Joint procurement of fuel cell buses

ZERO EMISSION

JIVEs / MEHRLIN projects

@fuelcellbus www.fuelcellbuses.eu

Main author(s): Wouter Tettero (wouter.tettero@rebelgroup.com), Marc van der Steen (marc.vandersteen@rebelgroup.com), Frederik de Vries (frederik.devries@rebelgroup.com), Jan Willem de Kleuver (jwk@tg.nl), Falco Breedt (fbr@tg.nl) Joost Boudewijns (jbo@tg.nl).

Contributors: George Carew Jones, Eva Baker (Element Energy)

Table of contents

Executive summary

The overall objective of the JIVE initiatives are to advance the commercialisation of fuel cell buses through large-scale deployment of vehicles and infrastructure so that, by the end of the project, fuel cell buses are commercially viable for bus operators to include in their fleets without subsidy. And that local and national governments feel empowered to regulate for zero emission propulsion for their public transport systems.

In 2015 the FCH-JU stated that cities and operators need to engage and jointly prepare for large-scale deployment projects, for example with a joint procurement construct. Over the past years several exercises and preparations of exercises are conducted in Northern Europe, the Netherlands, United Kingdom and Germany.

Joint procurement strategies are a strategy whereby cities and/or operators with similar needs agree on common base specifications for vehicles and coordinate their tendering exercises are core to realising the economies of scale required to bring about the cost reductions. In this report learnings are shared about joint procurement strategies with EU-regions, cities, public transport authorities and operators.

In this summary are first the effects of joint procurement are described. Second, we give an overview of three different joint procurement models. Third, the lessons learned of case study in the Netherlands are listed and we conclude with the key findings of this study.

1. Effects of joint procurement

The primary purpose of joint procurement is cost reduction. However, we see additional spin-off effects that a joint procurement strategy for fuel cell buses can drive which in turn lower the overall costs and enhance the quality (reliability) of fuel cell bus exploitation. The effects of joint procurement are:

- *Cost reduction:* Simply placing a larger order by a manufacturer or through indirect cost reduction through operational efficiencies.
- *Stimulation of market development:* This can be met by simply placing a larger order by a manufacturer or through indirect cost reduction through operational efficiencies.
- *Stimulation of innovation:* This has the effect that critical demand levels can be attained by bundling market power and therewith attract manufacturers and suppliers to produce, supply or innovate in hydrogen technologies. This increased competition stimulates the entire supply chain to produce smarter and better, resulting in further innovations throughout the supply chain.
- *Potential for standardization:* This can be facilitated by the creation of dedicated supply chains which also benefit and stimulate further production. This could be specifically true for innovative techniques that require for instance standardisation between the vehicles and the hydrogen infrastructure.

2. Different joint procurements models

In the analyses we see three different organizational structures to accommodate a joint procurement, with a distinction based on the ownership of the buses. This can be done by ownership by operators, by operators organized in a collaboration or in a Special Purpose Vehicle (SPV) owning the buses. These ownership models leads to three different structures joint procurement.

1. *Joint procurement by independent operators*: Independent bus owners join forces in order to put out an order for a larger number of buses. The operators all have their own contract with the OEM and are separately responsible for arranging funding and maintenance contracts
2. *Joint procurement by a collaboration of authorities:* The collaborating PTA's procure the buses from an OEM. The buses will be owned by the respective PTA's and will be made available to the already contracted PTO's. The buses are delivered based on a single contract between the OEM and the cooperating PTAs
3. *Joint procurement by Special Purpose Vehicle (SPV):* the prospect of fully financing these investments and being responsible for the related risk, might discourage operators to invest in fuel cell buses. To limit these risks and uncertainties and eliminate the high CAPEX, a joint procurement scenario with a third party owning entity can be initiated that leases the buses to the operators.

3. Lessons Learned Case study in the Netherlands

In 2018 the Benelux cluster joined the Jive2 Consortium with 50 hydrogens busses through three PTAs. To gain insights in the feasibility and market appetite for the delivery of these buses including hydrogen supply *Joint procurement by Special Purpose Vehicle (SPV)* was analysed. The analyse was carried out by setting up the structure of the SPV including carrying out a substantive market consultation. The outcome of the case study was as followed:

- First the private sector was willing to adopt SPV and sees the benefits of joint procurement via a SPV construction. Some OEMs were thinking of pulling the SPV concept into their organisation, providing fuel cell buses – whether or not including hydrogen delivery – as a service towards their customers.
- Second, there was very limited market appetite for system responsibility hydrogen supply and buses. This is a contrary tan with battery electric buses and Infrastructure. The businesses of bus OEMs and hydrogen suppliers/infrastructure constructors do not yet understand the others' business enough to come to a fruitful partnership.
- Third, collaboration between public parties for joint procurement of buses proved to be difficult. Although the goal of a full zero emission public transport sector is equal for the PTAs, they all do have their own agenda, strategies and timings which potentially makes a sound collaboration difficult.

In the study these results were also compared the earlier analysed case studies in Germany, the UK, France and Eastern Europe. Although the joint procurement 50 fuel cell buses in the Benelux cluster was not conducted, separate procurements with of batches of busses and infrastructure have been successfully undertaking in the Benelux. The goal of implementing 50 fuel cell buses in the Netherlands is – at the time of writing – under way to be achieved to even 60 fuel cell buses.

4. The main take aways of the study.

Joint procurement is a method that has the potential to speed up the development of higher production numbers and therefore, increase the benefits of economies of scale and reducing the costs per unit. Next to the goal of cost reduction, joint procurement can be used on a broader scale in the transition towards cost competitive fuel cell buses through the stimulation of market development and innovation. However, it might not be evident that joint procurement always necessarily leads to the desired results. Or that the efforts needed for joint procurement weigh up against a single procurement of smaller numbers of fuel cell buses.

