

# Introducing renewable fuel in public bus transport – challenges and opportunities

**Malin Aldenius**<sup>a,b\*</sup>

<sup>a</sup> *Environmental and Energy Systems Studies, Lund University Faculty of Engineering, Box 118, SE-22100 Lund, Sweden*

<sup>b</sup> *K2 – Swedish knowledge centre for public transport, Medicon Village AB S-223 81 Lund, Sweden*

\* Corresponding author: Environmental and Energy Systems Studies, Lund University Faculty of Engineering, Box 118, SE-22100 Lund, Sweden +46 (0)46 222 9542 [malin.aldenius@miljo.lth.se](mailto:malin.aldenius@miljo.lth.se)

## **Keywords:**

Green public procurement; public transport; renewable fuel; sustainable transport

## **Classification codes:**

O2, Q2, R4, R5

## **ABSTRACT**

The differences between type and share of renewable fuel in Swedish public bus transport is large today. A previous study showed that the differences between regions could possibly be related to regional context and choice of strategic approach. Therefore, the aim of this study is to further analyse the strategic approach for implementation of renewable fuel in ten Swedish transport regions, looking at how actors in the regions experience the challenges and opportunities with use of green public procurement as a tool to implement renewable fuels in relation to economical, geographical, organisational and political factors. The findings from this study confirms that functional requirements is the most cost efficient way to introduce renewable fuels, but at the same time it always results in the cheapest fuel, which today is biodiesel. If a region instead wants to create a market for production, use or infrastructure for a fuel such as biogas, they either have to use specific requirements or own the traffic themselves.

## **1. Introduction**

Being responsible for around one-fifth of EU's total carbon dioxide emissions and the main contributor to air pollution in cities, today's road transport cannot be deemed sustainable (Hickman & Banister, 2014). To tackle the problem, all EU member countries have set individual targets to decrease the negative environmental impact from the transport sector. In Sweden, the goal is to have a fossil-fuel independent vehicle fleet in 2030 (prop. 2008/09:93). Representing 26% of the market share in 2015, Swedish public transport obviously has a role to play in the transition to become less dependent on fossil fuel (Lindblom, Bondemark, Brundell-freij, & Ericsson, 2016).

The public transport sector has set their own target in order to contribute to more sustainable transport. In 2020, 90% of vehicle km in public transport should be made with renewable fuel (Partnersamverkan för en fördubblad kollektivtrafik, 2013). The Swedish public transport regions were well on their way to reach the target for renewable fuel in 2016, with an average share of 72%. However, the variations are large within the country with some regions already exceeding 90% renewable fuel while other are around or below 30%. Also type of renewable fuel vary between the regions (Svensk kollektivtrafik, 2017).

The large differences in share of renewable fuel in the regions indicates a gap in the implementation of targets. In Sweden, deregulation of public transport during the last decades has meant that 90% of the regulated bus traffic in Sweden is procured today (Sveriges Bussföretag, n.d.) and separately carried out by each regional public transport authority. Hence, Green Public Procurement is an important tool for regions to introduce sustainable fuel and technologies (Michelsen & de Boer, 2009; Preuss, 2007).

A previous in-depth study of two geographically diverse transport regions in Sweden analysed the challenges and opportunities with strategic use of GPP in the bus sector. It was seen that influence from different factors (strategy and goals, requirements, cost, size and knowledge and information) were perceived differently in the two regions. The regions had also achieved different types of renewable fuel. This implicates a high relevance of context and choice of strategic approach when evaluating the elements of success or failure in relation to public procurement as a tool for sustainability (Aldenius & Khan, 2017).

The influence on share and type of renewable fuel by context and choice of strategic approach seen in the study by Aldenius & Khan (2017), motivates the need to go broader and explore what different strategic implementation approaches entail in regions with other contextual conditions. Thus, the aim of this paper is to look at what different strategic approaches to implementation of renewable fuel in the public bus transport sector results in, when it comes to type and share of renewable fuel as well as which challenges and opportunities they entail. The study is carried out by further analysing the strategic approach for implementation of renewable fuel in ten Swedish transport regions, selected based on a diversity in both geographical condition and achievement in deployment of renewable fuel. I will look at how actors in the regions experience the challenges and opportunities with use of green public procurement as a tool to implement renewable fuels in relation to economical, geographical, organisational and political factors.

This paper is structure as follows. After a presentation of the empirical method, the organisational prerequisites for Swedish public transport is presented. This is followed by a discussion of previous literature on barriers and facilitators to sustainable implementation and green public procurement. After, I give a presentation of the situation for deployment of renewable fuel in the bus sector in Sweden today. Last, I present the empirical results of the study, including regions' motivation of choice of strategic approach and the challenges and opportunities it entailed.

## **2. Material and methods**

The aim of this paper is to look at the factors influencing choice and share of renewable fuel in Swedish public bus transport, with point of departure in findings from a previous in-depth study of two transport regions. In this paper the aim was to see if findings from the previous study were valid for other Swedish transport regions. Therefore, further ten regions were chosen to be analysed in this study. The choice of regions were made with the ambition to get an as large variety of fuel choice and regional conditions as possible, looking at: share and type of renewable fuel, regional population and size of bus fleet.

The empirical material for the regions came from a combination of document studies, foremost regional transport supply programs, and semi-structured interviews. The interviews were carried out with one or two actors in each region. The ambition was to interview actor responsible for strategic environmental decisions. Due to size and organisational differences between the regions the actors interviewed differed a bit in position in the regions. The interviews were either carried out over the phone or in person and were between 40 and 90 minutes long. The chosen regions and interviewees can be seen in table 1.

