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The role of environmental requirements in Swedish public procurement of bus transports

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The transport sector needs to become sustainable and public transport has an important role to play. Green public procurement has proven to have great potential to influence the transition to a sustainable public transport sector. Sweden is a good example of a country that uses public procurement in the public transport sector to a large extent and has at the same time come far in the transition to renewable fuel. The aim of this study is to examine what role public transport authorities (PTAs) can have in supporting more environmentally sustainable public transport through public procurement. This was done by a content analysis regarding the expressions of environmental requirements historically, over a ten-year period, in tender documents in Sweden, followed by a workshop where the implications of the findings and future tender processes were discussed with relevant actors. The results showed that all the environmental requirements have become stricter during the studied period, but indicate a tendency for higher use of environmental requirements in tendering of larger areas as well as in tendering of public transport within cities. Specifically, for requirements for fuel, the same tenders also use specific requirements to a higher extent. However, the subsequent workshop discussions indicated that the use of specific requirements is one reason for disagreement among involved actors. Overall, this study of the Swedish public transport case showed that PTAs have a large potential to support more environmentally sustainable solutions using environmental requirements in public procurement.

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1. Introduction

The transport sector is a large contributor to climate change and responsible for almost a quarter of greenhouse gas emissions in the EU, and so far, there has been little progress in the reduction of emissions (EEA (European Environmental Agency), 2019). In light of this issue, public transport has the possibility to play an important role in decreasing the emissions, both by reducing car use and by being a forerunner in the shift to renewable fuel (European Environment Agency, 2018).

In many parts of Europe, public transport is governed on a regional or local level and carried out by private operators through competitive tendering in the public procurement process. Thus, the transport sector has been identified as a sector with good potential for successful use of green public procurement (GPP) to address environmental goals (European Commission, 2016; von Oelreich & Philp, 2013). Nevertheless, many countries were behind the EU's target, which was that 50% of all tenders should include green requirements by 2010 (Renda et al., 2012). Recently, the European Commission has introduced new individual minimum procurement targets for share of clean vehicles in the EU countries. The targets for procurement of buses after 2021 vary from 24% to 45% between the member states, but will be increased further after 2026 (Directive 2019/1161).

Existing literature has looked at both sustainable- and green public (SPP and GPP) procurement in several sectors and countries. GPP often focuses purely on environmental impact; while SPP can target a combination of social and environmental impacts on procurement (Amann et al., 2014; Brammer & Walker, 2011) or just the social and economic aspect (Cheng et al., 2018). Studies have also showed that public procurement often prioritizes social goals in comparison to environmental ones (Amann et al., 2014). In this study the focus will be on GPP.

Even though there are positive trends in the public transport sector that are possibly pushed forward by the use of GPP, little research has been done on how this can be achieved (Cheng et al., 2018; Chersan, Dumitru, Gorgan, & Gorgan, 2020). Moreover, existing literature is limited regarding the barriers that small and medium suppliers face in the adoption of GPP (Cheng et al., 2018) as well as the application of GPP practices (Amann et al., 2014). A few explorative qualitative interview studies have been conducted of the strategies behind the use of GPP in the public transport sector (Aldenius & Khan, 2017; Aldenius, 2018). Drawing upon the findings from previous qualitative studies

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this paper provides a quantitative picture of how requirements have been expressed in tender documents historically over a ten-year period in Sweden.

In Sweden, most of the public bus transport sector is procured (Bussföretag, 2019) and at the same time, the sector has come far in the introduction of renewable fuel. In 2018, 87% of the vehicle kilometers were run on renewable fuel (Svensk kollektivtrafik, 2019). This makes Sweden a good example of how GPP has been used in a sector that has come far in terms of environmental sustainability, and thus an interesting case to study.

The aim of this study is to examine what role public transport authorities (PTAs) can have in supporting more environmentally sustainable public transport through public procurement. This will be examined by answering the following two research questions:

- How are the overall environmental requirements expressed in public procurement documents in the Swedish bus transport area?
- Do the factors size of procurement, type of traffic and location play any important role regarding the definition of environmental requirements?

The methods used are content analysis and workshops. The content analysis is used regarding the expressions of environmental requirements historically, in tender documents in Sweden. The environmental requirements will be analyzed in relation to the factors; size of tender documents (vehicle kilometer), type of traffic procured (city, local or regional), regional differences and changes over time. Further, the findings from the content analysis and implications for the future were discussed in focus groups in a workshop with practitioners within public transport. The results showed that all the environmental requirements have become stricter during the studied period, but indicate a tendency for higher use of environmental requirements in tendering of larger areas as well as in tendering of public transport within cities. The findings from the study contribute to a further understanding of GPPs role in the transition toward a sustainable public transport sector.

The paper begins with an overview of previous studies of environmental requirements in tender documents (Green Public Procurement, GPP). After follows a description of the Swedish public transport sector and a description of the methods and material used. Thereafter, the results from the content analysis and workshop are presented and the results are analyzed. Finally, the results from the content analysis and workshop are discussed together and conclusions are drawn in the summary and conclusion section.

2. Green public procurement

Public procurement is used in many different sectors, such as, schools, health care and public transport. In these sectors, Green Public Procurement (GPP) can be used as a tool to target environmental issues and reach environmental goals in order to achieve a more sustainable society (Maroon, 2003; Palmujoki et al., 2010). GPP can be seen as a help for public authorities to decrease unsustainable consumption and impact on the environment and it can be applied during all steps in the procedure of public procurement (Appolloni et al., 2019). An overview of GPP implementations is presented in Appolloni et al. (2012). GPP is defined by the European Commission in the Communication (COM (2008) 400) as:

"a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured."

The European Commission (2019b) has suggested ways to use GPP requirements for purchasing of bus services by dividing the requirements into "technical specification" and "award criteria". Technical specification (in the Swedish bus sector divided into functional and specific requirements) can include for example, technical options to reduce greenhouse gas emissions. The term "functional" requirements refers to requirements to reach a goal without exactly specify how it should be done; it can be expressed as a function, effect or result. One example thereof is to demand a maximal level of emissions rather than specifying a type of fuel. The latter demand regarding the choice of fuel is one example of a "specific" requirement. Previous research of the public transport sector has shown that how the requirements are set can be influenced by the cost factor (Aldenius & Khan, 2017; Brammer & Walker, 2011; Guenther et al., 2013; von Oelreich & Philp, 2013). For example can functional requirements lead to lower capital and operational costs (WSP, 2014), but at the same time it has been seen to only result in the cheapest renewable fuel on the market (Aldenius, 2018). On the other hand, specific requirements can lead to higher costs, but the public sector has better control of the procured services (WSP, 2014). The award criteria refer to how sustainability can be reached by including some kind of incentives motivating the bidder to act in a preferred way. It can be done by providing points to the bus operator for sustainable initiatives in its offer, for example, regarding air pollutant emissions or using more environmental technologies in the buses. When the winner of the bid then is to be chosen, the most common way in tendering is to use "best" price as the criteria, but other criteria have entered the field in combination with the price. In cases where the firm wants to create a green supply chain, the selection of suppliers is based on criteria apart from the price, on quality, flexibility and criteria around environmental management (Tseng & Chiu, 2013).