We extracted three key factors for the success of joint procurement. The key factors consist of rational and subjective factors and can be extrapolated to other transport and/or hydrogen sectors. We see the following categories:

- *Determine size, order, technologies and specifications:* Order sizes should be in such numbers that both the industries (for instance OEM's) can find an optimum in increasing efficiency and purchasing power and the operator is willing to implement. Also the tender order should include a limited set of proven technologies to cap the maximum of innovation in the product, to increase the potential for an larger market in the near future. Specific innovations, such as complex energy infrastructure changes should be addressed in parallel to the procurement. And important is identical standardised specifications increases the effectiveness of the joint procurement.
- *Determine type of joint procurement;* This is based on three conditions, first the type of ownership of the vehicles and infrastructure by the involved parties. Second the desired result of the procurement. Experience showed that market readiness for cross sector responsibilities (buses and hydrogen refuelling infrastructure) is not preferable by the majority of market parties. And third a clear picture of the marked insights, our analysed showed that the market readiness for different type of joint procurement changes over the years. Two years after the SPV exercise in the Netherlands more market parties are interested in the cross sector system responsibility via a SPV.
- *Determine commitment by involved parties.* Be aware of the interest and strategy of all possible involved partners when considering different approaches of joint procurement. Interests can strongly differ between partners and this influences the benefits of jointly procuring vehicles and/or infrastructure. The institutional setting of a region and/or the way ownership of buses and/or infrastructure is organized heavily influences the possible joint procurement strategies. It is critical that involved parties see the benefits of joint procurement and are therefore willing to give up some level of autonomy. And experiences showed that only when the initiative is started joint procurement ideas will continue to develop. The review process of pro's and con's starts within and between organizations. Creating of trust between organizations supports the willingness for joint procurement.

To finalize, experiences shows that the public private ecosystem in the sector and the commitment of partners are most important for the success and/or failure of a possible joint procurement, even if all rational factors indicate future success.

1. Introduction: implementation of fuel cell buses within the JIVE2 program

The JIVE2 (Joint Initiative for hydrogen Vehicles across Europe) project seeks to deploy 152 new zero emission fuel cell buses and associated refuelling infrastructure across 11 European cities throughout France, Germany, Spain, the Netherlands and the UK (see Figure 1). JIVE2 will run for six years from January 2018 and is co-funded by a 25 million euro grant from the FCH-JU (Fuel Cells and Hydrogen Joint Undertaking) under the European Union Horizon 2020 framework programme for research and innovation. The project consortium comprises 23 partners from nine countries.

The JIVE2 project is an expansion of the JIVE project which is now entering its second year of activity. Combined, the JIVE projects will deploy nearly 300 fuel cell buses in 17 cities across Europe by the early 2020s – the largest deployment in Europe to date.

The overall objective of the JIVE initiatives are to advance the commercialisation of fuel cell buses through large-scale deployment of vehicles and infrastructure so that by the end of the project, fuel cell buses are commercially viable for bus operators to include in their fleets without subsidy, and that local and national governments feel empowered to regulate for zero emission propulsion for their public transport systems.

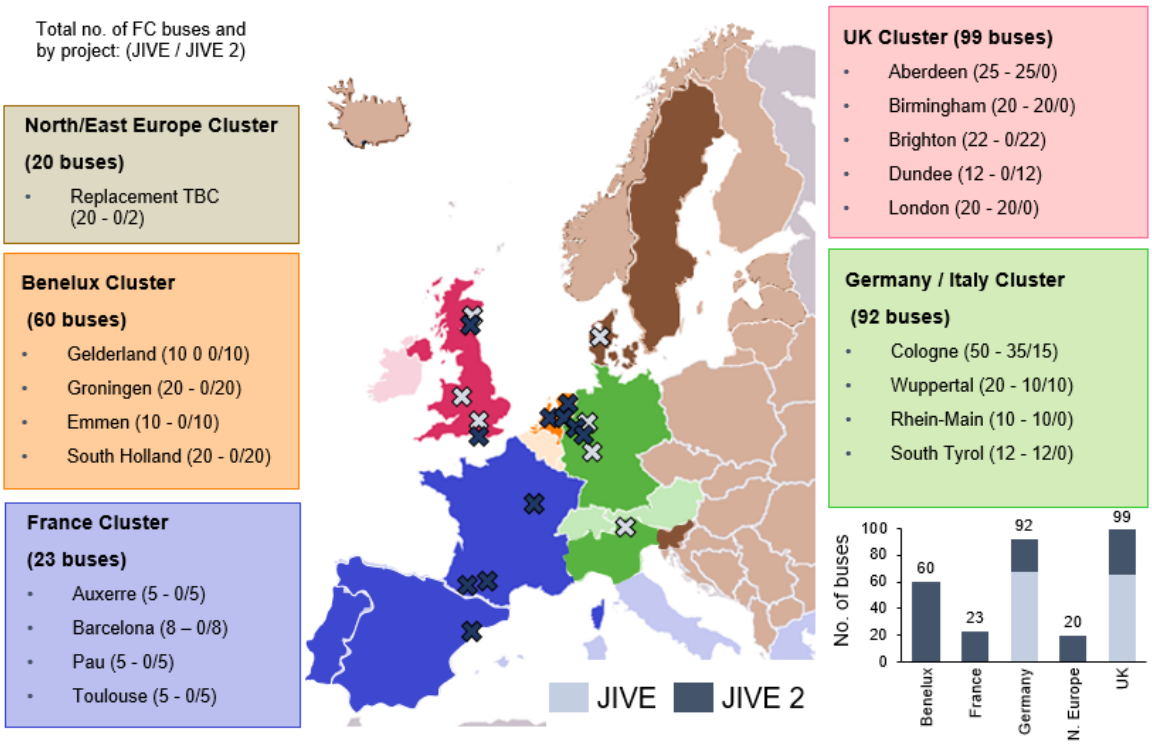


Figure 1. Overview of the JIVE2 project

General objectives of the JIVE and JIVE 2 projects:

- Reduce the purchase price of a fuel cell bus to a maximum price of €625k for a standard fuel cell bus thanks to economies of scale;
- Foster joint procurement processes, encourage manufacturers to develop and refine their fuel cell bus offers;

- Validate large scale fleets in operation and encourage further uptake, showcasing that fuel cell buses represent a viable alternative for public transport authorities, offering the same operational flexibility as diesel buses but without the harmful tailpipe emissions;
- Deploy largest hydrogen refuelling stations in Europe and operate them at near 100% reliability;
- Demonstrate routes to achieve low cost renewable hydrogen;
- Share data and best practice to support the adoption of the technology and provide evidence of the suitability of fuel cell buses for wider roll-out.