For the interviews, a guide with questions were used to ask about the motivation behind fuel choice in the region today and in the future, possibilities with use of green public procurement, what requirements they use to promote renewable fuel, reasons for not having tougher requirements, how costs influence the choice of fuel, who is responsible, how they think the system can be improved and how they experience the influence of national governance. All interviews were recorded and transcribed, and then analysed using meaning condensation and categorisation based on thematic descriptions (Kvale & Brinkman, 2009).

**Table 1. List of interviews:**

Interview A.	Environmental and market strategist, Västra Götalandsregionen, Västra Götaland. Interview carried out 1 November 2016.
Interview B.	Manager society and transport, Kollektivtrafikförvaltningen UL, Uppsala. Telephone interview carried out 10 November 2016.
Interview C.	Environmental strategist, County Council, Uppsala. Telephone interview carried out 10 November 2016.
Interview D.	Manager strategic development, Region Östergötland. Interview carried out 17 November 2016.
Interview E.	Public transport strategist, Traffic and society planning, Region Örebro län. Telephone interview carried out 28 October 2016.
Interview F.	Development manager, Värmlandstrafik AB, Värmlands län. Telephone interview carried out 2 November 2016.
Interview G.	Responsible for procurements, Länstrafiken Kronoberg, Kronobergs län. Telephone interview carried out 26 October 2016.
Interview H.	Strategic planner, Public transport authority, Region Blekinge. Telephone interview carried out 17 May 2016.
Interview I.	Strategist fuel and energy, Trafikförvaltningen, Stockholm läns landsting. Telephone interview carried out 12 May 2016.
Interview J.	Strategist, Public transport authority, Region Västerbotten. Telephone interview carried out 10 May 2016.
Interview K.	CEO, Västerås local traffic, Västmanland län. Telephone interview carried out 8 June 2016.

### 3. Theory

#### 3.1 Organisation of Swedish public transport

Public transport in Sweden is organized around the regional level. Following the Swedish public transport Act (2010:1065), which came into force in 2012, there are today 21 regional public transport authorities (PTA), consisting of either the county, municipalities, or a combination of the two. The PTA is responsible for the strategic decisions concerning public transport and are obliged to express long-term targets for both commercial and contracted services in a traffic supply program. The transport business is then either administrated by the PTA or run by a company owned by the PTA (SFS 2010:1065).

As most other sectors, public transport is facing an increasing pressure to include environmental measures in the political agenda. Therefore, it comes as no surprise that “measures to protect the environment” should be included in the traffic supply programs (SFS 2010:1065, 2 ch §8). However, in the public transport act there are no closer instructions of what is to be included in these measures. Though, in the proposition to the law it can be read that apart from contributing to less private cars, public transport should also be planned so that it successively decreases climate and environmental impacts. The idea is that public transport should contribute to reaching the overall environmental goals in the society and the traffic supply programs should “be based on the transport political targets and other national, regional and local targets, plans and programs of interest for a sustainable development and growth” (Sveriges regering, 2010, p. 47).

The overarching national target for transport in Sweden is a fossil fuel independent vehicle fleet in 2030 (prop. 2008/09:93). The public transport sector has also, through “Partnership for improved public transport”, set their own target in order to contribute to more sustainable transport. In 2020 should 90% of vehicle km in public transport be made with renewable fuel parallel with an increased market share (Partnersamverkan för en fördubblad kollektivtrafik, 2013). Beside this, the regions also have regional development plans, budget document, visions and so forth, influencing the priorities and formulation of environmental issues in the traffic supply programs (Stjernborg & Mattisson, 2016).

### **3.2 Strategic implementation of renewable fuel and the role of public procurement**

Another consequence of the implementation of the Swedish public transport Act (2010:1065) is an attempt to combine a competitive tendering regime with a deregulated regime, which has left room for a lot of flexibility (Van De Velde & Wallis, 2013). This also meant that fully commercial traffic was being allowed to enter the market, but so far their market share is limited (Van De Velde, 2014).

Today 90% of regulated bus services in Sweden is procured (Sveriges Bussföretag, n.d.), hence 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). This role of public procurement is often referred to as green public procurement (GPP) which by the European commission (European Commission, 2016) is defined 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."*

In a previous study of how two Swedish public transport regions strategically used green public procurement in the bus sector to introduce renewable fuel, two ways of setting requirements were seen; functional and specific requirements. The two types of requirements were seen to have different functions and give rise to different challenges. Specific requirements (eg. demanding a specific type of fuel) were used to create a market for biogas, but resulted in high costs and problems with availability. Functional requirements

(eg. CO<sub>2</sub> reduction) on the other hand were more cost efficient and resulted in easily available biodiesel, it was also the preferred way by the operators (Aldenius & Khan, 2017).

Today, 63% of procured bus traffic in Sweden uses functional requirements (Sveriges Bussföretag, 2017). This is also the preferred way to procure traffic by the Swedish Public Transport Association. To help the Swedish public transport authorities to procure in a uniform way, they have developed guidelines for functional requirements, called Buss 2014 (previously Buss 2010). For environmental guidelines there is also a supplementary document suggesting levels for the functional requirements, for example reduced emissions of CO<sub>2</sub> between 30 to 70% (Partnersamverkan för en förbättrad kollektivtrafik, 2014).