Besides the cost factor, size of the procurement area is another factor that has been seen to influence strategic choices behind the use of GPP. Michelsen and de Boer (2009), studied to what extend Norwegian municipalities and counties use GPP and found that GPP is better established in the larger municipalities. Large municipalities were seen to be more efficient in comparison to smaller ones and they were more likely to have purchasing strategies, something that contributed positively to the implementation of GPP (Michelsen & de Boer, 2009). Similar results were seen

in a study of small firms, where they were seen to face difficulties with innovation in tendering process (Uyarra et al., 2014). One way to address the challenge of being a smaller organization was to cooperate in networks to increase the amount of procured goods, increase knowledge and decrease the price (Ottander & Söderström, 2005).

Also in research specifically focusing on the Swedish public bus sector the size of the procurement area has been suggested to influence the strategic approach behind how environmental requirements are set. In a comparison between the use of GPP in two Swedish transport regions, Aldenius and Khan (2017) found that larger regions felt like they had the potential to influence the development of a fuel market with the use of specific requirements, while the smaller regions needed the knowledge from bus operators and national guidelines. Another study of the Swedish public bus sector by Xylia and Silveira (2017) focused on the outcome of renewable fuel and the decrease in energy use. Also in this study, it was shown that smaller regions often had a lower share of renewable fuel, which might be connected to differences in the economic situation between large and small regions. Larger regions often have more resources and therefore have the opportunity to make larger investments. If one is to convert to more innovative and fossil-free alternatives, this often requires more resources both in monetary terms and in terms of knowledge in the form of competent staff. However, the same study showed that high-populated regions with a large decrease in emission levels also had low energy efficiency (Xylia & Silveira, 2017).

Other differences between the procuring areas have also been seen to influence the implementation of GPP; both political support and knowledge are often brought up in previous studies as influential factors. Testa et al. (2016) even claimed that awareness and knowledge about GPP techniques seemed to be the factors that influenced the use of green requirements the most. On a similar note, the European Commission (2019a) has highlighted that barriers to successful use of GPP includes: lack of political support, lack of knowledge and awareness of the social and environmental impacts of purchasing goods, lack of practical tools and information about GPP, as well as a lack of training for staff responsible for the implementation of GPP. Additionally, there is a lack of cooperation between authorities (European Commission, 2019a). Similar factors were also seen to be important in the Swedish public bus sector. Aldenius (2018) claims that factors like politicians' contribution and stakeholders' knowledge can influence the application of GPP and Xylia and Silveira (2017) discuss the importance of strategic planning and policies for regional fuel choices.

GPP is also closely related to sustainable supply chain management (SSCM). Literature show that SSCM has the possibility to enhance the relationship between firms by using responsible procedures and reduce risks, and use social and environmental techniques in order to secure product quality. By doing that, firms can not only enhance their reputation, but also strengthen their status toward stakeholders (Hoejmose et al., 2014). Roehrich et al. (2017) pointed out the importance of the selection of green suppliers to drive green supply chain management. This selection is vital for firms and it is important that supply chain partners focus on and understand the importance of values toward green supply chain management (Roehrich et al., 2017). Additionally, Roehrich et al. (2017) concludes that the positive results of green supply chain management application can improve the market share and cost savings. Moreover, ISO 14001 certification is used to implement green supply chain practices and to measure the suppliers' environmental activities (Amann et al., 2014).

It is clear from looking at previous research that GPP has potential to contribute to more environmentally sustainable purchasing. However, previous research also points out many challenges and large variations into what extent GPP is implemented. In the rest of this study, we will illustrate how GPP has been used in one of the more successful sectors, but also show some factors that unites more or less successful implementation.

3. Swedish public bus transport

We have chosen to study the use of GPP in the public bus transport in Sweden because it presents an interesting area of innovations regarding the environmental issues. The public procurement process regarding bus transport can be compared to, for example, procurement of care for the elderly. It is about procurement of services and several parties are involved; authorities, operators as well as customers (passengers). In Sweden today, 90% of regulated bus traffic is exposed to competitive tendering. The local and regional public transport is subsidized by tax funds in the order of 44-80 percent in Sweden (Jansson et al., 2018).

In 2012, a new Swedish Public Transport Act (2010, p. 1065) was introduced. The Act stipulates that every county have to have its own public transport authority (PTA) consisting of the county, municipalities or a combination of the two. In Sweden, all tenders use the standard procedures if they want to use public procurement. The form of negotiated procedures used in other countries (Kavanagh, 2016) is not used in Sweden. Some regions have recently chosen to operate the traffic under its own auspices (van de Velde et al., 2019). The reason behind this is often lack of competition in the area. There are 21 regional PTAs in Sweden. The PTA in the region of Stockholm (SLL) has almost half of the market for public transport in Sweden (Sveriges Bussföretag, 2018b). Large regions also often have big procurements areas, expressed in vehicle kilometer, but it is not always the case. Sometimes large regions choose to divide the procurements into smaller areas. The reasons behind this can be different kind of traffic, different kind of geographical conditions or possibilities to test innovations in a limited area.

Around four big operators and many small operators dominate the supply side. Only two percent of the companies have more than 100 employees. The big operators control more than 50% of the market and some of them are owned by international companies. The small companies are often family companies. One trend that can be seen is that

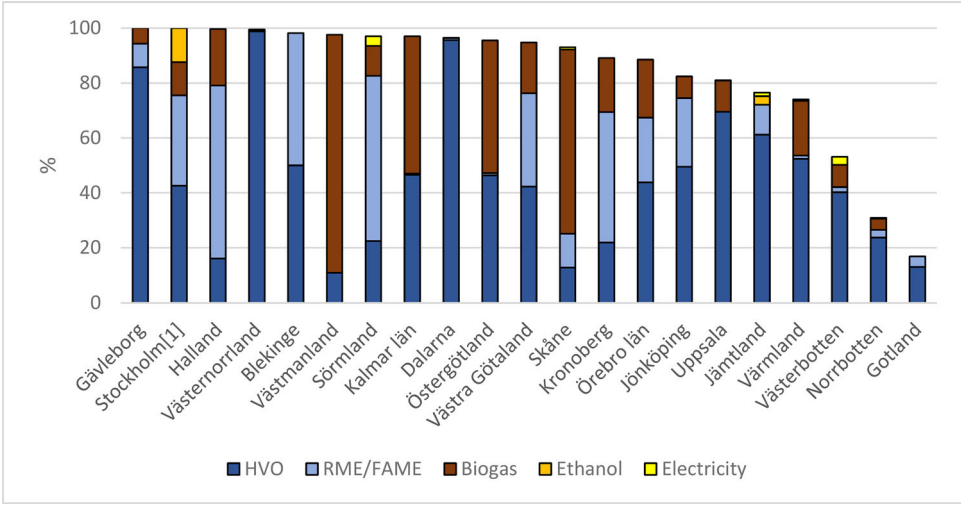

Figure 1. Share of renewable fuel in the Swedish public transport regions in 2018[1] (Svensk kollektivtrafik, 2019).

the market is consolidating; there will be fewer but larger operators in the bus market in the future. One reason could be that when public procurement becomes more complicated it can be hard for the small companies to follow the procedures (Sveriges Bussföretag, 2019). The PTAs have responsibility for the strategic long-term decisions in their regions and can consequently influence the environmental sustainability of the bus fleet: both through targets in the mandatory strategic document (transport supply program) and through requirements in the contract between the authority and the assigned bus operator. Thus, public procurement has great potential to be used as a tool for cities and regions to transform environmental targets and policies into practice (Michelsen & de Boer, 2009; Preuss, 2007).

