Zero Emission Bus Financing Ideas Pack

March 2021

Contents

Chapter 1

Executive Summary

1.1 Executive Summary (1)

Zero Emission Buses in Scotland is a priority

The transport sector is the largest emitter of greenhouse gases in Scotland. The Scottish Government is determined to reduce emissions from transport. In March 2020, under the auspices of the Zero Emission Mobility: Industry Advisory Group, a green bus workshop was convened to discuss the challenges and opportunities of decarbonising the bus sector.

One of the priorities identified at the workshop was a need to explore how innovative business models could lead to different financing solutions for fleet transition and infrastructure. Since then, further work has been done throughout 2020, exploring the economic and financial details of potential leasing models for battery-electric buses (part of which included a detailed analysis of whole-life costs).

In parallel, the Bus Decarbonisation Taskforce (comprising industry stakeholders across the bus finance and energy sectors) has been set up to agree on a vision for a zero-emission bus sector in Scotland, and co-design a potential pathway for the transition to zero-emission fleets. Scotland is at a pivotal point in relation to its ambition to decarbonise the public service bus fleet. Transport Scotland is now focused on working with industry sectors to support the development of innovative financing models to support investment into zero emission buses. The aim is to identify and support development of creative solutions that benefit all parties, and facilitate a swift transition to zero-emission buses.

The purpose of this Information and Ideas Pack is to provide an indication of potential financing models / solutions which can be used to enable the transition to zero emission buses across Scotland.

Selecting the right financing model(s) can help to accelerate the transition

Bus operators are currently experiencing a number of challenges in transitioning to zero emission fleets. The economic and financial impacts of COVID-19 have left many operators cash constrained with low capital reserves to invest. Patronage levels in February 2021, as a percentage of pre COVID-19 baseline, stood at 28%[1]. This figure was 17% in June 2020, and 50% in August and December 2020[1]. Based on the long-term revenue uncertainty from bus services, combined with the risks and uncertainty of the technologies involved, and the complexity and costs of infrastructure provision – the market stresses the need for available, accessible, and affordable financing models. The analysis in this pack considers and analyses a number of (non-mutually exclusive models), including:

Existing	Emerging	Potential
Operating leases	Component (battery) leases	Residual Value Guarantee
Finance leases	Green bonds	Revolving Fund
Concessional loans	Integrated end-to-end financing	Mezzanine Loan
Sale-and-leaseback (refinancing)		Partial Risk Guarantee (PRG)
		Demand Aggregation

Sources:
1. Scottish Government, Transport Scotland – figures are provided at an aggregate level.

1.2 Executive Summary (2)

Industry engagement suggests a number of challenges and opportunities

Between one-to-one interviews and an industry workshop, **over 30 individual stakeholders were engaged** including: bus operators, bus manufacturers, financiers (banks and equity houses), energy companies, technology providers, trade bodies / associations, local authorities, and others. It is acknowledged that a successful transition to zero emission buses will require a collaborative and united effort, between Government and Industry. Key challenges and opportunities discussed as part of stakeholder engagement include:

- The upfront capital costs associated with the technologies and infrastructure;
- The provision of adequate infrastructure to best meet depot requirements;
- The standardisation of assets, in particular the buses / vehicles;
- The protection of the residual value of assets, namely the technologies;
- The lack of accessible and accurate industry information, particularly for operators; and
- The lack of clarity of demand / volume of buses being ordered and operated, which is required to reduce both manufacturing and financing costs.

The consensus amongst industry stakeholders is that existing financing solutions available are not necessarily unaffordable but that there are insufficient offers in the market and few proactive offers being made to operators.

The issue / challenge is in addressing the technology risk associated with zero emission buses, the revenue uncertainty (largely as a result of Covid-19), and clarity on when and how many buses will be ordered and operated.

Higher Total Costs of Ownership (TCO) of zero emission solutions present additional challenges

The analysis for this pack has been focused on battery electric and hydrogen fuel cell solutions only. This is not to suggest that these two technologies are favoured but instead to reflect those that are most prominent as viable, available, and (relatively) mature, zero emission technologies across the industry. Higher total costs for both battery electric and hydrogen buses, result in a number of implications when developing / deploying appropriate financing models.

- The **varying reliability of batteries** and fuel cells means that operators may need to replace them more than once over the circa. 15-year lifespan of the bus, increasing whole life costs of the asset;
- **Power trains are more likely to fail** (in the early stages i.e. first three years of the technology, usually during the trialling stage) and are also **more expensive** to replace or repair than diesel engines;
- There is likely to be a **higher Peak Vehicle Requirement** for both types of ZEBs due to both reliability and performance constraints; and
- **Skilled maintenance and active management** of batteries and fuel cells is required to improve battery/fuel cell **reliability, performance and residual value**, and improve affordability of financing.

1.3 Executive Summary (3)

The "must haves" of any financing model

Based on findings from detailed analysis of different models, and views gathered from stakeholder engagement, financing solutions should incorporate the following "must have" components:

1) **Protection of the residual value** of assets (particularly the battery / fuel cell components)
2) **Enablement of off-balance sheet** access and use of zero emission bus fleets
3) **Ability to minimise the upfront capital costs** of vehicles, technology and infrastructure
4) **Appropriate sharing of risk** between manufacturers, operators and financiers
5) **Incentivisation of vehicle homogeneity** – reducing risk associated with default/hand-back of assets and enabling development of "as-a-service" models

Conclusion: "As-a-service" models and technology value protection capabilities are key to the future market

Our research, analysis, and stakeholder engagement, suggests that **the overall market is shifting towards financing models where (the majority of) operators no longer own (the entirety of) their assets.**

The **most prominent** financing models within the **current market are leasing models** (namely operating leases). For operators, leasing models reduce up front costs significantly, whilst providing a predictable and steady cashflow prediction (for budgeting purposes). Financiers also benefit from premiums via regular lease payments.

However, **changes in accounting standards** (e.g. IFRS 16) present difficulties e.g. having to now recognise most assets on balance sheets (unless certain criteria are met). Combining this with **infrastructure challenges and costs**, as well as **technology risks and revenue uncertainty**, **operators are becoming more and more attracted to models based on "use and access",** for a particular asset / service e.g. "as-a-service" models, with specialist companies managing the new technology components within the assets.

There are currently a **limited number of market players** providing "battery / fuel cell / bus **as-a-service models**". 'Traditional' **financiers** (e.g. banks and equity houses) are **willing to invest** in this space but **require comfort** around the **residual value risk** of the technology. Upfront capital and financing costs could also be reduced by providing **clarity and certainty of demand for new zero emission buses.**

An opportunity exists to **explore how models can be combined** to: improve visibility of demand for zero emission buses; connect operators with financiers; help bridge technology risk (and policy) uncertainties; and, expedite not only transition for first owners of assets but also help establish an affordable second hand market for zero emission buses. Potential examples include **residual value guarantees, demand aggregation and auctioning, and partial risk guarantees.**

Chapter 2

Introduction and Background

2.1 Scottish Government's Net Zero Objectives

The Climate Change (Emissions Reduction Targets) (Scotland) Act 2019 sets targets for the reduction of Scotland's greenhouse gas emissions (GHG) to net-zero by 2045 at the latest, with interim targets of 56% reduction by 2020, 75% by 2030, and 90% by 2040. The anticipated trajectory is illustrated below. Scottish Government also intends to use the reduction in GHG emissions as an opportunity to develop and enhance, economic growth opportunities, via net zero / decarbonisation initiatives.

As of 2018, GHG emissions in Scotland stood at 41.6 $MtCO_2e$ which includes LULUCF (land use, land use change, and forestry) as well as international flights and shipping. Of these emissions, 27% was attributed to domestic transport. Domestic transport remains a significant contributor to GHG in Scotland with 78% of it attributed to road transport[1]. Furthermore at Scotland (hovering around 12-14 $MtCO_2e$ since 1990) and the UK level, transport emissions have remained stagnant for the past two decades[2].

Figure 2.1.1:Scotland government's path to net zero carbon by 2045

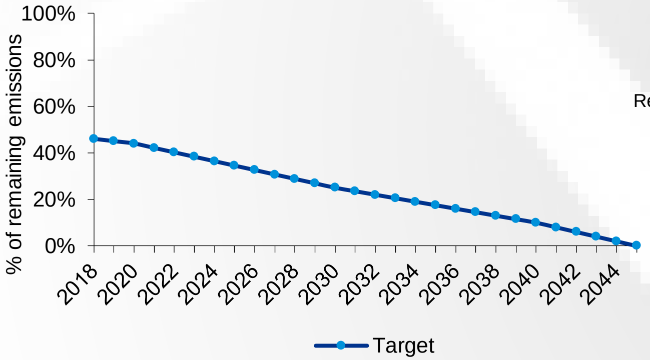


Figure 2.1.2: Breakdown of emissions by sector in Scotland (2018)

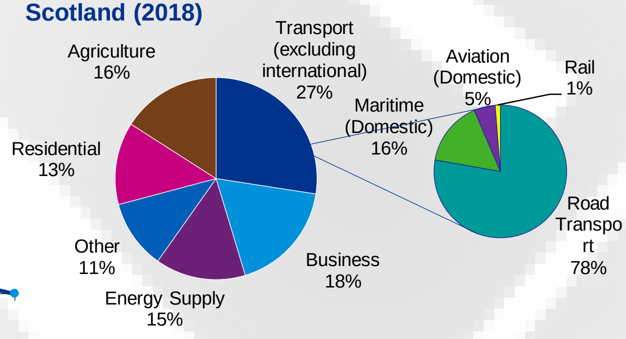
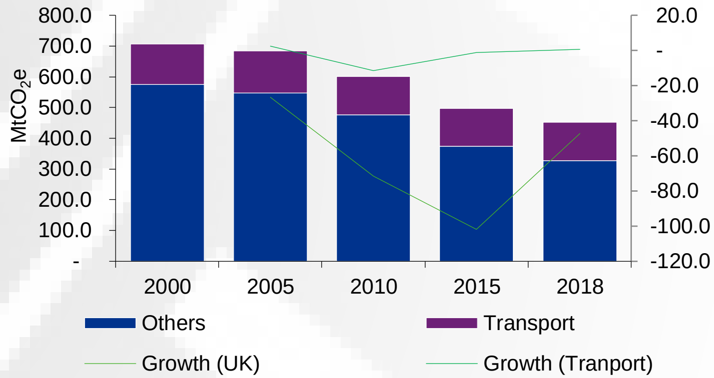


Figure 2.1.3: 5-yearly Total GHG emissions in the UK and growth rates



In order to reduce transport related carbon emissions, Scottish Government has committed to a number of policy outcomes[3 4]:

- Average emissions per kilometre of new cars and vans in Scotland will be reduced in line with EU/UK the emissions standards
- The proportion of ultra-low emission new cars and vans registered in Scotland is targeted to reach 100% by 2030
- The average vehicle kms travelled is reduced by 20% by 2030
- Average emissions per tonne km of road freight to fall by 28% by 2032
- **Proportion of bus fleet which are low emission vehicles will increase to >50% by 2024**
- By 2032, low emission solutions have been widely adopted at Scottish ports and airports
- Proportion of ferries in Scottish Government ownership which are low emission will increase to 30% by 2032
- 70% of the Scottish rail network is electrified by 2034
- Proportion of domestic passenger journeys travelled by active travel modes will increase by 2032, in line with the Active Travel Vision and Cycling Action Plan for Scotland Vision (10% by bike by 2020)

Sources:
1. Transport Scotland (2020). Greenhouse gas emissions 2018: estimates. Source.
2. Final UK greenhouse gas emissions national statistics 1990-2018. Source
3. Scottish Government (2019). Climate Change Plan Monitoring Report. Source
4. Scottish Government (2020). Update to the Climate Change Plan. Source

2.2 Zero Emission Bus Fleet Ambitions

- The transport sector is the largest emitter of greenhouse gases in Scotland. **Scottish Government is determined to reduce emissions from transport.**
- In March 2020, **under the auspices of the Zero Emission Mobility: Industry Advisory Group, a green bus workshop was convened** to discuss the challenges and opportunities of decarbonising the bus sector.
- **One of the priorities identified at the workshop was a need to explore how innovative business models** could lead to different financing solutions for fleet transition and infrastructure.
- Since then**, further work** has been done throughout 2020, **exploring the economic and financial details of potential leasing models** for battery-electric buses (part of which included detailed **analysis of whole-life costs**). Through this work, it became apparent that there are a number of commercial investors interested in this area
- In parallel, **the Bus Decarbonisation Taskforce** (comprising industry stakeholders across the bus finance and energy sectors) has been set up to agree on a vision for a zero-emission bus sector in Scotland, and co-design a potential pathway for the transition to zero-emission fleets

- Scotland is at a pivotal point in relation to its ambition to decarbonise the public service bus fleet.
- Transport Scotland is now focused on working with industry sectors to support the development of innovative financing models to support investment into zero emission buses.
- The aim is to identify and support development of creative solutions that benefit all parties, and facilitate a swift transition to zero-emission buses.

- **The purpose of this Information and Ideas Pack** is to provide an indication of **potential financing models / solutions which can be used to enable the transition to zero emission buses across Scotland.**
- This analysis on Financing Models / Solutions reflects research conducted at a point in time, as well as key themes and information arising from interviews with industry stakeholders. Though technology options and whole-life costs are discussed in this pack, these have been explored in further detail across other programmes of work through Transport Scotland / Scottish Government.

2.3 Zero Emission Bus Market

Low Carbon and Zero Emission Buses in Scotland

The Scottish Government has demonstrated a long-standing commitment to help decarbonise the bus sector. Between 2011 and 2018, eight rounds of funding (via the Scottish Green Bus Fund) were held to encourage the shift towards Low Emission Buses (LEBs). The eight rounds of funding amounted to £17m which funded 191 electric-diesel hybrid buses and 18 full battery powered buses. **In 2020, the Scottish Government has also made available a further £40.5m worth of funding as part of the SULEB (Scotland Ultra Low Emission Bus) scheme (first round of funding equated to £10.1m for 57 zero emission buses). As of today, only 0.5% of buses operating in Scotland are zero emission, with plans being put forth to increase this to 1.5%.** However there is still a long way to go to reach a 100% zero emission fleet. Currently, there are approximately 4,200 buses operating in Scotland, 64% of which meet Euro V and VI standards. The profile of zero emission buses in Scotland is as follows:

– **Electric** – Funding from SULEBs round 1 and 2 have been awarded for 57 and 215 zero emission buses, respectively, depicted in the following breakdown[2].

SULEBs 1 and 2 Funding			
Bus operator	**No of buses**	**Bus supplier**	**Infrastructure**
SULEBS Round 1			
First	22	ADL SDs	11 chargers, and grid connection upgrade
McGills	23	22 Yutong SDs, 1 ADL SDs	14 Dual Gun DC Chargers, 1.5 MW connection upgrade
Xplore	12	ADL DDs	6 dual-gun DC compatible chargers, grid connection
SULEBS Round 2			
First	126	91 ADL DDs, 35 ADL SDs	69 DC Combined Charging System (CCS) double-headed chargers, 2 mobile chargers, 10 MVA power upgrade
Stagecoach West	15	ADL SDs	8 x Multistand EV Chargers
Stagecoach East	9	ADL SDs	10 charging points, 1.5 MVA connection and substation
Stagecoach Bluebird	22	ADL DDs	11 mobile chargers and 1 depot charger
McGill's	33	Yutong SDs	17 dual-gun DC chargers, 1.5 MW connection
Ember	10	6 Yutong SDs, 4 Arrival SDs	Two DC fast chargers

– **Hydrogen** – 10 single decker buses were operating in Aberdeen from 2015-2019 as part of a demonstrator project. 15 double-decker buses are currently in operation from 2020-2024. More recently Dundee has also successfully applied for EU funding which will help procure 12 buses.

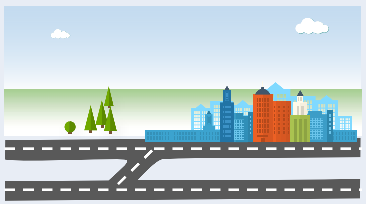
Sources:
1. Transport Scotland. £9 million SULEB scheme opens. Source
2. Transport Scotland. SULEBS Round 1 Outcomes. Source

Chapter 3

Technology Options

3.1 Scope of technology options considered

Zero Emission



Urban and rural

Maturity

The scope for technology refers to options for zero emission buses for use in rural and urban public transport, using mature or near-mature technologies.

Zero Emission – technologies for vehicle propulsion with potential for zero tailpipe emissions as opposed to existing diesel engines. This can include technologies with relatively high GHG emissions (or other environmental impacts) associated with the manufacturing of the vehicle, vehicle components, and supporting infrastructure construction (e.g. Gigafactory).

Buses for use in rural and urban public transport – road vehicles providing 12 or more seating positions and with a self-contained energy storage and traction power systems. The buses employed will be providing services between locations predominantly within a single urban or rural area for the general public.

Mature or near-mature – technologies for bus propulsion currently deployed in significant numbers in several urban bus fleets globally. This includes technologies being trialled in-service on complete routes in multiple cities.

Based on the above, our analysis for this pack has therefore been focused on battery electric and hydrogen fuel cell solutions only, as research suggests these to be the two most prominent and viable solutions for zero emission buses, at present.

3.2 Battery Electric

Commerciality

The cost of production for electric buses remains almost twice than that of diesel equivalents (see chapter 4). The uncertainty of reliability could also add to the (short-term) maintenance and repair costs.

Varying reliability of batteries and (therefore) high charging frequency requirements can affect performance and utilisation rates of buses (e.g. long charging periods required).

Infrastructure

There are two types of charging points: **AC and DC**. AC is currently most common, though DC enables much faster charging (although, it is also more expensive).

Depots will need to be retrofitted to enable charge point installations. There is also a need to ensure sufficient grid capacity to accommodate increased energy requirements / demand.

Performance

Current single decker buses with NMC (nickel, manganese, cobalt) batteries of **138 kWh capacity could cover up to 150** miles. In order to meet the public service requirement of **200 miles, an additional 70 kWh is required. Manufacturers are actively undertaking R&D to address this challenge[1].**

For **double decker buses, a battery stack with 400 kWh is required to cover 200 miles on a single charge**.

