularly for Public Transport Authorities (PTAs), whose assignment expands and where normative principles, such as technology neutrality, are reinterpreted (RQ2). Third, procurement instruments and practices have themselves evolved during the transition, moving from procurement focused on services and their quality to procuring a system that incorporates increasingly specific technological and sustainability requirements (RQ3).

To summarise, the findings and answers to the research questions show that procurement of public transport is not a static context, but a dynamic structure undergoing reconfiguration during the transition to electric buses in public transport, which addresses the aim of this thesis. Materiality (new electric bus technology), actors (role changes and strategic behaviour), and institutions (regulative, normative, and cognitive frameworks) co-evolve, shaping and

being shaped by the pace and direction of this transition. Public procurement influences technology adoption through requirements and ownership strategies, while electrification reshapes procurement practices and actor roles.

8.2 Connecting Empirical Insights to the Theoretical Framework

8.2.1 The Structural Role of Material Assets in Electrification

Sorrell (2018) argues that the analytical priority of transitions research shifting to rules (institutions) as determinants of system stability neglects the opportunities and constraints imposed by differences in access to material resources. The findings in this thesis support this critique by showing how material components and the distribution of these directly shape what is possible, permissible, and strategically attractive for actors in the system.

One example of this is the finding that ownership of electric bus technology emerges as an increasingly important factor determining the direction of the transition and actors' access to resources. The findings show a trend towards increased public ownership of depots, and that ownership of buses may shift from private to public, or a combination of the two, due to electrification. This represents a material reconfiguration, as depots and charging infrastructure become central assets around which responsibilities, risks, and strategic control are organised. Attention to how this new technology is managed sheds light on how access to these physical elements can constitute an advantage or opportunity to actors in the transition, and how changes to established divisions of ownership influence the transition direction.

As buses have traditionally been owned by PTOs, this indicates a change to established practices. A recent report from the industry organisation confirms that the ownership of buses can change due to electrification, as there are economic benefits to utilising the bus over its entire technical lifespan, which is often longer than the contractual period (The Partnership for Improved Public Transport, 2024). However, with electric buses being in regular operations in urban public transport only since ca 2018 (in Sweden), the actual technical lifetime of an electric bus in frequent service has not yet been established. Suggestions such as the one above by the industry, and the use of takeover clauses, are therefore perhaps based more on expectations than on established technical realities. This underscores the value of recognising both the role of materiality and the role of cognitive frameworks, such as expectations, as factors influencing the transition. The interplay between

materiality and cognitive frameworks becomes particularly visible when decisions with long-term implications, such as depot construction or charger location, must be made under conditions of technological uncertainty.

The findings further show how, when material features shift, procurement instruments adapt, in particular where long-lived and resource-intensive infrastructure is concerned. This links back to Sorrell's (2018) critique that transition studies underestimate the contribution of materiality in lock-in or path-dependency, but priority is given to institutions as stabilising mechanisms. In the public transport system, depots, chargers, and grid connections represent investments with lifespans that exceed tender periods. Once this infrastructure is established, they constrain technological options, creating potential lock-ins that shape future procurement decisions, actor roles, and transition direction. For instance, the emerging dominance of depot charging strategies is not only a result of preferences, but also the spatial availability of suitable locations and the physical feasibility of opportunity charging. Materiality, therefore, plays an important role in stabilising particular configurations, even when other technological alternatives may exist.

8.2.2 Electrification as the Optimal Path to Sustainability?

The approach that material changes to the structure cause reconfiguration does not mean that changes to institutions or actors go overlooked. The findings also point to the influence of normative and regulatory frameworks and their influence on and of the transition. Regulatory frameworks, such as EU and national legislation on clean vehicles and procurement legislation, have established formal rules that shape procurement and permissible approaches. The regulative frameworks define allowable technological choices, appropriate ownership models, and sustainability measures.

One such regulatory framework is the new Batteries Regulation (EU 2023/1542), which came into force in August 2023, and seeks to address environmental, social, and economic risks of the reliance on batteries for electrification; specifically, by obligating public authorities to include these in the procurement process. While climate impact in terms of reduced emissions and improvements for local environments remains at the forefront of discussions on electrification, the findings further indicate that sustainability considerations have broadened during the transition. The introduction of electric buses has shifted the system boundaries of what is procured and what is considered relevant in procurement. Initially, tenders focus on emissions, but as electrification progresses, attention expands to also include social impacts of battery production, sourcing of critical materials, and end-of-life

management. This development illustrates that adopting what is perceived as "the most sustainable" technology does not eliminate the need for extended sustainability requirements; rather, it introduces new dimensions of responsibility and complexity. This aligns with the arguments of Semple (2023), who notes that while cost and performance considerations still dominate in procurement, electrification entails that lifecycle and broader societal impacts need to be addressed.

Gasparre et al. (2025) claim that the regulatory emphasis and political appeal of electric buses have fostered a dominant narrative, positioning electrification as the optimal path to sustainability. However, this risks narrowing the scope of sustainable public transport by overlooking alternative or complementary solutions. The findings of this thesis align with this narrative, with the transition converging around depot-charged battery electric buses with increasingly large battery capacities as the dominant configuration. This standardisation may not be the most sustainable solution in an absolute sense, but it harmonises with the existing institutional structure, operational planning practices, and procurement frameworks. As Semple (2023) argues, achieving real environmental gains requires a systems perspective rather than assuming that introducing zero-emission vehicles is inherently beneficial.

8.2.3 Competence and Principles in Procurement

Normative frameworks, informal but widely accepted as standards, roles, and appropriate technologies, have proven influential. Equally, the transition has triggered changes to these frameworks, with emerging norms regarding ownership, and reinterpretations of the meaning of some procurement principles, such as technology neutrality, illustrating how institutional frameworks adapt with technological shifts. This mutual shaping highlights that procurement is not only constrained by institutional frameworks but also acts as a mechanism through which these frameworks are reinterpreted and reconfigured during the transition. Schotanus & Nicolas (2023) write that in highly structured organisational fields, such as the public sector, authorities can cope with uncertainties by relying on institutional reference points, and emphasise mimetic behaviour, where authorities copy procurement practices even when these practices are not suited to new technological conditions. The findings suggest that normative frameworks, whilst influential, do not always lead to replication based on past experience or established practices, but have been adapted iteratively, drawing on established norms but with modifications in response to new technological and sustainability demands.

The results in this thesis further add empirical evidence and support the argument from Jagiełło et al. (2023) and Ammenberg & Dahlgren (2021); that

existing procurement practices often failed to account for the characteristics of electric bus technology. However, this thesis moves beyond identifying inadequacies and illustrates how procurement practices evolve during the transition. The findings go beyond the technical and efficiency focus of procurement measures, showing that procurement of electric buses also necessitates changes to what is being procured (from procurement of services to procurement of a system), how this is procured (increasing specificity and sustainability requirements), and what guiding norms and principles emerge as priorities in this transition (public value and long-term planning balanced with technology neutrality and fair competition).

As the results point to both increasing specificity and the broadening of the scope of procurement with electrification, this brings new requirements and a need for competency from actors in the system, not least for PTAs. To design tenders with such specificity and evaluate bids requires technical competence and current market knowledge, in addition to the resources necessary to evaluate supply chains and ensure regulatory compliance, setting high demands on PTAs as procurers. This finding is significant as it makes visible the evolving roles and responsibilities of actors in the system, and how this influences both technological choices and the framing of such technological choices.