The Swedish Public Transport Associations developed a common sector standard, which is called Buss 2014 (and earlier versions like Buss 2000 and Buss 2010). Buss 2014 contains several instructions and recommendations of what characteristics the buses should have. A new form of standard with intentions to be used in the Nordic countries, called *Bus Nordic,* was developed in 2018. These kinds of recommendations can range from deciding the distance between the seats to how the seat belts are to be fastened. In order to support the regions in achieving an environmentally sustainable bus fleet, an annex to these kinds of documents contains guidelines of how to develop and implement environmental requirements for public bus services and shows how the environmental requirements should be expressed in tender documents in Sweden. These guidelines contain recommended requirements for fuel (e.g. increased share of renewable fuel or decreased CO_2 emissions), energy use (e.g. maximum energy use per kilometer or in person kilometer), local emissions (e.g. decrease of NOx and particles) and noise (e.g. maximum decibel), as well as work with environmental improvements (e.g. inclusion of environmental management system) and monitoring. In the environmental guidelines, the use of technical functional requirements is strongly advocated over specific requirements. Functional requirements are seen as more cost efficient, to contribute to real competition between bus operators and flexible enough to allow for technology development during the contract period (Sveriges Bussföretag, 2018a). The environmental guidelines have been updated several times (2009, 2010, 2011, and 2014) during the time span of the period analyzed in this study (2008-2018). Between the different editions, the environmental requirements have become more ambitious and the expression of some requirements has been altered (Svensk kollektivtrafik, 2018). The recommendations are often divided into minimum- base- and extended requirements and for some of the environmental guidelines a further category is included where the procurers can express their own requirements, which could mean asking for a specific fuel.

During the analyzed period in this study, there has been a strong increase in renewable fuel in Swedish public transport. In 2018, 86% of the vehicle-kilometers in the public bus sector were run on renewable fuel compared to 9% 2008. However, the large majority of buses still have diesel engines (73%) and the share of renewables is therefore highly dependent on the availability of biodiesel. In addition, as seen in Figure 1, the share and type of renewable fuel are not evenly distributed over the Swedish transport regions (Svensk kollektivtrafik, 2019). This makes Sweden an interesting case to study.

The average energy use for buses stayed unchanged for many years, but in 2018 the trend seemed to have changed and the average energy use per bus came down to around 210 MWh from 270 MWh in 2017. There have also been improvements for local emissions. Between 2014 and 2018 NO_X (nitrogen oxides) decrease from an average of 2.35 g/kWh per bus to 1.45 g/kWh per bus. During the same period particles decreased from an average of 0.02 g/kWh to an average of 0.01 g/kWh per bus (Svensk kollektivtrafik, 2019). These factors (fossil fuels, energy use, NO_X and particles) are together with noise pollution the environmental factors in focus in the study.

4. Method and material

In this paper, we performed a content analysis on tender documents regarding the expressions of environmental requirements historically, over a ten-year period. Content

[1]For Stockholm the statistics for buses and share of renewable fuel are from 2017

analysis enables the researcher to gain new insights, knowledge and provide valuable directions for the future by making inferences from specific data to a general context (Krippendorff, 2004). According to Kassarjian (1977), the main characteristic of good content analysis is that it is objective, systematic and quantitative. Objectivity includes providing a clear motivation for the selection of documents and categories and assuring inclusion of the same type of information; meaning that if another researcher used the same categories the analysis should result in the same outcome (Kassarjian, 1977). Additionally, to get a deeper understanding of the results the document analysis was complemented with a workshop with public transport practitioners. The methodology of the content analysis is described in three steps below.

The first step of the content analysis was to select the documents. The selection was made by focusing on the Swedish public bus transport sector. Having most of the governance happening on the regional level in the 21 different public transport regions, with very different regional preconditions and outcomes in terms of transition, it provides a good ground for comparisons. Tender documents over a ten-year period (2008-2018) have been collected for research in this area. In total, it added up to 84 public procurements which corresponds to 95% of all procurements during the studied period (school traffic, 5%, has been excluded from the analysis). Each year, between five and fifteen regions have procured in Sweden. Every procurement consists of several hundred pages structured in different ways, a fact that made it hard to search for different categories in them.

The second step was to select categories for analyzing the documents. With a point of departure in the sector guidelines for environmental requirements in public bus transport focusing on climate issues, a number of procurement documents were read through in order to understand how these issues were expressed in the contracts. Our ambition was to find subjects that differed in degree of flexibility for the bus operator regarding climate change issues. After reading and analyzing a selection of tender documents, how to rate and judge the different categories was discussed in detail resulting in the choice to look deeper into the following subjects regarding environmental flexibility: requirement for fuel, requirements for energy use, requirements for local pollution and requirements for noise pollution. The choice of categories was inspired from the policy document regarding environmental issues in bus traffic developed by the Swedish organization "Partnersamverkan för en bättre kollektivtrafik" (Svensk kollektivtrafik, 2018).

Two of the authors have done the content analysis and to get good validity we have first divided the work into different years, thereafter we instead analyzed the rest of the tender documents by dividing them into different subjects. Each author therefore analyzed all categories for three years of public procurement documents summing up to six years, and thereafter one author analyzed the first half of the categories for the remaining four years and the other author analyzed the other half of the categories for the remaining four years. This division of work made the analysis more consistent because both of the authors have analyzed all different categories of flexibility concerning the environment. However, this division meant the material was not read through by more than one person and this fact is, of course, a limitation of the study. Relevant key words, connecting to environmental aspects, were also identified and searched for in the documents to ensure nothing was missed. Some examples of key words are: "*drivmedel*" (fuel), "*bränsle*" (fuel), "*biogas*", "*biodiesel*", "*eldrift*" (electric power), "*energi*" (energy), "*energieffektivisering*" (energy efficiency), "*Euro*", "*avgas*" (emission), and "*buller*" (noise).

The third and last step was to analyze the requirements in relation to the factors; size of procurement [vehicle-kilometers procured], type of traffic [city, local, regional], regional differences and changes over time. The factors were derived from previous studies of GPP in the public transport sector (Aldenius & Khan, 2017; Aldenius, 2018). This step was done in order to facilitate relevant comparisons between the factors. The requirements were divided into specific- and functional requirements based on previous literature (Aldenius & Khan, 2017; Aldenius, 2018), as well as incentives and options based on findings in the tender documents. Many procurements contained both specific- and functional requirements. When specific- and functional requirements were further analyzed separately, the tender documents containing both types of requirements were included in both further analyses. When the specific requirements were further analyzed, they were categorized depending on what type of renewable fuel that was required. The functional requirements were ranked based on how demanding they were in relation to the latest available environmental sector guidelines at the time the tender document was written. Four levels were used, inspired by Testa et al. (2016); *Non green* (tender documents not containing any environmental requirements in the concerned category), *Light green* (tender documents containing environmental requirements lower than latest available basic sector guidelines), *Green* (tender documents containing environmental requirements in line with latest available basic sector guidelines) and *Hard green* (tender documents containing environmental requirements higher than latest available basic sector guidelines).