In the study by Aldenius & Khan (2017) it is suggested that there is a connection between the way the region set requirements and their regional strategic approach. Functional requirements were seen to be used in the region where the main goal was only to reach the sector target of 90% renewable fuel in 2020. In the region that had used specific requirements, they instead had an ambitious regional strategy to promote a biogas market (Aldenius & Khan, 2017). Other studies also highlights the importance of strategic planning's influence on fuel choice in Swedish public transport regions. Xylia & Silveira (2017) looked at performance factors impacting the differences seen between the Swedish transport regions' success in decarbonizing the bus fleets. They came to the conclusion that political will, strategic planning and policies are key factors affecting the performance in the regions, in most cases to a larger extent than other factors such as size of population and bus fleet, technology, driving conditions or length of trips. Other studies also stress the importance of an active top-management (Brammer & Walker, 2011; Walker & Brammer, 2009) and strong political support when green public procurement is used (European Commission, 2016).

One of the reasons strong political support is so important, is due to a common perception among procurers that including environmental requirements increases costs (Brammer & Walker, 2011; Preuss, 2007; Walker & Brammer, 2009; von Oelreich & Philp, 2013) and other research has shown that more detailed contracts tend to increase costs (Lidestam, Johansson, & Pyddoke, 2016; Vigren, 2015). In the comparison of two Swedish public transport regions made by Aldenius & Khan (2017) cost also showed to have played an important role. Firstly, it was one of the main reasons for one of the regions to use functional requirements instead of specific. Secondly, had the other region experienced increased costs when they used specific requirements, and the use was only made possible due to high acceptance by regional politicians (ibid., 2017).

The geographical variety between Swedish public transport regions is large. They vary in for example size, population density, distance between towns and availability of fuel and infrastructure. Previous research has shown that green public procurement often is more established in larger municipalities (Michelsen & de Boer, 2009), while smaller regions can feel like they are too small to create a market for a new fuel (Aldenius & Khan, 2017). Also the availability of green products in the region can influence the possibility to procure environmental goods (Brammer & Walker, 2011). In the study by Aldenius & Khan (2017), the lack of production was an important reason given not to choose biogas. Though, it should be noted that it is not allowed to prioritise a supplier based on location in the tender (The National Agency for Public Procurement, 2017).

**3.3 Renewable fuel in Swedish public transport today**

To be on track to reach the sectorial target of 90% of vehicle km made with renewable fuel in 2020 the regions should have 65% vehicle km made with renewable fuel in 2016. Together the Swedish transport regions have already surpassed this target and had achieved almost 72%, while the public bus sector alone has come even further and reached 77% renewable fuel. The main reason for the lower total share of renewable fuel is the services carried out by car, such as service trips and taxi. The source for the discussion of share and type of renewable fuel in this paper is fully based on what is reported by the regions to the database FRIDA (Svensk kollektivtrafik, 2017).

**Figure 3.1. Share and type of renewable fuel in all Swedish transport regions 2012 respectively 2016.**

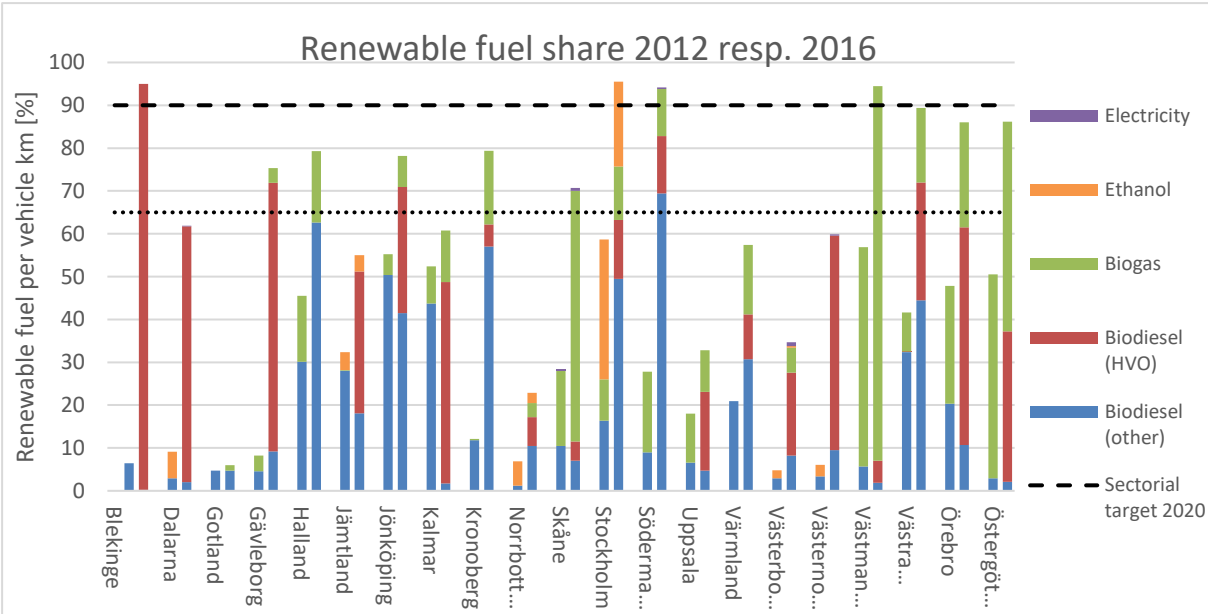


Figure 3.1 shows that a large increase in renewable fuel in the Swedish bus sector occurred between 2012 and 2016, with the exception of Gotland where they still have a very low share. Despite this increase, the variation in fuel deployment between the regions is large, both when it comes to share and type of renewable fuel. It is worth notifying that the share of renewables differed already in 2012 and in a previous study by Xylia & Silveira (2017) this was explained by the increase of renewables that took place after the first sector standard was introduced in 2010. Looking at the trend for choice of fuel in all regions 2012 to 2016 biodiesel has by far increased the most, in the last year mainly through HVO (hydrogenated vegetable oil). Biogas was strong in 2012, but has since only increased modestly, while ethanol even decreased since 2012. Electricity on the other hand, just started to grow and is still barely visible in the graphs, still it is interesting to observe that electricity was seen as the most attractive future fuel option by key stakeholders for Swedish public transport in the study by Xylia & Silveira (2017). In 2016, the bus kilometre per renewable fuel was

dominated by biodiesel (RME<sup>1</sup> (29%), HVO<sup>2</sup> (23%)) and biogas (21%), while ethanol (5%) and electricity (0.1%) were used to a lesser extent (Svensk kollektivtrafik, 2017).