Carbon Emissions

Battery Electric busies have up **to 64-80% of savings in well-to-wheel carbon emissions as** compared to its diesel equivalents.

Battery Electric buses have an overall well-to-wheel energy efficiency of **77-81%** (i.e. accounting for energy loss as energy is generated and transported through the grid).

Supply Chain

Greater battery manufacturing / recycling facilities and capabilities will be needed. Scottish Power has received approval to build one of the largest battery energy storage facilities in the UK (in Glasgow).

There is also an opportunity to upgrade the capabilities of battery recycling and disposal companies, such as WEEE Solutions in Glasgow and Brightwaste in Musselburgh.

Implications on costs and financing requirements – *see slide 18 for further detail*

Commerciality: Cost of batteries and ongoing maintenance = high up front and operating costs. Buses may need to be charged often, reducing the time spent on routes and/or increasing PVR.

Infrastructure: Depot retrofitting will need to factor in charging point installation and grid connection costs.

Performance: Varying reliability of batteries could mean multiple mid-life replacements required, increasing replacement costs.

Carbon Emissions: Sufficient investment needed to ensure well-to-wheel emission reduction is achieved (e.g. infrastructure), and not just emission reduction from bus operations only.

Supply Chain: Costs associated with the development of battery manufacturing / recycling capabilities, to improve second use case applications, will need to be considered.

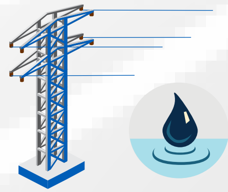
Sources:
1. Stakeholder interview with a UK-based bus manufacturer.

3.3 Hydrogen Fuel Cell

Commerciality

Hydrogen buses currently have a higher Total Cost of Ownership, driven by higher unit purchase costs and fuel costs.

The reliability and maturity of hydrogen buses is still low, with most activities still at testing / trialling stage (as opposed to full commercial operations). However, significant improvements are expected with more trials.



Infrastructure

The greenest way of producing hydrogen fuel is through water electrolysis powered by renewable energy. Scotland has a competitive advantage in that it is naturally well endowed with onshore and offshore wind.

Hydrogen can be transported either in pressurised tanks via trucks or refurbishing existing unused gas pipes.

Performance

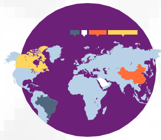
Hydrogen buses can be refuelled as quickly as diesel buses and travel up to 270 miles on a full tank.

With its higher energy density, it is also more suitable for routes with challenging terrains and lower temperature e.g. where additional energy is required to keep passengers warm.

Carbon Emissions

Hydrogen buses have up **to 50% savings in well-to-wheel emissions or more** depending on fuel production method.

Hydrogen buses have an overall energy efficiency of 33%-42% from well-to-wheel, which is the next best to electric battery in terms of efficiency.



Supply Chain

Though in general the supply chain of hydrogen buses all around the world is still in its development stage, Scotland possesses some existing capabilities in respect of technology development (e.g. Arcola Energy). However, further investment is needed to strengthen the end-to-end supply chain, particularly in developing secondary use cases for hydrogen fuel cells.

Implications on costs and financing requirements – *see slide 18 for further detail*

Commerciality

- Higher up front capital and ongoing operating costs for now as compared to battery electric and diesel buses.

Infrastructure

- Significant investment is needed in wider refuelling and distribution network infrastructure.

Performance

- Greater investment and funding is needed to prove test / trial use cases, before scaling to full commercial operations
- High replacement costs for parts are expected until economies of scale is achieved.

Carbon Emissions

- Sufficient investment is needed to ensure well-to-wheel emission reduction is achieved (e.g. green hydrogen production via water electrolyser), and not just emission reduction from bus operations only.

Supply Chain

- Potential costs associated with the development of second use case applications for Fuel Cells.
- Opportunities to offset some costs from development and use of a multi-purpose, shared distribution network, given linkages to heating and other industrial use cases.

3.4 Key comparatives between electric and hydrogen

Battery Electric

Pros	Cons
Maturity – battery-electric buses are now operating in significant numbers in global bus fleets, including in cities across the UK, Europe and North America. The solution is considered to be more mature than hydrogen fuel cells.	**Charging infrastructure** – battery-electric buses will require significant charging infrastructure in depots, in addition to charging infrastructure on-street if opportunity charging is to be used. This infrastructure could, in some places, require reinforcement of electricity grid infrastructure.
Energy supply chain – battery-electric buses use electrical power directly, allowing the electricity grid to be used which plays well into Scotland's rich endowment in offshore and onshore wind. There is also greater energy efficiency in not needing to transform energy from one form to another.	**End of life risks** – pathways for recycling batteries at their end of life are not well established and understanding of residual value for battery-electric buses is limited. There may be potential for batteries to be reused in lower-intensity applications, including in chargers. Progressive reductions in battery costs will reduce financial risks.
Air quality – battery-electric buses are fully zero-emission at the tailpipe.	**Constrained operation** – relatively low energy density of batteries mandates trade-offs between range and passenger capacity. Use of opportunity charging may require additional cycle time, with a resulting impact on peak vehicle requirement and fleet size.
GHG emissions – energy is drawn directly from the grid (which itself is decarbonising) and does not need to be transformed in any way.	

Hydrogen Fuel Cell

Pros	Cons
Flexible operation – hydrogen fuel cell buses can have a similar range to diesel buses (around 300-450km) and a similar refuelling time (less than 10 minutes). This will allow fuel cell buses to directly replace diesel buses on most routes.	**Technology is still maturing** – hydrogen fuel cell buses are nascent in maturity. There are in-service trials around the world but the technology has not yet reached a maturity level where it can be adopted in scaled deployments Availability of buses from manufacturers is still limited and costs are very high.
Limited infrastructure requirement – if hydrogen is produced offsite, the vehicle operating range enables overnight refuelling at depots using infrastructure with a similar footprint and electrical power requirements to diesel storage and refuelling equipment.	**Limited supply chain** – meeting hydrogen requirements for deployment of fuel cell buses in significant numbers will require significant increase in the production of hydrogen in the UK together with the establishment / development of logistics, storage and refuelling assets and services.
Air quality – fuel cell buses are fully zero-emission at the tailpipe.	**End of life risks** – understanding of residual value for hydrogen fuel cell buses is very limited.
GHG emissions – only the use of green hydrogen (produced via electrolysis) will result in zero-emissions.	**Volatile fuel costs** – due to the relatively smaller scale of supply of hydrogen. However, this volatility is expected to smooth out once the market grows and sufficient scale is achieved.

Chapter 4

Whole-life Costs

4.1 Overview TCO analysis – financial implications

*Higher total costs for both battery electric and hydrogen buses, result in a **number of implications when developing / deploying appropriate financing models.***

£'000	Diesel (Single)	Electric (Single)	Hydrogen (Single)
Capital Cost	180	392	516
Operating Cost (p.a.)	37	20	42
Personnel Cost (p.a.)	35	40	40
Total	**252**	**452**	**598**

*Building on the whole-life costs analysis work conducted by EY, **our research indicates higher costs associated with the acquisition and operation of hydrogen buses, as compared to battery electric buses.***

Implications for electric and hydrogen financing models

- The **varying reliability** of batteries (/fuel cells) means operators will likely need to swap them more than once, across the life of the bus (e.g. 5-7 year lifespan of battery, 15 year lifespan of bus)
- **Power trains are more likely to fail** (in the early stages of the technology) and are also **more expensive to replace or repair** than diesel engines;
- There is likely to be a **higher Peak Vehicle Requirement** for both types of ZEBs; and
- **Skilled maintenance and active management of batteries and fuel cells** could help to improve battery/fuel cell reliability and residual value, improving affordability of financing.

Additional implications for hydrogen financing models

The **higher costs of hydrogen buses** (due to current lack of maturity and scalability) result in **additional implications** including:

- The need for short-medium term **government support to cover the cost premium of purchasing buses and fuelling infrastructure**
- The need for **greater protection of residual value** (through increased Government funding or risk taken by industry financiers)
- Higher cost of infrastructure – the costs will **include wider costs** associated with making the solution available (e.g. distribution networks)
- The more gradual pace of development resulting in a **limited supply chain**, increasing costs for maintenance / training
- Overall significantly higher costs, likely leading to **higher lease premiums** (compared to battery electric) over an equivalent contract period
- Reliability issues with hydrogen buses, potentially **impacting revenue services**, and resulting in a **higher peak vehicle requirement**

4.2 Overview TCO analysis – key cost drivers

Analysis and observations

Among the three powertrains, the total cost of ownership (TCO) of hydrogen remains the highest. This is followed by battery electric and diesel buses in descending order.

Battery Electric bus

The higher capital cost of battery electric buses compared to their diesel counterparts is attributed to the following factors:

- **Vehicle cost**: the technologies involved within a battery electric bus are more condensed than that of diesel which increases cost of production
- **Battery packs**: the battery of a battery electric bus makes up approximately 35% of its purchase value
- **Charging infrastructure:** battery electric buses require charging infrastructure installation and depot retrofit as opposed to a diesel depot which incurs only fuel related costs.

Despite the fact that e-buses have a lower operating cost than diesel buses, the savings throughout the asset life are unlikely to offset the high upfront capital cost in its current state. This is also attributed to the Peak Vehicle Requirement (PVR) due to more frequent charging cycles, also adding to the TCO of running the same routes.

Hydrogen FCEV bus

The higher capital and operating cost of hydrogen buses is mainly attributed to the lack of maturity of the technology and scalability. Green hydrogen produced via electrolyser plants also requires new infrastructure and distribution channels to be established and/or retrofitted from unused gas pipes. Last but not least, a higher PVR is also expected due to reliability challenges currently observed in demonstrators. Despite its challenges, hydrogen fuel is more suited for longer, more energy intensive routes which could present itself as a promising technology in the long-term (particularly for longer, rural bus routes).

Future prices of Battery Electric Buses vs. Hydrogen FCEV Buses

Based on a report by Ballard Power Systems and Element Energy as well as an interview with a UK based bus manufacturer, the prices of individual battery electric buses and hydrogen FCEV buses are expected to converge in the future, as shown by Chart 4.2. Assuming that the demand for FCEV buses could reach 1,500 buses by 2025, the price an individual double-decker unit could be £350,000, comparable with a battery electric equivalent (£321,000).

Chart 4.1: Comparative TCO of diesel, battery electric, and hydrogen buses

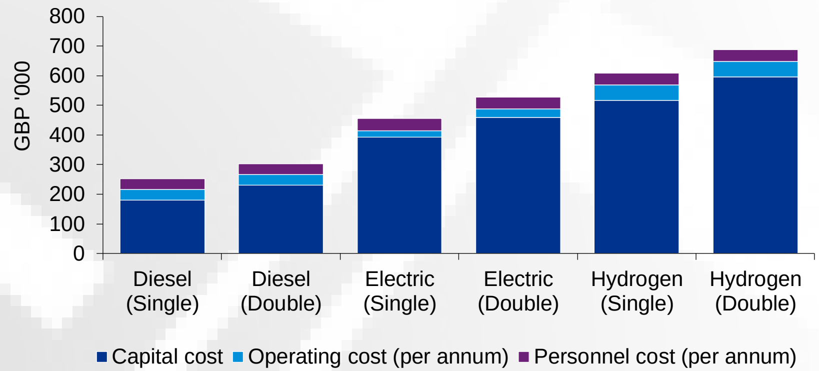
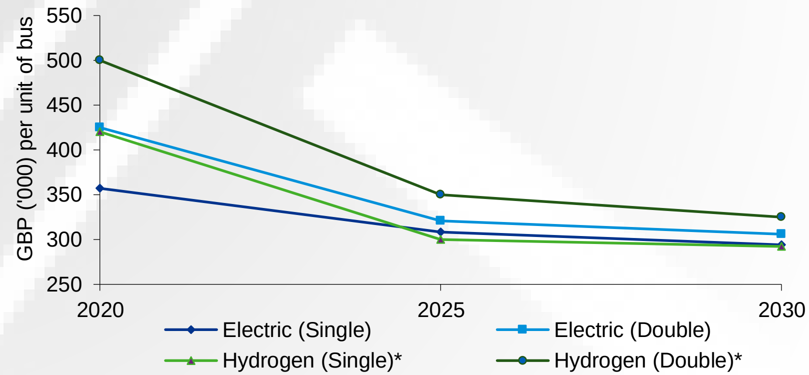


Chart 4.2: Future prices of battery electric and hydrogen buses



**Based on demand of hydrogen buses reaching 1,500 and 3,000 by 2025 and 2030 respectively. Please refer to slide 22 for the list of other assumptions used.*

Sources:

- EY's report: Low Carbon Investment – Scottish Bus Electrification commercial and economic content
- Fuel Cells and Hydrogen Joint Undertaking: Fuel Cell Electric Buses – Potential for Sustainable Public Transport in Europe [Source]
- Ballard Power Systems, Element Energy Ltd – Economic Case for Hydrogen Buses in Europe [Source]
- Recent costs from UK based bus manufacturer
- KPMG Analysis

4.2 Capital Costs (acquisition and infrastructure)

Analysis and observations

The capital cost across the three options is expressed in per unit of bus so as to standardise the TCO and enable a fair comparison across options. The capital costs include the bus vehicle, its key components, and associated infrastructure. The industry has also indicated that there may be higher PVR with Electric Buses and Hydrogen given the more frequent charging cycles and the reliability issues respectively, both of which add to the capital costs. An indexing factor for higher PVRs has not been included in calculations but could be calculated and added.

Battery electric bus

The higher capital costs of a battery electric bus are mainly attributed to:

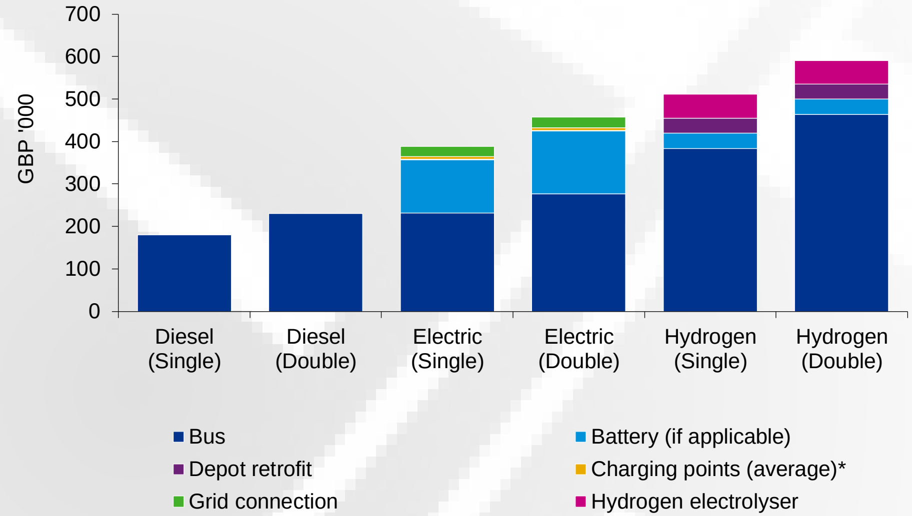
- **The battery pack** which constitutes approximately 35% of its market price.
- The cost of extending **grid connections** and associated charging infrastructure. There is also an issue with extending grid connection in rural areas and the competitiveness of prices quoted by providers.
- It is also noteworthy that **DC charging points**, which will enable faster charging, cost significantly more than their AC counterparts.

Hydrogen FCEV bus

Hydrogen FCEV buses are still more expensive than battery electric buses, with these costs being attributed to:

- **Lower maturity of the fuel cell technology** and its lack of scale in the market
- **Cost of the battery pack**, even though these are smaller than batteries in a battery electric buses
- **Associated fuel production and distribution infrastructure**

Chart 4.3: Capital cost comparison and breakdown by composition



Acquisition costs						
£ '000	**Diesel (Single)**	**Diesel (Double)**	**Electric (Single)**	**Electric (Double)**	**Hydrogen (Single)**	**Hydrogen (Double)**
Bus	180	230	232.1	276.3	383.6	463.6
Battery (if applicable)	N/A	N/A	125.0	148.8	36.4	36.4
Depot retrofit	N/A	N/A	1	1	35	35
Charging points AC	N/A	N/A	1.5	1.5	N/A	N/A
Charging points DC	N/A	N/A	45	45	N/A	N/A
Charging points (average)*	N/A	N/A	5.9	5.9	N/A	N/A
Grid connection	N/A	N/A	25	25	N/A	N/A
Hydrogen electrolyser	N/A	N/A	N/A	N/A	55.6	55.6
Infrastructure contingency	N/A	N/A	3.1	3.1	5.6	5.6
Average cost per bus	**180**	**230**	**392**	**460**	**516**	**596**

**A ratio of 1:10 for AC to DC chargers is assumed. Please refer to slide 22 for list of assumptions used.*

Notes:

- The above analysis does not consider ancillary revenue opportunities to offset capital costs (e.g. community charging)
- The impact of higher PVR on capital costs has not been taken into account due to the lack of current data

4.3 Operating and personnel costs

Analysis and observations

Electric battery bus

Compared to diesel buses, electric battery buses have significantly lower operating costs. This is attributed mostly to **the cheaper costs of electricity than diesel, to cover the same distance, and also potentially lower maintenance costs as there are fewer parts (as there are fewer components involved in a battery-electric powertrain)**. Lower maintenance costs are however expected to be realised in the long-term, once the technology has further matured. It is also noteworthy that the performance of battery packs may deteriorate over time which results in declining efficiencies and the need for more frequent charging (or replacement of batteries).