A key aim of this initiative is to reduce the costs (and hence prices) of fuel cell buses by deploying large fleets of standardised vehicles. Joint procurement approaches whereby cities with similar needs agree on common base specifications for vehicles and coordinate their tendering exercises are core to realising the economies of scale required to bring about the cost reductions in line with the project's aims. This approach is consistent with the recommendations of the 2015 fuel cell bus commercialisation study[1]:

"cities and operators need to engage and jointly prepare for large-scale deployment projects. Preparing joint procurement of FC buses is expected to stand at the centre of the work in regional clusters. Jointly procuring FC buses in cooperation with other bus operators and/or public transport authorities in the same region can help to achieve the scale effects required for a price reduction."

In JIVE and JIVE2 consortium partners work together to deliver the results as recorded in the Grant Agreement. One objective is to create economies of scale through joint procurement. In the Netherlands 3 Public Transport Authorities have tried to set up an integrated joint procurement for 50 fuel cell buses.

As a delivery of task 2.2 this document elaborates on different joint procurement approaches and describes in detail the case study of joint procurement in the Netherlands by means of setting up a joint Special Purpose Vehicle.

The aim of this task is to share learnings about joint procurement strategies with EU-regions, cities, public transport authorities and operators in order to help these parties to improve conduct joint procurement strategies in the future.

The primary purpose of joint procurement is cost reduction. However, we see the following additional spin-off effects that a joint procurement strategy for fuel cell buses can have. These effects can lead to further cost reduction and can enhance the quality (reliability) of fuel cell bus exploitation. These effects are:

- Stimulation of market development;
- Stimulation of innovation;
- Potential for standardization.

[1] https://www.fuelcellbuses.eu/sites/default/files/documents/150909_FINAL_Bus_Study_Report_OUT_0.PDF

2. Joint procurement: what is it and why should we use it?

2.1 The benefits of joint procurement

Fuel cell buses are characterized by higher CAPEX (and potentially lower OPEX). The higher CAPEX can be explained by the innovative character and the small-scale and therefore cost-inefficient production of fuel cell buses. Although capex costs are reduced over the past years, there is still a gap to bridge in relation with conventional diesel buses. It is not likely that the capex costs of fuel cell buses will drop below the capex of diesel buses within the foreseeable future. Also, the operational costs of fuel cell buses are still higher than these of diesel buses. However, the maintenance costs of fuel cell buses have the potential to decline, in particular when the number of buses on the road (in Europe) increase and service locations of bus suppliers are more present and spare parts are abundant.

Hydrogen technology is still developing strongly and orders for buses currently often consist of numbers up to ten to twenty. In total, over 250 fuel cell buses have been ordered in Europe. Not all bus manufacturers supply hydrogen models and the ones that do so generally do not yet have a standardized production line. The production capacity is therefore limited and delivery times are still long and can increase quickly if demand rises. Manufacturers are not yet expanding production lines due to uncertainties about future orders and quantities. The bundling of orders of buses can offer manufacturers more certainty of purchase in the short term, enabling them to set up their processes better and more efficiently. This also makes it easier for manufacturers to bear any development costs and to better cover risks.

Diesel buses are the established order even though they are phasing out as a result of sustainability goals that governments have set. In the diesel bus market, the size of orders has hardly any effect on the purchase and maintenance price per bus. Therefore, bundling orders in a joint procurement does not yield (virtually) any financial benefit. Manufacturers have standardized their production process and can easily scale up or down in numbers in response to (predictable) market demand. The diesel bus market is settled and there is a wide range of manufacturers to create healthy market forces and thus a 'good' price for a diesel bus. The technology of diesel buses (innovation) is - apart from ever ‘cleaner’ Euro standards - basically fully developed and does not need any further incentive to further reduce costs.

The primary purpose of joint procurement is cost reduction. However, we see the following additional spin-off effects that a joint procurement strategy for fuel cell buses can drive which in turn lower the overall costs and enhance the quality (reliability) of fuel cell bus exploitation:

- Stimulation of market development;
- Stimulation of innovation;
- Potential for standardization;

Below we elaborate on the purpose of cost reduction and the spin-off effects that joint procurement can drive.

2.1.1 Cost reduction

Joint procurement is a method that has the potential to speed up the development of mass production and therefore, harness the benefits of economies of scale and reducing the costs per unit. This can be the result of direct cost reduction by, for instance, simply placing a larger order by a manufacturer or through indirect cost reduction through operational efficiencies.

Furthermore, producers can purchase components from second-tier suppliers in larger quantities, resulting in lower costs. These advantages can be significant when orders are large enough.

2.1.2 Stimulation of market development

Next to the goal of cost reduction, joint procurement can be used on a broader scale in the transition towards cost competitive fuel cell buses through the stimulation of market development and innovation. Critical demand levels can be attained by bundling market power and therewith attract manufacturers and suppliers to produce, supply or innovate in hydrogen technologies. Due to larger orders, a supplier has the possibility to spend more funds on research and development and setting up new supply or production chains. A more mature market leads to lower costs, but also to higher quality of vehicles (reliability) and better support and or service in case of malfunction or defects.

2.1.3 Stimulation of innovation

With the increase in market demand, new producers and suppliers will be attracted to hydrogen technologies. This increased competition stimulates the entire supply chain to produce smarter and better, resulting in further innovations throughout the supply chain. These innovations will again lower the cost and increase the quality (reliability of vehicles) of the product.

2.1.4 Potential for standardisation

By increasing the order size in the implementation of new technologies, this leads potentially to market standardisation. This could be specifically true for innovative techniques that require for instance standardisation between the vehicles and the hydrogen infrastructure. This standardisation can be facilitated by the creation of dedicated supply chains which also benefit and stimulate further production. Or the standardisation can be encouraged through external factors by, for example, using the same standards for infrared communication between HRS and bus. In its turn, standardisation can lead to lower CAPEX and OPEX.

3. Organisational structures for joint procurement

There are many possible approaches and forms in which joint procurement can be applied. To select suitable types of joint procurement the involved stakeholders and the most applicable parameters for the implementation of fuel cell buses need to be identified. Based on joint procurement examples in different sectors and interviews, the following parameters are identified to be key:

- Level of organization, from individual to centralized;
- Ownership of vehicles;
- Responsibility for the procurement procedure;
- Responsibility for finance;
- Responsibility for vehicle maintenance.