After the analysis of the content, the information from the tender documents was structured in an excel file with dating sequences. Based on this information, in order to understand the properties of the material, statistical analyses have been applied. These statistical analyses require numerical data; thus, some information was transformed from text into numerical data. Different categories were combined for the statistical analysis, for example the type of requirements in relation to the size of the procurement or type of traffic and fuel requirements in relation to energy use requirements.

A workshop was held to complement and get perspective on the results from the document analysis. The main purpose thereof was to find out which requirements the participants prioritized in order to achieve environmentally sustainable bus transports. The workshop participants consisted of PTAs,

Table 1. Categorization for size of tenders and the share of tenders that included the sector recommendations for environmental requirements. The category size is based on how many kilometers were asked for in the tender documents.

Procurement's size	Vkm procured	Number of procurements	Use of sector environmental recommendations
Very small	0 – 100000	117	22 (19%)
Small	100001 – 500000	52	27 (52%)
Medium	500001 – 1000000	33	20 (61%)
Large	1000001 – 5000000	77	63 (82%)
Very large	5000001 – up to	29	16 (55%)

Table 2. Categorization for procurement belonging to different types of traffic and the share of tenders that included the sector recommendations for environmental requirements.

Category	Number of procurements	Use of sector environmental recommendations
City	6	3 (50%)
Local	34	21 (62%)
Regional	227	86 (38%)
All	3	1 (33%)
City and local	2	1 (50%)
Local and regional	54	42 (78%)

bus operators, researchers, and consultants from southern Sweden; in total they were 16 participants divided into two groups. The biggest PTAs and the biggest bus operators were represented at the workshop. The first step in the workshop was to present the results from the content analysis in order to give a base for further discussions. During the workshop, the participants had to write down their own view of environmentally sustainable public bus transport and then rank which requirements they thought were most important to achieve environmentally sustainable public transport 1) in general, 2) in city traffic and 3) in regional traffic. For each of these questions, the participants got three stickers to place behind different requirements (*specific fuel required*, *max CO_2 emissions*, *max NOx and particles*, *specified engine type (Euro)*, *degree of energy efficiency*, *max noise level*) based on what they thought was most important. Between each question, the results were discussed to give the participants a chance to explain their choices. The discussions were recorded, and notes were taken. The analysis from the workshop was based on the results from the stickers, together with analysis of the discussions. Of course, the result depends on the people represented in the workshop; other people from the same organizations could have different opinions. However, in order to ensure good reliability, we have tried to select participants who work with procurement in bus transport and thus were expected to have relevant expertise in the area. All participants were informed that the workshop was recorded and approval was given for use of the information in a research paper.

5. Results and analysis

The results presented in this paper start with some general facts about the prerequisites. Thereafter the aspects connected to climate requirements are analyzed followed by aspects connected to local pollution. Lastly, the results from the workshop are presented.

5.1. Content analysis – general prerequisites

The regions in Sweden, 21 in total, have all used public procurement of bus transports during the current period, from 2008 to 2018. Some of them have used it only once during the period while other regions have used the process each year concerning different areas. The difference in number of procurements during the period can be explained by the different sizes of the regions and by different sizes of the final contracts. Documents from 84 public procurements have been executed during the current period, from 2008 to 2018. These regions have further been divided into 326 areas. These divisions of areas were made because they constituted areas that could be bided on separately. The environmental sector recommendations, described in Section 3, were referred to in less than half of the tenders (47%). Especially in very small procurements and in regional traffic the sector environmental recommendations are referred to, to a limited extent (Tables 1 and 2). Nonetheless, in some of the procurements requirements similar to the recommended requirements are being used without referring to the recommendations.

The content analysis confirmed that there are large differences between regions in how environmental requirements are set which agrees with previous research on GPP in public transport (Aldenius & Khan, 2017; Aldenius, 2018; Xylia & Silveira, 2017), but in this paper differences were also seen between procurements within the regions. Previous research has pointed out size of the region, as one of the factors influencing if environmental requirements are used in public procurement (Marron, 2004; Michelsen & de Boer, 2009). Aldenius and Khan (2017) suggested that not only the size of the region matters, but also the volume of procured goods, which could possibly explain the differences within the regions. In this paper, we examined if this claim was true by analyzing how the vehicle kilometers (vkm) have been related to, and to what extent the sector environmental recommendations have been referred. In Table 1, the categorization of the sizes of the tenders can be seen. Most of the public procurements fall under the category 'very small'. In a minority of them, the size in vkm was not set, these tenders are excluded in this part of the analysis and that explain the fact that the number of procurements in Table 1 is not summing up to 326.

Another factor that could explain variations between and within regions is type of traffic procured. In previous

research, specific requirements for renewable fuel seemed to appear more frequently in city traffic than in regional traffic (Aldenius, 2018). Therefore, we chose to divide the traffic into city- (traffic within large cities with more than 300 000 inhabitants, in Sweden only Stockholm, Gothenburg and Malmö), local- (traffic within smaller cities, under 300 000 inhabitants) and regional- (traffic between cities) areas. In Table 2, it can be seen that regional traffic in Sweden makes up for by far the largest group, while city traffic concerns just a few procurements. Some of the procurements contained a mix of these types of traffic; these are excluded in this part of the analysis.

Analysis showed that the two categories; size of the regions and type of traffic, had some correlations. Procurements for city traffic were for example very closely connected to large and very large procurements and there were no very small, small or medium procurements in city traffic. On the contrary, over 50% of the procurements for regional traffic consist of very small procurements. In local traffic, all sizes of procurements could be seen.

Based on the first analysis carried out in this paper (step 2 in the method section), we chose to focus on four of the requirement categories from the environmental sector guidelines: fuel, energy use, local emissions and noise. Requirements for fuel mostly aim at decreasing CO_2 emissions by increasing the share of renewable fuel. Requirements for energy use focus on decreasing the use of fuel both by technical and behavioral measures. The category for local emissions includes requirements for both NO_x and particles, which can also be expressed as Euro engine standards. Lastly, noise focuses mostly on decreasing the noise outside the bus. The two first categories (fuel and energy efficiency) mostly deal with decreasing climate impact, while the two last categories (local emissions and noise) focus more on the local environment. Bellow we describe the basics of different ways of setting these requirements that were seen in the tender documents: technical specifications as functional- or specific requirements, incentives and options.

How much flexibility the PTAs leave to the bus operators in the contracts can be categorized based on if the environmental requirements are expressed as functional- or specific requirements. Setting functional requirements, has in previous literature been described as a way for the PTA to leave more flexibility to the bus operator and to achieve a desired function (such as decreased pollution or decreased use of fossil fuel) in the most cost-effective way. When the PTAs instead chose to set specific requirements, they were seen to take on a larger responsibility and had to be prepared for increased costs. At the same time, they had the possibility, for example, to get a fuel with co-benefits for the region or to contribute to a new market (Aldenius & Khan, 2017; WSP, 2014). The environmental sector recommendations advocated what will be referred to as functional requirements in this paper. Using specific requirements goes beyond the recommendations in the environmental sector guidelines, which was seen to result in large variation of how these types of requirements were expressed in the tender documents. Incentives are often used in contracts in order to increase the number of passengers, but can also be used to award more environmentally friendly solutions by promising more money or more points in the evaluation of the tender. Lastly, it is possible to ask for an option in procurements where the bidder has to come in with an alternative price for a more sustainable solution.