Hydrogen FCEV bus

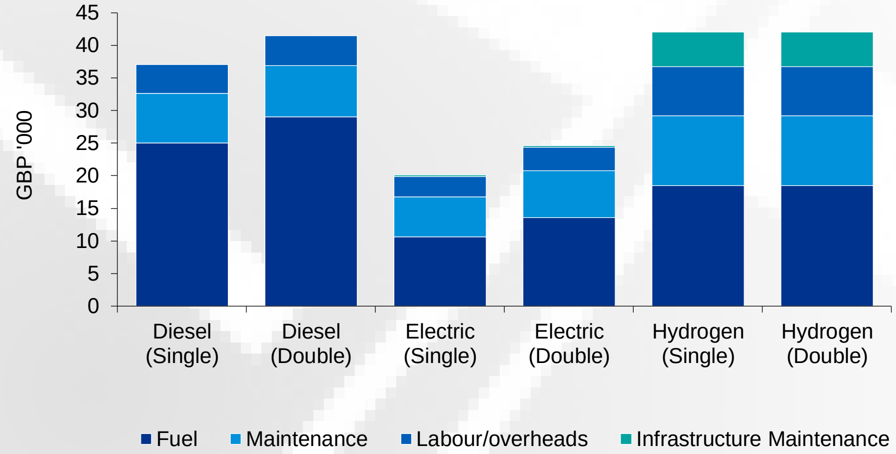
On the other hand, FCEV buses operating costs are higher because of the high production cost of green hydrogen. However, with the right scale of production the fuel cost has the potential to match that of diesel.

Given its complex technology and lower level of maturity, maintenance of the fleet and its associated infrastructure is also expected to be higher than its diesel and electric counterparts until its deployment is significantly scaled up.

Personnel costs

Personnel and driver costs for both electric battery and hydrogen FCEV buses are expected to be higher due to the cost of retraining / reskilling. According to EY's report on Scottish Bus Electrification commercial and economic content, this will be a short term additional cost of £5k per annum per bus. In terms of labour cost and overheads, it is expected that newer models of electric battery and FCEV buses are likely to be more sophisticated which allow for capabilities aimed at maximising efficiency, such as remote maintenance data monitoring.

Chart 4.4: Operating cost comparison and composition breakdown



Operating costs (per annum)						
£ '000	**Diesel (Single)**	**Diesel (Double)**	**Electric (Single)**	**Electric (Double)**	**Hydrogen (Single)**	**Hydrogen (Double)**
Fuel	25	29	10.6	13.6	18.5	18.5
Maintenance	7.6	7.9	6.15	7.15	10.7	10.7
Insurance	NI	NI	NI	NI	NI	NI
Labour/overheads	4.48	4.6	3.08	3.58	7.5	7.5
Infrastructure Maintenance	N/A	N/A	0.27	0.27	5.3	5.3
Average cost per bus per anni	**37.1**	**41.5**	**20.1**	**24.6**	**42**	**42**

Please refer to slide 22 for list of assumptions used.

4.4 Assumptions

Capital costs

- The full asset life of all three types of buses (diesel, electric battery and FCEV) is assumed to be 15 years.
- It is assumed that an electric battery bus will need its battery placed in its 7th or 8th year.
- In order to derive the capital cost per unit of bus, the cost of infrastructure has been spread across the assumed full asset life: 15 years.
- Additional capital costs of £25k-£30k per year will be incurred from Year 9 to 11 to place batteries under a maintenance programme.
- The costs of FCEV hydrogen buses and their associated infrastructure are approximated from Aberdeen City Council's experience in managing the FCEV hydrogen bus trial, relevant press releases and studies which have been published by the EU's Fuel Cells and Hydrogen Joint Undertaking (FCH JU).
- It is also assumed that for every 10 AC charger for electric buses there will be at least one DC charger available.
- Per HMT's Green Book Guidance, a 10% contingency on cost has been applied for large infrastructure projects.
- Import tariffs, wherever applicable, may not have been considered in the TCO analysis. For instance, according to an interview with a bus importer, a 10% tariff is payable for every bus imported from China.
- It is assumed that the cost of battery packs will be either similar or lower in the future. While the prices of new technologies do fall over time, it is noteworthy that batteries rely on mined metals which are limited in nature. The sustainability of its supply relies on the industry's ability to achieve a very high retrieval and recycling rate.

Operating costs

- It is assumed that battery performance can be maintained to prevent significant deterioration over its 7-year life cycle, which is theoretically achievable by adopting best practices on driving behaviour, charging behaviour and frequency of charging.
- Electric battery and FCEV buses are able to provide better datasets to operators which will enable greater efficiency in maintenance and fuel performance.
- In order to calculate its operating cost, each bus is assumed to cover a total of 50,000 miles a year, which is based on the average covered by a bus operating in Scotland.

4.5 Methodology (Acquisition Costs)

Acquisition Costs (£'000)	Electric (Single)	Electric (Double)
Bus	232.1	276.3
Battery	125.0	148.8
Depot retrofit	1	
Charging points AC	1.5	
Charging points DC	45	
Charging points (average)*	5.9	
Grid connection	25	
Infrastructure contingency (10% which is within the range of Green Book guidance)	3.1	

Acquisition Costs (£'000)	Hydrogen (Single)	Hydrogen (Double)
Bus	383.6	463.6
Battery	36.4	
Depot retrofit	35	
Hydrogen electrolyser	55.6	
Infrastructure contingency (10% which is within the range of Green Book guidance)	5.6	

Electric buses

- **Bus and battery:** The report on Low Carbon Investment – Scottish Bus Electrification commercial and economic content quoted a per unit price of £357k and £425k for single and double decker respectively (inclusive of battery costs). It was also assumed that the battery makes up 35% of the value of the bus. This is further verified by: 1) a report by Ballard Power Systems (36%) of the total value; and 2) an interview with a bus manufacturer which suggests (38%).
- **Depot retrofit:** The report on Low Carbon Investment – Scottish Bus Electrification commercial and economic content made this assumption under the pretext that no expansion of land is required.
- **Charging points:** The report on Low Carbon Investment – Scottish Bus Electrification commercial and economic content quoted £1.5k and £45k respectively for AC and DC chargers. It is further assumed that there is approximately at least one DC charger for every 9-10 AC chargers. The average cost per bus is therefore: 90% x £1.5k + 10% x £45k = £5.9k
- **Grid connection:** The quoted cost in the same report is £25k per vehicle. However, based on interviews with connection providers, this could differ depending on the depot's location and reinforcement requirements.

Hydrogen buses

- **Bus and battery:** Based on an interview with a bus manufacturer, the prices of a hydrogen on an individual basis are £420k and £500k for single decker and double decker respectively (inclusive of battery costs). According to the report by Ballard Power Systems, a battery in a hydrogen bus could cost around €40k (£36.4k)
- **Depot retrofit:** Based on an interview with a bus manufacturer, the cost quoted per unit of bus is approximately £35k which includes installing refuelling infrastructure in existing bus depots.
- **Hydrogen electrolyser (40 year asset life):** According to the report published by SSEN, an electrolyser plant with a capacity of 480 kg/day) will cost approximately £8.3m in an unconstrained scenario (sufficient energy is always available to power plants). Normalising this to the 15 year asset life of buses will give us 15/40 x £8.3m = £3.1m. Assuming that each bus travels 140 miles per day and a consumption rate of 3.85kg/100km (based on interview), this will give us 8.6 kg/day/bus. A facility of this capacity can therefore serve approximately 480/8.6=56 buses. The cost of hydrogen electrolyser per unit of bus is therefore: £3.1m/56 buses = £55.6k.

Sources:
- EY's report: Low Carbon Investment – Scottish Bus Electrification commercial and economic content
- Fuel Cells and Hydrogen Joint Undertaking: Fuel Cell Electric Buses – Potential for Sustainable Public Transport in Europe [Source]
- Ballard Power Systems, Element Energy Ltd – Economic Case for Hydrogen Buses in Europe [Source]
- SSEN (2016). Impact of Electrolysers on the Network, Part of the Aberdeen Hydrogen Project. [Source]
- Khzouz et al (2020). Life Cycle Costing Analysis: Hydrogen Production Cost for Fuel Cell Vehicle Technology. [Source]
- Interview with UK based bus manufacturer
- KPMG Analysis

4.5 Methodology (Operating and Personnel Costs)

Operating and personnel costs per annum (£'000)	Electric (Single)	Electric (Double)
Fuel	10.6	13.6
Maintenance	6.15	7.15
Labour/Overheads	3.08	3.58
Infrastructure Maintenance	0.27	
Training	5	
Driver	35	

Electric buses

- **Fuel:** The report on Low Carbon Investment – Scottish Bus Electrification commercial and economic content made the following assumptions 1) Miles travelled per annum: 50,000 miles; 2) Day and Night electricity charges at 15p and 11p/kWh respectively; 3) 20% of a fleet will need charging during the day and 80% at night; and 4) A single and double decker will require 1.8 kWh and 2.3 kWh respectively to travel for 1 mile. The calculations therefore go as follows:
  Single = 50,000 miles p.a. x 1.8kWh/miles x (0.8x£0.11+0.2x£0.15)/kwh=£10.6k p.a.
  Double = 50,000 miles p.a. x 2.3kWh/miles x (0.8x£0.11+0.2x£0.15)/kwh=£13.6k p.a.
- **Maintenance, labour/overheads, infrastructure maintenance, and training:** Figures are taken from the report on Low Carbon Investment – Scottish Bus Electrification commercial and economic content.
- **Driver:** The figure is based on a high estimate of a survey on the average annual salary of a bus driver in the UK

Operating and personnel costs per annum (£'000)	Hydrogen (Single)	Hydrogen (Double)
Fuel	18.5	18.5
Maintenance	10.7	10.7
Labour/Overheads	7.5	
Infrastructure Maintenance	5.3	
Training (Personnel costs)	5	
Driver (Personnel costs)	35	

Hydrogen buses

- **Fuel:** Based on our interview with a bus manufacturer, the following information is obtained: 1) A double decker bus is able to travel 100km with 3.85 kg of fuel; 2) Hydrogen fuel produced by the Aberdeen electrolyser plants currently costs £6 per kg. There is no information obtained on a single decker bus (by the virtue of buses used for single decker trial were manufactured by another OEM); hence the calculation goes as:
  Double = (50,000 miles p.a. x ~1.6km/mile)/100km x 3.85 kg x £6/kg = £18.5k p.a.
- **Maintenance:** The report by Ballard power system quoted a cost of €11.8 p.a. This translates into approximately £10.7k p.a.
- **Labour/Overheads:** The report by Ballard power system quoted a cost of €8.2 p.a. This translates into approximately £7.5k p.a.
- **Infrastructure Maintenance:** The report by Ballard power system quoted a cost of €5.9 p.a. This translates into approximately £5.3k p.a.
- **Driver and Training:** The figures are taken from: 1) the assumption made in the report on Low Carbon Investment – Scottish Bus Electrification commercial and economic content; and 2) a high end estimate of a salary survey on bus drivers' annual salary.

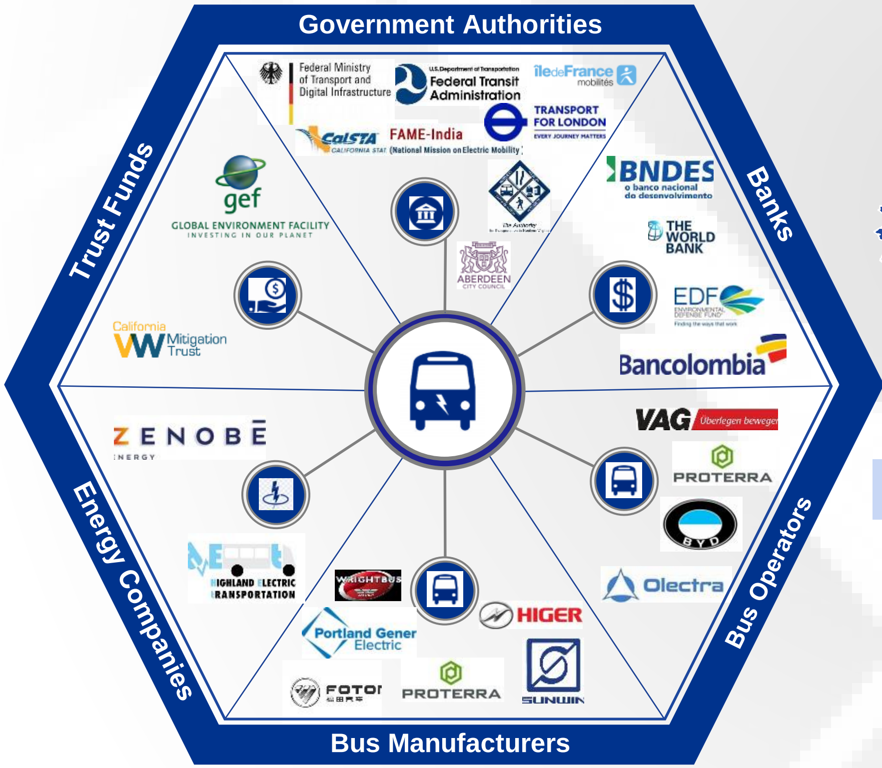
Sources:
- EY's report: Low Carbon Investment – Scottish Bus Electrification commercial and economic content
- Fuel Cells and Hydrogen Joint Undertaking: Fuel Cell Electric Buses – Potential for Sustainable Public Transport in Europe [Source]
- Ballard Power Systems, Element Energy Ltd – Economic Case for Hydrogen Buses in Europe [Source]
- SSEN (2016). Impact of Electrolysers on the Network, Part of the Aberdeen Hydrogen Project. [Source]
- Khzouz et al (2020). Life Cycle Costing Analysis: Hydrogen Production Cost for Fuel Cell Vehicle Technology. [Source]
- Interview with UK based bus manufacturer
- KPMG Analysis

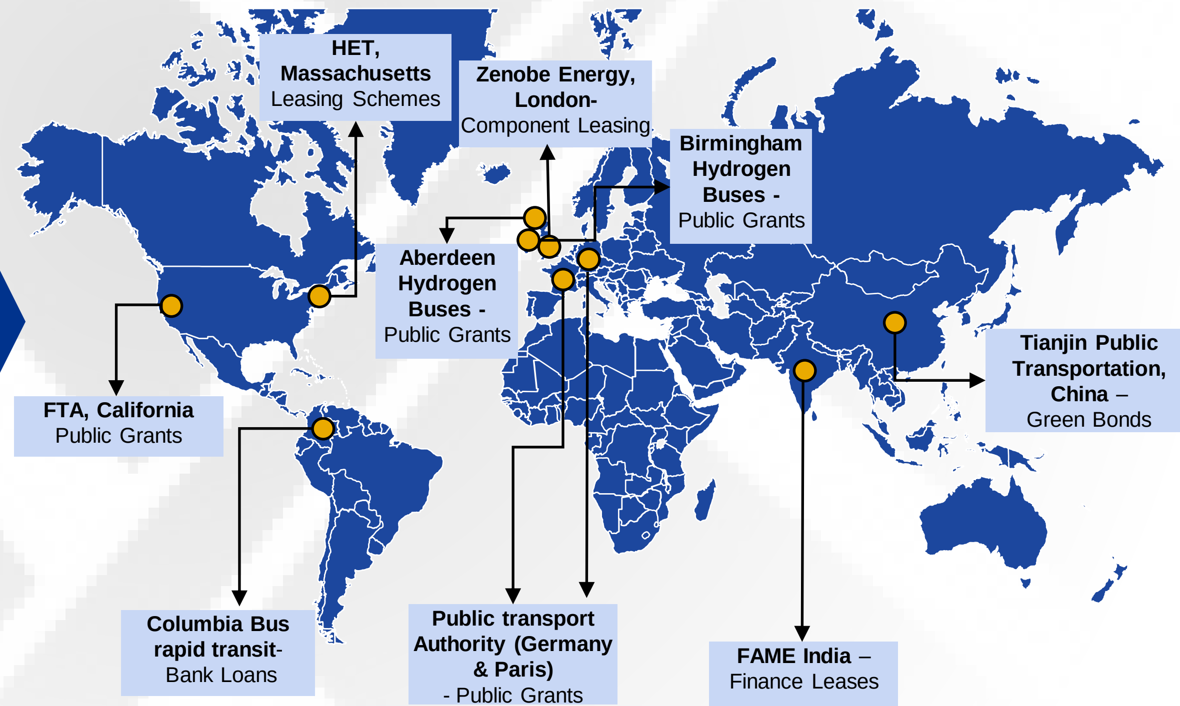
Chapter 5

Financing Mechanisms, SWOT Analysis and Case Studies

5.1.1 Global Landscape – Market Players

There are multiple players involved in innovative financing mechanisms, shaping the potential for widespread adoption of zero emission buses across the world. We have highlighted just a few examples across the next few slides (please note that this is not an exhaustive nor comprehensive list). The purpose is to provide an indication of the potential scale of the market. Not every example is covered within our detailed analysis, as this is focused on those examples (and models) that we think would be most applicable in a Scottish market / landscape context. That said, our research and analysis process has considered, incorporated, and embedded, insights and learnings across a wide range of models and examples, including those depicted. The examples of finance models outlined in slides 27 and 28 in particular, are explored in further detail in this pack.





5.1.2 Global Landscape – Existing Financing Models (1)

Financing Providers	Financing Model	Financing Recipients
Federal Ministry of Transport and Digital Infrastructure, Germany; Federal Transit Administration, US; Île-de-France Mobilités, France; California State Transportation Agency	Public Funding or Grants	Berlin transport authority BVG; Aberdeen City Bus System; Private Bus Manufactures in Paris; California State Bus fleet
Highland Electric Transportation; Greater Jakarta Transportation Agency (BPTJ); Verkehrs-Aktiengesellschaft Nürnberg (VAG); Olectra Greentech, India	Operating Leases	Massachusetts district school buses; Jakarta's bus rapid transit system; Indore Intercity Buses; Namma Metro, Karnataka
Bancolombia; FAME India scheme; Shenzhen Energy Conservation	Finance Leases	Transmilenio, Columbia Bus rapid transit; The Brihanmumbai Electric Supply and Transport (BEST); Shenzhen Bus Group

- Government Authorities
- Banks
- Trust Funds
- Energy Companies
- Bus Manufacturers
- Bus Operators

5.1.3 Global Landscape – Existing Financing Models (2)

Financing Providers	Financing Model	Financing Recipients
Brazilian Development Bank (BNDES); Clean Technology Fund - International climate loan; The Global Environment Facility; Área Metropolitana del Valle de Aburrá	Concessional Loans & Agreements	Curitiba's Bus Rapid Transit; Bagota Bus Rapid Transit; Lima Transport Project to the Republic of Peru (RP)
Zenobe Energy; TriMet and Portland General Electric; Proterra Catalyst®	Component / Part Leases	Newport Transport, London; Transporte Público Colectivo" (TPC); North American public transit industry
Transport For London (TFL); Ministry of Finance, Norway; New York State Energy Research and Development Authority	Other Models*	Niagara Frontier Transportation Authority; Vy Buss, Norway; Capital District Transportation Authority

Note*
- Tax Incentives
- Bus Scrappage payment
- Buy the Service (BTS) Scheme
- Advertising revenue
- Research & Development Grants

Legend:
- Government Authorities
- Banks
- Trust Funds
- Energy Companies
- Bus Manufacturers
- Bus Operators

5.1.4 Overview of Financing Options (1)

To accelerate the transition to zero emission buses across Scotland's public service fleet, there are a number of potential financing models which can be adopted. Many of these models have already been tested and proven in the existing bus market. The analysis in the following slides sets out how some of the existing models may be different in the context of a zero emission bus fleet.