Based on these parameters, 3 scenarios of joint procurement are defined that give a general overview of the possibilities of joint procurement.

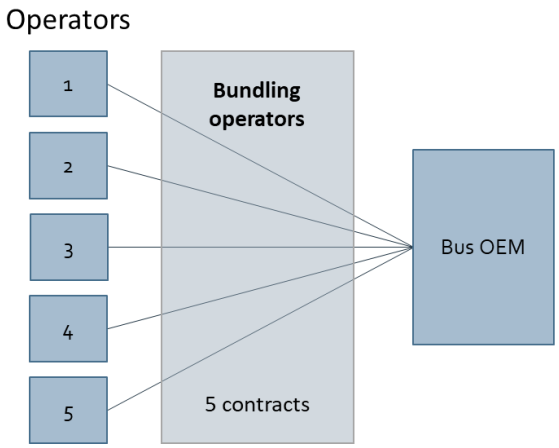
On the one side of the spectrum there is the most conservative structure that maintains the current capital funding approach of the operator. At the other end of the spectrum is the most radical form of joint procurement by means of a newly established SPV from where the buses are jointly procured for the operators. In between there are numerous ways of joint procurement one can think of. For the ease of this document we elaborate on 3 different organizational structures to accommodate a joint procurement, with a distinction based on the ownership of the buses:

1. Ownership by operators;
2. Operators organized in a collaboration;
3. A Special Purpose Vehicle (SPV) owning the buses.

Hereafter we elaborate on the 3 models of organizing the joint procurement.

3.1 Joint procurement by independent operators

In this joint procurement scenario, bus owners join forces in order to put out an order for a larger number of buses. The buses will be build based on the specifications and criteria of the different operators, however, the most benefits are attained when these specifications and criteria are as uniform as possible. The operators all have their own contract with the OEM and are separately responsible for arranging funding and maintenance contracts. This strategy was used in Germany under JIVE/JIVE2 (see also section 5 of this document) where Regional Verkehr Köln and Wuppertal Stadt Werke procured fuel cell buses based on relatively similar technical and tender requirements.

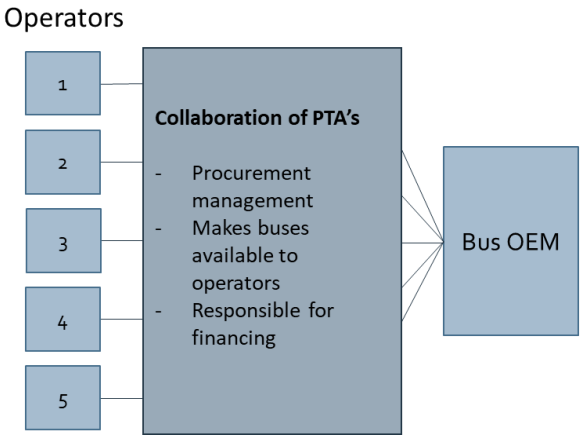


Parameter	Specifics/ Responsibility
Level of organization	Low
Ownership of buses	Operator
Responsibility for procurement procedure	Operator
Responsibility for Finance	Operator
Responsibility for Maintenance	Operator

Figure 2. Joint procurement by individual operators

3.2 Joint procurement by a collaboration of authorities

It is also a possibility that PTA's join forces in order to procure a larger number of fuel cell buses. This could be done by working together based on a cooperation agreement for joint procurement. In this scenario, the collaborating PTA's procure the buses from an OEM. The buses will be owned by the respective PTA's and will be made available to the already contracted PTO's. The buses are delivered based on a single contract between the OEM and the cooperating PTAs.



Parameter	Specifics/ Responsibility
Level of organization	Moderate
Ownership of buses	PTA(s)
Responsibility for procurement procedure	Collaborative of PTA's
Responsibility for Finance	Collaborative of PTA's
Responsibility for Maintenance	PTA and/or operator

Figure 3. Joint procurement by a collaboration of PTAs

The collaborative PTAs are responsible for the management of the procurement, drafting tender documents, drafting contracts. However the PTA's will be responsible for their own funding and financing. In addition, the PTAs are forced in this scenario to play a project management role during the construction phase and act as an intermediate in case of any issues between OEM and operators. With the collaborating PTAs, efficiency towards the OEM and more standardisation can be attained.

3.3 Joint procurement by Special Purpose Vehicle (SPV)

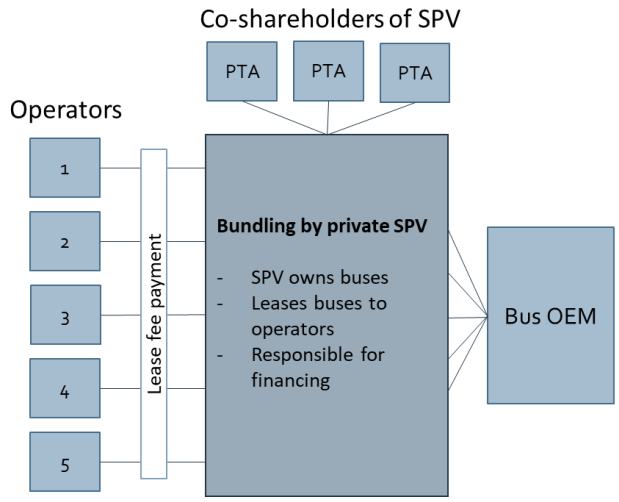
Fuel cell buses come with relatively high investment costs and bring (still) more operational risk and uncertainty with them. The prospect of fully financing these investments and being responsible for the related risk, might discourage operators to invest in fuel cell buses. To limit these risks and uncertainties and eliminate the high CAPEX, a joint procurement scenario with a third party owning entity can be initiated that leases the buses to the operators.

