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EMISSION FREE MODES OF PUBLIC TRANSPORT

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The commitment in many countries to zero emissions at the tailpipe for buses opens up an era under transition with a new set of risks and uncertainties to both bus operators and the regulator. The switch to clean energy brings energy providers, both generators and distributors, as well battery pack and electric or hydrogen bus providers, and infrastructure specialists, into the mainstream of service provision, signifying that the risks in transition over the next 30 or so years should be shared amongst a larger set of upstream service providers who stand to gain through new opportunities from the transition. De-risking through greater sharing is common in many supply chain ventures and is an appealing way of transitioning to a green energy future for the provision of bus services. We promote the idea of a competitively defined supply chain partnership procurement model, implemented through tendering or negotiation, as a way of spreading the risk to all who will gain from this new future. This has the potential, without guarantee, to support many more bus operators staying in (or indeed entering) the industry to enable an effective competitive process, especially the relatively smaller operators who currently lack the expertise and knowledge to weather this transition, best described as an extreme event. This paper is a conceptual think piece rather than a scientific one, designed to open up new ways to consider procurement and contracting in the context of the transition to zero emission buses, but it has wider value in other sectors.

Is it time for a new bus contract procurement model under a zero emissions bus setting?

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Abstract

The commitment in many countries to zero emissions at the tailpipe for buses opens up an era under transition with a new set of risks and uncertainties to both bus operators and the regulator. The switch to clean energy brings energy providers, both generators and distributors, as well battery pack and electric or hydrogen bus providers, and infrastructure specialists, into the mainstream of service provision, signifying that the risks in transition over the next 30 or so years should be shared amongst a larger set of upstream service providers who stand to gain through new opportunities from the transition. De-risking through greater sharing is common in many supply chain ventures and is an appealing way of transitioning to a green energy future for the provision of bus services. We promote the idea of a competitively defined supply chain partnership procurement model, implemented through tendering or negotiation, as a way of spreading the risk to all who will gain from this new future. This has the potential, without guarantee, to support many more bus operators staying in (or indeed entering) the industry to enable an effective competitive process, especially the relatively smaller operators who currently lack the expertise and knowledge to weather this transition, best described as an extreme event. This paper is a conceptual think piece rather than a scientific one, designed to open up new ways to consider procurement and contracting in the context of the transition to zero emission buses, but it has wider value in other sectors.

Key Words: Zero emission buses; Bus contracts; procurement; competitive tendering; negotiation; supply chain partnership; risk and uncertainty; zero emission buses

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Introduction

> *"What is required is not a myopic, blind pursuit of a process goal [of a contract specification] often driven by dogma and ideologism, but a better appreciation of nuance in ensuring that context-specific institutional structures are put in place, guided by clear end goals."* (Wong 2020)

The bus sector has, for many years, relied on a set of inputs best described as 'well known' in terms of the cost obligations that operators need to account for in providing a service delivered through a regulatory process that is either negotiated or tendered (Hensher and Stanley 2008, Hensher 2020). While there are always risks associated with the fine tuning of costs in order to provide both cost and service efficiency, the historically accumulated knowledge has enabled the great majority of bus operators to work within a standard, fixed route market using diesel buses that they understand with varying degrees of capability. Historically, although bus operators since de-nationalisation in many countries have come and gone, especially under economic deregulation, and the popularity of competitive tendering or negotiation under a performance regime, this has resulted in a healthy number of efficient bus operators[1].

This circumstance has been rocked in recent years with the commitment of many governments to a zero emission (at the tail pipe) target defined in a timetable or a plan to achieve full electrification of existing diesel bus fleets[2] as part of wider targets for the decarbonisation of the transport sector. Suddenly, we see a new set of risks given the uncertainty associated with the availability and cost of non-diesel buses, the capability of energy suppliers to provide sufficient electricity from the grid to charge a fleet of buses (as distinct from one or two trial buses), the associated cost of energy, the need for a significant re-construction of the depot to accommodate charging, let alone the training required for maintenance and other staff in operating non-diesel buses. This risk is made more complex by uncertainty as to whether electric or hydrogen is the way to go, with an investment in electric buses having a stranded asset risk if hydrogen subsequently is a preferred energy source[3] (see Hensher et al. 2022 and the Appendix of the current paper).