The analysis also covers potential models which are currently emerging in the market and have drawn interest from multiple stakeholders, as well as models which are currently at concept stage (or developed in other sectors but could be relevant to the bus market). The following slides provide detailed descriptions and analysis of each potential model, including key opportunities and risks for different stakeholders, as well as the practicality of adopting these models/solutions for zero emission buses.

Note

The models explored and analysed in the following slides are based on a range of different stakeholders assuming particular roles. A view can be taken in some cases and across some models, that other parties could instead assume the role of those depicted as part of the models presented in this pack.

The roles of different stakeholders presented in the models within this pack, are based on research conducted at a point in time, as well as outputs from stakeholder engagement across the industry – a combination of which has provided a view on the most suitable, potential roles of different stakeholders, at present.

Example

In the case of Government, some of the models explored within this pack have assumed Government to play a role in some capacity (e.g. funding role or facilitating role). This is based on industry views on ensuring the development and deployment of optimal models, to best ensure a successful transition to zero emission buses. Where there is an absence of Government support (for instance, if a private sector stakeholder was to assume the role of Government in some of the models), further subsequent impacts / risks would need to be considered, such as an increase in fares (due to costs of associated risks e.g. residual value, being passed down to the consumer). Government could provide long-term subsidies (e.g. operating cost subsidies), without assuming a direct role in a particular financing model, to help keep fares stable, though this pack does not address such considerations as the primary focus is on initial financing models.

Sources:
1. Moudgal S. (2021). The India Times. Karnataka government eyes green rewards from pricey electric push. [Source]
2. Moon-Miklaucic et al (2019). World Resources Institute. Financing Electric and Hybrid-electric buses. [Sources]

5.1.4 Overview of Financing Options (2)

Existing	
Operating leases	The operator leases the buses from the owner (e.g. manufacturers, private investors, energy providers etc.), and pays for rent, taxes, and insurance. Maintenance is usually dependent on the provisions agreed in the lease agreement, and can be provided as part of the operating lease contract or as part of a separate contract with a third party maintenance provider. ***Example(s):*** • ***In India, the government of Karnataka[1]*** *has secured the central government's approval to lease 390 electric buses over a 15-year period. The fleet will consist of 90 small buses as feeder services to the Metro Rail, while the remaining 300 are full-sized electric buses which will be serving the city's urban bus routes. As part of the scheme, the government is going to subsidise the additional operating costs of e-buses vs. diesel buses (estimated at 8%) during the first few years of transitioning before operators can truly benefit from the lower operating costs in the long-run. The government has quoted that "initial investment is high as batteries have to be imported but costs will come down once local battery manufacturing picks up".*
Finance leases	Similar to an operating lease, the operator pays a regular lease payment to the vehicle owner. The difference is the expectation of (or opportunity for) the operator to purchase the asset at the end of the lease term (which is also usually longer spanning the asset's useful economic life). ***Example(s):*** • ***In Shenzhen, China[2]*** *in order to reduce the upfront costs of a fleet renewal to electric buses, Shenzhen Energy Conservation (a public body) introduced a finance leasing model which used a finance leasing company who purchased and owned the vehicles outright. The vehicles are then leased to the Shenzhen Bus Company Group for a period of 8 years with regular leasing payments being made. At the end of the contract, the bus operating company takes ownership of the vehicles. In this case, given that the leasing period is the same as the total life of the buses, the batteries are then returned to manufacturers for recycling, while the bus vehicle itself is sent for scrappage and metal recycling.*

Sources:
1. Moudgal S. (2021). The India Times. Karnataka government eyes green rewards from pricey electric push. [Source]
2. Moon-Miklaucic et al (2019). World Resources Institute. Financing Electric and Hybrid-electric buses. [Sources]

5.1.4 Overview of Financing Options (3)

Existing	
Concessional loans	The operator obtains a loan from a financing institution, which is provided with slightly more favourable lending conditions (compared to commercial loans) e.g. lower interest rates and/or longer repayment schedules. Concessional loans can also be used as part of: 1) blended financing (e.g. co-funded with private investments or public grants; and 2) lessor financing whereby manufacturers take out loans to acquire batteries or buses which are then leased out to operators. ***Example(s):*** • ***Concessional loans[1]:*** *The EU provided RET, a Dutch public transport provider, with a loan of EUR 115 million to acquire electric buses and charging infrastructure. The loan allows RET to keep cost of capital low due to the low interest rate offered by EIB.* • ***Blended financing[2]*** *with loans: In 2014* ***The Technological Transformation Program for Bogotá's Integrated Public Transport System*** *acquired 282 Low-emission buses by utilising a Clean Technology Fund concessionary loan for USD 40 million. In this instance, the national development bank Bancóldex then co-financed each vehicle purchased with an amount equal to that provided by the local financial institution, resulting in a total investment of USD 80 million.*
Sale-and-leaseback (refinancing)	Using the traditional form of this model, the operator would be assumed to already own the asset which it would then sell to a buyer, to free up capital and then lease the very same asset from the buyer. It's unlikely however that ownership of zero emission buses is currently (or will be) common amongst operators. Therefore the applicability of this model could be from operators selling (refinancing) their existing diesel fleet (which they own) to help pay for zero emission buses. ***Example(s):*** • *Sale-and-leaseback is more often observed in the shipping and aviation industries.* ***Recently, Virgin Atlantic[3]*** *raised just over USD 230 million by putting two units of its planes on a leaseback agreement. The model allowed Virgin to free up some capital in the midst of the economic downturn caused by COVID-19.*

Sources:
1. European Commission (2019). Juncker Plan and Connecting Europe Facility provide financing for electric buses in Rotterdam. [Source]
2. Moon-Miklaucic et al (2019). World Resources Institute. Financing Electric and Hybrid-electric buses. [Source]
3. Toman (2021). Sharecast. Virgin Atlantic to raise $230m via sale and leaseback of two planes. [Source]

5.1.5 Overview of Financing Options (4)

Emerging	
Component leases	The operator purchases the actual vehicle but leases the most expensive (pain point) part of the vehicle, for example electric batteries, hydrogen fuel cells or even charging infrastructure. ***Example(s):*** • ***In London[1],*** *Abellio and Zenobe energy are working together to bring 34 electric buses onto the roads of London. Abellio operates the buses for TfL whilst Zenobe Energy owns and operates the batteries on board as well as the charging infrastructure in the depots.* • ***Proterra (in the USA)[2]*** *is pioneering a new model by which they sell a battery electric bus for the price of a diesel bus (thereby reducing the upfront costs) and recuperating the discount by converting the capital cost of the battery into an operating cost for the operator over a number of years. This model has received acclaim from a green bus accelerator, the Climate Finance Lab, and has been utilised in Utah where this has resulted in an increased number of battery electric buses that were able to be purchased.*
Green bonds	The government or financiers issue bonds to the public to raise funding, to support more traditional forms of financing such as loan arrangements, for zero emission buses. This could become more prominent with the emergence of more 'Green Investment Banks' and financers with 'ESG' focused portfolios. ***Example(s):*** • *In* ***2017 in China[2]****, the Tianjin Public Transportation Group partially funding the purchasing of 500 electric buses (worth $154.5 million) by using a loan at preferential rates that was sourced through a capital pool created from the issuance of green bonds by the Shanghai Pudong Development Bank. The deal was partially funded by national fiscal subsidies worth 250 million yuan ($38.63 million) and long-term, low-cost financing totalling 469 million yuan ($72.46 million), which was jointly provided by the Shanghai Pudong Development Bank (SPDB) and the SPDB Financial Leasing Co. Ltd. The bonds pay an annual interest of 2.95% during their three-year term. The bonds were so popular when issued that they were oversubscribed, resulting in an estimated 20.4 billion yuan ($3.15 billion) worth of unmet demand.*
Integrated end-to-end financing (Bus-as-a-service)	An integrated financing package / solution, providing all necessary assets to the operator via a service model, where the operator only pays a fee for the availability and use of the asset(s), on a per mile / km basis. The integration provider "bundles" the vehicle, battery (or fuel cell) and infrastructure into one package, and the operators pays a regular fee for use and access. ***Example(s):*** • ***Siemens Financial Services*** *in the UK has outlined the potential benefits of financing models which help to deliver an end-to-end electric bus solution. Through our stakeholder interviews a bus manufacturer and battery owner have also indicated their support for this type of model, where an operator simply pays for a service use / access charge on a cost per km / mile basis. The provision of the fuel technology, maintenance, servicing and infrastructure is integrated into one end-to-end package for which the operators pays a monthly fee for.*

Sources:
1. Zenobe (2020). Abellio and Zenobe Energy to bring 34 electric buses to London. [Source]
2. Moon-Miklaucic et al (2019). World Resources Institute. Financing Electric and Hybrid-electric buses. [Source]
3. Energy Market Magazine (2019). 'End-to-end finance is helping charge the electric bus revolution' [Source]

5.1.6 Overview of Financing Options (5)

Note: not all of the case studies presented on this slide are bus related – this is because these are potential models taken from other sectors, with potential applicability to a zero emission bus market.

Potential	
Residual Value Guarantee	The government uses grants to guarantee a percentage / portion of the residual value of assets after the initial contract period. ***Example(s):*** *Residual value guarantee/agreement is often used in the aviation industry as a way to protect financiers from the residual value risk. There are 3 main reasons for using a residual value guarantee: 1) to provide additional security for the financing parties in asset acquisitions; 2) to minimise the exposure of a lessor to residual value risk in operating leases; and 3) to provide an airline with the confidence in the value of its investment in an aircraft[1].*
Revolving Fund	A principal financier (via a special purpose vehicle/SPV) provides capital for investment in fleets, charging infrastructure and grid network connections. The SPV is responsible for fleet services to bus operators but also works with energy suppliers for the provision of infrastructure and grid connection (who are assumed to own the infrastructure in the long-term). The underlying premise is that energy suppliers benefit from the initial investment in infrastructure, and can provide better deals to operators for energy use (where additional revenue can also be generated through increased energy demand). This can generate proceeds for individual profit and to repay the SPV for initial investment in the infrastructure and grid connection. ***Example(s):*** *A revolving fund is typically used by the government to compel energy and utility companies to invest in energy efficiency projects through an SPV. As the ultimate beneficiaries of the energy efficiency projects, energy and utility companies will repay the costs of the project through the additional margin enabled by the efficiency measures or additional infrastructure. A similar model has been used by the governments of the US, UK, and Thailand[2].*
Mezzanine Loan	A financier provides a debt arrangement for the asset owner (e.g. operator, technology provider etc.). Should the asset owner default on loan repayments, the debt is converted in equity. ***Example(s):*** *A mezzanine loan is usually used to fill in a financing gap whereby the buyer has exhausted its ability to take out senior debt. The model is often used in corporate equity financing. However, the model has not been applied to the bus market yet.*

Sources:
1. LexisNexis. The use of residual value agreements in aviation finance. [Source]
2. Gouldson et al (2015). Innovative financing models for low carbon transitions. [Source]
3. Prudential Private Capital. '8 Uses for Mezzanine Financing' [Source]

5.1.6 Overview of Financing Options (6)

Note: not all of the case studies presented on this slide are bus related – this is because these are potential models taken from other sectors, with potential applicability to a zero emission bus market.

Potential	
Partial Risk Guarantee (PRG)	A Partial Risk Guarantee (PRG) is offered by the government where some form of financial support is in place should there be any changes on original (policy / project based) commitments. ***Example(s):*** *The World Bank has rolled out a PRG to help infrastructure developers in eligible member countries cover the costs in the event the government reneges on its commitment either due to a change in the government or political agenda. The PRG guarantees a certain percentage of the remaining cost of infrastructure to allow developers more time while it seeks for other ways of filling in the remaining financing gap[1].*
Demand Aggregation	Government aggregates demand across bus operators and positions this to financiers (once a minimum threshold in demand has been met), potentially with a cap on the maximum price operators are prepared to pay and the deals they would want. The guaranteed demand could then incentivise financiers to offer attractive solutions. This could then be extended into a 'reverse auction' where the most attractive solutions from financiers are provided to operators registering an interest, for them to decide which deal to proceed with. ***Example(s):*** *In the energy market, there is a role for aggregators to coordinate and aggregate demand response from individual consumers to better meet the industry parties' requirements for infrastructure and routes to entering the market. Aggregators in turn send signals back to their consumers in the form of the pricing that suppliers agree to for the said level of demand[2].*

Sources:

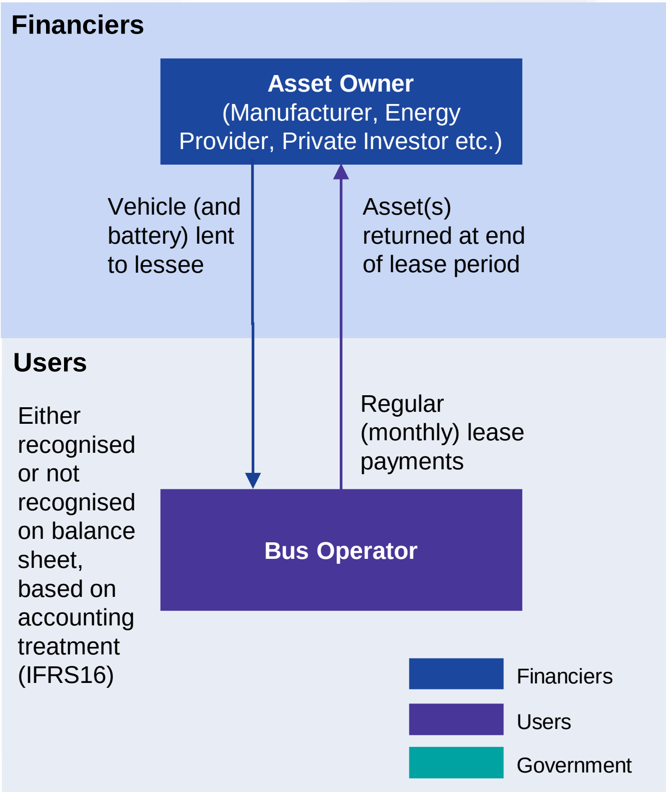
1. Hansen (2016). Norton Rose Fulbright. World Bank Guarantees for Private Projects. [Source]
2. Gouldson et al (2015). Innovative financing models for low carbon transitions. [Source]
3. PA Consulting Commissioned by Ofgem (2016). Aggregators – Barriers and External Impacts. [Source]

Chapter 5

Existing

5.2.1 Operating Lease

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

An operating lease is a contract model which allows the lessee use of a vehicle in return for regular lease payments. The ownership of the asset is retained by the asset owner (or lessor). Maintenance of the asset is usually incorporated as part of the lease agreement (and therefore covered by the owner of the asset) but can sometimes also be delivered as part of a separate service contract. All asset retaining risks (e.g. utilisation, technology, residual value etc.) would be retained by the owner of the asset. The new IFRS16 accounting standard requires operating leases to be reflected on balance sheets unless: 1) the reporting entity is a subsidiary which holds less than 10% of the group's total lease in value; 2) underlying asset is of low value; and 3) lease term ends within 12 months of the date of initial application

Evaluation of Characteristics

Risks		
Type	For Operators	For Financiers / Lessors
Performance	Technical issues with battery/fuel cell/infra could disrupt bus services and revenues in the short term	Technical issues with battery/fuel cell/infra could disrupt bus services and repayments in the first few years of deployment
Obsolescence	No significant obsolescence risk	Financiers/lessors incur most of the costs/risks of obsolescence
Residual Value	No residual value risk	Incurred by financiers/lessors
Non Payment	Financees/lessees rely on sufficient ridership to cover lease payment	Risk of non payment is a concern if the operator has low ridership levels / revenue
Other considerations		
Criteria	For Operators	For Financiers / Lessors
Upfront Costs	Spread high upfront costs over the leasing period	Financiers incur this cost upfront.
Maintenance Costs	Maintenance is typically covered by lessor	Maintenance is typically covered by lessor
Skills & Capabilities	There could be knowledge transfer from the lessor to lessee in respect of maintenance	The lessor may save on maintenance costs by providing training to the lessee
Access to Funding / Financing	Lessee needs to show robust / strong balance sheet position	Lessor who finances assets with loans needs to show a strong balance sheet
Financing Costs / Income	Relatively manageable lease costs over a short period, and the potential to exclude from balance sheet if IFRS16 criteria is met	Financiers benefit from a premium (via receipt of lease payments) in exchange for providing the asset upfront