#### **4. Results and analysis**

In the following sections, the results from analysis of ten Swedish public transport regions is discussed. In the first section a presentation of the different strategic approaches used in the regions will be given, together with how they chose to carry out the approach: functional requirements, specific requirements or by not procuring. This will be followed by a discussion of the reasons given by interviewees to use a specific strategic approach and chose a certain way of carrying it out. Last, I will present what share and type of fuel the approaches resulted in, together with how the interviewees in this study experienced challenges and opportunities commonly seen in previous research.

##### **4.1 Strategic approach and how it is carried out**

The results indicate that the two strategic approaches identified by Aldenius & Khan (2017) in an in-depth study of Skåne and Jämtland (described in section 3.2), also can be seen in the ten regions analysed in this study. However, only Blekinge had chosen to do like Jämtland and not promote any specific fuel in any part of the traffic. In the rest of the studied regions a combination of the strategic approaches were used, specifying which fuel should be used for part of the traffic, and leaving the choice of fuel to the operator for the remaining part. Resulting in the strategic approach varying for type of traffic and between municipalities, towns or bus routes. Uppsala and Västmanland were closest to the approach seen in Skåne and requested biogas in most of their regulated traffic, only leaving the fuel choice to the operator for non-regular traffic such as school buses and service routes. The two metropolitan regions in the study (Västra Götaland and Stockholm) showed varying approaches within town specifically requested biogas or ethanol on some routes or vehicles, while the rest of the traffic was left to the operators to make the choice of fuel themselves. However, the most common approached seemed to be to leave the choice of fuel to the operator in most of the regional traffic and then request a specific fuel in a certain towns (Värmland, Västerbotten, Örebro, Östergötland) or municipalities (Kronoberg). In most cases the specific fuel chosen was biogas, except for one city where it was electricity.

As mentioned in section 3.1 most public transport in Sweden is procured, but there is also the opportunity for the RPTA to have a company, own and carry out their own traffic. As opposed to the study by Aldenius & Khan (2017), where all traffic in the two studied regions were procured, this study show examples of both ways of carrying out traffic. For the procured traffic both functional and specific requirements are used. Below, I will go through when the studied regions have chosen to use functional requirements, specific requirements or own and carry out the traffic themselves.

When traffic is procured and functional requirements used, as recommended by Partnersamverkan för en förbättrad kollektivtrafik (2014), the responsibility is left to the operator to provide a renewable fuel or technology that fulfils these requirements. All regions in this study use functional requirements for at least a part of their procured traffic. However,

---

<sup>1</sup> Biodiesel produced from rapeseed oil

<sup>2</sup> Biodiesel that has been treated so that it has similar characteristics to fossil diesel

the ambition level and which function is requested can vary. Common ways to set the requirements are either as share of renewable fuel or a limit for maximum CO<sub>2</sub> emissions from the traffic. In theory, the functional requirements could be formulated so strictly that they promote a specific fuel, a suggestion seen in Aldenius & Khan (2017). However, this was not seen as a good option by some regions in this study (Interview A). Instead, the most common way to go when promoting a specific fuel was either to use specific requirements or to not procure the traffic.

If a fuel was promoted with specific requirements, or if they had chosen to own the traffic themselves was almost fifty-fifty between the regions. All regions using specific requirements aimed to introduce biogas, but one region had also used it to introduce ethanol in parts of their traffic (Interview I), and further one region had specific requirements for the municipality owned electric buses to be used (Interview J). When a fuel was introduced in a smaller part of the traffic two ways to go was seen. Either, the specific requirements stated that the operators have to use the fuel that the regional PTA provides (Interview I) or that a specific fuel should be used in a certain number of vehicles (Interview E). Specific requirements can also be used to procure traffic in a whole town (Interview D). In the regions that did not procure their traffic, all had chosen to introduce biogas. This was often the case for one town in the region (Interview B, C, E, F), with the exemption for one region that owned all their traffic except for school and service traffic (Interview K). The next section will present the reasons given by the interviewees to why they had chosen a specific approach.

## **4.2 Reasons given for use of chosen approach**

### **4.2.1 Cost**

The reason for choosing a specific approach varied between the regions. Previous research shows that increased costs is often brought up as the main reason not to promote environmental measures. In Aldenius & Khan (2017) it was also one of the main reasons given by Jämtland to set functional instead of specific requirements, while Skåne said the political will and acceptance of increased cost for public transport had been crucial to enable the promotion of biogas. Similar trends were seen in regions in this study. All regions mentioned that using functional requirements were at least partly based on that they did not want increased fuel costs. When the region only using functional requirements was asked what the biggest obstacle to have harder requirements on renewable fuel and sustainable technologies was, the interviewee answered:

*“It is the economy. In theory today we could say that we want electric buses in all city traffic for example, that is technically possible, but as it is today ...It would lead to that we would have to cut down on traffic volume to get those buses in and that the politicians don't want”* (Interview H)

Some interviewees also brought up the risk that stricter requirements might lead to fewer tenders, which in turn might increase cost (Interview F, G, H)

*”Yes, you could have own requirements, but it gets...the breakthrough is much better if you follow the national demands because it leads to a totally different economy because then you get more manufacturers, more that are interested, then if everyone*



*have different requirements. It inhibits the competition, And that is very unfortunate because it drives the development backwards.” (Interview G)*

#### **4.2.2 Geographical conditions**

Even if the economic constraints are influential, they are not alone decisive for the regions decisions. The geographical setting also have a role to play. Previous research has both shown that availability (Brammer & Walker, 2011; Aldenius & Khan, 2017) and size (Michelsen & de Boer, 2009; Aldenius & Khan, 2017) are important factors influencing which requirements are set in green public procurement and how ambitious a region is to create a market for a renewable fuel. Also, in this study the geographical conditions seem to have an important role to play.