In the following sub-sections, the analysis of how and when different requirements are used will be divided in accordance with the two categories: climate requirements and local pollution.

5.1.1. Climate requirements

In this section, we present the most significant results from the content analysis of environmental requirements for climate impact. First by presenting how the requirements for fuel and energy use are expressed in the tender documents, followed by how the requirements are influenced by the size of the tendered regions and type of traffic procured. Thereafter we bring up regional examples that stand out and lastly, we show how the requirements have changed over time.

5.1.1.1. How requirements are expressed. The requirements concerning fuel were seen to be expressed in many different ways in the tender documents. Most common was to set functional requirements (26%) as recommended by the environmental sector guidelines, but many tender documents contained specific requirements (15%), incentives (18%) or a combination of different requirements (7%). However, many of the tender documents did not contain any requirements for fuel (34%).

The most common way to express functional requirements was to specify a decreased share of fossil fuel or an increased share of renewable fuel (based on vehicle kilometers (vkm) or on number of vehicles), which is in line with the recommendations in the first three versions of the environmental sector guidelines. However, the specified share ranged from 5% to 100%. Another way to set functional requirements was by asking for a "decrease of emissions effecting the climate compared to baseline", as recommended in the environmental sector guidelines from 2014. These types of requirements were seen in some of the later tender documents and the required decrease in emissions ranged from 20% to 70%. In common for all functional requirements were that the share was expressed in steps over the contract period.

Specific requirements were foremost used to introduce biogas buses and in the later years electric buses. In addition to requirements for how much of the traffic that should be carried out with the specified fuel, it often comes with attachments describing who is responsible for supplying the fuel, who is responsible for the infrastructure and definitions of the characteristics of the fuel. In the cases when HVO, RME or gas buses are requested, fewer extra attachments are provided. In the case of setting specific requirements for biogas, the content analysis showed that who is responsible for supplying the fuel is an important topic. For electricity

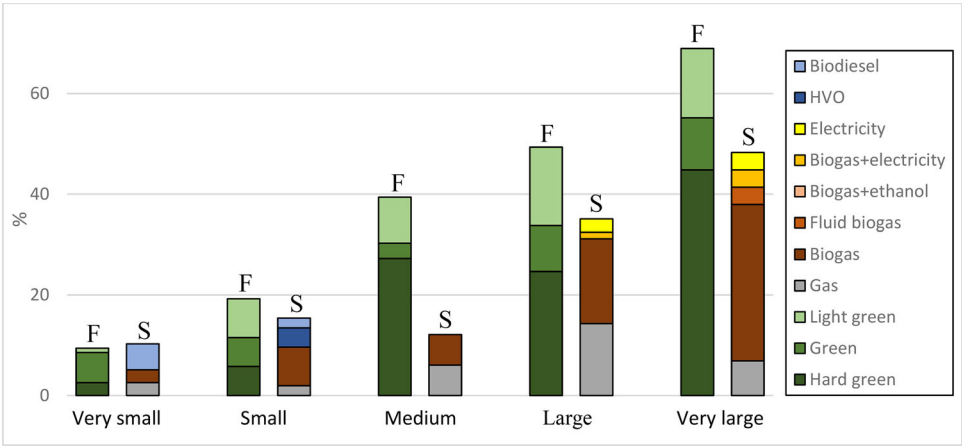

Figure 2. Share of functional and specific requirements in different sized procurements. The column to the left represents functional requirements (F), while the column to the right represents specific requirements. The reason the total of the columns is over 100% is that some tenders included both functional- and specific requirements.

on the other hand, more focus was on the charging infrastructure.

Seen to the number of contracts, incentives were used to a large extent in the Swedish tender documents. However, it is foremost two regions using this method in small regional contracts. Different kinds of incentives were seen in the procurement documents, including offering extra SEK if renewable fuel was used or extra points in the evaluation of the procurement bid. To ask the bus operators for an option for renewable fuel was quite uncommon in Sweden.

Requirements for energy use on the other hand were usually expressed as a functional requirement. Sometimes they followed the SORT recommendations (given as maximum energy use per kilometer or in person kilometer) in the environmental sector recommendations, but very often the requirements were expressed as a very soft requirement that is hard to follow up. The requirements can for example include requirements for driving efficiency (e.g. eco-driving, education of drivers, technical systems), engine maintenance, active work to decrease fuel use, optimizing vehicle size, and develop programs to decrease energy use. In one tender document, incentives were used to promote energy efficient engines. They offered 0.10 SEK per kilometer for vehicles with more energy efficient engines.

5.1.1.2. Influence of size of tender documents. Moving to the analysis of the connection between the size of tender documents and inclusion of environmental requirements, there was a clear trend that the larger the tender, the more common it was to have requirements for renewable fuel overall. Especially the inclusion of specific requirements increased steadily with increasing size of the tender. Incentives, on the other hand, were most common in very smaller tender documents and did not exist at all in very large tenders.

As described earlier, both functional- and specific requirements can vary a lot between the contracts. While functional requirements varied in share of renewable fuel, specific requirements varied in what type of fuel that was requested. Figure 2 gives an overview of these variations for functional- and specific requirements. For functional requirements, it can clearly be seen that the use of hard green requirements increased with larger contracts. Specific requirements did not only become more common in the larger contracts, there was also a shift in which fuel were requested. Electricity was only requested in large or very large contracts and biogas got more common the larger the contracts. Requirements for HVO or other biodiesel were only seen in the smallest tender documents. These results are in line with previous research, which suggested that larger procurements facilitate the possibility to create a market for new technologies (Aldenius & Khan, 2017).

The requirements for energy use did not follow the same clear trend as fuel requirements when it comes to inclusion in the tender documents. To include requirements for energy use was most common in very small and small procurements, while hard requirements for decreased energy use were foremost seen in very large tender documents.

5.1.1.3. Influence of type of traffic. Similar to the connection to size of tender document, the type of traffic followed a clear trend when it comes to including requirements for fuel. Inclusion of environmental requirements was most common in city and local traffic, only 17% respectively 24% of the tenders had no requirements for renewable fuel. The trend is foremost influenced by the much higher inclusion of specific requirements in city and local traffic. In tenders for regional traffic less than 40% of the tender documents included requirements for renewable fuel, around 20% of the tenders had used incentives instead and the rest had no requirements for renewable fuel.

When looking more in detail at the functional- and specific requirements, Figure 3 shows that the difference between requirements in different types of traffic was most interesting for specific requirements. Specific requirements were used in city and local traffic to a much larger extent than in regional traffic. In the cases specific requirements existed in regional traffic, it was often for some type of biodiesel. So far, all procurements including electricity have been in local traffic, while biogas and gas buses have been requested in all types of traffic. As expected, city traffic followed a similar pattern to large and

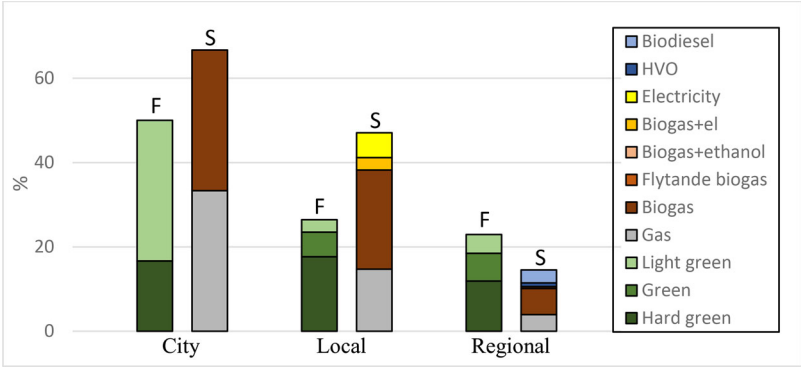

Figure 3. Share of functional and specific requirements in procurements for different types of traffic. The column to the left represents functional requirements (F), while the column to the right represents specific requirements. The reason the total of the columns is over 100% is that some tenders included both functional- and specific requirements.