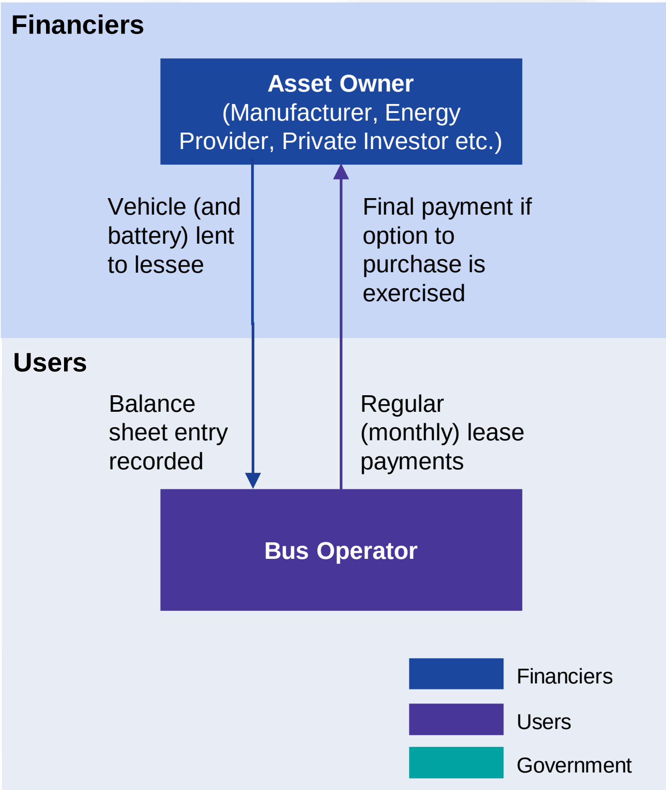
Sources:
1. Moon-Miklaucic, C., A. Maassen, X.Li, S/ Castellanos. 2019 "Financing Electric and Hybrid-Electric Buses: 10 Questions City Decisions-Makers Should Ask". Source
2. Pegasus Finance website. Source

5.2.2 Operating Lease: SWOT Analysis

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Operators get to spread the high upfront cost over the lease term – Lease terms are typically short and therefore provide operators with the option at the end of lease term to transition to other technologies – No Residual Value risks to operators. – Maintenance and service is usually provided. Asset owners may also offer training. – Monthly payments can be made out of operating income and therefore offset from taxable profits (subject to appropriate accounting rules). – Provides predictable cash flow impacts.	– The terms of the lease are linked to the credit profile of the lessee based on the lessor's own assessment (instead of an official credit rating), therefore this option could be less attractive to some operators than others. In particular, operators with lower credit ratings may struggle to acquire this form of contract, or may pay higher lease costs if they do. – The cost for using the asset (prorated for the term of the lease) could be greater than the equivalent of if the operator bought the asset.	– **There is an incentive for operators to improve the service quality of zero emissions buses and make fares more competitive if the leasing contracts incentivise them to do so. For example, in exchange for (financial) support, the government can work with the lessor to introduce KPIs into lease terms, such that operators could be financially rewarded / penalised, depending on level of service quality provided (or even condition of battery / fuel cell upheld).**	– There is a possibility that without sufficient ridership levels, the overall additional cost of leasing would hamper the operators' ability to make reasonable profits to sustain its zero emissions bus operation in the long term.
Financiers/Asset Owners	– The asset owner can have greater control over how the assets are maintained and therefore maximise residual value. – The asset owner can train the operators to reduce long-term maintenance costs.		– **Asset owners could receive incentives from the government in return for stipulating certain T&Cs/KPIs as part of the lease contract to operators.** – **There is an opportunity to combine government's financial support and conventional debt arrangements to acquire to-be-leased assets.** – **There is also an opportunity to work with operators to identify and establish a channel to secondary market to provide some level of certainty to RV.**	– Inability to establish secondary and tertiary use cases for used batteries will greatly compromise residual value at the end of asset life. – Batteries are reliant on the limited supply of rare earth and/or established facilities and processes to recycle and remanufacture batteries after initial use. Increasing these capabilities could help to reduce costs of new batteries (and increase RV of used batteries) in the long-term.

5.3.1 Finance Lease

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

Finance (capital) leases offer bus operators the opportunity to lease the asset for usually the majority of its useful life and then purchase the asset at the end of the term. This is different to an operating lease in that the lease period is considerably longer (spanning the Useful Economic Life of the asset), and usually includes:

1. A residual value agreement – which the operator has to pay the asset owner for acquiring the asset; and
2. A repurchase/rebate agreement – which allows the lessor to repurchase (or a third party to purchase) the asset from the lessee given that the assets are well maintained and other requirements in the contract are met.

Evaluation of Characteristics

Risks		
Type	For Operators	For Financiers / Lessors
Performance	Technical issues with battery/fuel cell/infra could disrupt bus services and revenue in the short term	Does not affect financiers or lessors directly
Obsolescence	Obsolescence risk is shared with the lessor	Obsolescence risk is shared with the lessee
Residual Value	The lessee bears the majority of the risk	The lessor bears low residual risks
Non Payment	Financees/lessees rely on sufficient ridership to pay rent	Risk of non payment is present if the operator has low ridership levels / revenue
Other considerations		
Type	For Operators	For Financiers / Lessors
Upfront Costs	Diminishes upfront costs significantly	Financiers incur this upfront cost
Maintenance Costs	The lessee bears the maintenance costs	Financiers bear no maintenance costs
Skills & Capabilities	No straightforward arrangement to fill in for the gap in skills and capabilities	Financiers may provide training
Access to Funding / Financing	A relatively strong balance sheet is required to enter into finance leases	A strong balance sheet is required if the lessor resorts to debt financing
Financing costs / Income	Relatively manageable lease costs over the period; however a longer lease period (i.e. over the UEL of the asset) may mean higher costs overall than owning / short-term leasing due to the uncertainties around RV of batteries as more time lapses.	Financiers benefit from a premium (via receipt of lease payments) in exchange for providing the asset upfront

Sources:

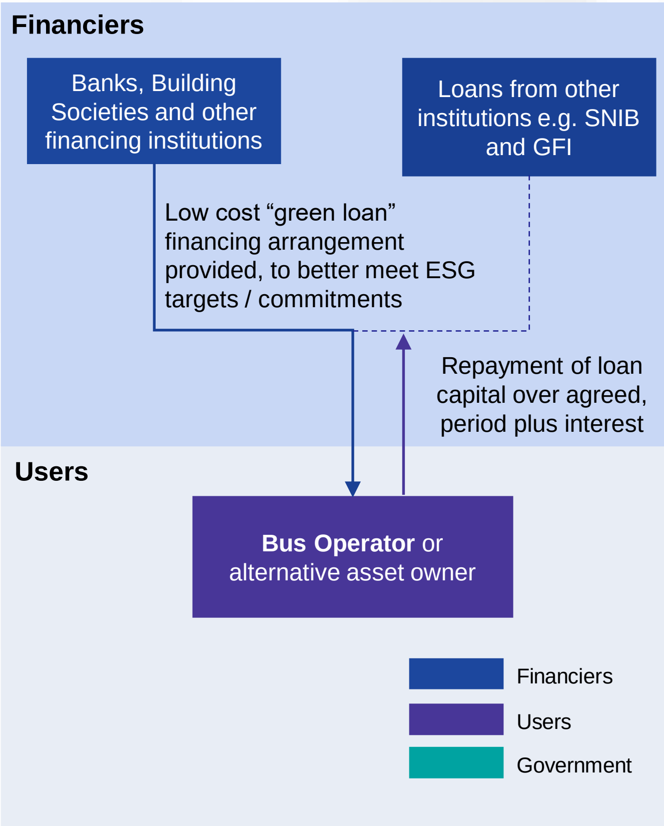
1. Moon-Miklaucic, C., A. Maassen, X.Li, S/ Castellanos. 2019 "Financing Electric and Hybrid-Electric Buses: 10 Questions City Decisions-Makers Should Ask". Source

5.3.2 Finance Lease: SWOT Analysis

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Reduces the high upfront cost of acquiring assets. – Considered as capital spending allowing operators who are working with capex-designated funds more flexibility. – Potential tax and VAT benefits depending on prevailing government's regulations. – Operators may benefit from the trade-in value in the event of a repurchase if the assets are sufficiently well-maintained.	– Operators likely to bear the residual value risk at the end of the lease term. – Since an upfront deposit is required, operators still need to have 'healthy' balance sheet, demonstrating sufficient cashflow and reserves (and ability to take on risk), before they can opt for this financing scheme. – Operators are usually left to maintain the asset, including the replacement of batteries which in the case of electric buses is a significant cost.	– **There is an opportunity to complement existing finance leases with a government funded 'Help-to-Buy' / concessional loan scheme. Government could commit to funding as part of the lease structure, with a favourable condition for the operator such as zero-interest repayment on the government's equity for 'n' number of years, subject to operators meeting certain KPIs for zero emission buses (e.g. revenue/patronage targets, service quality, etc.)** – **There is also an opportunity to work with finance lease providers to identify and establish a channel to secondary markets, to provide some level of certainty to RV.**	– The end-state of technology for each local area may differ from one to another. Acquiring one type of technology upfront may risk obsolescence if it is later found to be unsuitable.
Financiers / Asset Owners	– In the case of electric buses, batteries can often be returned to manufacturers for recycling at the end of lease term, maximising the end of life value of batteries. – Low residual value risk to the lessor as full asset life value has been embedded into the lease fee.	– Since the asset owner bears low residual value risk, there is no clear incentive to help the operators maintain the buses in the best way possible.		– The residual value of the bus, especially that of batteries, relies on the ability to establish facilities and processes to recycle and remanufacture batteries after initial use.

5.4.1 Concessional loans

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

Concessional loans are loans which are provided at more-competitive-than-market interest rates and repayment terms (e.g. usually spread over a longer term). The aim of this financing option is to reduce the overall cost of capital in acquiring zero emissions buses. However, in order to obtain access to large amounts of financing via loans from conventional lenders such as banks and building societies, the entity applying for the loan (i.e. asset owner) will need to demonstrate a relatively strong balance sheet.

Evaluation of Characteristics

Risks		
Type	For Recipients	For Loan Providers
Performance	Assumes performance risk of asset	None
Obsolescence	Assumes obsolescence risk of asset	None
Residual Value	Assumes residual value risk of asset	None
Non Payment	If operator, reliance on sufficient ridership to cover repayments	Loan provider undertakes default risk of repayment

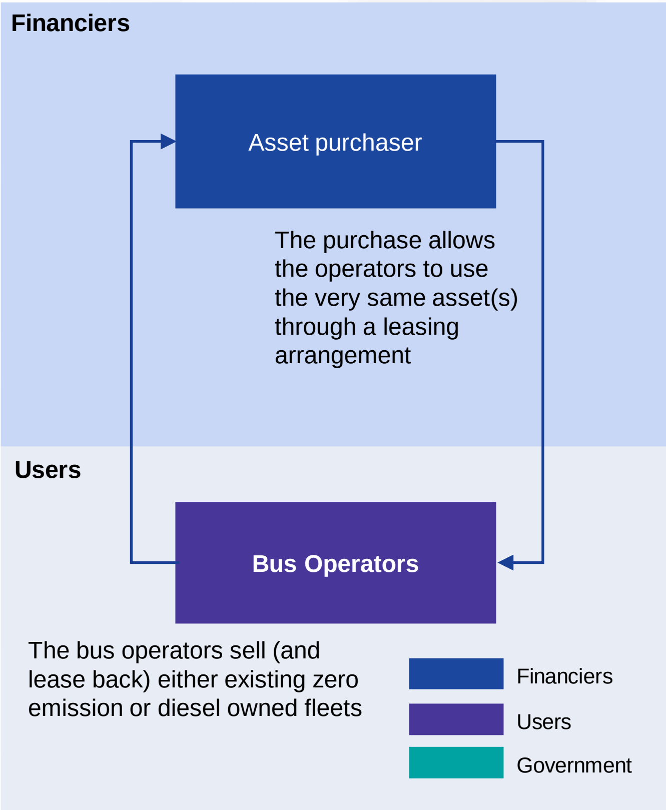
Other considerations		
Type	For Recipients	For Loan Providers
Upfront Costs	Lessens the impact of upfront costs through use of loan	Loan provider provides the capital required upfront
Maintenance Costs	Responsible for maintenance costs	No need to cover maintenance costs
Skills & Capabilities	No straightforward method to fill in the potential gap in skills and capabilities	N/A
Access to Funding / Financing	ESG loans (e.g. NatWest) can provide access to low-cost capital	Loan providers earn interest for providing access to capital
Financing Costs / Income	Financing costs should be lower if a concessional (ESG) loan is accessible. However, this depends on the operator's ability to demonstrate a strong balance sheet and certain level of revenue certainty.	Earns interest in exchange for providing access to capital upfront

5.4.2 Concessional Loans: SWOT Analysis

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Concessional loans provide a benefit to the borrower in the form of favourable terms and conditions that they would otherwise not be able to obtain in the commercial market. Financially, this benefit is the difference between the payment pattern under the concessional loan and the payment pattern under an equivalent commercial loan. – The concessionary terms of the loans can reduce the upfront cost barriers to transitioning towards cleaner fleets. – The more financiers who are willing to come forward and offer concessional loans, the more options available for the operators to choose from.	– Potentially less accessible to operators who cannot yet demonstrate their capability to minimise the technology risk – Due to the nascency of the technologies involved, operators may not always have the necessary capabilities and skills to adopt best practices in maintaining the batteries or fuel cells, and neither can the loan providers necessarily help.	– **There may be an opportunity for operators to identify banks or building societies which offer ESG loans, usually at a more competitive rate than market-rates.**	– There is a threat in which the opted technology is not sufficiently future-proof. Operators must be confident that the opted choice of technology will be the prevailing choice in the future before entering into long-term loan agreements.
Financiers / Asset Owners	– Concessionary loans can be utilised as a part of achieving relevant government strategies (e.g. supporting the Net Zero agenda). – Greater numbers of financiers could potentially result in opportunities for risk-pooling, whereby each financier finances a smaller proportion of the zero emission bus market (decreasing overall risk).	– Given that these loans require the providing organisation to take on more risk in return for societal benefits, it can be harder to find financiers willing to provide concessional loans. – Higher numbers of financiers would mean fewer / lower margins and premiums for individual financiers, who would each have a smaller share of the overall market.	– **There is an opportunity to embed KPIs (as part of the conditions of the loan) to make sure that the assets will be well maintained per best practices and fully used for its entire UEL in exchange for a concessional (lower) interest rate.**	– There is a threat in which the assets do not last as long as studies have shown them to do. Loan providers would then undertake more risk if assets fail to last as long as they are expected to.

5.5.1 Sale-and-leaseback

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

In this model, bus operators can either: 1) sell their existing diesel buses and lease them back to free up cash and invest in zero emission buses; or 2) sell their zero emission buses and lease them back as part of a transition to another, more suitable zero emission technology (e.g. electric battery to hydrogen, or vice versa). This can also be deemed as a re-financing arrangement. Operators would then be able to free up some capital to invest in other items which could potentially generate a higher return. This option also provides flexibility in that if improved or other technologies better suit the requirements (e.g. geographical features, capacity, route distance, etc.) of operators, fleets can be upgraded quicker with lower transitional costs and effort involved.

Evaluation of Characteristics

Risks		
Type	For Operators	For Asset Purchasers
Performance	Shared between asset purchase and operator dependent on leasing contract	Shared between asset purchase and operator dependent on leasing contract
Obsolescence	Low risk – mainly held with asset purchaser	Assumes obsolescence risks
Residual Value	Low risk – mainly held with asset purchaser	Assumes residual value risks
Non Payment	Operator relies on sufficient levels of revenue to cover leasing payments	Risk of operator not generating sufficient revenue to pay for lease costs
Other considerations		
Type	For Operators	For Asset Purchasers
Upfront Costs	Frees up capital for the operator	The cost is transferred to the asset purchaser
Maintenance Costs	Dependent upon the leasing arrangement with the asset purchaser	Dependent upon the leasing arrangement with the asset purchaser
Skills & Capabilities	Assumed to be pre-existing	N/A
Access to Funding / Financing	Asset purchaser may not be as willing to refinance mid-life assets	Asset purchasers are assumed to have free capital to invest in refinancing contracts
Financing Costs / Income	Operators may have to sell the asset at lower than market value as sale-and-leaseback is typically used to recover cash in the short term.	Earns premium from lease payments as part of refinancing contract arrangement; also obtains asset at potentially lower than market value

5.5.2 Sale-and-leaseback – SWOT Analysis

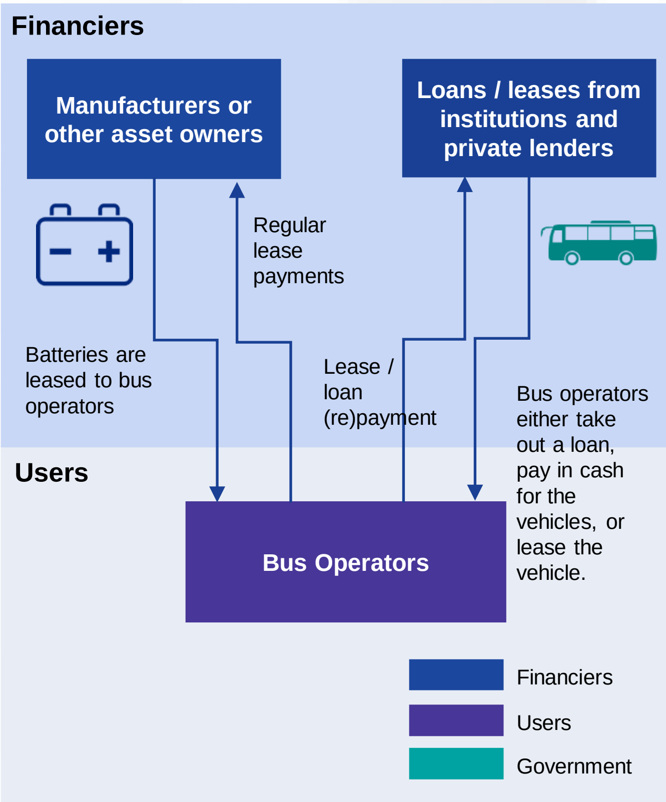
	Strengths	Weaknesses	Opportunities	Threats
Operators	– Opportunity to free up capital for other uses and shift residual value risk to a third party. – Opportunity for any operator wishing to transition from one technology to another (e.g. from diesel to electric buses or from electric buses to hydrogen). – The operators also benefit from the advantages of engaging in an operating lease, as outlined in previous slides.	– Lifetime cost of leasing is ultimately still going to be higher than lifetime cost of ownership. Hence, there should be a strong business case of an alternative investment, in which the 'released capital' is allocated towards, generating a higher return for the operator. – Financiers may be less willing to acquire used assets due to lack of information on its status, particularly if they are at mid-life stage (e.g. how well-maintained they are, etc.).	– **Greater flexibility provided to operators in selecting, or switching to, technology types most suited to meet the requirements of a particular region / area / bus route – particularly if the technology types, or route requirements, are constantly evolving or changing.**	– There is a threat in which the new technology the operator switches to being even less favourable than the previous one. This will lead to an increased financing cost for operators. Therefore, a comprehensive trialling is always recommended before opting for a new technology.
Financiers / Asset Owners	– Operators looking to refinance their assets could likely be struggling with cashflow. Hence, it could be a good opportunity for financiers who are looking to invest in assets at below the typical market value.	– Financiers could be less willing to acquire second-hand assets if there is a lack of information on the asset (e.g. maintenance of assets and usage patterns, all of which influence the RV of the assets).	– **The government may want to provide some form of assurance to financiers in the form of compensation if the refinanced zero emissions buses do not live up to their expected remaining asset life, or a residual value guarantee.**	– Financiers should also ideally have some level of capacity in recycling, disassembling and remanufacturing to get the most value of buses when they reach the end-of-life state i.e. set up for secondary usage. The lack of a channel to the secondary market may lead to greater uncertainties around RV and the future price of components (e.g. batteries).