Especially when it comes to biogas, the local availability has been very influential. The lack of local or regional production of biogas, were seen to be a reason not to use any specific requirements in the procurement.

*”Interviewer: Do you have biogas? You don’t have that right now do you?*

*Respondent: No, we don’t have that. That question was brought up when we prepared the procurement in 2014, but we and the politicians didn’t dare setting requirements on it because the availability were uncertain and so.” (Interview H)*

Vice versa, can the motivation to put specific requirements on biogas, or introduce it in traffic owned by the PTA, be motivated by either high production of biogas in the area, or a wish to increase the production. Public transport’s role here became to be a stable user of the produced fuel. The actor or organisation that wanted to make the investment varied between the regions. It could for example be made as a cooperation between the local politicians, regional PTA and a waste management company (Interview K). In other regions it was a municipality (Interview D, G) or regional politicians (Interview A) that wanted to promote the use of local biogas. Another case that was seen was that a town had a long-lasting contract with the biogas provider and therefore set a specific requirement that the operator needs to use the biogas the town has already bought (Interview I).

Not only the production of a fuel influence the choice, also the possibility to distribute the fuel is crucial for the fuel choice. The lack of possibilities to distribute for example biogas could be the reason for a region to choose biodiesel over biogas (Interview G) or even fossil diesel (Interview F). Though, sometimes the motivation was reverse and specific requirements were used to make it possible for a town to build new infrastructure (Interview E).

*”There we also made an active choice in that procurement and pointed at that those two vehicles should run on biogas and the reason was that Kumla wanted a biogas pump in the municipality and to motivate the building of that then.” (Interview E)*

One region said that when they decided to use liquid biogas in the non-procured traffic, it was because they did not see any other options at the time, a decision based on the system perspective existing back then. In this case it was the municipality together with the water management company that wanted to use an offensive approach.

*“Then it felt like it was a more political decision and I think it grew a bit from the societal perspective and system thinking then, that it should be locally produced and so forth plus that it then maybe didn’t exist so many other plausible alternatives.”*  
(Interview C)

Other geographical factors can also influence the choice of strategic approach. In one region all regional traffic was procured with functional requirements, except for the two largest towns where they used electricity respectively biogas. The motivation was here that in a towns the air quality was most important, while avoiding increased costs was most important in regional traffic (Interview J).

The size of the region seemed to have less influence, than the availability. Nevertheless, there are examples of situations where size influence the decisions. One region motivates waiting with introduction of electricity with the argument that it is too vulnerable to have a new technology in a very small municipality because you do not have any backup (Interview F).

#### **4.2.3 Knowledge**

In a previous study it was seen that the use of functional requirements was a way to leave the responsibility to the operators while the use of specific requirements demanded much more of the strategists and politicians in the region (Aldenius & Khan, 2017). In this study, the insecurity the regions felt for which renewable fuels and sustainable technologies will be dominating in the future, influenced the choice of approach. They both thought that future fuel prices as well as the fast development of new technologies made the future uncertain (Interview A, D, F, H). Also, investing too much in vehicles or technologies that could be outdated soon was seen as a big risk to take (Interview H). Due to this uncertainty several of the regions thought that functional requirements was the preferred way to go, since it both leaves the choice of fuel to the operator and a possibility to change fuel during the contract period if something more cost efficient or technically better comes along (Interview D, E, G). Another way to deal with uncertainties for the future and avoid being locked-in to one fuel could be to own the traffic themselves (Interview C, E, K).

### **4.3 Results and consequences of chosen approach**

This section contains a discussion of the challenges and opportunities different ways to procure traffic entailed, but first the type and share of renewable fuel the different strategic approaches resulted in is presented

#### **4.3.1 Type and share of renewable fuel**

In the regions studied in this paper it could be seen that if the choice of fuel was left to the operators by using functional requirements in the procurement process, they exclusively ended up with biodiesel, either HVO or RME. If a region wanted to have any other type of renewable fuel in some part of their traffic, they either had to use specific requirements (Interview A, D, E, I) or introduce it in traffic they own by themselves (Interview B, C, F, J, K). This is foremost the case when a region want to use biogas as a renewable fuel, but has in the past also been used to introduce ethanol (Interview I).

Looking at the share of renewable fuel in the regions biodiesel is often dominating. Blekinge who had used rather ambitious functional requirements to accomplish 100% renewable fuel already in 2015, had in 2016 one of the highest shares of renewable fuel with 95%. Stockholm had managed to reach a similar share, also here the largest part was biodiesel achieved through functional requirements, while biogas and ethanol had a much lower share and was achieved through specific requirements. Many of the regions in this study (Kronoberg, Västra Götaland, Örebro) had in 2016 reached 80 to 90% of renewables, where biogas represented around 20% and the rest was biodiesel (Svensk kollektivtrafik, 2017). Two of the regions in the study had a remarkably high share of biogas. In Västmanland they had almost 90% of renewable fuel in 2016, consisting of biogas achieved by introducing it in the traffic they own themselves. The part that is not biogas is foremost school buses and service transport procured with functional requirements. Östergötland had almost 50% biogas and in total 86% renewable fuel (Svensk kollektivtrafik, 2017). Here all traffic was procured, but while regional traffic was procured with functional requirements and had biodiesel the towns had specific requirements for biogas, here it has been foremost Linköping municipalities investments in biogas in the 90s that have been driving the development.