This paper proposes a way forward to share the risks associated with an uncertain transition to ZEBs and is structured as follows[4]. We propose a procurement model for the bus sector which entails greater risk sharing amongst all stakeholders who will benefit from the ZEB transition. Essentially, optimal risk allocation seeks to assign project risks to the party in the best position to control them[5]. The party with greatest control of a particular risk has the best opportunity to reduce the likelihood of the risk

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[1] Several of whom have become large multinational enterprises in their own right with the ability to influence Government.

[2] Especially relevant now that COP26 has just occurred. See Global Commercial Drive To Zero Program — Landmark commitment at COP26: Countries, subnational governments, vehicle manufacturers and fleets target 100% zero-emission new truck and bus sales by 2040 | 10 Nov 2021 (globaldrivetozero.org)

[3] Industry specialists advise me that this risk amounts to no more than 20% of the investment in electric charging at the depot. Also, London is putting itself forward as aspiring to be a world leader in hydrogen. Cleaner buses | London City Hall

[4] In writing this paper (including a plenary presentation at a ZEB Forum in Sydney in December 2021 (150 participants online), I have consulted with and discussed the ideas and received much feedback from OEMS (e.g. Volvo, Futon, Yutong), Energy providers (notably Energy Australia), battery pack manufacturers and distributors, bus associations and specific operators in Australia and Europe (such as Tower Transit in London and Singapore and Transit Systems throughout Australia), and a limited number of government organisations (who seem less keen to share ideas other that say there appears to be merit). It is with this experiential setting that I have prepared this paper. Volvo in particular were extremely supportive and the Vice-President Australasia and Asia (David Mead) provided extensive feedback on earlier drafts.

[5] This may become even more important with the aftermath of the Ukraine war, resulting in higher prices of diesel and the cost of minerals used in batteries. It will increase the cost of all energy sources.

eventuating and to control the consequences if it. We then discuss how this might be introduced into the market and what it will mean for bus operators and the regulator. If, however, the regulator desires total control, then it is likely that such an opportunity to de-risk the transition will fail. The preferred way forward is a likely paradigm shift from traditional contracting between government and operator, to contracts or management agreements between government and consortiums that account for competitive input selection across the entire supply chain i.e., energy, OEM, asset owners, and operators, to give the government greater certainty of service continuance in a ZEB era with shared risk with those who stand the gain through the transition. These efficient supply chain partnering contracts will then be the basis of tendering or negotiation with government. The ideas should be considered as relevant to any country, developed or developing, and in developing countries the ability and interest in risk sharing may be even more relevant.

Risk and ZEB Transition Approaches

The new spectrum of risks at the centre of this transition to green energy to date, however, have been proposed by governments in a number of countries to be shared, to varying degrees, amongst the bus operator and the regulator. As part of the planning for a green future, many governments have suggested ways in which they can contain the risk to the bus operator, through financial support and associated transfer of ownership of assets, especially depots, to the regulator. In general, with exceptions[6], there appears to be little if any change in the procurement model despite this risk transfer to the regulator, although in some jurisdictions this is suggestive of government desiring to move bus contracts closer to a management contract, and if so, it leaves little for the bus operator other than timetabling, rostering and labour hiring. It is not clear as to whether this really is an objective intertwined with the transition to zero emission (at the tailpipe) buses[7] or whether this is just a potential opportunity and outcome of current government thinking in some jurisdictions.