Chapter 5

Emerging

5.6.1 Component leasing

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

Component leasing is an emerging financing model in the zero emission bus space which targets specifically the operators' pain point in acquiring a new zero emission bus e.g. the batteries (electric), fuel cells (hydrogen) or charging infrastructure which usually make up a substantial proportion of costs. In this model, a third party owns the component/infrastructure during the lease term, and is also responsible for the maintenance of said component/infrastructure. Operators then lease the required component from the third party whilst separately purchasing the vehicle itself, either from the same entity or an entirely different one. This model first emerged in 2019 when Abellio and Zenobe proposed to deliver e-bus services to TfL with Abellio (operator) separately leasing the batteries and charging infrastructure from Zenobe.

Evaluation of Characteristics

Risks		
Type	For Operators	For Financiers / Lessors
Performance	Shared between operator and financier based on assets in use / service	Shared between operator and financier based on assets in use / service
Obsolescence	Only responsible for the vehicle	Assumes risk for the costly elements
Residual Value	Only responsible for the vehicle	Assumes risk for the costly elements
Non Payment	Dependent upon levels of ridership and revenue generated	Dependent upon operators' levels of ridership and revenue generated

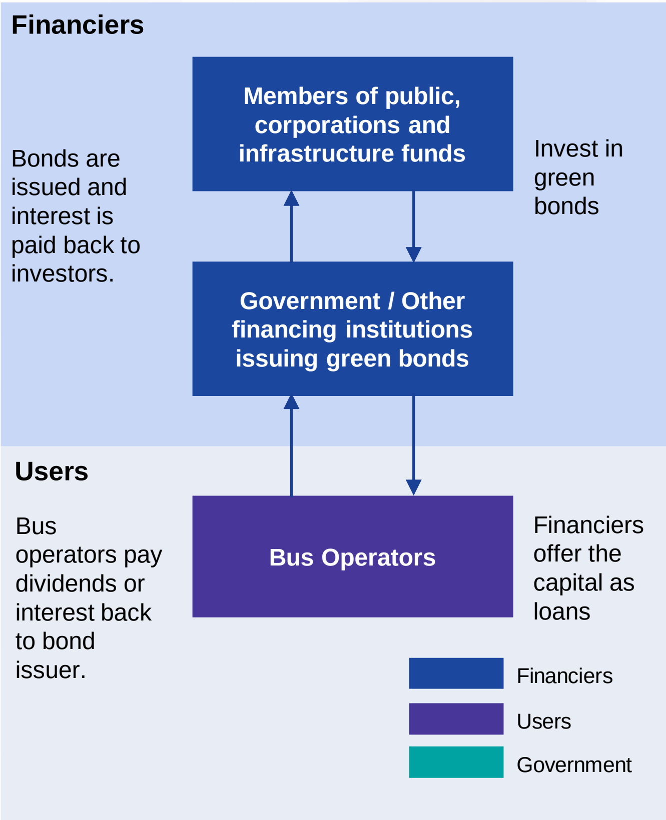
Other considerations		
Type	For Operators	For Financiers / Lessors
Upfront Costs	Lowers the cost of acquiring batteries / fuel cells / infrastructure	Receives premium for providing batteries / fuel cells / infrastructure
Maintenance Costs	Responsible for vehicle maintenance only (pre-existing / BAU)	Responsible for all maintenance
Skills & Capabilities	May need to obtain training from the lessor	Can provide training to operators
Access to Funding / Financing	Relatively affordable in the short term	Strong balance sheet needed to acquire initial assets
Financing Costs / Income	Potentially high lease costs over the period in order to also cover asset maintenance, monitoring, training, etc.	Component lessor earns a premium for providing and maintaining components, and potentially associated infrastructure servicing

5.6.2 Component leasing: SWOT analysis

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Ensures that operators are not tied to certain technologies, as the lessor can provide refreshed technology part way through the contract, if needed. For instance, if a more efficient battery technology comes along in the future, the lessee will have the option to upgrade after the contracted lease term. – Furthermore, if the battery / fuel cell degrades or breaks, then a replacement will be provided with minimal additional costs to the operator. – Protects the operators from the value depreciation of batteries.	– The downsides are predominantly financial; the total lifetime cost of the battery / fuel cell can be more through this model than if operators purchased both the vehicle and component outright up front. – Some leasing contracts can have stipulations which limit the total use of the assets e.g with mileage limits in some instances to preserve lifespan of batteries.	– **Provides greater scope for different stakeholders to play more significant roles in a self-sustainable model (e.g. energy provider owns and maintains batteries, manufacturer owns/maintains buses, and operators own buses and/or focus primarily on quality of service provision).**	
Financiers / Asset Owners	– If the asset owner specialises in the technology, through maintenance and servicing activities, this will also allow the asset owner to maximise the residual value of the component leased.	– Bespoke requirements by each operator may affect the scale at which the lessor can offer its service, thus compromising its competitiveness or market offering efficiency. – Asset owners will need to have sufficient capabilities / means of ensuring second usage (as they hold residual value risk).	– **Since battery maintenance and power consumption comprise the majority of an operators' operating costs, there is an opportunity for component lessors to undertake the role of an integrator of other essential services.**	– There have been observations whereby batteries/components do not live up to their promised UEL. This will result in higher costs for battery owners for conducting more repairs and replacing more batteries.

5.7.1 Green bonds

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

The government or financiers issue bonds to the public to raise funding, to support more traditional forms of financing such as loan arrangements, for zero emission buses. This could become more prominent with the emergence of more ‘Green Investment Banks’ and financers with ‘ESG’ focused portfolios.

Evaluation of Characteristics

Risks		
Type	For Operators	For Bond Issuers
Performance	Technical issues with battery/fuel cell/infra could disrupt bus service in the short term	Performance risk has less impact on investors and/or bond issuers
Obsolescence	Operator assumes obsolescence risk due to using bond financing to own the asset	Assumed by operator but represents a risk if operator defaults on loan / interest payments
Residual Value	Operator assumes residual value risk due to using bond financing to own the asset	Assumed by operator but represents a risk if operator defaults on loan / interest payments
Non Payment	Operators rely on sufficient revenue levels to pay off loans and interest	Dependent on operator generating sufficient revenue to pay off loan / interest

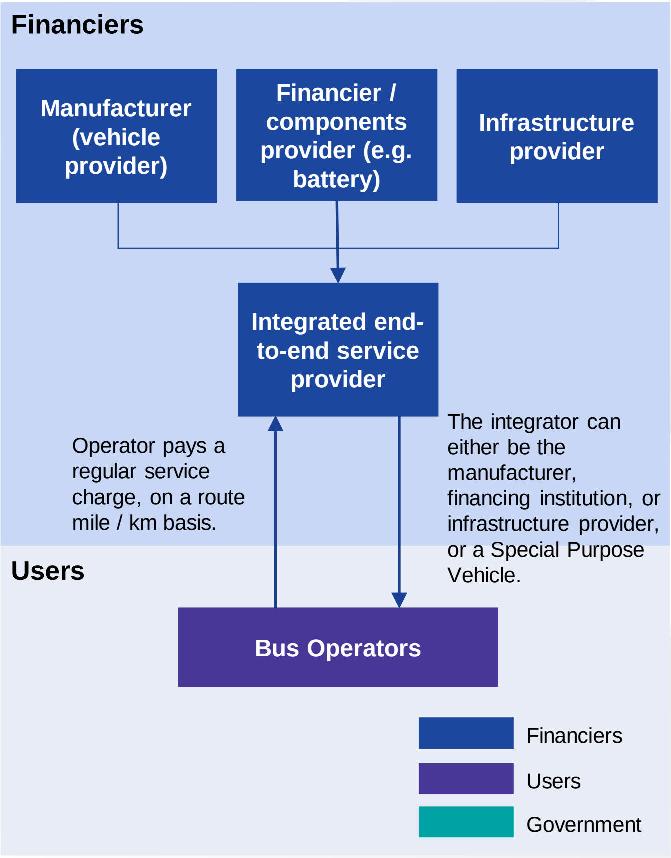
Other considerations		
Type	For Operators	For Bond Issuers
Upfront Costs	Potentially cheaper access to capital	Earns a premium for providing capital
Maintenance Costs	Responsibility of operator	No maintenance responsibility
Skills & Capabilities	Potential need to fill gaps in skills and capabilities, as this is not provided by financier	N/A
Access to Funding / Financing	Competition from other types of bonds makes operators exposed to the volatility of the capital market, which may commensurately affect interest rates in the long-term.	N/A
Financing Costs / Income	Financing costs should be lower if a concessional (ESG) loan is accessible. Interest rates may be more volatile as it is subject to the fluctuations of the green bond market.	It is likely that the marginal profit earned by the bond issuer will be modest at best. The bond issuer also needs to share it’s dividends with the bond holders.

5.7.2 Green Bonds – SWOT Analysis

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Access to capital raised through the issuance of green bonds can significantly reduce the up front capital required from operators. – Green bonds provide a way to secure large amounts of capital to support environmental investments that may not otherwise be available, or that may be uneconomical using more expensive capital.	– For a fixed rate bond, the operators could 'lock in' less than favourable market rates if they do not have a strong credit score. – Uncertainty of funding due to susceptibility to the fluctuation of the capital market encourages short-sightedness and could discourage long-term investments, such as in R&D.		– There may be other investment opportunities which are more attractive to investors and issuers of green bonds, than zero emission buses – Susceptibility to wider capital market fluctuations and economic downturn which may compromise the certainty of financing for bus operators in the long run. Certainty of funding is also often an important feature for successful infrastructure planning, which is a key element in delivering zero emissions buses.
Financiers / Asset Owners	– Raising funds via green bonds aligns with many organisations' ESG agendas, as well as the wider Net Zero agenda. – Raising funds via issuing bonds allows access to a wider pool of potential investors, including emerging, solely 'green focussed' investors.		– **There is an opportunity for Transport Scotland to work with green bond providers to explore ways to incentivise investors to invest in zero emissions buses, or make zero emissions buses an attractive offering in the bond market.**	

5.8.1 Integrated end-to-end financing (Bus-as-a-Service)

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

To provide an integrated financing solution to operators, different parts of the service (e.g. vehicle, battery/fuel cell, infrastructure etc.) required to operate a bus service, can be "bundled" up by a potential investor (e.g. manufacturer/component provider, financing institutions, or infrastructure provider), to provide a complete end-to-end package. The benefit is that, for all infrastructure, vehicle and component requirements, operators will only need to engage with one entity, therefore potentially saving costs in contract management and ancillary fees – not to mention the time and effort saved from having to work with multiple different entities for different aspects of their buses. These savings in costs and time can then be better allocated to improving their overall service and quality to passengers. Operators would simply pay for the availability and use of an asset on a route per mile / km basis. This would however mean that the provider of the platform / service would need to be highly mature and one which can assure the availability of the required fleet and optimise performance.

Risks

Type	For Operators	For Service Providers
Performance	May be required to meet certain KPIs / criteria as part of service agreement	Dependent on operator to maintain assets appropriately
Obsolescence	None – assumed by service provider	Assumes obsolescence risk of asset
Residual Value	None – assumed by service provider	Assumes residual value risk of asset
Non Payment	Low – payment dependent on service usage and not financing agreement	Low – operator will pay as and when they use the service

Other considerations

Type	For Operators	For Service Providers
Upfront Costs	None – operator simply pays for use of service	High – purchasing of assets required to provide the service
Maintenance Costs	None – responsibility of service provider	Responsible for maintenance
Skills & Capabilities	Operator doesn't necessarily benefit from skills gain but can be provided by service provider later in contract period	Would require appropriate skills to maintain provided assets (e.g. vehicle / battery / fuel cell / infrastructure)
Access to Funding / Financing	Operators pays for service dependent on its own levels of ridership/bus usage	Strong balance sheet needed to obtain financing for purchasing the assets
Financing Costs / Income	Operators pay more for integration and a more streamlined interface with infrastructure and energy providers	Service provider earns premium for providing the integration service but internalises some of the risks associated with integration

5.8.2 Integrated end-to-end financing: SWOT Analysis

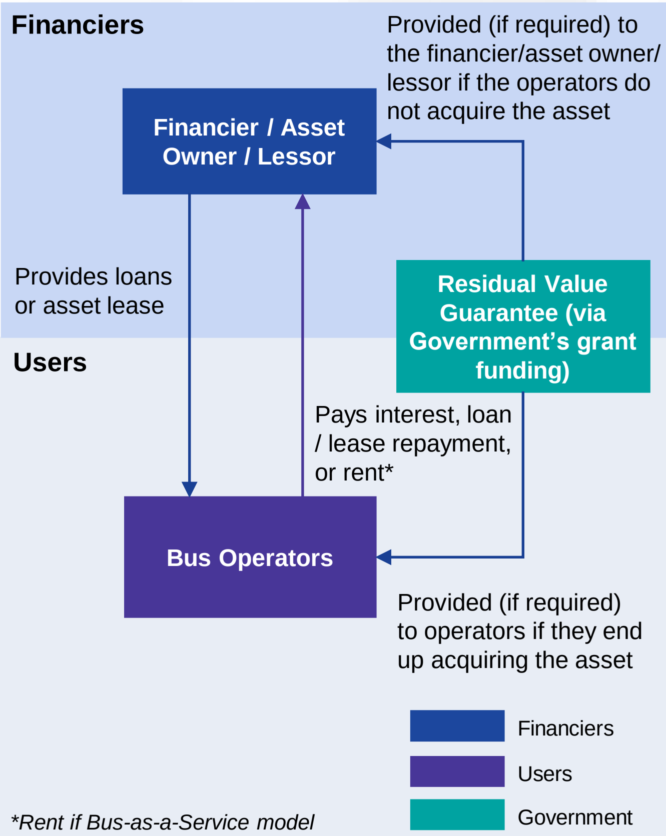
	Strengths	Weaknesses	Opportunities	Threats
Operators	– An integrated service offering will enable operators to overcome the complexity of technology and infrastructure transitions. – Operators can focus efforts on improving service quality and attracting more passengers, as opposed to contract management. – Tailored service offering which targets the “financing pain points” and other financing requirements of the operator depending on its characteristics (e.g. strength of balance sheet, size, skills and capabilities etc.).	– Operators likely pay a premium to access and use such a solution (the premium being to incentivise service providers to build and offer this service). – For smaller operators, this higher premium could be more than the revenue levels being achieved, thereby requiring a robust cost-benefit analysis.	– **There is an opportunity for public funding to subsidise the higher premium (for operators) or to incentivise service providers to take the role of an integrator.** – **Opportunity to work with industry (manufacturers, infrastructure providers, energy providers etc.) to identify the technology cost curve to identify the right time to withdraw financial support, to achieve a successful transition to a self-sustainable model.**	– There could be a lack of pace in developing sufficient regulation to keep up with the market offering or solution being developed. – A deregulated market may lead to an inability of the integrator(s) / service providers to provide competitive offerings in the market due to lack of scale.
Financiers / Asset Owners	– Some risks are internalised by the integrator which benefits the financiers/asset owners. – Integrator has the incentive to maximise the UEL and RV of assets therefore improving potential secondary and tertiary use of assets (e.g. batteries). – Low risk of non payment as operators will pay as and when they use the service, rather than having to ‘repay’ a financing agreement.	– The role of integrator needs to be regulated to ensure that the service offers sufficient level of integration and is competitive or affordable from operators’ perspective. – There is a need to build a risk-sharing model in the integrated model involving multiple parties. To what extent will the various parties, including the integrator, bear the risk of residual value, obsolescence, default, etc.	– **There is an opportunity to consult with the FCA for permissibility to scale the product / service offering across an entire market / geography.** – **Such a model could provide an opportunity to build a suitable model that can also be applied / scaled to other EV / Low Emission vehicle markets.**	– Without regulation, integrators may add other unnecessary (and costly) layers of complexity in an already complex market environment.

Chapter 5

Potential

5.9.1 Residual Value Guarantee Scheme

Financing model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

Grant funding could be used as part of a residual value guarantee scheme, providing greater security for the asset and greater reassurance to financiers that the residual value of zero emission buses will not fall below a certain level. The scheme could be set up in such a way that the financiers or asset owners are compensated for the difference between the expected residual value and actual residual value, at the end of the initial contract period. Alternatively, an arrangement could also be made to cover a portion of whatever the residual value is at the end of a contract period.