These changes involve some tensions, particularly between maintaining some procurement principles and enabling strategic action, which positions PTAs as both facilitators of change and as custodians of an established order. As technology matures, procurement evolves from enabling initiation of the transition to ensuring sustainable implementation of electric bus technology when it is being adopted at scale. Gasparre et al. (2025) note that each procurement cycle introduces new challenges, creating an “eternal return” to new or unresolved issues, examples in this thesis being ownership models, charging strategies, and sustainability criteria. As Stelling & Brunner (2022) note, procurers must now navigate complex systems, anticipate future operational needs and technological configurations, and translate new sustainability goals and measures into viable procurement requirements. The findings of this thesis support these observations; as procurement expands to include charging infrastructure systems and supply chains, the skillset required by PTAs and civil servants expands accordingly.

This also warrants attention to the effect on private actors, and how decisions on charging strategies, ownership of depots, and the design of technical requirements directly influence the conditions within which operators compete.

8.3 Contributions and Recommendations

This thesis advances the knowledge on the dynamics of the transition to electric buses in public transport and public procurement. It does so by applying a sustainability transitions perspective and conceptualising public procurement as a structure that both influences and is influenced by the introduction of electric buses in public transport, in contrast to approaches where public procurement is regarded either as a policy instrument or as an organisational context. Empirically, it provides both in-depth insights into the dynamics between electric bus technology, actors, and institutional frameworks in several European cases, and breadth by analysing procurements over a long time period. This approach thus contributes to research on public procurement in public transport and electrification, and to research on technological change and transitions.

Whilst these results are anchored in empirical insights from specific contexts, the findings carry broader practical relevance for understanding the introduction of new technologies into public transport systems, also in other organisational contexts. As electrification increases the complexity of procurements, particularly through the inclusion of charging infrastructure and sustainability requirements for batteries, there is a growing need for shared learning across regions and actors. Existing collaborative arenas, such as The Partnership for Improved Public Transport ("Partnersamverkan"), play an important role in developing procurement frameworks and common formulations of requirements. This is especially relevant concerning the emerging issues of battery sustainability, supply-chain transparency, and reporting obligations, where both regulatory and knowledge are still developing. Given the varying resources and experience among procurers and regions, continued collective learning is important to address these complexities.

In relation to this, clear routines for the handling and management of batteries throughout their lifecycle, including reusing and recycling, are important to establish. Developing approaches to battery management, be it through contractual requirements, shared standards, or coordination between sectors such as waste and recycling systems, could support both environmental objectives and long-term system reliability.

Now, at the time of the publishing of this thesis, there is an opportunity to draw lessons from early electric buses reaching retirement. Questions concerning the actual technical lifetime of an electric bus, and how this compares to assumptions made in early procurements, are increasingly relevant. Lessons from these first retirements could inform lifecycle cost assessments, identify replacement strategies, and contract lengths in future procurements. Further,

clear interfaces of responsibility between actors, in particular regarding infrastructure investments, grid connections and depot adaptations, are key for successful deployment and operations of electric bus services. This requires attention to municipal planning processes and effective coordination between authorities, municipalities, and energy actors in the design of tenders. Recognising that electrification is a cross-sectoral system change, rather than just a matter of vehicle substitutions, supports more coherent long-term planning.

It is important to recognise that this research was conducted within a rapidly changing context. Studying the transition to electric buses in public transport *as it is happening* (see, for example, Figure 2) has required an adaptable and reflexive approach to the methods employed and considerations of the type of empirical material available during the research period. As the aim of this thesis is to understand the dynamic between the transition and public procurement of public transport, it is important to acknowledge that the number of procurements of electric buses was limited at the start of the research in 2020. This is reflected in the use of interviews and selected tenders as empirical material in Papers I-III.

Paper I departs from the question of *why* transition to electric buses in Sweden, when substantial progress towards low-emission bus fleets has already been made. The results of this study nuance the often-cited environmental benefits as drivers of the transition and also illustrate the expectations and visions surrounding electric buses that existed at the early stages of the transition. These expectations are also present in Papers II and III, where the *how* of this transition is more in focus. These studies also reflect an early stage of the transition, and perhaps address a *proposed how* to transition to electric buses, as the material was based on the first or early procurement of electric buses.

The final paper, Paper IV, reflects a different stage of the transition with data collected nearly three years after the first three papers. Paper IV reflects more of the *practical how,* with a larger set of tenders available as material. Comparing the expectations of electric buses that were present in Paper I to what has actually been procured, as shown in the later tenders included in Paper IV, shows how present technical realities are both different and similar to what was expected at the outset of the transition and this research. There is more research to be done on this transition as technology matures, systems are established, and public transport systems globally move towards fully electrified urban bus fleets.

8.4 Future Research Avenues

Whilst the results have made the role of the PTA a focal point, consideration of other roles and their changes should be addressed in further research. As Paper III points out, the roles exist in a system, and changes to one role imply changes to another as duties and responsibilities are added, shifted, and adapted in the electric bus system. Particularly, the role of PTOs and their interests in this transition is an avenue for potential research. As the results indicate both tendencies towards increased public ownership and increasingly specified technological choices, this changes the playing field for PTOs, as perhaps fewer elements of the public transport services being procured are subject to competition. This is also a key consideration for future developments; what do these shifts in ownership and technological choices outside of the procurement process imply for competition in tendering? The market is already dominated by a few large operators. What happens to the market when smaller operators are left behind due to a lack of resources to bid on electric bus tenders?

Since starting my doctoral studies, there have been rapid developments both in terms of technological maturity and deployment rate. In recent years, electric buses have also been introduced in regional public transport, with electric Class II buses available on the market. As the operational and geographical characteristics of urban and regional bus services differ, further research into the procurement of regional electric bus services would bring insights into how regions are moving towards fully electric public transport by bus. Further, such technology and operational characteristics could yield important insights for the electrification of the freight sector, which is, today, behind public transport in terms of electrification.

New, amended, and proposed legislation on the sustainability of electric vehicles, particularly at the EU-level (e.g. Battery Regulation 2023/1542) will require that procuring bodies of member states need to address broader sustainability concerns and introduce additional criteria for traceability and circularity. Future research will be important to understand how these new obligations are interpreted and implemented in practice, and whether they influence technological choices and available manufacturers and markets.

This research was conducted during a period when the adoption of electric buses rapidly increased, and, as mentioned, limited material existed in terms of procurement documents and experiences. As the share of electric buses is now much higher, and electric buses are being procured regularly and continuously, it would be interesting to compare the evolution of tenders and contracts, specifically where electric buses are procured for the same service for consecutive contract periods.

References

Ager-Wick Ellingsen, L., Jayne Thorne, R., Wind, J., Figenbaum, E., Romare, M., & Nordelöf, A. (2022). Life cycle assessment of battery electric buses. Transportation Research Part D: Transport and Environment, 112, 103498. https://doi.org/10.1016/j.trd.2022.103498

Aldenius, M. (2018). Influence of public bus transport organisation on the introduction of renewable fuel. Research in Transport Economics, 69, 106–115. https://doi.org/10.1016/j.retrec.2018.07.004

Aldenius, M. (2021). Steering green buses: The opportunities and challenges of introducing renewable fuel in public transport. [Doctoral Thesis (compilation), Department of Technology and Society]. Department of Technology and Society, Lund University.

Aldenius, M., Forsström, E., Khan, J., & Nikoleris, A. (2016). Elektrifiering av stadsbussar - En genomgång av erfarenheter i Sverige och Europa [Electrification of buses - A review of experiences in Sweden and Europe]. K2 Working Papers 2016:12. K2 – The Swedish Knowledge Centre for Public Transport.

Aldenius, M., & Khan, J. (2017). Strategic use of green public procurement in the bus sector: Challenges and opportunities. Journal of Cleaner Production, 164, 250–257. https://doi.org/10.1016/j.jclepro.2017.06.196

Aldenius, M., Mullen, C., & Pettersson-Löfstedt, F. (2022). Electric buses in England and Sweden – Overcoming barriers to introduction. Transportation Research Part D, 104, 103204. https://doi.org/10.1016/j.trd.2022.103204

Aldenius, M., Tsaxiri, P., & Lidestam, H. (2021). The role of environmental requirements in Swedish public procurement of bus transports. International Journal of Sustainable Transportation, 1–14. https://doi.org/10.1080/15568318.2021.1879975

Ammenberg, J., & Dahlgren, S. (2021). Sustainability Assessment of Public Transport, Part I - A Multi-Criteria Assessment Method to Compare Different Bus Technologies. Sustainability, 13, 825. https://doi.org/https://doi.org/10.3390/su13020825

Ampe, K., Goeminne, G., Hendriks, A., & Block, T. (2026). No Neutrality Here: Mobilising Reflexivity in Sustainability Transitions Research. In J. Wesche & A. Hendricks (Eds.), Introduction to sustainability transitions research (pp. 496–514). Cambridge University Press. https://doi.org/10.1017/9781009437318.035

Avelino, F. (2017). Power in Sustainability Transitions: Analysing power and (dis)empowerment in transformative change towards sustainability. Environmental Policy and Governance, 27(6), 505–520. https://doi.org/10.1002/eet.1777

Avelino, F., Grin, J., Pel, B., & Jhagroe, S. (2016). The politics of sustainability transitions. Journal of Environmental Policy and Planning, 18(5), 557–567. https://doi.org/10.1080/1523908X.2016.1216782

Avenali, A., Catalano, G., Giagnorio, M., & Matteucci, G. (2024). Factors influencing the adoption of zero-emission buses: A review-based framework. Renewable and Sustainable Energy Reviews, 197, 114388. https://doi.org/10.1016/j.rser.2024.114388

Bakker, S. (2014). Actor rationales in sustainability transitions - Interests and expectations regarding electric vehicle recharging. Environmental Innovation and Societal Transitions, 13, 60–74. https://doi.org/10.1016/j.eist.2014.08.002

Bakker, S., & Konings, R. (2018). The transition to zero-emission buses in public transport – The need for institutional innovation. Transportation Research Part D: Transport and Environment, 64, 204–215. https://doi.org/10.1016/j.trd.2017.08.023

Behnia, F., Schuelke-Leech, B. A., & Mirhassani, M. (2024). Optimizing sustainable urban mobility: A comprehensive review of electric bus scheduling strategies and future directions. Sustainable Cities and Society, 108, 105497. https://doi.org/10.1016/j.scs.2024.105497

Belcher, B., & Claus, R. (2025). A quality assessment framework for transdisciplinary research design, monitoring, and evaluation: Guidance for application. MethodsX, 14, 103264. https://doi.org/10.1016/j.mex.2025.103264

Blynn, K., & Attanucci, J. (2019). Accelerating Bus Electrification: A Mixed Methods Analysis of Barriers and Drivers to Scaling Transit Fleet Electrification. Transportation Research Record, 2673(8), 577–587. https://doi.org/10.1177/0361198119842117

Borén, S., & Grauers, A. (2019). Stakeholder Collaboration Models for Public Transport Procurement of Electric Bus Systems. The International Journal of Sustainability Policy and Practice, 15(1), 19–29. https://doi.org/10.18848/2325-1166/CGP

Bowen, G. A. (2009). Document analysis as a qualitative research method. Qualitative Research Journal, 9(2), 27–40. https://doi.org/10.3316/QRJ0902027

Brammer, S., & Walker, H. (2010). Sustainable procurement in the public sector - An international comparative study. International Journal of Operations & Production Management, 31(4), 452–476. https://doi.org/10.1108/01443571111119551

Brinkmann, S. (2020). Unstructured and Semistructured Interviewing. In P. Leavy (Ed.), The Oxford Handbook of Qualitative Research (2nd ed., 15). Oxford University Press.

Brinkmann, S., & Kvale, S. (2015). InterViews - Learning the Craft of Qualitative Research Interviewing. SAGE Publications.

Camén, C., Tsaxiri, P., Aldenius, M., & Lidestam, H. (2020). Flexibility in contract design - is that possible? Research in Transportation Economics, 83, 100899. https://doi.org/10.1016/j.retrec.2020.100899

Canıtez, F. (2019). Urban public transport systems from new institutional economics perspective: a literature review. Transport Reviews, 39(4), 511–530. https://doi.org/10.1080/01441647.2018.1552631

Canıtez, F., & Çelebi, D. (2018). Transaction cost economics of procurement models in public transport: An institutional perspective. Research in Transportation Economics, 69, 116–125. https://doi.org/10.1016/j.retrec.2018.03.002

Costa, Á., & Fernandes, R. (2012). Urban public transport in Europe: Technology diffusion and market organisation. Transportation Research Part A: Policy and Practice, 46(2), 269–284. https://doi.org/10.1016/j.tra.2011.09.002

Dahlgren, S., & Ammenberg, J. (2021). Sustainability Assessment of Public Transport, Part II - Applying a Multi-Criteria Assessment Method to Compare Different Bus Technologies. Sustainability, 12, 1273. https://doi.org/10.3390/su13031273

de Haan, F. J., & Rotmans, J. (2018). A proposed theoretical framework for actors in transformative change. Technological Forecasting & Social Change, 275–286. https://doi.org/10.1016/j.techfore.2017.12.017

Directive No 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles. https://eur-lex.europa.eu/eli/dir/2019/1161/oj/eng

Douglas, E. P. (2017). Beyond the interpretive: Finding meaning in qualitative data. ASEE Annual Conference and Exposition, Conference Proceedings, 2017-June. https://doi.org/10.18260/1-2--27658

Dulce, F., Murillo-Hoyos, J., & Caicedo, E. (2024). Comparative analysis of the performance, environmental impact, and costs of electric, combustion, and gas buses in an operating context of a mid-sized city of an emerging country. Transportation Research Interdisciplinary Perspectives, 25, 101113. https://doi.org/10.1016/j.trip.2024.101113

Duygan, M., Stauffacher, M., & Meylan, G. (2019). A heuristic for conceptualizing and uncovering the determinants of agency in socio-technical transitions. Environmental Innovation and Societal Transitions, 33, 13–29. https://doi.org/https://doi.org/10.1016/j.eist.2019.02.002

Earl Rinehart, K. (2021). Abductive Analysis in Qualitative Inquiry. Qualitative Inquiry, 27(2), 303–311. https://doi.org/10.1177/1077800420935912

Edquist, C., & Zabala-Iturriagagoitia, J. M. (2020). Functional procurement for innovation, welfare, and the environment. Science and Public Policy, 47(5), 595–603. https://doi.org/10.1093/scipol/scaa046

European Commission. (2019). EU green public procurement criteria for road transport.