We briefly look at a number of ways ZEBs are being introduced in various geographical jurisdictions drawing on Hensher (2021)[8]. In Sweden a requirement to introduce electric buses is included in a number of tendered contracts, becoming the norm in most city contracts. In respect of investments in depots etc., such costs will typically be undertaken by the procuring authority with depot ownership handed over to government at a later date. The transition to ZEBs is being led in the UK by government with operators taking little of the risk[9]. The UK Government is proposing to invest in 4,000 zero-emission vehicles (or around 10% of the fleet), to be undertaken through competitive bidding for Central Government capital grants through schemes such as Zero Emission Bus Regional Areas and All Electric Bus Cities (initial awards to Oxford and Coventry). This is against a backdrop of a move to Enhanced Quality Partnership and Quality Contracts which give more local governmental control, as well as increases in subsidy as a result of COVID-19. Importantly, in the UK model the role of Local Government in partnering with operators to bid for capital grants to replace diesel buses and upgrade depots is very important. Successful partnerships will have an obligation by the local partnership to fund the ZEB plan, which is expected to be slow and over the next 30 years.

The Netherlands is very much at the forefront of bus electrification. Currently 23.5% of all busses are zero-emission. There is also a strong national policy agreement with all public transport-authorities to move to zero-emission quickly by 2030 having all buses be zero-emission[10], and from 2025 onwards

[6] See the later discussion on joint ventures.

[7] This paper promotes a model that is not being targeted at a specific geographical jurisdiction, since we know that it may not be applicable to all situations, but in general appears to have appeal in many locations. Typically, the route to a management contract is not in the best interest of the governments which are known for their x-inefficiency.

[8] Aldenius et al. (2022) have recently compared experiences of introducing electric buses in the UK and Sweden, two countries with different institutional settings, by way of case studies of four cities. They conclude that developing good collaboration with good communication was found to be key in overcoming challenges. This paper, like many on ZEBS says little about new procurement models and opportunities.

[9] Personal correspondence with John Preston, 26 August 2021.

[10] This seems ambitious if the new bus requirement is only coming in from 2025.

all newly bought buses. Operators typically buy the rolling stock and arrange for their own depots. Since COVID-19, combined with net-cost contracts and with the size of contracts becoming larger (e.g., a 260 buses recently bought and financed by the operator), even the larger operators are finding it increasingly difficult to bear the risks. This has led to intermediate contracting arrangements for the time being, and an increased review of what to do with amortization and financing while the operators continue to buy and manage buses. Bus take-over arrangements have been added to contracts; however for depots, this is typically still the operator's responsibility. There are only a few exceptions so far, one in Groningen and the other in Amsterdam[11].

Australia is committed to zero emission (at the tailpipe)[12] bus fleets with the obligations on bus operators still evolving and generally best described as ambiguous. A number of trials are in place or planned in Australia. For example, in May 2021 in Victoria, the State Government, via the Department of Transport (DOT) announced a series of trials of ZEB's to inform its policy of having all new negotiated contract buses as of 2025 to be ZEB. This sees approximately 100 low-floor route buses and approximately 75 school buses (large, medium, and small) replaced annually. The NSW government plans to have all buses on competitively tendered metropolitan government contracts zero emission by 2030 (see Hensher 2021) with a similar intent for outer metropolitan and rural/regional contracts under negotiated arrangements, although there is a qualification that allows for an extended period. The most recent ZEB related contract is a tendered contract in Sydney (Region 9), replacing the last region operated by the government bus service provider State Transit Authority, and was won in late November 2021 by a consortium of Transdev (a French-owned bus operator who has been active in Australia for some years) and John Holland (an infrastructure network design specialist), known as Transdev-John Holland Buses (NSW) joint venture (JV)[13]. This is one of the first in Australia to recognise the value of a supply chain partnership as part of a tendered contract with government in providing bus services, with a commitment to provide a minimum of 136 electric buses up to 2030. Separately, Transit Systems West has, post-contract success, partnered with Transgrid and Zenobi to upgrade their depot (owned by the government as part of the new contract passed from a government operator to the private sector)[14] in Sydney. This may well signal the value of partnerships or joint ventures as a way of sharing risk and expertise, resulting in benefit creation[15].

We can learn a great deal from the Canadian Urban Transit Research and Innovation Consortium (CUTRIC). Within CUTRIC, federal and provincial government, infrastructure financiers, transport operators, bus and truck manufacturers, energy companies, and charging infrastructure firms come together to develop standards, and workable transition paths, with industry and academia involved in facilitating these groups. Whole-of-life cycle analytical models are being developed assist the parties in the contract, supply and operational chain, to design a commercially, technically, and politically viable transition that manages risk, and which allows for different rollout scenarios to be tested.[16] Gao et al.