Evaluation of Characteristics

Risks		
Type	For Guarantee Scheme Recipients	For Guarantee Scheme Providers
Performance	Compensation could be contingent to meeting certain performance criteria / KPIs	Compensation could be contingent to meeting certain performance criteria / KPIs
Obsolescence	Risk of obsolescence is shared with the guarantee scheme provider	Residual value risk is shared with the guarantee scheme recipient
Residual Value	Residual value risk is shared with the guarantee scheme provider	Residual value risk is shared with the guarantee scheme recipient
Non Payment	N/A (assume non-repayable grant)	N/A (assume non-repayable grant)

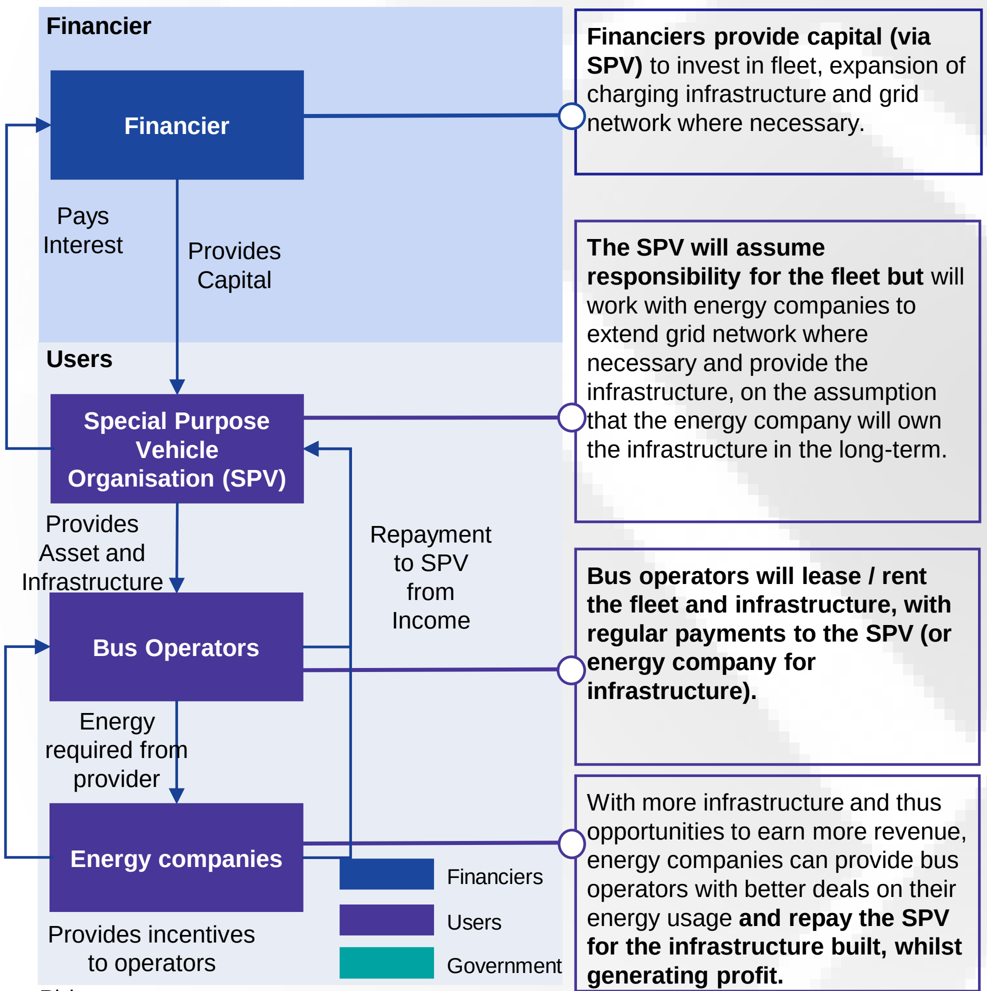
Other considerations		
Type	For Guarantee Scheme Recipients	For Guarantee Scheme Providers
Upfront Costs	N/A	N/A
Maintenance Costs	Grant recipient takes full responsibility	N/A
Skills & Capabilities	Grant recipient takes full responsibility	Responsibility of asset owner
Access to Funding	Access to funding may be provided on a first come first serve basis	State aid considerations in potentially distorting competition in the market
Financing Costs / Income	Minimum level of guarantee may reduce interest rates / lease payments	Government may have limited funds given wider budget constraints and find it difficult to retract once the market overly relies on grant

5.9.2 Residual Value Guarantee Scheme

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Operators could be provided lower financing costs from financiers as the uncertainties around the RV have been internalised to an extent by the guarantor (i.e. Government).	– Some operators may still struggle with the up front costs of capital, and though the scheme would guarantee a portion of the residual value, operators will still be largely reliant on financiers in the market, providing them with attractive solutions.	– **There is an opportunity for the guarantor to embed KPIs to the conditions of receiving compensation so as to encourage the adoption of best practices among operators and asset owners.**	– As the funding is provided at the end of the asset life, changes in Government and political agendas, may affect the availability of any initial, committed scheme, in future years
Financiers / Asset Owners / Guarantor	– Increased willingness among potential financiers or asset owners to acquire and invest in the assets. – If KPIs are attached to the conditions of receiving the guarantee scheme, it encourages the financiers to work together with operators to work towards them. For example these KPIs may include employing best practices in maintenance, improving service quality, among others.	– There is a question on how the funding allocated to a guarantee scheme for residual value should be used/banked in the present and whether it can be carried forward beyond the 5-year funding period. – Excessive residual value guarantee could lead to an excessive supply of zero emission buses across the market, potentially diminishing second hand value; emphasis will need to be placed on ensuring appropriate and simultaneous demand levels (e.g. combining this scheme with a Demand Aggregation Model).		

5.10.1 Revolving Fund

Financing Model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

A principal financier (via a Special Purpose Vehicle / SPV) provides capital for investment in fleets, charging infrastructure and grid network connections. The SPV is responsible for fleet services to bus operators but also works with energy suppliers for the provision of infrastructure and grid connection (who are assumed to own the infrastructure in the long-term). The underlying premise is that energy suppliers benefit from the initial investment in infrastructure, and can provide better deals to operators for energy use (where additional revenue can also be generated through increased energy demand). This can generate proceeds to repay the SPV for initial investment in the infrastructure and grid connection.

Evaluation of Characteristics

Risks		
Type	For Operators	For Financiers
Performance	Technical issues with battery/fuel cell/infra could disrupt bus services in the short term	Poor performance increases the frequency of repairs and replacement of assets
Obsolescence	Low risk – assumed by financier / energy provider / SPV	Shared between financier and energy provider (infrastructure)
Residual Value	Low risk – assumed by financier / energy provider / SPV	Shared between financier and energy provider (infrastructure)
Non Payment	Dependent upon levels of ridership and revenue generated	Risk-pooled among the financier, SPV and energy company

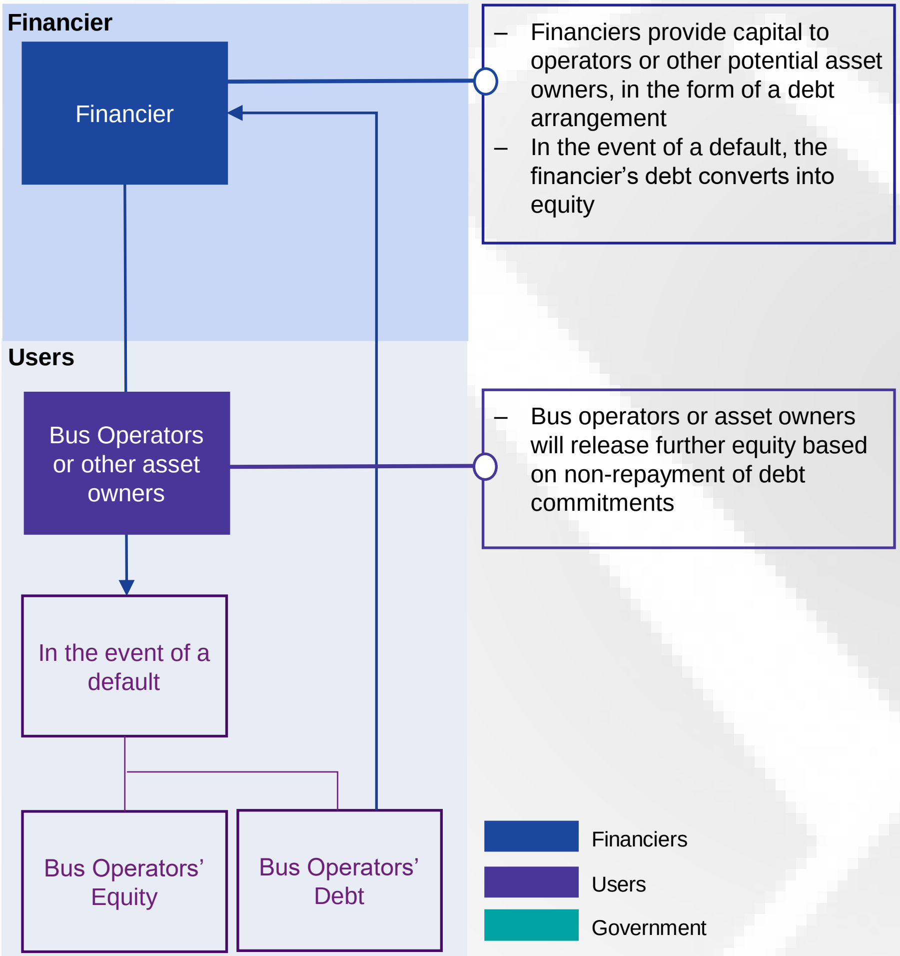
Other considerations		
Type	For Operators	For Financiers
Upfront Costs	Lowers upfront costs	Incurred by the financier
Maintenance Costs	Benefits from the managed service provided by the SPV	Incurred by the SPV in exchange for premium paid
Skills & Capabilities	Training provided by the SPV subject to T&Cs agreed	Benefits from economies of scale by skilling up the operators' staff
Access to Funding	Operators only need to be able to afford the rent or lease	Bespoke arrangement or organisation to be established
Financing Costs / Income	Bus operators benefit from better deals from energy companies	Shared between financier and energy provider in the long-term

5.10.2 Revolving Fund

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Can be built in such a way that the SPV provides an integrated end-to-end financing model to bus operators, thereby lowering upfront costs, reducing risk and increasing convenience for operators.		**– Given the involvement of multiple different stakeholders, the model could support economic growth opportunities across a number of different industries – If the model proves successful, it could be used a blueprint for investment into other zero emission transport sectors, including electric vehicles but also the maritime / aviation industries (where investment in infrastructure and costs of energy are a determining factor, in the pace of transition to zero emission fleets).**	– Being a market with a history of nationalisation and privatisation, government funding on this front is likely to have a significant implication on state-aid and market competition amongst utilities.
Financiers / Asset Owners	– Provides a greater role for energy companies, in scaling and contributing to the development of required infrastructure; the scheme also enables energy companies to provide greater incentives, directly to operators (e.g. reduced tariffs). – The scheme is slightly more complex than others and therefore will involve / require multiple different parties to work together, and share risks / benefits appropriately	– The energy market is already a very competitive space in that there is not necessarily a shortage of investment opportunities. The energy companies may choose to go with other investors whose projects appear to be more lucrative than providing connections to remotely located depots. – The energy market is already a heavily regulated space and it is unclear how acceptable this model is when it interacts with the regulated side of the market. It is noteworthy that providing electricity to the transport sector is considered under the non-regulated side of the energy market.		

5.11.1 Mezzanine Loan

Financing Model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

Financiers provide initial capital to operators (or other asset owners) in the form of a debt arrangement. Upon any form of non-repayment of the loan / debt arrangement, the financier's debt is converted into equity. It will be important to determine whether financier's will be willing to enter this type of arrangement as having equity is likely to be primarily attractive in a strong market place, with high value of assets and revenue generation.

Evaluation of Characteristics

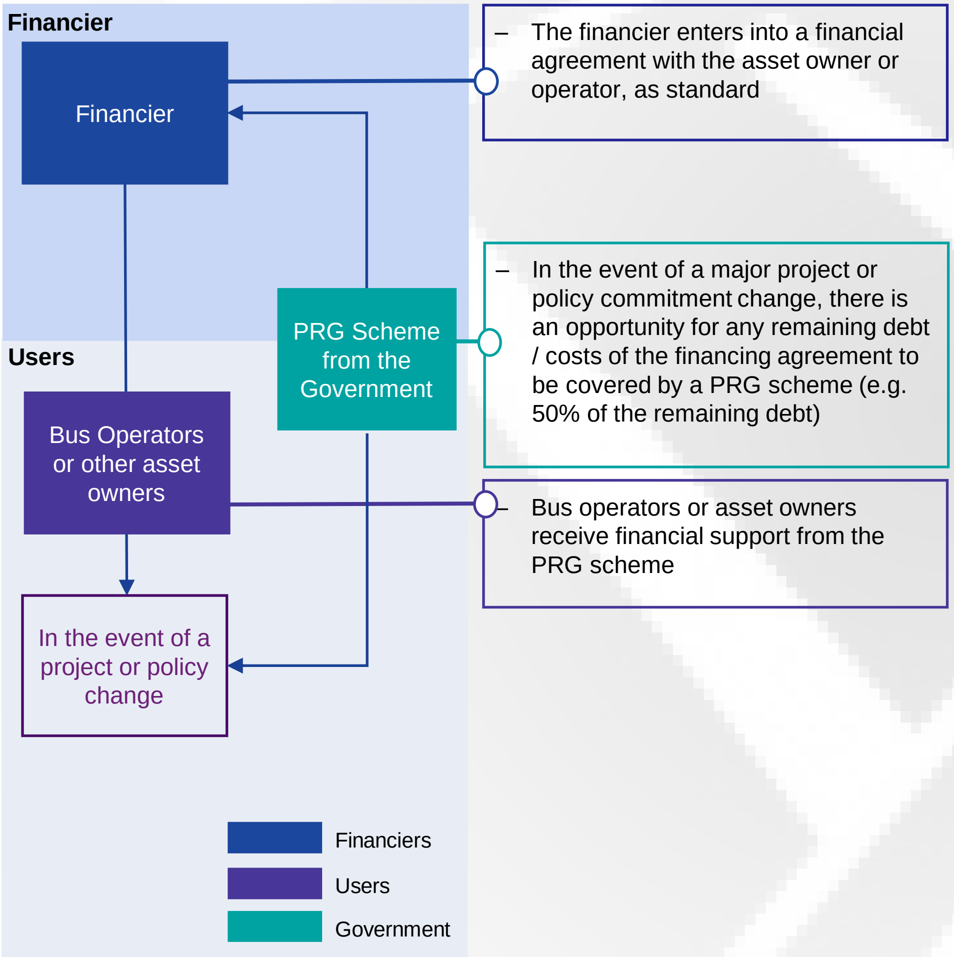
Risks		
Type	For Operators	For Financiers
Performance	Technical issues with battery/fuel cell/infra could disrupt bus services in the short term	This may affect the RV of the equity to be acquired in the event of a default
Obsolescence	This sits with operator, but shared with the financier in the event of default	This sits with operator, but shared with the financier in the event of default
Residual Value	Shared between the operator and financier	Shared between the operator and financier
Non Payment	Dependent on ridership levels / revenue generation – risk of releasing more equity	Assumed by financier but potential for equity claim
Other considerations		
Type	For Operators	For Financiers
Upfront Costs	Lowers upfront cost	Incurred by financier
Maintenance Costs	Dependent upon finance agreement	Incurred by either the operator or operating lease provider
Skills & Capabilities	Dependent upon finance agreement	Financiers may want to provide training to maximise RV
Access to Funding	There is a need to demonstrate a strong credit rating	Financiers' appetite on such financing models could be low
Financing Costs / Income	Financing cost could be higher due to the higher risk of non-repayment to financier	The risk could be made lower to financiers if they end up with equity in the company as well as the defaulted assets.

5.11.2 Mezzanine Loan

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Allows the operators to retain an equity of the defaulted asset and keep running the buses by sharing its ownership with the financier.	– Due to the much reduced level of security from the financiers' perspective, operators believe that this model is likely to increase the cost of financing.	– **Potential to use this as an incentive to make shared ownership work for both financiers and operators (e.g. the equivalent of Shared Ownership in the property market).**	
Financiers / Asset Owners	– This may be an opportunity for financiers to diversify their businesses by obtaining equity in assets and possibly in the operators' companies as well.	– Currently / likely to be very little appetite amongst financiers to own assets. This means that having to share ownership of assets in the event of default will increase the risk from the financiers' perspective due to the reduced level in security (of investment).		– Bus operators defaulting on their payments could suggest that there may not have been many resources for adopting best practices in maintaining the assets. Financiers may have to expect assets (partially acquired due to default on loans) to be in poor condition. – Financiers could end up obtaining equity in a technology solution that is no longer 'the clear choice' in the market.

5.12.1 Partial Risk Guarantee (PRG) Scheme

Financing Model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

A Partial Risk Guarantee (PRG) is offered by the government where some form of financial support is in place should government renege on any original (policy / project based) commitments. In the event of a policy or large project change, Government could agree a percentage of debt / remaining costs for operators / financiers, to be covered by government, in case of a transition or change.