We refer to this entity as a Special Purpose Vehicle (SPV). The SPV acts as a vehicle for the investment, procurement, and maintenance of the buses and is therefore also responsible for risks related to the procurement procedure and the operation of the buses. For the availability of the vehicles, operators pay a (monthly) lease fee to the SPV. In addition a SPV creates flexibility; if an operator is unable or unwilling to continue operating the buses, the SPV can lease out the buses to another operator and/or in a different geographical area. By doing so, deployment of the fuel cell buses for their technical life time is better secured. The SPV construction also allows for adding new (joint) procurements to the portfolio where the procedures, tender documents etc. can be re-used creating more standardisation and efficiency in the procurement process.

The core of this scenario is the establishment of a SPV. The operator or manager of the SPV can be a financial party, which often have established leasing offices. However, also bus operators/cooperatives or OEMs can be installed as managers of the SPV. The ownership of the SPV can be public and/or private. However, in the case of private ownership, it would be recommended to have the involved PTAs as shareholder of the SPV as well. By doing so, the PTAs are in control over the activities that the SPV performs and can align this with the operation of the buses via the concession contract with the operator.

Through the SPV, operators need to concede ownership of the buses and become ‘end-users’ through a full operational lease contract. This represents a significant change in the business model for the current operators (in most European countries), who take ownership and autonomy in high regard. Due to this change, this model might lead to push back by operators.

This type of joint procurement might also provide a good opportunity to integrate with the realization of new energy infrastructure. It will be difficult to secure the required minimal hydrogen offtake from individual operators for the realization of new energy infrastructure. With the SPV, end-users are bundled together with compatible buses. With this joined market power, an agreement or possible collaboration between an infrastructure provider and the SPV will have a higher chance of success.



Parameter	Specifics/ Responsibility
Level of organization	High
Ownership of buses	SPV
Responsibility for procurement procedure	SPV
Responsibility for Finance	SPV
Responsibility for Maintenance	SPV/operator

Figure 4. Joint procurement by applying an SPV

The key question in joint procurement is how the involved operators collaborate and organize themselves and whether or not they should do this in alignment with the PTAs. Again, the above described models are possible ways to organize a joint procurement. However, there a numerous scenarios in between that one can apply. In our search for the organizational structure for joint procurement in the Netherlands we defined different scenarios that we explored. Although we had the preferred scenario for an SPV for the context at hand in the Netherlands it is well conceivable that other models may apply better in different circumstances. We therefor stretch our experience and lessons learned based on the case study in the Netherlands described in chapter 0.

4. Case study the Netherlands

4.1 Introduction

The public transport sector in the Netherlands has historically grown into a public operator dominated sector in the bigger cities (Amsterdam, Rotterdam and The Hague) and an open market sector in the more rural area and smaller cities. In the latter there is market competition among private PTOs where they answer on tenders for concessions which are issued every 8 years plus a possible extension of 2 years. The provinces in the Netherlands act as PTA for their geographical area of responsibility. PTOs that win a concession are responsible for the procurement of buses and equipment.

The PTAs in the Netherlands agreed on a plan (BAZEB agreement) on making the public transport sector buses 100% zero emission by the year 2030 and accept only new zero emission buses to flow in operation from the year 2025 onwards. Part of the bus lines in the Netherlands are characterised by long distances and high average speeds (freeway), being suitable to apply fuel cell buses as part of the solution for a complete zero emission bus fleet.

Based on the experience with several small pilot projects in the Netherlands a step up was made by joining the JIVE2 consortium with 3 PTAs. Subsidy for 50 buses is allocated to these 3 PTAs which serve an 'open market area' in the Netherlands (Groningen 20 buses, Zuid-Holland 20 buses, Noord-Brabant 10 buses). A context that in principle is suitable for joint procurement.

Although a joint procurement seemed to be achievable in this situation, the PTAs faced challenges as well. Setting up a joint procurement was complicated by the following factors:

- **3 different public transport authorities** that have a common goal of a 100% zero emission bus fleet in the Netherlands. Although the ambition of full zero emission bus fleet in the Netherlands was agreed upon in the BAZEB agreement, the strategy and actions set out to accomplish this differs per authority and may be contradictory. The collaboration for joint procurement started with the 3 PTA's province of Noord-Brabant, OV Bureau Groningen-Drenthe and the province of Zuid-Holland. The province of Noord-Brabant sought the combination of 10 buses with hydrogen garbage trucks to be refuelled at the same refuelling station. Lack of financial support of local project partners and a lock-in effect due to subsidies for the refuelling infrastructure collapsed the local project forcing the province of Noord-Brabant to withdraw from the JIVE2 project. An alternative partner for the 10 buses was found in Emmen. Withdrawal of the Noord-Brabant partner weakened the benefits from joint procurement since it was not clear if an order of 50 buses would be possible. The OV Bureau Groningen-Drenthe then had the pressure of the start date of the new concession and decided to procure their batch of 20 buses in a single procurement.
- **3 different (private) operators** which are competitors in the Dutch public transport market and all have their specific preferences regarding the specifications of the fuel cell buses. In a normal situation these operators would never go hand in hand procuring their vehicles. Due to the innovative approach of an SPV they were willing to work together. Another complication was that due to the timings of the concessions it was not clear yet for each concession which operator would be the concessionaire.

- **3 different concessions** with unaligned starting dates and durations (see figure below) complicated the timing of joint procurement and delivery of the fuel cell buses. In addition, the contractual obligations regarding the application of fuel cell buses differed per concession contract. In the new to tender Groningen-Drenthe concession it was possible to oblige the winner of the concession to operate the 20 fuel cell buses. In the HWGO concession, for example, no agreements were made for the operation of fuel cell buses, causing the PTA to set up an extra contract and provide a compensation for the extra costs for the fuel cell buses.

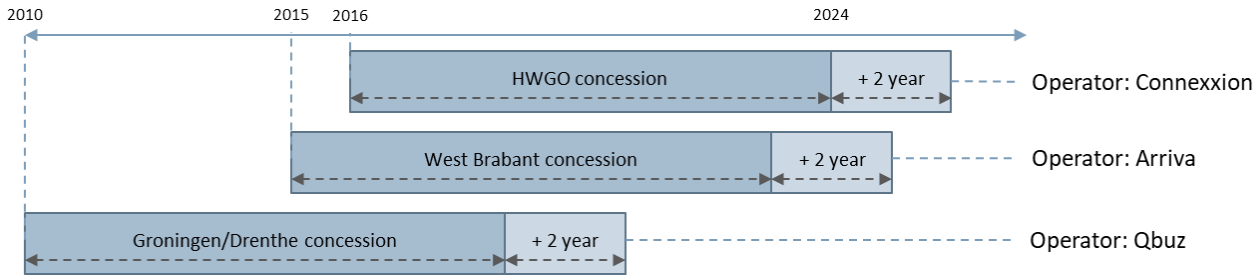


Figure 5. The 3 concessions with timings and operators

In hindsight, **the scope (number of buses and strategy)** of the joint procurement as well as the **involved stakeholders** (PTAs and PTOs) changed during the development phase of the joint procurement/SPV construction. This was due to political and financial considerations of induvial parties not related to the joint procurement. It caused serious delays in adding new partners to the collaboration for joint procurement.