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[11] Personal correspondence with Didier van de Velde, 30 August 2021.

[12] Noting that over 65% of electricity is generated from coal-powered stations (Hensher et al. 2021)

[13] https://www.busnews.com.au/industry-news/2111/sydney-region-9-bus-contract-secured-john-holland-transdev

[14] The recent tendered services that have replaced a government operator in three regions in Sydney, have received financial input for depot upgrading from the NSW government who still effectively own the depot. This is not the case for depots owned by private bus operators.

[15] A Joint Venture provides bus operations with the opportunity to gain new capacity and expertise. It also enables bus operators to enter related businesses or new geographic markets or gain quick access to modern technology as well as providing access to greater resources - including specialised staff and technology. It can also deliver competitive advantage compared to going it alone and subcontracting in other services and expertise; and can reduce cost of offer and hence improve success in winning contracts (on cost, service, risk….), including access to internal cross-subsidy capability. Bus operators who do not start to think this way may be more exposed to a limited (uncompetitive) future?

[16] Source: https://lens-monash-edu.cdn.ampproject.org/c/s/lens.monash.edu/@climate-change-rising-to-the-real-urgent-and-globa/2021/11/11/1384045/wheels-in-motion-battery-powered-buses-and-the-road-to-zero-transport-emissions?amp=1

(2017), Gohlich et al. (2014), Rithgange et al. (2015) are examples of research that has detailed some of the technology and planning challenges in introducing electric buses.

Table 1 shows why a risk model and the understanding for the purposes of developing a business model is required, regardless of what procurement model is adopted and who will be responsible for funding the ZEB transition. In comparing a number of business models around the world related to energy, batteries, infrastructure and contract models, we see quite a lot of variation. For example, in Australia (Table 1) a number of elements are unique including vehicle life, continuous replacement (versus traffic start), length of contracts, and ownership. The differential in time means that the various stakeholders involved in the process have a different view of contract cost, lifetime cost, etc. which needs to be accounted for and resolved in developing a cost efficient and transparent ZEB transition plan[17]. The choice we see is that private industry could solve the investment issues for zero emission buses, but they would require longer contract terms (suggest 15 years[18]). On the flip side, Government needs to test the market for competitive options for the operation of vehicles. One solution to this might mirror existing management contracts such as those in Perth and Adelaide where large scale standardisation of infrastructure solutions is embedded in the depot, and the variability already seen in some markets (such as NSW) can be managed out of the system by Government. There is, however, an important distinction between who manages the transition process and who is best positioned to deliver the expertise through an appropriate partnership model, which is the focus of this paper. There is a clear need for a trusting partnership between government and the bus operators; but there is also an opportunity for an additional layer of partnership, formal or informal, between supply chain members in the private sector.

Table 1: The variations in economic life of elements of bus contracts (typical Australian durations)

Part of System	Length of Time (Expected Life)
Vehicle Life	25 Years*
Batteries	5-10 Years
Energy Contracts	Variable
Contract Length	7-10 years
Charging Infrastructure (Hardware)	10-15 years

* This is 12 years in the USA

[17] The implications for SCPC of varying time durations is very relevant. The biggest concern we are hearing is the lack of supply in some countries, of ZEBs and the need to still purchase diesel buses (typically Euro VI). This simply delays the full transition. Most contracts allow for the fact that assets are often depreciated over a longer period than the 7-10 year current contract, and hence if the contract is not renewed, this cost must be allowed for in the transfer of the contract to a new operator. There are well established practices for doing this where the assets are owned by the operator. Where the operator provides a service under a management contract (e.g., Singapore, Adelaide, Perth), then this matter is the responsibility of the regulator or tendering authority. Amortising buses over a shorter period (such as within the current contract life) is attractive if the revenue flows justify supporting higher costs (something we saw on buses purchased during the Sydney Olympics in 2000); but otherwise it a risky plan that can result in high levels of debt which cannot easily be recouped. Thus the mix of green and diesel buses in transition can be challenging where the depots need to handle both fuel sources. EU Regulation 1370/07 about passenger services in the EU sets as maximum contract duration 10 years with a possibility to extend this by 50% - i.e., up to 15 years - when there is a long duration to amortize the various assets needed for the service (fleet, rolling stock, depots, etc.). Given that with the investment requirements associated with the ZEB, there is a need for longer contracts, there may be a need for modification of the EU legislation.