Three regions had a much lower share of renewable fuel, between 30 to 60%. In these regions biodiesel, and especially HVO, had a rather high share of the renewable fuel (Svensk kollektivtrafik, 2017). In Uppsala the low share of renewables can be traced to an attempt to build up a market by using liquid biogas in their own city traffic, which failed. In Värmland and Västerbotten the target for renewable fuel has been rather low for a long time and the traffic procured with functional requirements, with exception of a few towns where biogas or electricity has been introduced by use of specific requirements or in traffic owned by themselves.

#### **4.3.2 Challenges and opportunities**

The main reasons for functional requirements to result in biodiesel, is the fuel prices. Neither biogas, nor ethanol or electricity can compete with biodiesel in tenders due to the tax exemptions which make RME and HVO almost in the same price range as fossil diesel (Skatteverket, n.d.). Like in previous studies on use of green public procurement, the use of specific requirements was seen to increase the cost of the traffic. The cause of the higher cost being both fuel price, new vehicles and infrastructure. Therefore, a prerequisite to be able to put specific requirements on biogas or use it in non-procured traffic had to be enabled through political acceptance (Interview A, C, E, I). In Västmanland, where they own their traffic themselves and have almost 90% biogas, they expected prices on fossil diesel to increase so biogas would be cheaper even though infrastructure and vehicles were more expensive initially (Interview K). Stockholm is one of the regions who previously put specific requirements on biogas and ethanol, but that are now considering to changing to functional requirements instead.

*"So far, what should I say, the challenge is that it has costed us more money to change to renewable fuel in terms of investments in infrastructure for biogas and for ethanol, there it has costed. And these buses have also been more expensive to buy. But we have had politicians in the county in Stockholm who has agreed over political borders that we should work proactive and targeted with environmental issues. It has*

*been allowed to cost more. But today we try to make it as cost efficient as possible. Today the operators get to buy the buses themselves, they get to choose which renewable fuel they want to use..."* (Interview I)

Not enough available fuel has caused problems for some of the regions that have used specific requirements on biogas or chosen to introduce biogas in their traffic. The problem of initial shortage of biogas lead to that many regions have had to complement with natural gas for longer or shorter periods (Interview B, C, E, G, I). The problems with availability even caused a drastically lower share of renewable fuel in one of the regions.

*"Yes we realised that 2020 was an offensive target and then we need to push for biogas, they said this we really want to go for...and that was fluid biogas. So they went all in. But then... it proved not to be possible both practically and economically to produce fluid biogas, so then it stopped."* (Interview B)

The same region today sees that biogas has to be complemented with other renewable fuels and has opened up for HVO in regional traffic and electricity on some routes in town. More and more regions see HVO as the solution for renewable fuel at the moment, but some of the interviewees are questioning the availability in the future, as the use is increasing both in and outside the bus sector (Interview A, D, F, I). Also, biogas is seen to have a future in regional traffic while electricity will get a bigger role in towns (Interview D, E, K), hence, the future will require a mix of renewable fuels.

Fuels are also dependant on available infrastructure. The reason for regions to push for a specific fuel, such as biogas, electricity or ethanol, in larger towns or densely populated areas but not in regional traffic or school traffic, were often the possibilities to distribute the fuel or have fuel stations. When functional requirements were used it often resulted in a fuel that did not need new infrastructure or special vehicles, which often means biodiesel or in some cases even fossil diesel (Interview F, G, D). The regions that have pushed for a fuel where new infrastructure is necessary have had different ways to solved the investments which could range from having the producer pay for it (Interview K) to having he county pay for it themselves (Interview I).

As mentioned earlier, the development of new technologies goes fast today. A benefit of setting functional requirements brought up by the studied regions was that it leaves a possibility for the operators to change the fuel during the contract, if something cheaper or better comes along during the contract time. The most common was the change from RME to HVO (Interview F, G, I, J).

*"HVO comes more and more because the bus operators already now get a better price for HVO than RME and furthermore does HVO have a better CO<sub>2</sub> reduction than RME has, and also you don't have to change the engines at all, but you can put fuel in the existing diesel engine."* (Interview I)

However, most regions still see that a change to electricity during the contract time would be too expensive, even with functional requirements, and will probably have to be done in connection with a new tender (Interview E, F, G, I). For the traffic that was not procured the

change between renewable fuels were often easier and could be done successively, since they are not bound to contracts in the same way as when procurement is used (Interview B, C, K).

*"However it is also interesting that we regulate our own future a bit since we are not in competition so we can change fast. This had been a difficult journey to make, the one we have made in Västmanland if we had procured. Because if you take procured traffic it is often a ten year contract on the procured traffic and then you have to decided on one thing when you procure. Then you sit there for ten years. We can make the change successively."* (Interview K)

The large investments done in infrastructure, vehicles and production done by regions who wanted to push for a fuel, also led to that many of the regions felt like they have to keep using the fuel even in upcoming tender and have in that way locked themselves into a specific type of fuel (Interview D, G, I, K). They also felt that they cannot be first when it comes to investing in a new fuel or technology, such as electricity, because the investments in previous fuel and infrastructure has been so expensive (Interview D, I).