4.2 Extensive market consultation, focus on joint procurement SPV

To gain insights in the feasibility and market appetite for the delivery of 50 fuel cell buses including hydrogen supply by means of a SPV construction, a market consultation was conducted. Bus OEMs, hydrogen suppliers and financial institutions were interviewed on which construction of joint procurement would prevail for them in order to set up a joint procurement with the highest success rate. The market consultation focused on gaining insight into the following disciplines:

- The feasibility of the maximum price for 50 fuel cell buses (combination of CAPEX and OPEX) indicated by the FCH-JU;
- The willingness of the market parties to offer and operationalize 50 fuel cell buses;
- The structure of joint procurement for 50 fuel cell buses that the market prefers;
- The willingness and price of the market to offer hydrogen refuelling infrastructure (including the delivery of hydrogen) for the concerning locations;
- An appropriate set of criteria / requirements of which the market prefers them to be part of the tender documents.

The outcome of the market consultation regarding the structure of joint procurement was:

- Joint procurement does lower the investment costs of the buses from batches of 30 buses onwards. When the number of buses in the joint procurement increases the cost reduction on the investment costs per bus decreases.
- One OEM saw the possibility and advantage of providing system responsibility (i.e. delivery of buses and hydrogen in one procurement) and collaborating in a consortium with a hydrogen supplier. We concluded that the market is still too immature and a request for system responsibility would be too much of a risk for the tender. Hydrogen suppliers were not willing to accept the risks related to the bus operations. Due to the severely different expertise and lack of knowledge and understanding it was impossible to come to acceptable risk assessment.
- The market consultation was conducted in 2018. At this moment it seems that the market is developing in their point of view regarding system responsibility. This shows for instance in the fact that a new Danish player introduced itself in the market with exactly this business model. In addition, bus OEM's are reconsidering their business models and are developing more 'Bus As A Service' type of contracts.

4.3 Joint procurement model in the Netherlands

Based on the exploration of different possible constructions for joint procurement as described in chapter 3 the 3 PTAs found the structure with a publicly owned Special Purpose Vehicle (SPV) that purchases the 50 buses and provide these via a lease construct to the 3 operators to suit best for the case (see figure below). The structure leaves the PTAs in control over both the purchase of the assets and the bounding of the PTOs to the use of the buses in the current as well as the subsequent concession.

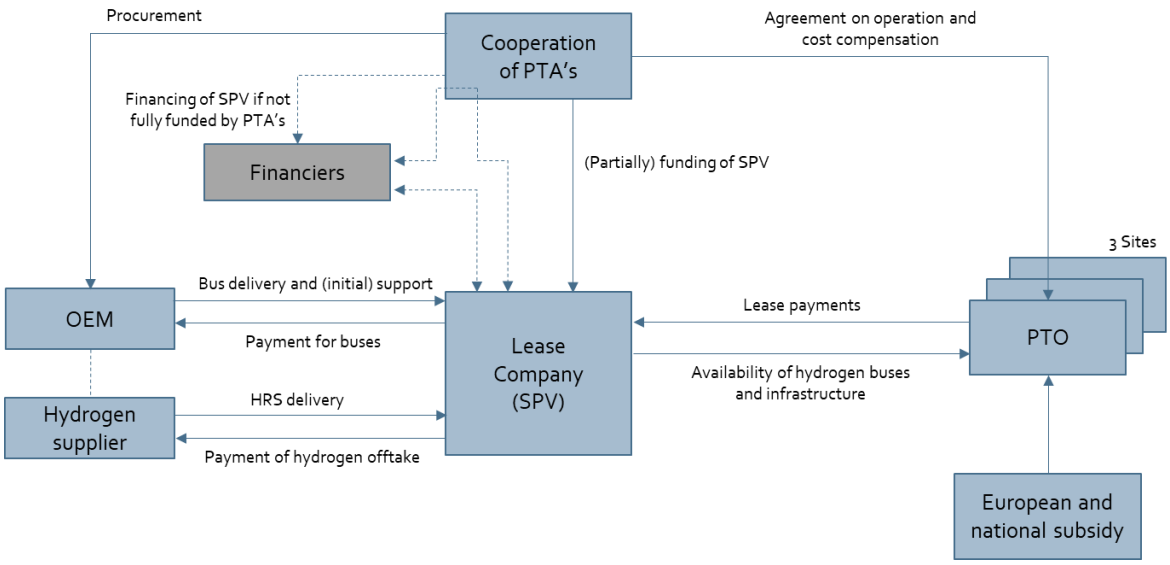


Figure 6. SPV model as to be applied in the case in the Netherlands

In this structure:

- The cooperation of PTAs procures the 50 fuel cell buses and in the case the PTAs chose to partially fund the SPV the cooperation procures the remaining financing as well;

- Financing agreements are either with the cooperation of PTAs and the cooperation passing the financing through into the SPV, or directly with the SPV – with government guarantee;
- Supply and deliver contracts for buses and hydrogen (infrastructure) (including an initial service & support agreement for maintenance training, initial spare parts, etc.) is signed by OEM with the SPV directly;
- The assets are held and/or managed in the SPV with PTAs remaining the final legal owner; and
- PTOs are required to lease the fuel cell buses from the SPV and are contractually bound to pay lease fees to the SPV, keep to a care and maintenance obligation, as well as a handover obligation for transfer of assets to possible subsequent concession holders. Agreements are made within- or in an amendment of the concession contract signed by PTA and PTO.
- The PTOs are the beneficiaries of the European and national subsidies. This creates an incentive for the PTOs to meet the obligations that come with these subsidies.
- There is a risk in managing the technical and planning interface between the hydrogen infrastructure and buses when bus OEM and hydrogen supplier are contracted separately. Including specific agreements for responsibilities in these separate contracts can mitigate this risk. A more robust solution would be to request for system responsibility and have one contract partner for hydrogen and bus delivery (the market should be ready for this, which is not the case at this moment).
- The structure allows for upscaling of the number of buses in the SPV within the areas of responsibilities of the involved PTAs. In addition other PTAs could join the cooperation of PTAs and have a share in the SPV ownership enabling for geographical expansion of the deployment of (additional) fuel cell buses.