[18] The request for tender (RFT) for Manly Fast and Lane Cove River Ferry Services in Sydney mentions that "*TfNSW is offering a contract of up to 15 years, dependent on continued satisfactory performance*". There is no mention of this for bus contracts, though there is a case for bus contracts being awarded up to 15 years to support the transition to ZEB and the need to amortise infrastructure costs.

A Procurement Model based on a Supply Chain Partnership

The switch to clean energy brings energy providers, both generators and distributors, as well as battery pack and electric or hydrogen bus providers, and infrastructure design specialists into the mainstream of service provision, suggesting that the risks in transition over the next 30 or so years should be directly shared amongst a larger set of service providers who can gain from the transition in contrast to just the bus operator and government. De-risking through greater sharing is common in many supply chain ventures and is an appealing way of transitioning to a green energy future for the provision of bus services in recognition of shared value and its role in building corporate social responsibility. The retail energy provider, for example, could undertake the risk associated with the future power prices, up to a certain level, and the availability of the necessary grid, etc.[19] In other words, the new model could also be considered as a technology related contract which further alters the procurement rules. Where we draw the line in upstream and downstream obligations is something that is best done in a specific context.

Under a green transition, it might not be unreasonable to assume that no one bus operator, let alone a regulator, can claim that they are the single agent best able to manage the risk, or indeed the experts advising each operator and government. Whatever the likely technology landscape may look like, the road to a green outcome might be best travelled through a trusting quality partnership between all the key stakeholders in the supply chain, of which the regulator and a committed bus operator are the main participants, working closely with bus manufacturers, energy suppliers and depot reconfiguration specialists etc.

We promote the idea of a supply chain procurement model, implemented through tendering or negotiation, as a way of spreading the risk in a transparent way between all who will gain from this new future, and ensuring that many more bus operators stay in the industry as a way of protecting the competitive process, as discussed below, especially the smaller operators who may lack the resources, expertise and knowledge to weather this transition, best described as an extreme event.[20] Hensher (2021) discusses in more detail the specific additional risks that have arisen from the ZEB transition. An alternative procurement model (tendered or negotiated) with a diversified group of agents is a way to de-risk upstream and downstream[21] of the operator in the supply chain: on the manufacturer's side with vehicles-as-a-service (VaaS)[22] and the ever advancing (digital) capabilities of buses with many defects/maintenance requiring the expertise of the original equipment manufacturer (with links to new technologies like autonomous and electric) as well as the energy providers; and on the government side with the government ownership of assets and management contracts. We call this a *Supply Chain Partnership Contract (SCPC)* for collaborative contracting (see Figure 1), similar to a public-private partnership (PPP) common to infrastructure projects. An attractive feature of the SCPC model is the

[19] An interesting point is what if there is only one energy retailer in a location? In many countries there are many retail providers who purchase from the network suppliers. This is a very competitive market and it may with greater de-carbonisation attract competing energy retailers into the market in particular locations. Talking with Energy retailers in Australia, the market is fiercely competitive. Where this does not happen, and we have a monopoly retail supplier of energy, then any competitive advantage may be neutralised with the possible exception of bulk discounts.

[20] Although smaller operators will be able to draw on resources and knowledge from the state-based industry representative body. Personal correspondence with Chris Lowe, 15 November 2021. The sector would be poorer if they are lost.

[21] Noting the issue of disposing of life-expired assets in an environmentally friendly way.