Even though long contracts and specific requirements make it harder and more expensive to introduce a new fuel, longer contracts also give the possibility to try a new fuel, since both producers and investors in infrastructure and vehicles know there will be a market for the fuel for a longer time period (Interview F). Other co-benefits of using specific requirements in procurements or choosing to introduce a new fuel in non-procured traffic, is that it can enable creation of a market. For biogas this was seen to happen through for example increased production of biogas in the region (Interview D, G), building of fuel stations for private vehicles (Interview E, K), and a regional cycle of resources (Interview A, B, C, E). The use of functional requirements have had less influence of investments in new infrastructure and vehicles and more focus on using what is already available in the region (Interview J).

## **5. Discussion/Conclusions**

The aim of this paper was to analyse strategic approaches used to implement renewable fuel in the public bus transport sector. The point of departure for the study was two strategic approaches identified in an in depth study of two Swedish transport regions. One approach aimed to reach the national target for renewable fuel in an as cost efficient way as possible by using functional requirements, while the other wanted to use public transport to create a market for biogas through specific requirements (Aldenius & Khan, 2017). These two approaches could be found also in the ten regions analysed in this study, but instead of permeating the whole regional planning like in the previous study, choice of approach often differed between different parts of the traffic within the region.

If the ambition is to reach the national or sectorial target for share of renewable fuel, it is often seen to be enough to use functional requirements. In this study there are examples of this approach being used in all types of traffic, but it seems to be most preferred in regional traffic, and for procurement of school and service routs. The reason to choose this approach is quite similar to what was seen in the previous study by Aldenius & Khan (2017). The main reasons being that it is the most cost efficient approach and leaves the choice to the operators who are believed to have the best knowledge of the market. Often the availability

of any specific renewable fuel in the area was low, and therefore it was not seen as possible to create a market for a new fuel. Another reason to use functional requirements, was the speed of technology development today, which made the regions avoid locking themselves into any specific fuel.

This approach seemed to almost exclusively result in biodiesel, in the past RME, but today more and more HVO. How large share it resulted in varied between the regions, from 27 to 95% and was dependant on how ambitious the functional requirements were set. Many of the regions had not experienced a significant increase in cost compared to using fossil diesel and there was no need for the region to invest in for example new infrastructure. The flexibility of the functional requirements had also made it possible for some regions to change from RME to HVO during the contract period. However, this strategy foremost contribute to reaching the overall national target, it cannot be used to achieve further regional winnings.

When the strategic approach instead was to promote a specific renewable fuel, the reasons and consequences were more varying between the regions. In the previous study by Aldenius & Khan (2017) the analysed region had used specific requirements to promote biogas in the whole region. Also in this study, the approach was foremost used to promote biogas, but in some cases also ethanol or electricity. The strategy was foremost used in towns or densely populated areas. Some regions had chosen not to procure the traffic and instead owned the traffic in a municipality, town or larger area. The reasons for wanting to push for a specific fuel varied a bit between the regions. In some cases the politicians or producers of a fuel wanted the existing fuel or infrastructure to be used by public transport. In other cases the politicians wanted to build up a market to be able to build new production plants or infrastructure.

Even if the strategic approach to push for a specific fuel in a region varied in how it was carried out and why it was used, there were some common challenges and opportunities. All regions said it had increased the cost for public transport due to investments in vehicles, infrastructure or fuel, and it was therefore dependant on political support. Due to this some saw that they could not be in the forefront for the next upcoming fuel such as electricity. Availability of fuel was also a problem in some cases and could then lead to a lower share of renewables, especially if the fuel was procured with specific requirements. This was a much smaller problem when the traffic was not procured since they then were free to change or complement with other fuels. The largest benefits of this approach was that it could help to increase production of a renewable fuel in a region, give a region new renewable fuel pumps also for private vehicles as well as other regional co-benefits.

Functional requirements are preferred by many since it leads to lower costs and more flexibility for the operators, however if a region want to push for another fuel than biodiesel it seems necessary that they use either specific requirements or own the traffic themselves. As mentioned by some of the interviewees in the study the development of new renewable fuel and technologies goes fast and the future vehicle fleets will probably not consist of only one type of fuel, but rather a mix. It is therefore reasonable to assume that the regions will continue to battle with how they best introduce new renewable fuels or technologies. At the moment most regions are starting to thinking about the best way to integrate electricity in

their city traffic which opens up for need of more research of challenges and opportunities in the introduction of electric buses.

**Table 2. Summary of conclusions of what is required and which consequences different ways of introducing renewable fuel have.**

	<b>Reach national targets for renewable fuel</b>	<b>Introduction of specific renewable fuel</b>
<b>Organisational factors</b>	<ul style="list-style-type: none"> <li>- Functional requirements</li> <li>- Sectorial guidelines important</li> <li>- Used for all type of traffic but foremost regional, school and service</li> </ul>	<ul style="list-style-type: none"> <li>- Specific requirements</li> <li>- Or PTA/Municipality own the traffic</li> <li>- Used foremost in towns and densely populated areas</li> </ul>
<b>Reasons for approach</b>	<ul style="list-style-type: none"> <li>- Most cost efficient solution</li> <li>- Insecure of availability</li> <li>- Too small to create a market</li> <li>- Operators have more knowledge of market</li> <li>- Fear of being lock-in, technologies develop fast</li> </ul>	<ul style="list-style-type: none"> <li>- Politicians or producers want to create market or use of a fuel or infrastructure available in region</li> <li>- Politicians want to motivate increased production of a fuel or building of fuel stations.</li> <li>- Only way to be in forefront</li> </ul>
<b>Results/ consequences</b>	<ul style="list-style-type: none"> <li>- Biodiesel (RME/HVO)</li> <li>- Does not have to cost more than diesel</li> <li>- Possible to change fuel during contract</li> <li>- Does not support regional development</li> </ul>	<ul style="list-style-type: none"> <li>- Biogas/ethanol/electricity</li> <li>- Increased costs (fuel, vehicle, infrastructure) - needs political support</li> <li>- Availability can be a problem</li> <li>- Requires investments in infrastructure - lock them into fuel</li> <li>- Specific requirements lock them to a fuel - not a problem if own traffic</li> <li>- Can create a market (for infrastructure, production),</li> <li>- Have regional co-benefits.</li> <li>- Do not want to be in the forefront for future fuels</li> </ul>

### Acknowledgements

The research for this paper has been funded by the Swedish Energy Agency. The author would like to thank Jamil Khan, Fredrik Pettersson and Robert Hrelja for valuable comments on the study, and the respondent for making this study possible.