4.4 Lessons learned from the case study

Private sector was willing to adopt SPV. The private sector sees the benefits of joint procurement via a SPV construction. Some OEMs are thinking of pulling the SPV concept into their organisation, providing fuel cell buses – whether or not including hydrogen delivery – as a service towards their customers. Financial institutes prey for the same market share providing in financial lease construction holding the entity of an SPV.

Very limited market appetite for system responsibility hydrogen supply and buses. Contrary with battery electric buses where – at least in the Netherlands – system responsibility is taken by (bus) OEMs to provide buses and infrastructure in one service, this is not the case for hydrogen. The businesses of bus OEMs and hydrogen suppliers/infrastructure constructors are still too far apart from each other, causing caution for them to collaborate and being dependent on the risks and of each other. Both parties do not yet understand the others' business enough to come to a fruitful partnership.

Collaboration between public parties for joint procurement of buses proved to be difficult. Although the goal of a full zero emission public transport sector is equal for the PTAs, they all do have their own agenda, strategies and timings which potentially makes a sound collaboration difficult. Understanding of- and respect for each other's approach and the requirement of sufficed pace are key element on which the partnership should be based on.

Market is not yet ready to provide system responsibility. After a second round of market dialogue it was decided not to jointly procure the buses and HRS in one procurement procedure (system responsibility). Based on the insights gained in the final market dialogue it became clear there was insufficient interest for system responsibility. Both bus OEM's and hydrogen suppliers have insufficient understanding of each other's businesses and have difficulty to assess the risks related to the other's business and incorporate these in their own (and finally combined) pricing and operational systems.

4.5 JIVE2 Results in the Netherlands

Although the joint procurement of the 50 fuel cell buses in the Benelux cluster was not conducted, there have been separate procurements of the buses batches in each region. By doing so, the goal of implementing 50 fuel cell buses in the Netherlands is – at the time of writing – under way to be achieved tot 60 fuel cell buses. A short update on the project sites:

Project site Zuid-Holland
The province of Zuid-Holland published a tender for the construction of a hydrogen refuelling station and the delivery of hydrogen for a period of 12 years. A contract was awarded in August 2020. The 20 buses were purchased by operator Connexxion in the spring of 2020. According to the planning the hydrogen refuelling station and the buses will be delivered in November 2021. The new buses will flow into operation when the operator starts the new operational schedule in December 2021.

Project site Groningen
Due to pressure of the start of the new concession by the end of 2018 the OV bureau Groningen decided to procure the 20 buses for their region themselves. It fell back to the regular procurement construction where the operator (Qbuzz) purchases the buses. the OV bureau tendered the construction of the hydrogen refuelling station and the delivery of hydrogen for a period of 10 years.

Project site Emmen
Due to a called-off project by the government of the province of North Brabant instead the OV bureau Groningen decided to procure 10 buses for the city of Emmen in the province of Drenthe. This is part of the same concession with the same operator as the project Groningen. It chose to follow the path of regular procurement where the operator (Qbuzz) purchases the buses. The OV bureau is expected to tender the construction of the hydrogen refuelling station and the delivery of hydrogen for a period of 10 years.

Project site Gelderland
Following called-off projects outside the Benelux cluster, the Province of Gelderland is proposing to start a project with buses as part of the JIVE2 project within the Jjssel-Vecht concession. The aim for this project is to be operational by the end of 2021. The PTO Arriva procured 10 fuel cell buses (Solaris) in the IJssel-Vecht concession. The HRS will be realized in the City of Doetinchem.

5. Comparison with other joint procurement exercises in Europe.

In the years 2015 to 2017 joint procurement exercises for fuel cell buses were conducted in several European regions. The results of these exercises are collected in an overall report named "Lessons from FCB Procurement" that can be found at https://www.fuelcellbuses.eu/public-transport-hydrogen/lessons-learnt-fcb-joint-procurement-d11-june-2018. We will not repeat the conclusions from the previous report, but highlight the characteristics of these exercises and compare these with the case study in the Benelux cluster.

Northern Europe

Compared to the other areas involved in this project, the Northern Europe cluster is unusual given the larger number of different countries (and very wide geographic area) represented. The work on supporting cities across this region with developing business cases and procurement plans for fuel cell buses revealed the following. Achieving the original ambition to establish a joint procurement approach encompassing all cities / regions in the cluster was fraught with difficulties arising from a combination of factors. These include differences in legal frameworks, languages, ownership arrangements, commercial structures, technical requirements, readiness to deploy fuel cell buses and levels of commitment to such projects between the different cities and countries.

The project in Northern Europe has provided the insight that there are important geographical factors which need to be taken into account in joint procurement processes. Several critical success factors have become apparent from studying Northern Europe:

- Between different geographical regions legal frameworks differ;
- Language barriers prohibit clear communication;
- Different ownership arrangements need to be made;
- Commercial structures differ from each other;
- Different technical requirements;
- Different levels of commitments and maturity towards fuel cell buses between cities.

This complexity, arising from the differences between the involved organizations, can also be seen in the Netherlands. The different governmental and public transport organizations need to cooperate and come to a combined strategy in everyone's favour.

Germany

In Germany a joint procurement exercise was conducted for 50+ buses. The number of OEMs prepared to respond to the formal tender in 2017 was lower than anticipated, with only two suppliers willing to provide vehicles and able to demonstrate an ability to satisfy all conditions of the tender. Besides mature buses, a high level of local aftersales support was requested to allow a reliable daily operation of the buses. At this moment (2021), the market for fuel cell buses is different from 2017. If a comparable tender would be put on the market at this moment a larger number of interested OEM's is expected.