Evaluation of Characteristics

Risks

Type	For Operators	For Financiers
Performance	Technical issues with battery/fuel cell/infra could disrupt bus services and income in the short term	PRG may not cover the gap between anticipated and actual performance, therefore loan payments
Obsolescence	Shared between the operator, financier and PRG provider	Shared between the operator, financier and PRG provider
Residual Value	Shared between the operator, financier and PRG provider	Shared between the operator, financier and PRG provider
Non Payment	Dependent on revenue generated but supported by PRG scheme	Shared between financier and PRG provider

Other considerations

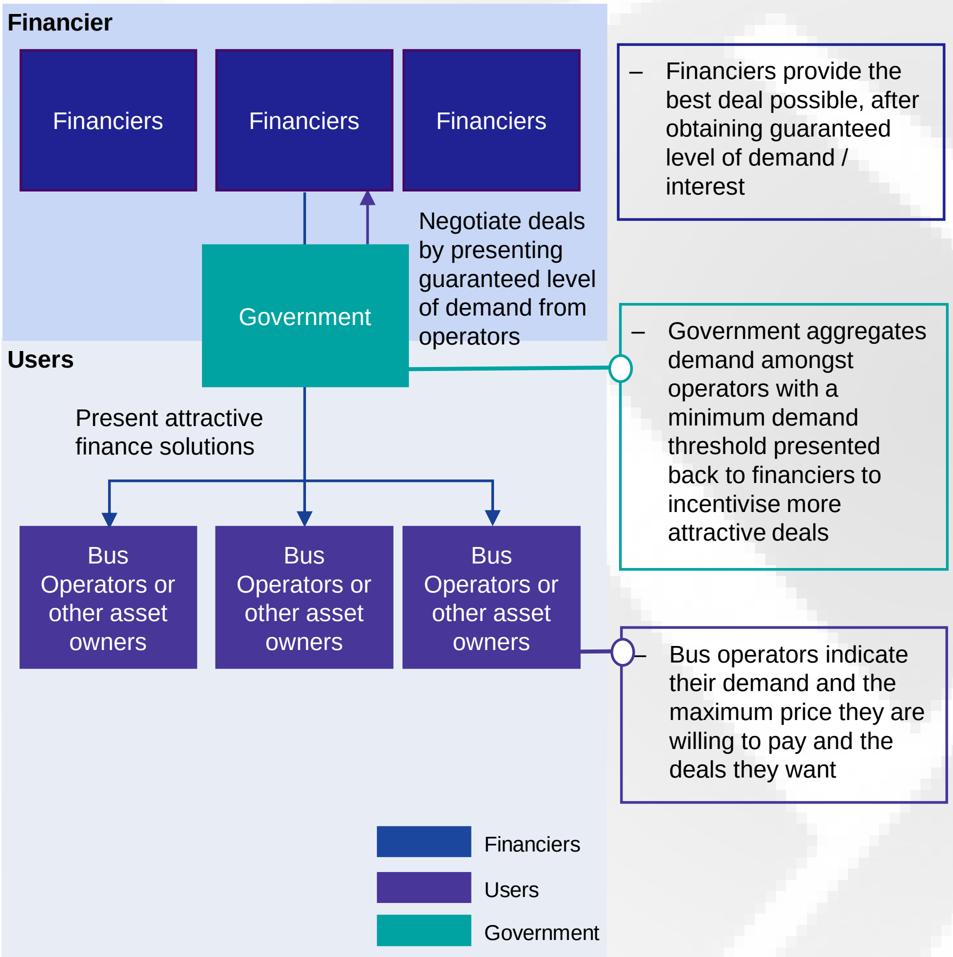
Type	For Operators	For Financiers
Upfront Costs	Lower upfront cost	Incurred by financier
Maintenance Costs	Dependent upon the financing deal agreed	Dependent upon te financing deal agreed
Skills & Capabilities	Assumed by operator or asset owner	Unlikely role for financier
Access to Funding	There is a need to demonstrate a strong credit rating	Dependent upon the financing deal agreed
Financing Costs / Income	Financing cost could be lower because the government absorbed some of the risks	Some security of investment achieved from PRG support

5.12.2 Partial Risk Guarantee (PRG) Scheme

	Strengths	Weaknesses	Opportunities	Threats
Operators	– PRG internalises some of the risks and uncertainties from the financiers' perspective, which may be passed on in the form of lower financing costs to operators.	– Financiers may be sceptical about the circumstances in which a PRG may apply and be unable or unwilling to pass on the potential benefits in financing costs for operators.	– **The PRG scheme can be complemented with any government scheme where there is a long lag time between the scheme roll out and the actual compensation.**	– This scheme may be perceived as a lack of commitment by the Government to providing support to the zero emission bus market. The expectation from the market is likely that the Government remains fully committed to the scheme before the policy change.
Financiers / Asset Owners	– PRG provides more certainty compared to other long term schemes such as the Residual Value Guarantee scheme. Industry participants have more legal reassurance that the government will not renege on their commitment due to changes in the ruling government and/or political agenda.			

5.13.1 Demand Aggregation (with/without Reverse Auction)

Financing Model



Risk:

Low	Medium	High

Other considerations:

Beneficial to counterparty	Potential up & downsides	Adverse to counterparty

Description

Government aggregates demand across bus operators and positions this to financiers (once a minimum threshold in demand has been met), potentially with a cap on the maximum price operators are prepared to pay and the deals they would want. The guaranteed demand could then incentivise financiers to offer attractive solutions. This could then be extended into a **'reverse auction'** where the most attractive solutions from financiers are provided to operators registering an interest, for them to decide which deal to proceed with.

Evaluation of Characteristics

Risks		
Type	For Operator	For Financier
Performance	Technical issues with battery/fuel cell/infra could disrupt bus services in the short term	Dependent upon the financing deal agreed
Obsolescence	Dependent upon the financing deal agreed	Dependent upon the financing deal agreed
Residual Value	Dependent upon the financing deal agreed	Dependent upon the financing deal agreed
Non Payment	Dependent upon the financing deal agreed	Dependent upon the financing deal agreed

Other considerations		
Type	For Operator	For Financier
Upfront Costs	Dependent upon the financing deal agreed	Dependent upon the financing deal agreed
Maintenance Costs	Dependent upon the financing deal agreed	Dependent upon the financing deal agreed
Skills & Capabilities	Dependent upon the financing deal agreed	Unlikely role for financiers
Access to Funding	Dependent upon the financing deal agreed	Dependent upon financing deal agreed
Financing Costs / Income	Dependent upon the financing deal agreed	Dependent upon financing deal agreed

5.13.2 Demand Aggregation (with/without Reverse Auction)

	Strengths	Weaknesses	Opportunities	Threats
Operators	– Operators regardless of size, assuming that they are purchasing the buses directly, can benefit from economies of scale from manufacturers. – Standardisation of fleets may allow for easier retrofitting of depots in terms of making sure that charging points and chargers are interoperable across different operators. This may also create an opportunity for an open charging model. – Information asymmetry could be bridged which results in operators receiving a better deal from financiers.	– Customisations may be inevitable due to route-specific requirements and this may partially compromise the extent of said economies of scale, though the cost-saving from bulk order will still arguably remain.	– **There is an opportunity to build this model on top of the integrated/Bus-as-a-Service model where this is also applied to the provision of maintenance, repairs, and component replacement.** – **There is also an opportunity to apply this model to the channelling of used assets towards their secondary markets/uses. For instance, the aggregator gathers the demand for used batteries and relay this information to asset owners to determine who is willing to arrange financing deals.** – **Demand Aggregation could be applied to vehicles, technology solutions, and infrastructure (e.g. separate demand aggregation model for requirements in energy supply, or charging points – as well as the buses themselves).**	– The model risks being a “one-size-fits-all” approach, which may unnecessarily increase the barrier for further innovation in the market. – The role of an aggregator has the quality of being a natural monopoly which may have implications on market competition e.g. the largest scale is only achieved when there is an aggregator in the market.
Financiers / Asset Owners	– Standardisation may lower the cost of setting up charging infrastructure if this is assumed by the financier. – Lessors who acquire assets through debt financing also benefit from the economies of scale enabled by demand aggregation. – Risk-pooling in the market as a whole is achieved due to the involvement of more financiers in the market.			

Chapter 5

Risk Allocation

5.10.1 Risk Allocation across options

This slide provides a high-level summary of the risk allocation across the different models explored / outlined in previous slides.

Options	Obsolescence Risk	Performance Risk	Residual Value Risk	Non-payment risk
Operating leases	Asset owner / lessor	Shared between operator and asset owner / lessor	Asset owner / lessor	Asset owner / lessor
Concessional loans	Operator	Operator	Operator	Loan provider / financier
Finance leases	Shared between operator and asset owner / lessor	Operator	Shared between operator and asset owner / lessor	Asset owner / lessor
Sale-and-leaseback	Asset owner / lessor	Operator	Asset owner / lessor	Asset owner / lessor
Component lease	Shared between operator and component owner / lessor	Shared between operator and component owner / lessor	Shared between operator and component owner / lessor	Component owner / lessor
Green bonds	Operator	Operator	Operator	Loan provider / financier
Integrated end-to-end financing (Bus-as-a-Service)	Financier / service provider	Shared between operator and financier / service provider	Finance / service provider	N/A
Residual Value Guarantee	Shared between operator and scheme provider	Shared between operator and scheme provider	Shared between operator and scheme provider	N/A
Revolving Fund	Shared among financier / energy company / SPV	Shared among financier / energy company / SPV	Shared among financier / energy company / SPV	Shared among financier / energy company / SPV
Mezzanine Loan	Shared between financier and operator in the event of a default	Shared between financier and operator in the event of a default	Shared between financier and operator in the event of a default	Loan provider / financier
Partial Risk Guarantee (PRG)	Shared among financier, guarantor and operator	Shared among financier, guarantor and operator	Shared among financier, guarantor and operator	Shared among financier, guarantor and operator
Demand Aggregation	Risk-pooling among more financiers in the market	Risk-pooling among more financiers in the market	Risk-pooling among more financiers in the market	Risk-pooling among more financiers in the market

Key:

Risk is concentrated on one party	Risk is shared between more than one party

Chapter 6

Industry Engagement

The following slides present a high-level overview of some of the key themes and outputs arising from industry engagement during the development of this pack.

Between one-to-one interviews and an industry workshop, ***over 30 individual stakeholders were engaged including:***

- *Bus Operators*
- *Bus Manufacturers*
- *Financiers (Banks & Equity Houses)*
- *Energy Companies*
- *Technology Providers*
- *Local Authorities*
- *Trade Associations / Industry Bodies*

6.1 Industry Engagement

***Key themes** arising from our engagement with stakeholders focused on:*

*The **up front capital costs** associated with the technology and infrastructure;*

*The **provision of adequate infrastructure** to best meet depot requirements;*

*The **standardisation of assets,** in particular the buses / vehicles;*

*The **protection of the residual value of assets,** namely the technology;*

*The **lack of accessible and accurate industry information,** particularly for operators.*

*A greater clarity of demand for buses to achieve economies of scale will be required to work towards **reducing both manufacturing and financing costs.***

Key Insights

*The consensus amongst industry stakeholders is that **existing financing solutions available are not necessarily unaffordable** but that there are **insufficient offers in the market** and **few proactive offers being made to operators.***

*The issue / challenge is in **addressing the technology risk** associated with zero emission buses, **the revenue uncertainty** (largely as a result of Covid-19), and clarity on **when and how many buses will be ordered and operated**.*

6.2 Residual Value

Operators	– *Few operators have knowledge and expertise on the end-of-life use cases for batteries / fuel cells. This leads to uncertainty in investment due to uncertainty in resale value of the asset, for secondary applications / markets.* – *Chargers also have mid-life obsolescence and are sometimes manufactured bespoke to a certain operator's requirements. Residual value needs to consider the value of chargers (as well as other components).*
Manufacturers	– *Transport Scotland / Scottish Government could use grants to provide security against the residual value of assets at the end of contract periods. Consideration would however need to be given to ensure operators / asset owners are not disincentivised to properly maintain the asset (e.g. condition and performance).*
Technology / Energy Providers	— *Risks should sit with the party which is most capable of managing the asset. If residual risk sits with the battery technology, then it should be the one closest to the technology (i.e. OEM) that manages and mitigates this.*
Traditional Financiers	– *Financiers are more willing to provide capital to companies who are well-positioned in terms of knowledge and expertise of the asset, providing greater security in terms of sufficient maintenance and upkeep, to maximise potential residual value at the end of a contract period.* – *The pace of shifting towards zero carbon emission fleets will also impact the need to re-use / recycle existing (diesel) fleets. We need to think about the transition pace while addressing the issue of selling / re-using the existing diesel fleet.*
Local Government Authorities	– *Smaller local authorities, including those operating in rural areas, are likely to be key in maintaining a secondary use market, as they'll likely use the assets / buses for a long period of time for school routes and local community services. It's therefore important to ensure residual value is as high as possible at the end of initial contract periods.*

6.3 Government Support

Operators	– *There is an opportunity to help bus operators with the initial recovery curve in ridership post-pandemic.* – *Operators are not concerned about whether they own assets in the long term, or whether they simply pay for a service for use and access to the asset – the key priority is on keeping operating costs as low as possible.*
Manufacturers	– *There are mixed views as to who should receive any form of grant funding – some believe it should be operators so that they are able to reduce the cost of operating their services; others believe asset owners / investors should because they ultimately hold the ownership risk (e.g. residual value).*
Technology / Energy Providers	– *There is a lack of sufficient sharing of information across the industry (around infrastructure and technology solutions), leading to higher costs for operators / investors. Bus operators are sometimes subjected to higher quotes from DNOs in respect of depot electrification / connection. Those that are able to challenge and/or are better educated/informed themselves, have seen significant reductions in connection quotes and costs. Government could help in leading / facilitating better information sharing across the industry.*
Traditional Financiers	– *Government support needs to show how different types of risks are being managed, structured or internalised to make lenders more comfortable with the investment.* – *Government support could take the form of a guarantee which ensures a certain minimum level of usage of zero emission buses, lowering the risk for financiers. (e.g. Similar to DfT's Section 54 Undertakings).* – *SME operators are crucial part of the secondary market for buses and we cannot afford for them to be priced out of the ecosystem, especially by the time the initial period of 5-7 years ends.*
Local Government Authorities	– *In some rural areas, operating subsidies are provided by local government to make bus fares more competitive. It's likely that these will need to be continued (potentially at a higher scale) to enable the transition to zero emission buses.*

6.4 Infrastructure Provision

Operators	– *There could be a lack of sufficient sharing of information across the industry (around infrastructure and technology solutions), leading to higher costs for operators / investors.* – *There is information asymmetry on how energy companies come up with the cost of extending their grid network given many of them are natural monopolies in their respective regions.*
Manufacturers	– *Developing charging infrastructure and depots with a multi-purpose use capability could provide additional revenue streams – however this would need to be done with health and safety in mind as well as ensuring it doesn't compromise day to day bus operations.*
Technology / Energy Providers	– *To ensure investments are as worthwhile as possible (particularly in required infrastructure), investment in buses needs to happen at a relatively large scale i.e. purchasing of buses in the hundreds / thousands as opposed to small, individual batches of 10 -20 at a time.*
Traditional Financiers	– *There is an opportunity to consider what ways the government can incentivise energy companies to contribute to the cost of infrastructure either through specific schemes or via a regulatory approach. The development of infrastructure should also be considered alongside wider development plans: housing, business centres, other transport modes, etc.* – *Investment in infrastructure is driven by clarity on the technology solution – further certainty is needed on the maturity and development of technologies before committing to infrastructure development.* – *Regulated DNOs have restrictions which makes investment challenging. IDNOs and ICPs are showing interest in investing in this area.*
Local Government Authorities	– *Given the energy-intensive nature of the long routes and cold weather in rural areas, hydrogen is likely to be the "end-state" technology for these areas. Government support should focus on developing electrolysers and distribution infrastructure, creating the path for a commercial hydrogen market.*

6.5 Standardisation of assets / requirements

Operators	– *Standardisation would restrict the tailoring and bespoke nature of fleets and services provided by operators to customers.*
Manufacturers	– *Standardisation of bus requirements and specification could lead to a quicker transition and be particularly beneficial for manufacturers / asset producers. In the long term, it would also ensure buses can be used across the market by any operator.* – *Standardisation will enable efficiencies in operating costs and benefits from economies of scale.*
Technology / Energy Providers	– *If standardised, the fact that the asset can still be used by other parties when they change hands will greatly influence the residual value of the buses. This could also enable technology / energy providers to achieve economies of scale by avoiding development of bespoke products / solutions.*
Traditional Financiers	– *Traditional Financiers are more familiar with the ROSCO model in the rail industry. While it may not be directly applicable to the bus market, there are probably some parallels which can be drawn.* – *Standardisation of charging infrastructure, chargers, and vehicles is important. The fact that the asset can still be used by other parties when they change hands will greatly influence the residual value of the buses, and ensure financiers have assets which hold value in the long-term and across the market.*
Local Government Authorities	– *Standards and requirements for provision of any grant funding need to be consistent across all regions / areas, and ensure they are not too stringent in restricting the use / application of buses / technology by operators.*

6.6 Required elements for a practical financing model

Combined with our detailed analysis of different models, views gathered from stakeholder engagement, indicate that ***financing solutions should incorporate the following "must have" components:***

1. **Protection of the residual value of assets** (particularly the battery / fuel cell components)
2. **Enabling off-balance sheet** access and use of zero emission bus fleets
3. **Ability to minimise upfront capital costs** of vehicles, technology and infrastructure
4. **Appropriate sharing of risk** between manufacturers, operators and financiers
5. **Incentivisation of vehicle homogeneity –** reducing risk associated with default/hand-back of assets and enabling development of "as a service" models

Chapter 7

Conclusion

7.1 Conclusion

*Our research, analysis, and stakeholder engagement, suggests that **the overall market is shifting towards financing models where (the majority of) operators no longer hold to the tradition of entirely owning their assets.***

The **most prominent** financing models within the **current market are leasing models** (namely operating leases).

For operators, leasing models reduce up front costs significantly, whilst providing a predictable and steady cashflow prediction (for budgeting purposes).

Financiers also benefit from premiums via regular lease payments.

However, **changes in accounting standards** (e.g. IFRS 16) present difficulties e.g. having to now recognise most assets on balance sheets (unless certain criteria are met).

Combining this with **infrastructure challenges and costs**, as well as **technology risks and revenue uncertainty**, **operators are becoming more and more attracted to models based on "use and access",** for a particular asset / service e.g. "as-a-service" models.

There are currently a **limited number of market players** providing "battery / fuel cell / bus **as-a-service models**". 'Traditional' **financiers** (e.g. banks and equity houses) are **willing to invest** in this space but **require comfort** around the **residual value risk** of the technology. Costs can also be reduced by providing **clarity and certainty of demand**

It may be that a **combination** of the models explored in this pack, is needed to facilitate the transition. However, some form of security needs to be provided for any investment(s) made, be it in the form of a residual value guarantee or a guaranteed level of demand from operators. This is an area where **Scottish Government / Transport Scotland** could intervene.

Transport Scotland, Buchanan House,
58 Port Dundas Road, Glasgow, G4 0HF
0141 272 7100
info@transport.gov.scot
http://www.transport.gov.scot