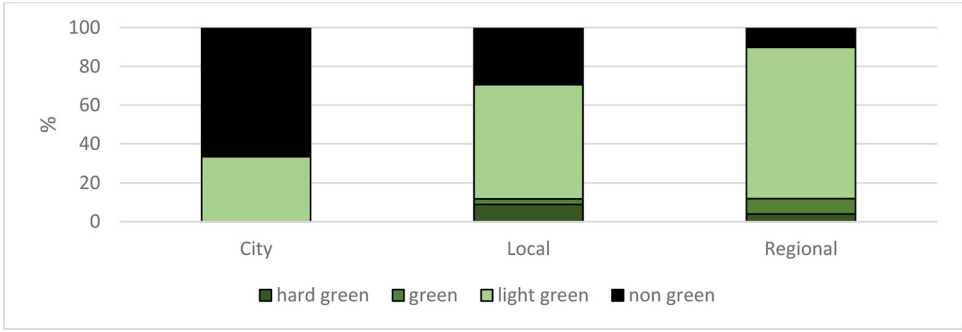

Figure 4. Share of requirements for energy use in procurements for different types of traffic.

very large procurements since they mostly correlated, while regional traffic followed a similar pattern to small and very small procurements.

Requirements for energy use had an opposite trend than requirements for fuel. Figure 4, shows that the inclusion of requirements for energy efficiency was most common in regional traffic and least common in city traffic. In the cases requirements were included in city traffic they were only light green. This can explain what was seen in Xylia and Silveira (2017), where high-populated regions had decreased emission levels, but not the energy use.

An observation from these comparisons was that requirements for fuel and energy use did not seem to follow the same trend. A theory could be that it was connected to which specific requirements were set for fuel, for example do gas engines have a lower efficiency than conventional engines, while electric buses are very energy efficient. The tenders with no requirements for energy use and the tenders with hard green requirements were therefore compared to the requirements set for fuel. The comparison showed that no requirements for energy use over half of the time appeared in procurements also containing specific requirements for biogas or gas buses. Hard requirements for energy use on the other hand were in 65% of the tenders combined with hard green functional requirements for fuel. In the few cases energy use requirements appeared in the same procurement as specific requirements, the specific requirements were most often for electric buses. It is therefore likely to believe that biogas investments have influenced the low inclusion of energy use requirements. This can also partly explain the observation from previous research where high-populated regions with a large decrease in emission levels were seen to have a high energy use (Xylia & Silveira, 2017).

5.1.1.4. Regional differences. Sweden is a country with large geographic and demographic variations within the country. It is therefore interesting to also look at differences in setting requirements between the regions and if it seemed to have an effect on the outcome in the region. In this section, we will take a closer look at the regions that have set very high functional requirements (Blekinge, Kalmar, Kronoberg and Halland[2]) or have a large share of specific requirements (Värmland and Skåne).

The regions with high functional requirements are foremost consisting of local traffic combined with regional traffic and have the population density of an average Swedish region. With the exception of one region (Kronoberg) they had large or very large procurements and shares of renewable fuel close to 100% in 2018. Kronoberg had small procurements and a share of renewable fuel just under 90%. (see Figure 1, Section 3). However, what differed between the regions was what type of renewable fuel they had in 2018. Blekinge, which had only used functional requirements only had biodiesel. The other regions that had functional requirements combined with specific requirements for biogas or gas buses had a mix of biogas and biodiesel in their

[2]Västmanland also have a high share of functional requirements, but will not be analyzed in this paper since their PTA run most of their traffic in own regime.

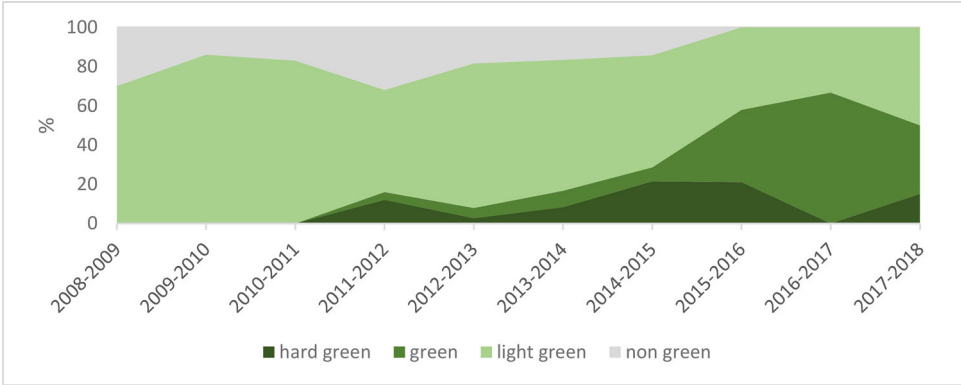

Figure 5. Energy efficiency over time.

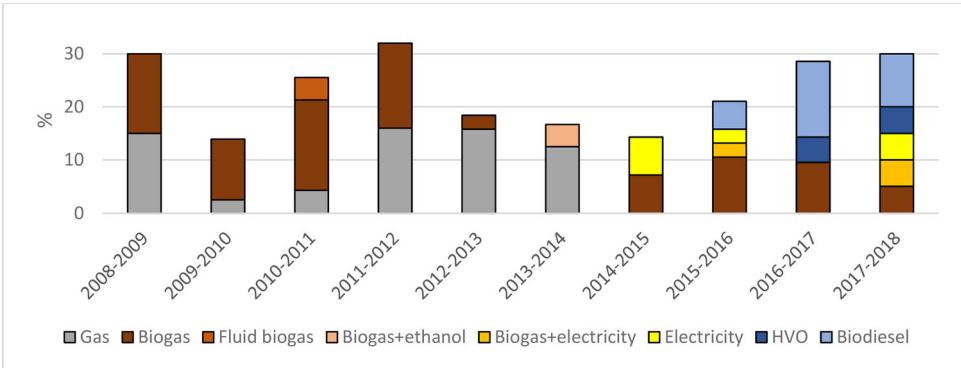

Figure 6. Specific requirements for renewable fuel over time.

bus fleet in 2018. Two regions had chosen to set specific requirement alone in more than half of their procurements (Värmland and Skåne). Both regions had a comparably high share of biogas, but Värmland, a region with low population density, had a significantly lower total share of renewable fuel in 2018 than the metropolitan area Skåne.

These findings support the theory that specific requirements are needed if a region wants another renewable fuel than biodiesel. The comparison also indicates that it is easier for a larger region to set specific requirements.

5.1.1.5. Changes over time. Moving on to how the requirements have changed over time, the clearest trend is seen for energy use. It has gone from non-green or light green requirements the first part of the studied period to all procurements containing some sort of requirements for energy efficiency the last three years (Figure 5).

For requirements for fuel, the sector recommendations have become higher over time and the regions seemed to have followed. There were no clear trends for if the regions had set higher or lower requirements than recommendations over time. However, one thing that has changed over time was which fuels were requested in the specific requirements. Until 2013-2014, it was common to request biogas buses or just gas buses. After that, only gas had not been requested and more fuels had appeared, such as electricity and biodiesel (Figure 6).

Overall, the analysis showed that requirements to decrease climate impact were dominated by requirements for renewable fuel, expressed as either functional or specific requirements. Requirements for energy efficiency had often been vaguer but has become harder and more common the last years. While requirements for fuel were seen to get harder and more specific the larger the contract and for city- and local traffic. The trend for energy use requirements on the other hand was almost the opposite, where requirements were most commonly found in regional traffic and no clear trend was seen for size of procurement.

5.1.2. Requirements for local pollution

Almost all of the tender documents included requirements to decrease local pollution. In this paper, local pollution includes requirements for NO_x, particles and noise.

5.1.2.1. How requirements are expressed. Requirements for NOx and particles were often set together either as a functional requirement for allowed g/kWh per bus or for the whole fleet, or as a requirement for Euro standard of the engine. Many followed the sector recommendations at least partly but might divert from the recommendation for either particles or NOx. Another way to set requirements for local emissions in the tender documents was to refer to the limits of an environmental zone. A large majority of the procurement documents had functional requirements expressed as light green (54%) or green (41%). Only 3% of the procurement documents contained hard green requirements, but even less contained no requirements at all (2%) and none of the procurement documents contained incentives. Most of the requirements for noise were also set as light green or

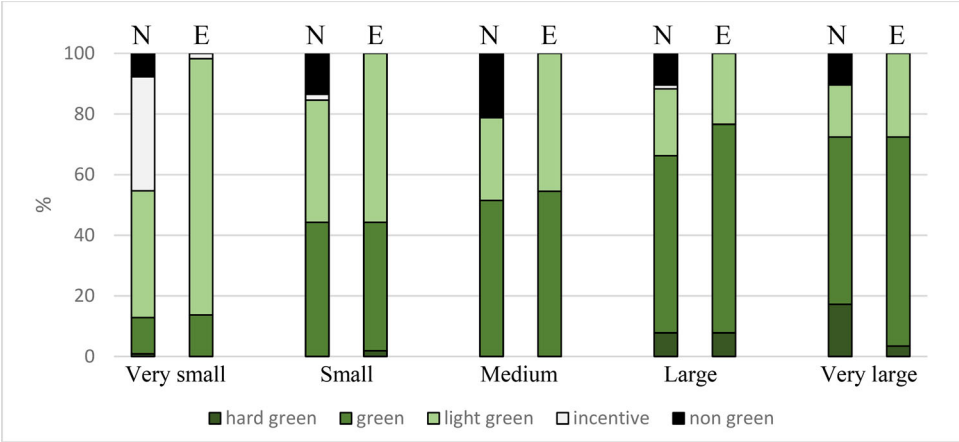

Figure 7. Requirements for noise and emissions in relation to the size of procurement [procured vkm]. Requirements for noise (N) can be seen in the column to the left and emissions (E) in the column to the right.

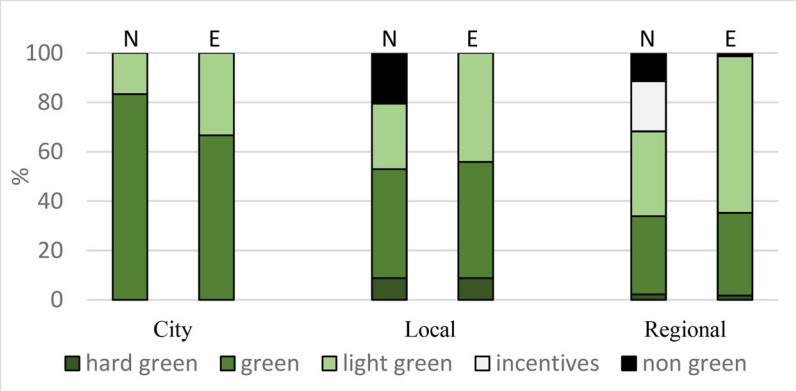

Figure 8. Requirements for noise and emissions in relation to type of traffic. Requirements for noise (N) can be seen in the column to the left and emissions (E) in the column to the right.

green functional requirements, 33% respectively 37%. Hard green requirements were seen in 5%, incentives in 14% and no requirements in 12% of the procurements.

In accordance with the sector environmental recommendations, a maximum noise level of 77 dB is used as a requirement in many tenders and only a few had set harder requirements of 70 dB. In addition, in accordance with the sector recommendation it was often specified how often the noise level must be followed up. Softer ways to write noise requirements were also common such as noise emissions are not allowed to increase after delivery. The incentives used points in the evaluation model.

5.1.2.2. Influence of size of tender documents. When it comes to influence of size of tender documents, both requirements for noise and air pollution followed a similar trend to the requirements for fuel (Figure 7). The larger the procurement the higher the requirements for both air pollution and noise. Incentives for noise were found in very small tenders.

5.1.2.3. Influence of type of traffic. For type of traffic, a similar trend to fuel requirements can be seen (Figure 8). For city traffic, requirements for noise and air pollution were included in all tenders and most of them were in line with the basic sector recommendations. In local traffic some tenders lack requirements for noise, but it was also in these procurements the hard-green requirements were found. In regional traffic, there was a larger share of light green requirements and the tender documents using incentives were seen here.

To sum up, requirements concerning the local environment were almost always included in the tenders. How strong they were followed a similar trend to requirements for fuel; larger tenders and tenders for city and local traffic had higher requirements. On a regional level, it was harder to find any clear trends or connections to the outcome. Similarly, there had been no significant changes over time compared to the sector recommendations.

5.2. Workshop

The workshop was concerned with the stakeholder's view on sustainable public transport and how they prioritized in creating environmentally sustainable bus transports as well as to find out if the differences were dependent of what type of traffic that is publicly procured. Although the workshop included different actors, no difference was made between which type of actor who had the opinion. The representatives from the PTAs and the bus operators agreed on most of the aspects discussed in the workshop.

For many participants environmentally sustainable bus transports did not foremost concern the transition to renewable fuel, energy efficiency, air pollution or noise. Instead, they claimed that creating attractive public transport to decrease car use and an effective use of vehicles was an as important part of achieving sustainable transport. The need for a broader and longer-term systematic perspective on sustainable bus transports was also brought up. For example, looking at the emissions from a life cycle perspective and including other sustainability aspects such as social aspects and economy.

When focusing on the participants' perception of the requirements from the document analysis, it was seen that they thought the most important requirements in order to achieve sustainable public transport were functional requirements regarding CO_2 emissions, NOx and particle restrictions and requirements for decreasing energy use. A few also thought that specific requirements for a specific fuel should be used. There were several arguments to why functional requirements should be chosen over specific. It was argued that procuring a function rather than a specific fuel is better for the competition and that the most important thing is what comes out of the tank, not what goes in, the fuel is just a tool. Some also argued that functional requirements promoted innovation without restricting the potential for development. It was also argued to be important not to be locked into a specific fuel in a long contract, since fuel is a very political question. On the other hand, other stakeholders argued that specific requirements were needed to build up a new infrastructure for, for example, electricity or biogas, because if no choice was made you would get biodiesel which at the moment is the cheapest renewable fuel on the market. Some thought that if you want to achieve certain co-benefits and you know what fuel you want it could also be better to set specific requirements, while others said it should be better to have stricter functional requirements defining what you want to achieve and leave how it is achieved to the bus operators. However, it was seen as quite difficult and in need of a lot of knowledge of the market and it was questioned if it is the PTAs that should pay for the co-benefits that affect other sectors. Most participants agreed that specific requirements should foremost be used in cities. However, many of the stakeholders thought that other requirements were at least as important when the goal is to achieve environmentally sustainable public transport. For example, air pollution is a very important question in cities, but also here most agreed that it is best to use functional requirements for NOx and particles. Noise reduction was also considered more important to work with within cities than in regional traffic. The overall opinion was that specific requirements only are to prefer under certain circumstances such as when new infrastructure is needed, and then only in cities.

Energy efficiency regarding both vehicles and engines was also considered important. One way to increase the efficiency could be to focus on getting more passengers and plan the traffic in a better way. This requires the requirements to be well expressed. However, sometimes fuel and energy efficiency go against each other (e.g. biogas). Another aspect that was highlighted during the workshop was the opportunity for smaller regions to collaborate on procurement issues. By creating networks, they could share experiences and create a more stable foundation when it comes to procurement. As procurements are not carried out as often, it becomes difficult to keep up to date and therefore similar networks for smaller regions would be very helpful. It is not easy to explain why it is not commonly practiced at present but the regions are very independent and work separately. Finally, some other things that were pointed out regarding wishes for the future are; using longer contracts, more freedom for the bus operators overall and also to use the possibility to include other parts of sustainability such as social aspects and life costs analysis.

6. Summary and conclusion

In this study, we analyzed Swedish tender documents over a ten-year period to examine what role PTAs can have in supporting more environmentally sustainable public transport through public procurement. Three main ways of setting environmental requirements were identified: technical specifications as functional or specific requirements, incentives and options. Of these, the use of technical specifications was by far the most common way to set requirements in Swedish bus tenders. Most common was that the technical specifications were expressed as functional requirements, leaving more flexibility to the bus operators. It has been used for setting requirements for fuel, energy use, air pollution and noise. Functional requirements are also the recommended way by the environmental sector guidelines. However, in the case of setting requirements for fuel, the PTAs were sometimes seen to take on a leading role and complement or replace the functional requirements with specific requirements.

For fuel, the requirements were often expressed as maximum share of fossil fuel or in later years as decrease of CO_2 emissions, while energy use requirements were expressed in maximum energy use per kilometer or per person kilometer. For air pollution, the requirements were expressed as maximum g/kWh NOx or particles, and for noise as maximum noise-level was given in dB. How high the functional requirements are set is also a way for the PTAs to take on differently much responsibility. During the studied period, the functional requirements have become higher overall, but for most of them they are the highest in tendering of city- and local traffic and in larger tenders. Regions with very high functional requirements for fuel have in general achieved a very high share of renewable fuel. However, to a large extent the fuel consists of biodiesel, which connects well to previous research.

An exception to these trends was requirements for energy use. The highest requirements for energy use were seen in tenders for regional traffic, and how high requirements were set did not seem to depend on the size of the tender document. Until the last years, many tenders did not include requirements for energy use at all and if they did, they were often

unspecific and hard to follow up. A connection can be seen to the investments in biogas, where high requirements for energy use seldom exists in the same contracts as specific requirements for biogas; a theory supported by the participants in the workshop. Requirements for energy use are instead often seen together with high functional requirements. Energy use requirements might become more important in connection to fuel requirements expressed as CO_2 decrease and in times when many cities want to introduce electric buses. Looking closer at the outcome of renewable fuel in regions with many specific requirements showed that there is an example of a densely populated region that has achieved a very high share of biogas and a region with low population density where the total share of renewable fuel is among the lowest in Sweden. This indicates that there is no guaranteed outcome for the use of specific requirements.

The participants of the workshop agreed that specific requirements should be avoided in regional traffic to let bus operators find the most suitable solution. They further highlighted that it is difficult to set good specific requirements, and some argued that it is better to set higher functional requirements since they thought it improves competition, gives more room for development, and have less risk of lock-in.

However, the workshop discussion indicated that the use of specific requirements is a cause for disagreement among involved actors; while they should be completely avoided according to some; others think that they are needed in situations where new infrastructure is required or when they want another renewable fuel than the cheapest, which today is biodiesel. This argumentation agrees with the results seen in Aldenius (2018).

In studies of green public procurement in other sectors size of municipalities was mentioned as one factor influencing to what extent environmental requirements are included in tenders (Michelsen & de Boer, 2009; Uyarra et al., 2014). This study confirms that size, as well as the type of traffic, have an influence over type of requirements set. The PTAs more leading role of setting specific requirements for fuel was foremost seen in larger tenders as well as in tendering of public transport within cities. It was also shown that smaller regions often had a lower share of renewable fuel, which might be connected to differences in the economic situation between large and small regions. Larger regions often have more resources and therefore have the opportunity to make larger investments. If one is to convert to more innovative and fossil-free alternatives, this often requires more resources both in monetary terms and in terms of knowledge in the form of competent staff.

To sum up, the PTAs asked for more environmental measures in larger tenders and in city- and local traffic. For example, this can, according to previous studies, be connected to stronger economy (Xylia & Silveira, 2017), more knowledge (Aldenius & Khan, 2017; Testa et al., 2016; Xylia & Silveira, 2017), or the belief that you can influence the market in larger regions or tenders (Aldenius & Khan, 2017). Based on this outcome, it can be discussed if there is a need for more support for procuring regional traffic, as well as support for increasing the use of larger tenders. Participants in the workshop saw more collaboration between smaller regions with less competence as one solution and previous research suggested the use of networks as a way to increase environmental requirements in small tenders (Ottander & Söderström, 2005). However, it can also be accepted that authorities in cities take the lead, while smaller regional tenders follow when the market matures. Finally, yet importantly, environmentally sustainable public transport is much more to the involved actors than just renewable fuel and lower emissions from the bus. It is important to see the whole picture and look at the issue from a life cycle perspective. Therefore, providing attractive public transport to attract car users is at least an as important environmental measure.

This study of the Swedish public transport case showed that PTAs have a large potential to support more environmentally sustainable solutions using environmental requirements in public procurement. However, this study was limited to the Swedish public bus transport sector and covered a limited period in time. Hence, it would be interesting for future research to compare the results from this study with the public bus transport sectors in other countries, as well as looking at how requirements for electric buses has further developed in the most recent years. Another limitation to this study was caused by the choice to use document studies as the main method, which restrains the understanding of why choices were made. This limitation was partly overcome by following up the results from the document study with a workshop. However, it would be interesting for future research, of the public transport sector and other public sectors, to seek explanations for less environmental requirements in small and regional tenders and see if there is a connection to other barriers such as knowledge, costs and top management. For example through interview studies. Further studies should also look at the use of award criteria to get around some of the challenges of specific requirements. Finally, the findings from the study can have some practical implications by helping the tender designers to give some more emphasis on the environmental requirements in public procurement to support more environmentally sustainable solutions.

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