European Commission. (2023). European Green Deal: Commission proposes 2030 zero-emissions target for new city buses and 90% emission reductions for new trucks by 2040. European Commission. https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_23_762/IP_23_762_EN.pdf

Farla, J., Markard, J., Raven, R., & Coenen, L. (2012). Sustainability transitions in the making: A closer look at actors, strategies and resources. Technological Forecasting and Social Change, 79(6), 991–998. https://doi.org/10.1016/j.techfore.2012.02.001

Farzaneh, F., & Jung, S. (2023). Lifecycle carbon footprint comparison between internal combustion engine versus electric transit vehicle: A case study in the U.S. Journal of Cleaner Production, 390, 136111. https://doi.org/10.1016/j.jclepro.2023.136111

Fischer, L., & Newig, J. (2016). Importance of actors and agency in sustainability transitions: A systematic exploration of the literature. Sustainability, 8(5), 476. https://doi.org/10.3390/su8050476

Frieß, N., & Pferschy, U. (2024). Planning a zero-emission mixed-fleet public bus system with minimal life cycle cost. Public Transport, 16(1), 39–79. https://doi.org/10.1007/s12469-023-00345-4

Fuenfschilling, L. (2019). An institutional perspective on sustainability transitions. In F. Boons & A. McMeekin (Eds.), Handbook of Sustainable Innovation (pp. 219–236). Edward Elgar Publishing.

Fuenfschilling, L., & Truffer, B. (2014). The structuration of socio-technical regimes—Conceptual foundations from institutional theory. Research Policy, 43(4), 772–791. https://doi.org/10.1016/j.respol.2013.10.010

Gadepalli, R., Gumireddy, S., & Bansal, P. (2022). Cost Drivers of Electric Bus Contracts: Analysis of 33 Indian Cities. Transportation Research Record, 2676(10), 38–50. https://doi.org/10.1177/03611981221088593

Gasparre, A., Burlando, C., & Pavanini, T. (2025). The electrification of local public transport as a strategic wayfinding process: policy implementation, path dependence, and organizational practices in Italy. Transportation Research Part A: Policy and Practice, 201, 104648. https://doi.org/10.1016/j.tra.2025.104648

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research Policy, 31, 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research Policy, 39(4), 495–510. https://doi.org/10.1016/j.respol.2010.01.022

Ghotge, R., van Rooij, D., & van Breukelen, S. (2025). Total Cost of Ownership of Electric Buses in Europe. World Electric Vehicle Journal, 16, 464. https://doi.org/10.3390/wevj16080464

Giagnorio, M., Börjesson, M., & D'Alfonso, T. (2024). Introducing electric buses in urban areas: Effects on welfare, pricing, frequency, and public subsidies. Transportation Research Part A: Policy and Practice, 185, 104103. https://doi.org/10.1016/j.tra.2024.104103

Giddens, A. (1984). The Constitution of Society. Polity Press.

Glebe, D., Parra, J., & Persson Waye, K. (2024). Replacing diesel buses with electric buses reduced residential low frequency noise. Transportation Research Part D: Transport and Environment, 137, 104516. https://doi.org/10.1016/j.trd.2024.104516

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research- concepts, procedures and measures to achieve trustworthiness. Nurse Education Today, 24, 105–112. https://doi.org/https://doi.org/10.1016/j.nedt.2003.10.001

Guevara, J., Garzón, D., & Castelblanco, G. (2025). Reexamining the Procurement Paradigm: Lessons from Urban Public Transportation Projects. Journal of Management in Engineering, 41(6), 04025048. https://doi.org/10.1061/jmenea.meeng-6828

Guida, U., Abdulah, A., & Vanhoutte, M. (2021). Expert Group on Clean Bus Deployment D.2 Procurement and Operation Expert Group on Clean Bus Deployment. https://cleanbusplatform.eu/storage/files/clean-bus-d25-procurement-and-operation.pdf

Gwilliam, K. (2008). Bus transport: Is there a regulatory cycle? Transportation Research Part A: Policy and Practice, 42(9), 1183–1194. https://doi.org/10.1016/j.tra.2008.05.001

Häll, C., Ceder, A., Ekström, J., & Quttineh, N. (2019). Adjustments of public transit operations planning process for the use of electric buses. Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, 23(3), 216–230. https://doi.org/10.1080/15472450.2018.1488131

Hansson, L. (2011). The tactics behind public transport procurements: An integrated actor approach. European Transport Research Review, 3(4), 197–209. https://doi.org/10.1007/s12544-011-0057-2

Hansson, L., Aldenius, M., Paulsson, A., Thoresson, K., & Vitestam, B. (2023). Innovation in stable competitive tendering regimes: An insoluble knot? Research in Transportation Economics, 100, 101332. https://doi.org/https://doi.org/10.1016/j.retrec.2023.101332

Harris, A., Soban, D., Smyth, B., & Best, R. (2020). A probabilistic fleet analysis for energy consumption, life cycle cost and greenhouse gas emissions modelling of bus technologies. Applied Energy, 261, 114422. https://doi.org/10.1016/j.apenergy.2019.114422

Harvey-Jordan, S., & Long, S. (2001). The process and the pitfalls of semi-structured interviews. Community Practitioner, 74(6), 219–221.

Hensher, D. (2021). The case for negotiated contracts under the transition to a green bus fleet. Transportation Research Part A: Policy and Practice, 154, 255–269. https://doi.org/10.1016/j.tra.2021.10.006

Hensher, D., & Stanley, J. (2010). Contracting regimes for bus services: What have we learnt after 20 years? Research in Transportation Economics, 29, 140–144. https://doi.org/10.1016/j.retrec.2010.07.018

Hirschhorn, F., van de Velde, D., Veeneman, W., & ten Heuvelhof, E. (2020). The governance of attractive public transport: Informal institutions, institutional entrepreneurs, and problem-solving know-how in Oslo and Amsterdam. Research in Transportation Economics, 83, 100829. https://doi.org/10.1016/j.retrec.2020.100829

Hirschhorn, F., Veeneman, W., & van de Velde, D. (2019). Organisation and performance of public transport: A systematic cross-case comparison of metropolitan areas in Europe, Australia, and Canada. Transportation Research Part A, 124, 419–432. https://doi.org/10.1016/j.tra.2019.04.008

Holland, S., Mansur, E., Muller, N., & Yates, A. (2021). The environmental benefits of transportation electrification: Urban buses. Energy Policy, 148, 111921. https://doi.org/10.1016/j.enpol.2020.111921

Hölscher, K., Wittmayer, J., Hirschnitz-Garbers, M., Olfert, A., Walther, J., Schiller, G., & Brunnow, B. (2021). Transforming science and society? Methodological lessons from and for transformation research. Research Evaluation, 30(1), 73–89. https://doi.org/10.1093/reseval/rvaa034

Hsu, Y., Yan, S., & Huang, P. (2021). The depot and charging facility location problem for electrifying urban bus services. Transportation Research Part D: Transport and Environment, 100, 103053. https://doi.org/10.1016/j.trd.2021.103053

Huttunen, S., Kaljonen, M., Lonkila, A., Rantala, S., Rekola, A., & Paloniemi, R. (2021). Pluralising agency to understand behaviour change in sustainability transitions. Energy Research & Social Science, 76, 102067. https://doi.org/10.1016/j.erss.2021.102067

International Council on Clean Transportation. (2025, March 25). China's zero-emission truck and bus market reaches historic high of 230,000 units sold in 2024. The International Council on Clean Transportation. https://theicct.org/pr-chinas-zero-emission-truck-and-bus-market-reaches-historic-high-of-230000-units-sold-in-2024/

International Energy Agency. (2022). Global EV Outlook 2022 - Securing supplies for an electric future. www.iea.org/t&c/

International Energy Agency. (2024). Global EV Data Explorer. https://www.iea.org/data-and-statistics/data-tools/global-ev-data-explorer?utm_campaign=IEA+newsletters&utm_medium=Email&utm_source=SendGrid

International Energy Agency. (2025). Global EV Outlook 2025: Expanding sales in diverse markets. https://iea.blob.core.windows.net/assets/7ea38b60-3033-42a6-9589-71134f4229f4/GlobalEVOutlook2025.pdf

Jagiełło, A., Wołek, M., & Bizon, W. (2023). Comparison of Tender Criteria for Electric and Diesel Buses in Poland—Has the Ongoing Revolution in Urban Transport Been Overlooked? Energies, 16(11), 4280. https://doi.org/10.3390/en16114280

Jefferies, D., & Göhlich, D. (2020). A comprehensive TCO evaluation method for electric bus systems based on discrete-event simulation including bus scheduling and charging infrastructure optimisation. World Electric Vehicle Journal, 11(3), 1–43. https://doi.org/10.3390/WEVJ11030056

Kemp, R., & van Lente, H. (2011). The dual challenge of sustainability transitions. Environmental Innovation and Societal Transitions, 1(1), 121–124. https://doi.org/10.1016/j.eist.2011.04.001

Kim, H., Hartmann, N., Zeller, M., Luise, R., & Soylu, T. (2021). Comparative TCO Analysis of Battery Electric and Hydrogen Fuel Cell Buses for Public Transport System in Small to Midsize Cities. Energies, 14(14), 4384. https://doi.org/10.3390/en14144384

Köhler, J., Geels, F., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemande, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M., … Wells, P. (2019). An agenda for sustainability transitions research: State of the art and future directions. Environmental Innovation and Societal Transitions, 31, 1–32. https://doi.org/10.1016/j.eist.2019.01.004

Koistinen, K., & Teerikangas, S. (2021). The Debate If Agents Matter vs. the System Matters in Sustainability Transitions—A Review of the Literature. Sustainability, 13(5), 2821. https://doi.org/10.3390/su13052821

Kok, K. (2023). Politics beyond agency? Pluralizing structure(s) in sustainability transitions. Energy Research & Social Science, 100, 103120. https://doi.org/10.1016/j.erss.2023.103120

Ku, A., Kammen, D., & Castellanos, S. (2021). A quantitative, equitable framework for urban transportation electrification: Oakland, California as a mobility model of climate justice. Sustainable Cities and Society, 74, 103179. https://doi.org/10.1016/j.scs.2021.103179

Lajunen, A. (2018). Lifecycle costs and charging requirements of electric buses with different charging methods. Journal of Cleaner Production, 172, 56–67. https://doi.org/10.1016/j.jclepro.2017.10.066

Li, X., Castellanos, S., & Maassen, A. (2018). Emerging trends and innovations for electric bus adoption—a comparative case study of contracting and financing of 22 cities in the Americas, Asia-Pacific, and Europe. Research in Transportation Economics, 69, 470–481. https://doi.org/10.1016/j.retrec.2018.06.016

Lidestam, H., Johansson, A., & Pyddoke, R. (2016). Kontraktsformer och deras inverkan på svensk kollektivtrafik - En kunskapsöversikt. K2 Outreach 2016:3. K2 – The Swedish Knowledge Centre for Public Transport.

Lindfors, A., & Ammenberg, J. (2021). Using national environmental objectives in green public procurement: Method development and application on transport procurement in Sweden. Journal of Cleaner Production, 280, 124821. https://doi.org/10.1016/j.jclepro.2020.124821

Liu, K., Feng, T., Yamamoto, T., & Song, Z. (2024). Electrification pathways for public transport systems. Transportation Research Part D: Transport and Environment, 126, 103997. https://doi.org/10.1016/j.trd.2023.103997

Longva, F., & Osland, O. (2010). Regulating the regulator: the impact of professional procuring bodies on local public transport policy and its effectiveness. Research in Transportation Economics, 29, 118–123. https://doi.org/10.1016/j.retrec.2010.07.015

Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability Transitions Research: Transforming Science and Practice for Societal Change. The Annual Review of Environment and Resources, 42, 599–626. https://doi.org/10.1146/annurev-environ-102014-021340

Lu, C., Xie, D., Zhao, X., & Qu, X. (2023). The role of alternative fuel buses in the transition period of public transport electrification in Europe: a lifecycle perspective. International Journal of Sustainable Transportation, 17(6), 626–638. https://doi.org/10.1080/15568318.2022.2079445

Lundström, A.-C., Holmström, M. N., Torstensson, E., & Eriksson, M. (2019). Elbussar i Sveriges kollektivtrafik - En kartläggning av Trafikförvaltningen Stockholm, Skånetrafiken och Västtrafik utifrån fyra perspektiv [Electric buses in Swedish public transport - A review of Trafikförvaltningen Stockholm, Skånetrafiken and Västtrafik from four perspectives]. The Swedish Transport Administration.

Magnusson, T., & Berggren, C. (2018). Competing innovation systems and the need for redeployment in sustainability transitions. Technological Forecasting and Social Change, 126, 217–230. https://doi.org/10.1016/j.techfore.2017.08.014

Manzolli, J. A., Trovão, J. P., & Antunes, C. H. (2022). A review of electric bus vehicles research topics – Methods and trends. Renewable and Sustainable Energy Reviews, 159, 112211. https://doi.org/10.1016/j.rser.2022.112211

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. Research Policy, 41(6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013

McCluskey, J., Druitt, T., & Larkin, C. (2025). Sustainability in transit: Assessing the economic case for electric bus adoption in the UK. Transport Policy, 162, 493–508. https://doi.org/10.1016/j.tranpol.2024.12.019

McGrath, T., Blades, L., Early, J., & Harris, A. (2022). UK battery electric bus operation: Examining battery degradation, carbon emissions and cost. Transportation Research Part D: Transport and Environment, 109, 103373. https://doi.org/10.1016/j.trd.2022.103373

Mohamed, M., Ferguson, M., & Kanaroglou, P. (2018). What hinders adoption of the electric bus in Canadian transit - Perspectives of transit providers. Transportation Research Part D, 64, 134–149. https://doi.org/10.1016/j.trd.2017.09.019

Molander, S., Fellesson, M., & Friman, M. (2018). Market Orientation in Public Service—A Comparison Between Buyers and Providers. Journal of Nonprofit and Public Sector Marketing, 30(1), 74–94. https://doi.org/10.1080/10495142.2017.1326342

Molliere, M. (2024, June 5). Battery-electric is now the most popular for new city buses in the EU. Transport and Environment. https://www.transportenvironment.org/articles/battery-electric-is-now-the-top-powertrain-type-for-new-city-buses-in-the-eu

Molliere, M. (2025, March 2). Half of new EU city buses were zero-emission in 2024. Transport and Environment. https://www.transportenvironment.org/articles/half-of-new-eu-city-buses-were-zero-emission-in-2024

Mulholland, E. (2023, May 25). Electric city bus sales overtake diesel in Europe. The International Council on Clean Transportation. https://theicct.org/electric-buses-europe-may23/?gad_source=1&gad_campaignid=22639629046&gclid=Cj0KCQjwjL3HBhCgARIsAPUg7a6wEoWtfvm3oK9QPHW8X-fm_P2WcCOoOTDNpIJlX0aefU-s5mTfPq4aArRrEALw_wcB

Mulholland, E., & Rodríguez, F. (2022). The rapid deployment of zero-emission buses in Europe. The International Council on Clean Transportation. https://theicct.org/publication/the-rapid-deployment-of-zero-emission-buses-in-europe/?gad_source=1&gad_campaignid=22639629046&gclid=CjwKCAjwwpDQBhAuEiwAa-4Wo9kw3OgA3EX_fWwLMYzmVTiFlj0Zh3fPEubXEhBYHC--alMXZ5MhmRoCYpQQAvD_BwE

Nash, C., & Smith, A. (2020). Public transport procurement in Britain. Research in Transportation Economics, 81, 100847. https://doi.org/10.1016/j.retrec.2020.100847

Nordelöf, A., Romare, M., & Tivander, J. (2019). Life cycle assessment of city buses powered by electricity, hydrogenated vegetable oil or diesel. Transportation Research Part D: Transport and Environment, 75, 211–222. https://doi.org/10.1016/j.trd.2019.08.019

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. International Journal of Qualitative Methods, 16, 1–13. https://doi.org/10.177/1609406917733847

Nylén, U. (2005). Att presentera kvalitativa data - Framställningsstrategier för emipiriredovisning [Presenting qualitative data - Presentation strategies for empirical reporting] (1st ed.). Liber.

Orbea, J., Castellanos, S., Albuquerque, C., Sclar, R., & Pinheiro, B. (2019). Adapting Procurement Models for Electric Buses in Latin America. Transportation Research Record, 175–184. https://doi.org/10.1177/0361198119846097

Othman, K., Hamed, S., Da Silva, D., Shalaby, A., & Abdulhai, B. (2024). Decision support tools for effective bus fleet electrification: Replacement factors and fleet size prediction. Transportation Research Interdisciplinary Perspectives, 28, 101267. https://doi.org/10.1019/j.trip.2024.101267

Panta, U., Gairola, P., & Nezamuddin, N. (2024). Modelling benefit-to-cost ratio for initial phase electrification using battery electric bus. Transport Policy, 145, 137–149. https://doi.org/10.1016/j.tranpol.2023.10.016

Paskett, A., Song, Z., & Graul, A. (2025). Drivers and barriers to bus electrification in the United States: Transit agency's perspective. Transportation Research Part D: Transport and Environment, 143, 104721. https://doi.org/10.1016/j.trd.2025.104721

Peräkylä, A. (2021). Validity in Qualitative Research. In D. Silverman (Ed.), Qualitative Research (5th ed., pp. 447–461). SAGE.

Prior, L. (2008). Repositioning Documents in Social Research. Sociology, 45(5), 821–836. https://doi.org/10.1177/0038038508094564

Quarles, N., Kockelman, K. M., & Mohamed, M. (2020). Costs and benefits of electrifying and automating bus transit fleets. Sustainability, 12(10), 3977. https://doi.org/10.3390/SU12103977

Rapport 2015/16:RFR14 Kollektivtrafiklagen – en uppföljning [The public transport act – a follow-up]. https://www.riksdagen.se/sv/dokument-och-lagar/dokument/rapport-fran-riksdagen/kollektivtrafiklagen-en-uppfoljning_h30wrfr14/

Regulation No 2007/1370 of 23 October 2007 on public passenger transport services by rail and by road and repealing Council Regulations (EEC) Nos 1191/69 and 1107/70. https://eur-lex.europa.eu/eli/reg/2007/1370/oj

Regulation No 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC. https://eur-lex.europa.eu/eli/reg/2023/1542/oj/eng

Regulation No 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1804

Ringqvist, S. (2016). Kollektivtrafikens styrning och organisering - Utveckling och erfarenheter av lokal och regional kollektivtrafik 1970-2015 [Public transport management and organisation - Development and experiences of local and regional public transport 1970-2015]. K2 Outreach 2016:11. K2 – The Swedish Knowledge Centre for Public Transport

Rizopoulos, D., & Gkiotsalitis, K. (2025). Extending electric bus charging infrastructure considering charging scheduling and energy pricing. Transportation Research Part C: Emerging Technologies, 176, 105141. https://doi.org/10.1016/j.trc.2025.105141

Rodrigues, A., Cipcigan, L., Potoglou, D., Dattero, D., Wells, P., & Regina da Cal Seixas, S. (2025). Impacts of subsidy efficiency on bus electrification: A participatory system dynamic modelling. Transport Policy, 167, 210–221. https://doi.org/10.1016/j.tranpol.2025.03.031

Rodrigues, A., & Seixas, S. (2022). Battery-electric buses and their implementation barriers: Analysis and prospects for sustainability. Sustainable Energy Technologies and Assessments, 51, 101896. https://doi.org/10.1016/j.seta.2021.101896

Rodrigues, A., Wells, P., Cipcigan, L., & da Cal Seixas, S. R. (2024). Forecasting the costs of battery electric buses: A system dynamics model perspective. Research in Transportation Business and Management, 57, 101223. https://doi.org/10.1016/j.rtbm.2024.101223

Rupp, M., Handschuh, N., Rieke, C., & Kuperjans, I. (2019). Contribution of country-specific electricity mix and charging time to environmental impact of battery electric vehicles: A case study of electric buses in Germany. Applied Energy, 237, 618–634. https://doi.org/10.1016/j.apenergy.2019.01.059

Say, K., Csereklyei, Z., Brown, F. G., & Wang, C. (2023). The economics of public transport electrification: A case study from Victoria, Australia. Energy Economics, 120, 106599. https://doi.org/10.1016/j.eneco.2023.106599

Schmidt, T., Battke, B., Grosspietsch, D., & Hoffmann, V. (2016). Do deployment policies pick technologies by (not) picking applications?—A simulation of investment decisions in technologies with multiple applications. Research Policy, 45(10), 1965–1983. https://doi.org/10.1016/j.respol.2016.07.001

Schotanus, F., & Nicolas, R. (2023). Coercive, Mimetic and Normative Influences on the Uptake of Sustainable Public Procurement: An Institutional Perspective. In W. Janssen & R. Caranta (Eds.), Mandatory Sustainability Requirements in EU Public Procurement Law: Reflections on a Paradigm Shift (1st ed., pp. 75–94). Hart Publishing.

Schürer, D. (2025). Seven questions on agency in sustainability transformations research: insights from a systematic-narrative review. Sustainability Science 2025 21:2, 21(2), 839–862. https://doi.org/10.1007/s11625-025-01758-9

Scott, R. (2014). Institutions and Organizations: Ideas, Interests, and Identities (4th ed.). SAGE.

Semple, A. (2023). Charge of the Light Brigade? The Clean Vehicles Directive and the Batteries Regulation. In W. Janssen & R. Caranata (Eds.), Mandatory Sustainability Requirements in EU Public Procurement Law: Reflections on a Paradigm Shift (1st ed., pp. 113–126). Hart Publishing.

SFS 2010/1065 Lagen om kollektivtrafik [The Public Transport Act]. https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/lag-20101065-om-kollektivtrafik_sfs-2010-1065/

SFS 2016:1145 Lagen om offentlig upphandling [The public procurement act] https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/lag-20161145-om-offentlig-upphandling_sfs-2016-1145/

SFS 2016:1146 Lag om upphandling inom försörjningssektorerna [Procurement in the utilities sector act] https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/lag-20161146-om-upphandling-inom_sfs-2016-1146/

SFS 2017:720 Klimatlagen [Swedish Climate Law] https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/klimatlag-2017720_sfs-2017-720/

Skånetrafiken. (2025). Hållbarhetsredovisning 2024 [Sustainability report 2024]. Skånetrafiken. https://www.skanetrafiken.se/globalassets/dokumentbank/miljo/hallbarhetsredovisning-2024-210x297mm-28-april.pdf

Skr. 2023/24:59 Regeringens klimathandlingsplan – hela vägen till nettonoll [The government climate action plan – all the way to net-zero]. https://www.regeringen.se/rattsliga-dokument/skrivelse/2023/12/skr.-20232459

Smith, A., & Stirling, A. (2010). The Politics of Social-ecological Resilience and Sustainable Socio-technical Transitions. Ecology and Society, 15, 11. https://doi.org/10.5751/ES-03218-150111

Smith, A., Voß, J., & Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research Policy, 39(4), 435–448. https://doi.org/10.1016/j.respol.2010.01.023

Sönnischsen, S., & Clement, J. (2020). Review of green and sustainable public procurement. Journal of Cleaner Production, 245, 118901. https://doi.org/https://doi.org/10.1016/j.jclepro.2019.118901

Sorrell, S. (2018). Explaining sociotechnical transitions: A critical realist perspective. Research Policy, 47(7), 1267–1282. https://doi.org/10.1016/j.respol.2018.04.008

SOU 2024:97 Mot en effektiv elektrifiering av transportsystemet [Towards an efficient electrification of the transport system]. https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2025/01/sou-202497/

Sovacool, B., & Hess, D. (2017). Ordering theories: Typologies and conceptual frameworks for sociotechnical change. Social Studies of Science, 47(5), 703–750. https://doi.org/10.1177/0306312717709363

Stelling, P., & Brunner, S. (2022). Regeringsuppdrag om elektrifieringen av transporter - Kunskapsläget hos transportsektorns nyckelaktörer [Government mandate on the electrification of transport - The state of knowledge among key players in the transport sector]. Report 1131. The Swedish National Road and Transport Research Institute.

Storstockholms lokaltrafik. (n.d.). Fler och fler av våra bussar kör på el [More of our buses are electric]. Retrieved October 20, 2025, from https://sl.se/om-sl/vart-miljo-och-klimatarbete/fler-och-fler-av-vara-bussar-kor-pa-el

Sunitiyoso, Y., Belgiawan, P., Rizki, M., & Hasyimi, V. (2022). Public acceptance and the environmental impact of electric bus services. Transportation Research Part D: Transport and Environment, 109, 103358. https://doi.org/10.1016/j.trd.2022.103358

Susur, E., & Karakaya, E. (2021). A reflexive perspective for sustainability assumptions in transition studies. Environmental Innovation and Societal Tranistions, 39, 34–54. https://doi.org/10.1016/j.eist.2021.02.001

Svensson, O., & Nikoleris, A. (2018). Structure reconsidered: Towards new foundations of explanatory transitions theory. Research Policy, 47, 462–473. https://doi.org/10.1016/j.respol.2017.12.007

Swedish Competition Authority. (n.d.). Upphandlingsreglerna - en introduktion [Procurement rules - an introduction]. Swedish Competition Authority.

Swedish National Board of Housing Building and Planning. (2025, October 27). Kommunens olika roller [The different roles of the municipality]. https://www.boverket.se/sv/PBL-kunskapsbanken/Allmant-om-PBL/roller-och-ansvar/kommunen/

Testa, F., Grappio, P., Gusmerotti, N., Iraldo, F., & Frey, M. (2016). Examining green public procurement using content analysis: existing difficulties for procurers and useful recommendations. Environment, Development and Sustainability, 18(1), 197–219. https://doi.org/10.1007/s10668-015-9634-1

The Economist. (2007, September 8). What is this that roareth thus? The Economist.https://www.economist.com/technology-quarterly/2007/09/08/what-is-this-that-roareth-thus

The Partnership for Improved Public Transport. (2020). Vägledning - Upphandling av kollektivtrafik 2020 [Guide - Public transport procurement 2020]. The Partnership for Improved Public Transport.

The Partnership for Improved Public Transport. (2024). Elektrifieringens ekonomiska påverkan på upphandlad busstrafik [The economic impact of electrification on procured bus services].The Partnership for Improved Public Transport.

The Swedish Bus and Coach Federation. (2024). Statistik om bussbranschen [Statistics on the bus industry]. The Swedish Bus and Coach Federation. https://www.transportforetagen.se/globalassets/rapporter/buss/statistikrapport-20241018.pdf

The Swedish Environmental Protection Agency. (2023). Miljöeffekter av elektrifiering av transporter [Environmental effects of electrification of transports]. Skrivelse 2023-02-16. The Swedish Environmental Protection Agency

The Swedish Public Transport Association. (2023a). Bus Nordic - Gemensamma nordiska krav vid upphandling av bussar [Bus Nordic - Common Nordic Bus Procurement Requirements]. The Swedish Public Transport Association.

The Swedish Public Transport Association. (2023b). Kollektivtrafikens bidrag till transportsektorns mål [Public transport's contribution to the transport sector's goals]. The Swedish Public Transport Association.

The Swedish Public Transport Association. (2023c). FRIDA miljö- och fordonsdatabas [FRIDA environment and vehicle database]. The Swedish Public Transport Association https://frida.port.se/hemsidan/default.cfm?val=startsida

Thompson, C. (2001). Situated Knowledge: Feminist and Science and Technology Studies Perspectives. In N. J. Smelser & P. B. Baltes (Eds.), International Encyclopedia of the Social & Behavioral Sciences (pp. 14129–141133). Pergamon. https://doi.org/10.1016/B0-08-043076-7/03159-4

Thorne, R. J., Hovi, I. B., Figenbaum, E., Pinchasik, D. R., Amundsen, A. H., & Hagman, R. (2021). Facilitating adoption of electric buses through policy: Learnings from a trial in Norway. Energy Policy, 155, 112310. https://doi.org/10.1016/j.enpol.2021.112310

Timm, J. F. G., Leichter, M. Z., Dalmoro, J. M., & Passuello, A. (2025). Implementation of green public procurement in public transport: criteria analysis and proposals evaluation. Clean Technologies and Environmental Policy, 27, 8443–8460. https://doi.org/10.1007/s10098-025-03330-6

Timmermans, S., & Tavory, I. (2012). Theory construction in qualitative research: From grounded theory to abductive analysis. Sociological Theory, 30(3), 167–186. https://doi.org/10.1177/0735275112457914

Tong, F., Hendrickson, C., Biehler, A., Jaramillo, P., & Seki, S. (2017). Life cycle ownership cost and environmental externality of alternative fuel options for transit buses. Transportation Research Part D: Transport and Environment, 57, 287–302. https://doi.org/10.1016/j.trd.2017.09.023

Transport Analysis. (2024a). Fordon 2024 [Vehicles 2024]. Transport Analysis.