[22] We are already seeing some service providers in the Australian industry providing VaaS. In these models a c/km proposition is in place where the bus, charging infrastructure and energy are packaged into a single charge to the operator. This model achieves the de-risking for operator and government; however the brokerage of finance, energy and assets appears to add a margin that may not be evident if the sub-components of the supply chain were isolated and procured separately; although if this was part of a competitive SCP one might expect these costs to still result in an efficient outcome. Importantly also, the cost of convenience and simplicity needs to be weighed against the true cost of the sub elements of the supply chain.

ability to demonstrate to the regulator that the bus operator has skills that are consistent with providing and operating specific technologies that are essential in the transition period to ZEBs and after all the fleet is ZEBs. The regulator would want to have confidence in this capability which can be of concern if a bus operator lacks such skills and has no mechanism to bring them on board either by competitive tendering or negotiation

Regardless of whether the contract between the bus operator and the regulator (government) is tendered or negotiated, the *SCPC* model involves *a competitive process at another agent interaction level* in order to obtain a partnership between the bus operator and crucial contributors to the ZEB task. While this often happens now in some countries, it is not formalised in the construction of a first stage competitive process used in the preparation of documents to go to government by operators. Multiple bids from different competing parties can then be offered to government based on the supply chain partnership model. Importantly, this competition in the formation of a partnership approach focusses on risk allocation in order to de-risk the arrangement between the bus operator and government (or reduce the risk) to, in part, minimise offloading all the risk to government as is often discussed in the transition to ZEBs. Bus operators like this since it gives them a direct link to these supporting services rather than having this directly controlled by the regulator. It is very consistent with the concept of partnership[23]. In proposing the *SCPC,* the purpose is not to map the *SCPC* to various countries to recognise that there will be variations or context specific development; but that variations can fit nicely within the proposed SCPC framework.

The *SCPC* process is competitive, with various suppliers to the bus operator offering prices and service levels in order to participate in a specific role with a bus operator in providing a ZEB solution. This is essentially a competitive tendering process at the input level, well before the final arrangements with the regulator. Through the bus operator, or a broker on their behalf[24], we can expect to obtain the best transparent competitive deal from the selected retail energy provider, infrastructure network specialists, OEM (bus manufacturer and associated businesses), battery or fuel cell supplier, and any other advisory group such as service and planning advisers, including experts in the disposal (and recycling) of assets. We then arrive at an offer to government as a supply chain partnership such as a joint venture, either through a tendered bid or by negotiation with the incumbent who has share the upstream competitive process with others to arrive at the offer price[25]. OEMS and energy suppliers are very keen to deal with and work with bus operators in such a competitive and transparent way, taking on some of the transition cost commitment in return for future rewards.

[23] The current NSW Procurement panel, for example, is well on the way to the SCP model but it does not yet include infrastructure and charging equipment. A small expansion of the current system which locks in technology solutions could move a long way towards the SCP model shown.

[24] Consulting companies appear to be important intermediaries in the competition for funds in England. The broker can also be a new business set up as joint venture between bus operators and other participants in the supply chain.

[25] This approach can improve on the current Transport for NSW (TfNSW) Bus Procurement Panel. TfNSW have a panel of different buses that operators can select from, of which currently seven are battery electric buses. The price which TfNSW agrees with the supplier via a Deed of Standing Offer is for a single unit and does not give the taxpayer full value for money i.e., the panel prevents volume discounts which may apply within a SCPC if the operator could deal directly with the supplier (and still comply with a government vehicle specifications).

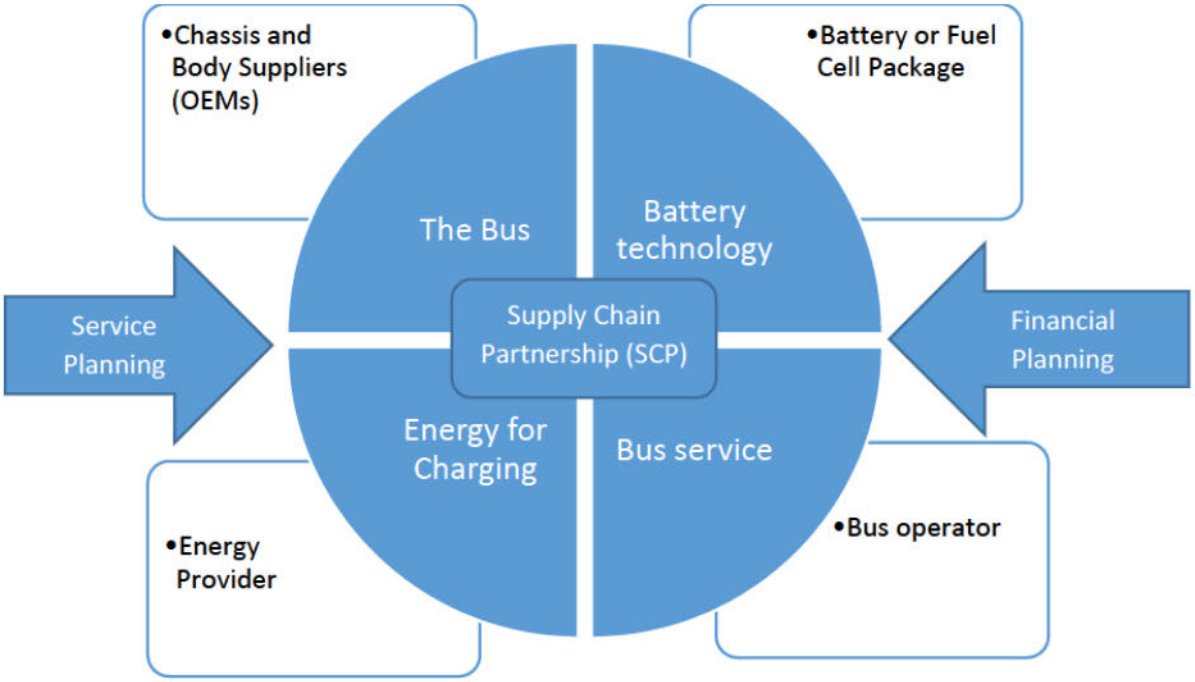

Figure 1: Supply Chain Partnership Contract Procurement Model

Conclusions and the way forward

In this paper, we have asked the question as to who will pay for the costs associated with achieving a smooth transition to ZEBs regardless of whether it involves battery electric buses (BEBs) or fuel cell electric buses (FCEBS), and in particular how can we provide a protective overlay to enable all bus operators who are efficient service providers to continue in the industry with confidence that the burden of greater risk and uncertainty is shared amongst all parties who stand to gain by the transition to ZEBS? This needs to be formalised to ensure that this new risk spectrum is reflected in the benefits on offer.

With an increased role for energy suppliers, bus manufacturers and network infrastructure specialists in particular who stand to benefit significantly, a paradigm shift from traditional contracting i.e., contracts between government and operator, to contracts or management agreements between government and consortiums that account for the entire supply chain i.e., energy, OEM, asset owners, and operators, to give the government certainty of service continuance in a ZEB era, might be more appropriate. It is not unusual for all parties benefiting from an action to be party to the contract. This is essentially what the proposed SCP model is proposing in a way that shares the risk and promotes a competitive process spread over the supply chain.

Many approaches have been proposed, with the dominant plan being the transfer of most of the risk to government through capital grants or government taking control in purchasing and paying for buses, the redesign of the depots and labour training, and subsequent ownership of most if not all infrastructure. As a consequence of a redistribution of risk, in large measure linked to the uncertainty faced by bus operators in costing their future services either through negotiation or competitive tendering, the idea that the current contracting model between government and the operator is sustainable in attracting enough bidders is open for review.

The binary agent tendering process between the bus operator and government throws everything up in the air and often, in many countries, places an unnecessary degree of uncertainty on government for the

'service continuance' imperative (see Hensher 2021)[26]. With benefits accruing to energy and bus suppliers in particular, there is a case that should be made for sharing the risks, as well as the benefits, with all parties who stand to benefit from the ZEB transition. This also aligns well with the real reason for contracting – to get the best value for the tax payers dollar, and should be achieved in the way that inputs to the ZEB supply future are competitively determined during the phase where input risks are identified in contrast to just output risks that are common to the traditional tendered model.

Although the SCPC model is conceptually appealing to both competitive tendering and negotiation, once the competitively obtained SCPC product offer is ready to deliver to government, with full disclosure of the competitive process used to select participants in the SCPC, we would support an initial negotiation between the regulator and the incumbent bus operator or another agent (representing the SCPC), as an appealing method for ushering in such transformational change, based on the premise that there are at present a lot of unknown risks associated with transitioning fleets, large or small, from diesel to ZEB (Hensher 2021). This is aligned with the adage 'give the efficient incumbent operator a chance'.

Importantly, this is very different to the current bus operator negotiating or tendering with government since we now have a supply chain procurement team doing this within a setting where many of the transition risks have already been resolved prior to dealing with government, and most if not all risks are then internalised through the sharing model between the consortium partners, enabling government to have a clear contractual pathway in terms of its obligations to covering residual risk. Given the growing interest in greater engagement of the wider set of stakeholders in the ZEB transition in sharing the risk through a new interpretation of bus contracts, we anticipate that the framework proposed in this conceptual paper will gain worldwide traction.

However, even if government wishes to use competitive tendering, the SCPC model will still work with a double dose of a competitive test at both the input and output stages of *efficiency determination*. Importantly, the SCPC model is a way of building in an incentive structure to move forward to a negotiated or tendered performance-based contract with the regulator that has already been subject to a rigorous transparent competitive process[27]. Like any reform, there are always caveats with one potential risk with the SPC consortium approach being the possible inclusions of financial buffers, margins and risk, although the competitive context proposed is designed to avoid or minimise this, but it needs to be compared to the inefficiencies of direct government engagement. The question is: can a model be developed to achieve the desired outcome without paying more than the sum of the sub-elements? The government model is essentially an ownership position that allows Government to 'solve' the infrastructure/ownership piece and simply tender or negotiate services. That is where we will see an industry divided in many countries with large multinational, national and progressive operators in particular looking to Government to take the ownership[28] and others resisting. We would suggest that the key role for government is to ensure appropriate regulation to deliver the infrastructure associated with a ZEB future in terms of technology, standards, charging principles and technology selection. Beyond that there is a case for greater engagement of the private sector to enable a value for (taxpayers) money outcome.

Finally, it is important to acknowledge that the market cannot "just provide" without help from government, as the market does not exist as such. It needs commitments from government to coalesce and formulate viable business models. Conversely, government cannot move forward without assurances as to what the market can reliably deliver, and at what price[29]. Catch 22; but a case for an SCPC as set out in this paper.

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[26] The broad objective(s) of government should be to provide "*a good quality, integrated and continually improving service for a fair price, with reasonable return to operators that gives value for money under a regime of continuity and community obligation"* (based on Hensher and Stanley 2008).

[27] With any failed efforts at this level being subject to an additional round of competitive tendering.

[28] With a risk of regulatory capture present in this preference.

[29] We thank David Ashmore for this perspective.

Appendix

Some important key tasks for bus operators in particular that need to be built into the transition process are as follows:

1. The importance of staying attuned to research on ZEB technology.
2. The need for early engagement with key suppliers.
3. Focus on developing an understanding of emerging regulations and standards.
4. Actively analyse how bus operations will change with the introduction of ZEBs.
5. Understand key operational and financial risks.
6. Analyse the financial implications, including key fixed and variable elements; sensitivities and risk; and undertake scenario modelling in advance of any major decisions.
7. Identify ways to manage and mitigate risks during transition.
8. Develop an initial business/operational plan with a view to implementation and business as usual.
9. Use all of the above to identify key decisions to develop a transition plan, including an operational model and a financial model to support the move to 'business as usual', including approach to business sustainability and continuity, and managing lifecycle investment, including asset management, refresh and residual values.
10. Review contractual implications which includes operational and financial contractual adjustments.
11. Recognise that the transition project should focused on activities such as
    a. Changes to depot infrastructure and fleet
    b. Operational changes, scheduling and maintenance
    c. People, process and system changes
    d. Procurement and supply chain opportunities (through partnering or sub-contracting) and the broader set of risks.

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