### References

- 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. <http://doi.org/10.1016/j.jclepro.2017.06.196>
- Brammer, S., & Walker, H. (2011). Sustainable Procurement in the Public Sector: An International Comparative Study. *International Journal of Operations & Product Management*, (31), 452–476.
- European Commission. (2016). Green Public Procurement. Retrieved June 28, 2017, from [http://ec.europa.eu/environment/gpp/index\\_en.htm](http://ec.europa.eu/environment/gpp/index_en.htm)

- Hickman, R., & Banister, D. (2014). *Transport, Climate Change and the City*. London: Routledge.
- Kvale, S., & Brinkman, S. (2009). *InterViews: Learning the Craft of Qualitative Research Interviewing*. London: Sage Publications, Inc.
- Lidestam, H., Johansson, A., & Pyddoke, R. (2016). *Kontraktformer och deras inverkan på svensk kollektivtrafik*. Lund.
- Lindblom, H., Bondemark, A., Brundell-freij, K., & Ericsson, E. (2016). *Fördubblad marknadsandel för kollektivtrafik till år 2030. Hur kan vi nå dit och vad blir konsekvenserna?* Göteborg.
- Michelsen, O., & de Boer, L. (2009). Green procurement in Norway; a survey of practices at the municipal and county level. *Journal of Environmental Management*, 91(1), 160–167. <http://doi.org/10.1016/j.jenvman.2009.08.001>
- Partnersamverkan för en förbättrad kollektivtrafik. (2014). *Miljökrav vid trafikupphandling - Buss: En bilaga till Avtalsprocessen inom Partnersamverkan för en förbättrad kollektivtrafik*. Stockholm.
- Partnersamverkan för en fördubblad kollektivtrafik. (2013). *Branschgemensamt miljöprogram*.
- Preuss, L. (2007). Buying into our future: Sustainability initiatives in local government procurement. *Business Strategy and the Environment*, 16(5), 354–365. <http://doi.org/10.1002/bse.578>
- Skatteverket. (n.d.). Skattebefrielse för biodrivmedel. Retrieved June 29, 2017, from <https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/energiskatterpabranslen/skattebefrielseforbiodrivmedel.4.2b543913a42158acf800021393.html>
- Stjernborg, V., & Mattisson, O. (2016). The Role of Public Transport in Society — A Case Study of General Policy Documents in Sweden. *Sustainability*, 8, 1–16. <http://doi.org/10.3390/su8111120>
- Svensk kollektivtrafik. (2017). The environmental and vehicle data base Frida [Miljö- och fordonsdatabasen Frida]. Retrieved June 28, 2017, from <http://frida.port.se/hemsidan/default.cfm>
- Sveriges Bussföretag. (n.d.). Upphandlad linjetrafik. Retrieved June 17, 2027, from [https://www.transportforetagen.se/ForbundContainer/sveriges\\_bussforetag/Branschfragor/Upphandlad-trafik/](https://www.transportforetagen.se/ForbundContainer/sveriges_bussforetag/Branschfragor/Upphandlad-trafik/)
- Sveriges Bussföretag. (2017). *Statistik om bussbranschen*.
- Sveriges regering. (2010). *Regeringens proposition 2009/10:200* (No. 2009/10:200). Stockholm.
- The National Agency for Public Procurement. (2017). About the public procurement rules. Retrieved June 28, 2017, from



<http://www.upphandlingsmyndigheten.se/en/publicprocurement/about-the-public-procurement-rules/>

- Walker, H., & Brammer, S. (2009). Sustainable procurement in the United Kingdom public sector. *Supply Chain Management: An International Journal*, 14(2), 128–137.  
<http://doi.org/10.1108/13598540910941993>
- Van De Velde, D. (2014). Market initiative regimes in public transport in Europe: Recent developments. *Research in Transportation Economics*, 48, 33–40.  
<http://doi.org/10.1016/j.retrec.2014.09.029>
- Van De Velde, D., & Wallis, I. (2013). “Regulated deregulation” of local bus services - An appraisal of international developments. *Research in Transportation Economics*, 39(1), 21–33. <http://doi.org/10.1016/j.retrec.2012.05.020>
- Vigren, A. (2015). *Costs in Swedish Public Transport: An analysis of cost drivers and cost efficiency in public transport contracts*. KTH, Stockholm.
- von Oelreich, K., & Philp, M. (2013). *Green public procurement - A tool for achieving national environmental quality objectives*. Retrieved from [http://msr.se/Documents/rapporter/ex/ex\\_Green\\_Public\\_Procurement\\_2006.pdf](http://msr.se/Documents/rapporter/ex/ex_Green_Public_Procurement_2006.pdf)
- Xylia, M., & Silveira, S. (2017). On the road to fossil-free public transport: The case of Swedish bus fleets. *Energy Policy*, 100, 397–412.  
<http://doi.org/10.1016/j.enpol.2016.02.024>