Transport Analysis. (2024b). Storskalig elektrifiering av transportsektorn - ett kunskapsunderlag [Large-scale electrification of the transport sector]. Transport Analysis.

Transport Analysis. (2026). Fordon 2025 [Vehicles 2025]. Transport Analysis.

Turnheim, B. (2023). Destabilisation, decline and phase-out in transitions research. In Z. Koretsky, P. Stegmaier, B. Turnheim, & H. van Lente (Eds.), Technologies in Decline: Socio-Technical Approaches to Discontinuation and Destabilisation (pp. 43–77). Taylor and Francis. https://doi.org/10.4324/9781003213642

UITP. (2016). ZeEUS eBus Report - An overview of electric buses in Europe. UITP. https://zeeus.eu/uploads/publications/documents/zeeus-ebus-report-internet.pdf

UITP. (2017). ZeEUS eBus Report #2 - An updated overview of electric buses in Europe. UITP. https://zeeus.eu/uploads/publications/documents/zeeus-ebus-report-2.pdf

UITP. (2021). Large-scale bus electrification - The impact on business models. UITP. https://www.uitp.org/wp-content/uploads/sites/7/2025/04/Large-scale-Bus-Electrification-KB-Final.pdf

UITP. (2022). Clean Bus Report - An overview of clean buses in Europe. UITP. https://cms.uitp.org/wp/wp-content/uploads/2022/05/ASSURED-Clean-Bus-report_final2.pdf

Vaismoradi, M., Jones, J., Turunen, H., & Snelgrove, S. (2016). Theme development in qualitative content analysis and thematic analysis. Journal of Nursing Education and Practice, 6(5), 100–110. https://doi.org/10.5430/jnep.v6n5p100

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. Nursing and Health Sciences, 15(3), 398–405. https://doi.org/10.1111/nhs.12048

van de Velde. (1999). Organisational forms and entrepreneurship in public transport Part 1: Classifying organisational forms. Transport Policy, 6, 147–157. https://doi.org/https://doi.org/10.1016/S0967-070X(99)00016-5

van de Velde, D. (2004). Reference Framework for Analyzing Targeted Competitive Tendering in Public Transport. TØI report 730/2004. The Institute of Transport Economics.

van de Velde, D., & Hirschhorn, F. (2021). Regulatory Reforms and Competition in Public Transport. International Encyclopedia of Transportation: Volume 1-7, 1, 365–370. https://doi.org/10.1016/B978-0-08-102671-7.10069-7

van de Velde, D., Veeneman, W., & Lutje Schipholt, L. (2008). Competitive tendering in the Netherlands: Central planning vs. functional specifications. Transportation Research Part A: Policy and Practice, 42(9), 1152–1162. https://doi.org/10.1016/j.tra.2008.05.008

van Hulst, M., & Visser, E. L. (2024). Abductive analysis in qualitative research. Public Administration Review, 85(2), 567–580. https://doi.org/10.1111/puar.13856

Varghese, A. M., & Pradhan, R. P. (2025). A comprehensive review and research agenda on the adoption, transition, and procurement of electric bus technologies into public transportation. Sustainable Energy Technologies and Assessments, 75, 104218. https://doi.org/10.1016/j.seta.2025.104218

Västtrafik. (2021). Nu elektrifierar vi Västsverige [We are electrifying Western Sweden]. https://www.vasttrafik.se/om-vasttrafik/hallbara-resor/elektrifiering/

Veeneman, W. (2018). Developments in public transport governance in the Netherlands; the maturing of tendering. Research in Transportation Economics, 69, 227–234. https://doi.org/10.1016/j.retrec.2018.07.002

Wang, Y., Shan, X., & Qiu, R. (2025). Lifecycle carbon dioxide emissions and cost assessment for battery electric bus systems. Journal of Cleaner Production, 501, 145278. https://doi.org/10.1016/j.jclepro.2025.145278

Wittmayer, J. (2026). The Roles of Actors in Sustainability Transitions. In J. Wesche & A. Hendriks (Eds.), Introduction to Sustainability Transitions Research (pp. 317–329). Cambridge University Press. https://doi.org/10.1017/9781009437318.023

Wittmayer, J., Avelino, F., van Steenbergen, F., & Loorbach, D. (2017). Actor roles in transition- Insights from sociological perspectives. Environmental Innovation and Societal Transitions, 24, 45–56. https://doi.org/https://doi.org/10.1016/j.eist.2016.10.003

Xiao, G., Xiao, Y., Shu, Y., Ni, A., & Jiang, Z. (2024). Technical and economic analysis of battery electric buses with different charging rates. Transportation Research Part D: Transport and Environment, 132, 104254. https://doi.org/10.1016/j.trd.2024.104254

Xylia, M. (2018). Towards electrified public bus transport - The case of Stockholm. [Doctoral Thesis] KTH Royal Institute of Technology.

Yin, R. K. (2014). Case Study Research: Design and Methods (5th ed.). SAGE.

Zhang, L., Guo, W., Wang, Y., Hu, Q., & Han, Y. (2025). Optimal charger deployment for electric buses: Incorporating en-route charging and battery management. Transportation Research Part D: Transport and Environment, 140, 104603. https://doi.org/10.1016/j.trd.2025.104603

Zhou, Y., Ong, G. P., & Meng, Q. (2023). The road to electrification: Bus fleet replacement strategies. Applied Energy, 337, 120903. https://doi.org/10.1016/j.apenergy.2023.120903

Zhou, Y., Wang, H., Wang, Y., Yu, B., & Tang, T. (2024). Charging facility planning and scheduling problems for battery electric bus systems: A comprehensive review. Transportation Research Part E: Logistics and Transportation Review, 183, 103463. https://doi.org/10.1016/j.tre.2024.103463

Zolfagharian, M., Walrave, B., Raven, R., & Romme, A. G. L. (2019). Studying transitions - Past, present, and future. Research Policy, 48, 103788. https://doi.org/10.1016/j.respol.2019.04.012

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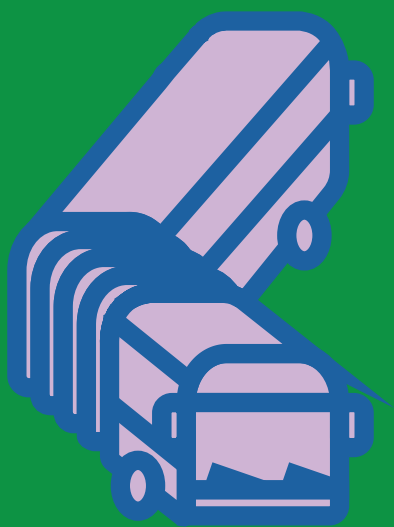

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