The main lesson learned from Germany is that there has to be ample market demand for a competitive bid. In the case of Germany the grand total was insufficient to create significant

demand. Subsequently, after sales is great importance to the added value. This has also been the case in the Benelux, where an SPV could be the solution.

For a cluster-wide identical tender it is necessary to find a simple specification and at least a uniform bus concept. But since every customer has different requirements (topography, length of lines etc.) and wishes regarding the equipment (e.g. driver's working place, announcement system, number of seats, doors), joint procurement of an identical bus in the German public transport bus business was a bigger challenge than expected.

The high level of organization specific requirements, both at governmental level as at carrier level, led to a situation where a functional inquiry became impossible. In the Benelux this situation has been averted by steering towards a simple inquiry through the SPV.

United Kingdom

In the United Kingdom the buses were after a several considerations tendered by Transport of London via a framework of suppliers for two lots for different types of buses. In the research phase the involved parties considered the option of jointly procuring hydrogen refuelling stations / hydrogen supplies. However, they concluded that given (a) the differing requirements in different locations and (b) the limited scope for economies of scale effects to reduce costs, it is more appropriate for cities to develop their own refuelling infrastructure plans.

The same approach has been applied in the Benelux, through the SPV. It has proven to be complicated, because there is still a too big of a difference between the bus and HRS sector and organizations.

6. Overall conclusions

In 2015 the FCH-JU stated that cities and operators need to engage and jointly prepare for large-scale deployment projects, for example with a joint procurement construct. Over the past years several exercises and preparations of exercises are conducted in Northern Europe, the Netherlands, United Kingdom and Germany.

As stated, joint procurement is a method that has the potential to speed up the development of higher production numbers and therefore, increase the benefits of economies of scale and reducing the costs per unit. Next to the goal of cost reduction, joint procurement can be used on a broader scale in the transition towards cost competitive fuel cell buses through the stimulation of market development and innovation. With the increase in market demand, new producers and suppliers will be attracted to the new hydrogen technologies. And by increasing the order size in the implementation of new technologies, this leads potentially to market standardisation. In theory there are valid reasons to bundle orders for fuel cell buses in a joint procurement. However, it might not be evident that joint procurement always necessarily leads to the desired results. Or that the efforts needed for joint procurement weigh up against a single procurement of smaller numbers of fuel cell buses.

Out of the case study in the Netherlands we extract key factors for success of joint procurement. The key factors consist of rational and subjective factors and can be extrapolated to other transport and/or hydrogen sectors. We see the following categories:

- Determine size, order, technologies and specifications;
- Determine type of joint procurement;
- Determine commitment by involved parties.

Determine size, order technologies and specifications
First is to determine the most effective order size of economies of scale from an industry perspective for a potential joint procurement exercise. Order sizes should be in such numbers that both the industries (for instance OEM's) can find an optimum in increasing efficiency and purchasing power and the operator is willing to implement. In specific cases we found that the operator was disappointed in delivery due to incorrect expectations based on his own sector.

Second the tender order should include a limited set of proven technologies. These types of joint procurement tenders are meant for scaling up the production of fuel cell buses, not as pilot project for technical innovations. Also, operators and industries have to invest in every technical development. And with these investments comes the risk that they might not be earned back. Therefore, joint procurement will not be very attractive for operators and industries if this means investing in a technique when market demand after this initial joint procurement is unsure or unlikely. Investment will be feasible when there is potential for an larger market in the near future.

Third, techniques that require large changes in energy infrastructure next to a vehicle, the issues concerning this infrastructure should be addressed in parallel and/or conjunction of the joint procurement of the vehicles.

Fourth, set identical specifications for a standardized product, for instance a standard bus concept. The most effective is fully identical specifications. The more identical they are, the

larger the potential benefits. Optional are a limited set of different lots with identical specifications per lot.

Determine type of joint procurement

The type of procurement is firstly dependent on the type of ownership by the involved parties. Key in the differences between independent parties, a cooperative of a Special Purpose Vehicle is the type of ownership when procuring, implementation and operation of the buses. A Special Purpose Vehicle has many benefits from a financial perspective, but is less attractive if an operator wants full control and ownership over the buses and/or infrastructure.

Second, experience showed that market readiness for cross sector responsibilities (buses and hydrogen refuelling infrastructure) is not preferable by the majority of market parties. Although there are limited parties which are very interested and see benefits based on their positioning in the market. Research showed that there was a very limited market appetite for system responsibility hydrogen supply and buses.

Third, provide optimal market insights due to the experiences that showed that the market readiness for different type of joint procurement changes over the years. Two years after the SPV exercise in the Netherlands more market parties are interested in the cross sector system responsibility via a SPV.

Determine commitment by involved parties

First, one should be aware of the interest and strategy of all possible involved partners when considering different approaches of joint procurement. Interests can strongly differ between partners and this influences the benefits of jointly procuring vehicles and/or infrastructure.

Second, the institutional setting of a region and/or the way ownership of buses and/or infrastructure is organized heavily influences the possible joint procurement strategies. In the Netherlands the way that transport authorities and operators are organized differed per region. Therefore joint procurement proved to be difficult.

Third, it is critical that involved parties see the benefits of joint procurement and are therefore willing to give up some level of autonomy. Inherent on all types of procurement is more collaboration and less control than single procurement by the own organization.

Fourth, experiences showed that only when the initiative is started joint procurement ideas will continue to develop. The review process of pro's and con's starts within and between organizations. Creating of trust between organizations supports the willingness for joint procurement.

And to finalize, experiences shows that the public private ecosystem in the sector and the commitment of partners are most important for the success and/or failure of a possible joint procurement, even if all rational factors indicate future success.

Project coordination:

elementenergy

Project dissemination:

Hydrogen Europe

The JIVE and JIVE2 projects have received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 735582 and 779563.

This Joint Undertaking receives support from the **European Union's Horizon 2020** research and innovation programme, Hydrogen Europe and Hydrogen Europe Research. The **MEHRLIN** project is co-financed by the **European Union's Connecting Europe Facility.**

@fuelcellbus
www.fuelcellbuses.eu

Co-financed by the Connecting Europe Facility of the European Union

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING