Urban Foresight

Scot Blue

Zero Emission Bus Market Transition Scheme

STREAM 1 REPORT

Contents

Introduction

This project has been completed as part of a transport Scotland funded project. Administered by Energy Saving Trust, the Zero Emission Bus Market Transition Scheme (ZEBMTS) aimed to provide assistance to SME bus and coach operators to establish the steps required in transitioning to zero-emission vehicles. This would provide a basis for the application of potential ScotZEB Phase 2 application in Spring 2023. There were three streams of funding available for ZEBMTS - this report focuses on stream 1.

Stream 1 of the scheme looked to support individual bus and coach operators by providing funding for consultancy expertise. Support was provided to assess the zero-emission technology that would best suit the operator's business model.

To date, government policies have focused solely on the bus market and, as a result, the coach and minibus markets are underdeveloped. These sectors provide many vital services from school and community transport to tourism and recreation activities.

This report aims to present the available options for Scot Blue's transition to a zero-emission fleet and the high-level cost. A full total cost of ownership (TCO) has been carried out on Scot Blue's fleet to be compared to a zero-emission alternative to determine lifetime financial savings. The results of this have been provided to Scot Blue to allow for further evaluation of vehicle feasibility.

Due to the availability of indicative costings for vehicles and infrastructure, all cost recommendations are high-level. Scot Blue has been provided with the full analysis of its fleet which can be altered following the acquisition of fixed costs.

Current context

Decarbonisation

While policies and legislation remain underdeveloped for the bus and coach market, the UK and Scottish Government have remained firm in their net-zero targets. These set legally-binding targets for both vehicles and councils.

Scot Blue is based in Dundee and, as such, carries out a number of contracts for Dundee City Council. Dundee City Council looks to achieve net-zero greenhouse gas emissions by 2045. As part of this commitment, the council is introducing a low-emission zone which is to be enforced by May 2024[1]. This change may mean additional costs for Scot Blue if its fleet remains diesel fuelled.

In an effort to control and meet decarbonisation targets, it is becoming increasingly commonplace to stipulate the need for zero-emission vehicles through procurement details. Tenderers will, therefore, score favourably if they have sustainable practices in place. For companies such as Scot Blue, transitioning a fleet may provide an element of future-proofing as well as lowering costs over the life of their vehicles.

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[1] Dundee City Council. Low Emission Zone Scheme.

Operational activities

Scot Blue is a professional minibus hire company based in Dundee and Angus, providing minibus hire with driver services across Scotland. They offer minibuses in the following locations:

- Arbroath
- Brechin
- Carnoustie
- Dundee
- Forfar
- Kirriemuir
- Monifieth
- Montrose

The fleet of accessible minibuses is provided for pupil transport to Kingspark School in Dundee. This service is run in conjunction with Dundee City Council who hires Scot Blue's minibuses and drivers to transport children to and from school.

Additionally, Scot Blue offers an on-demand, door-to-door minibus service for people travelling within Dundee and Angus as well as patient transfer services for those who require transport to hospitals in Tayside.

Existing fleet requirements

Scot Blue's bus fleet is made up of nine minibuses which range in size from ten to 15 seats. Of these vehicles, 45% are equipped to be accessible and capable of carrying up to six seated passengers and two wheelchair users at any one time.

Table 1 Scot Blue's operational activities

Average annual mileage	17,000 miles
Average annual fuel cost per vehicle	£4,000.00
Average lifetime cost per vehicle	£35,000.00

Due to the nature of Scot Blue's operation, having accessible vehicles is fundamental to business operations. While it may not be necessary for the entire fleet to be accessible, the current split of accessible vehicles would need to be carried forward. Considerations need to be made for this in the transition to zero-emission.

As certain modifications such as lift mechanisms may add extra weight to the vehicle, it is worth noting the following legislative changes. New draft legislation published by the UK Government states a two-tonne increase for EV vehicles and a one-tonne increase for other alternatively fuelled vehicles[2]. This weight increase may make accessible modifications more feasible.

Technology Requirements & Availability

Available technology options

Technologies considered

Electric (EV)

Plug-in electric vehicles make use of batteries to power a motor. They, therefore, produce zero tailpipe emissions. Electric vehicles are 'refuelled' similar to other battery-powered devices through a charging cable. Charging capability ranges from 3.6kW up to 350+kW.

[2] GreenFleet 2023. Weight-limit increase for alternatively-fueled and electric HGVs

Electric vehicles have become increasingly prevalent in the zero-emission market in recent years. There are three types of electric vehicles for purchase at present – battery electric, hybrid, and plug-in hybrid. Hybrid vehicles utilise petrol to power the electric motor rather than electricity.

Consistent advancements in technology mean batteries are becoming smaller. Therefore, weight has decreased over time while the range has increased. This has increased the number of electric options entering the larger vehicle market. Refuelling an EV is another advantage as private charging infrastructure can be installed on-site.

Pros	Cons
• Widespread public charging is available • Zero emissions at the tailpipe • An increasing number of models available • Lower maintenance costs than ICE	• Increased refuelling time • More expensive than ICE vehicles • Reduced mileage range compared to ICE • Expensive grid upgrades may be needed

Hydrogen

Hydrogen is an alternative fuel option for vehicles and produces zero tailpipe emissions. Hydrogen vehicles make use of a fuel cell in which chemical energy is converted to mechanical energy by burning hydrogen. This then powers an electric motor. Although zero emissions are produced at the tailpipe of a hydrogen vehicle, the environmental impact of hydrogen varies depending on the generation method.

- Grey hydrogen – Created through natural gas extraction which produces and emits carbon dioxide. Grey hydrogen is the most common form of generation in the UK.
- Green hydrogen –Generated through electrolysis. This process electricity (renewably generated) to split the hydrogen and oxygen from water. Green hydrogen is the cleanest production method.

Hydrogen vehicles can travel around 300 miles on a single tank, however, refuelling stations are not readily available in the UK and the technology is expensive.

Hydrogen fuel cell electric (HFCEV)

As the name states, hydrogen-electric vehicles use a combination of hydrogen and electric technology in a single vehicle. This is done to reduce vehicle weight and increase mileage.

The technology is similar to a hybrid electric vehicle where petrol or diesel is used to produce electricity. HFCEVs can be refuelled using hydrogen facilities. Theoretical analysis shows that hydrogen-electric technology would be best suited to heavy goods vehicles and could extend ranges to 500 miles and over and reduce the overall vehicle weight.

There are currently three hydrogen refuelling stations in Scotland – in Orkney, Aberdeen, and Edinburgh – and over 2,400 public charge points[3]. Due to the limited infrastructure, vehicle manufacturers still hesitate to produce vehicles at scale as they do not see the demand.

Pros	Cons
• Mileage range comparative with ICE • Only water vapour emitted • Weight load is lighter than electric and 14 times lighter than traditional petrol	• Refuelling infrastructure availability • More expensive than ICE and electric • Fewer vehicle options are available • Expensive and not as easily installed as electric • A variance in hydrogen production methods

[3] ChargePlace Scotland (2022) Accessing the network

Technologies not considered

Biodiesel

Biodiesel is a variety of diesel fuel which is derived from plants or animals. It is typically manufactured from domestic vegetable oils, animal fat, or recycled oil from restaurant cooking. The most common type of biofuel is hydrotreated vegetable oil (HVO). This type utilises hydrogen at high temperatures and pressures to treat vegetable oil and create a fuel similar to diesel. This type of fuel is only a suitable replacement for diesel vehicles.

As this fuel is not fully zero emission and typically costs more than diesel, it has not been considered here. Additionally, although it is referred to as renewable, it is not zero-emission. Thus, while it is a preferable alternative to diesel, it still contributes to increasing CO_2 emissions[4].

CNG and LNG

Compressed natural gas (CNG) is currently the cleanest fossil fuel on the market and, like biodiesel, is an eco-friendly alternative to diesel. CNG is typically generated by compressing methane to less than 1% of its original volume.

Liquified natural gas (LNG) is the liquid form of CNG. LNG also takes up less storage space than CNG. For example, after processing, 1m³ of fuel equates to 100m³ of CNG and 600m³ of LNG. However, at present, the process to create CNG and LNG is timely and complicated.

CNG and LNG have not been considered during this project. Current refuelling options for both CNG and LNG are low, somewhat due to the required storage temperature. LNG and CNG both need to be stored at -162°c. Additionally, they do not produce zero tailpipe emissions.

Stakeholder engagement

Stakeholder mapping and engagement activities were a necessary part of this project. Engagement sought to find the availability of vehicles and network capacity to assess the transition feasibility.

Vehicle availability

Engagement activities for this project began with a desk-based review of currently available zero-emission vehicles. Vehicle manufacturers and dealerships were then contacted to obtain a picture of the vehicles that may be entering the market and their suitability for Scottish operations.

Over 20 vehicle manufacturers and dealerships were engaged as part of this process and seven attended individual engagement sessions to detail their current and future plans for zero-emission buses and coaches. Engagement sessions were carried out with the following:

- ADL (Alexander Dennis)
- Daimler (Mercedes)
- EVM UK
- Pelican (Yutong)
- Stanford Coachworks
- Switch Mobility
- Wrightbus

Manufacturers were positive about the growth of the zero-emission bus market. However, it was also noted that this sector is still in its relative infancy and not all available vehicles will suit all operator needs. For example, while there is a growing market for electric buses which can be used for service routes in cities there is a lack of availability in the zero-emission coach market, particularly midi-coaches.

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[4] Sarah Moore – AZO Clean Tech (27.08.2019) Are Biofuels Renewable Energy?

Additionally, electric vehicles appear to be the preferred option for vehicle manufacturers at present. This may be due to the unavailability of widespread hydrogen refuelling infrastructure compared to electric. There are currently three hydrogen refuelling stations in Scotland – located in Orkney, Aberdeen, and Edinburgh – and over 2,400 public charge points[5]. Due to this, vehicle manufacturers are still hesitant to produce vehicles as they do not see the demand at this time.

Infrastructure

While engagement activities were underway with vehicle manufacturers and dealerships, a review of Scottish Blue's local distribution network operator (DNO), SSEN, was carried out.

SSEN's open portal data review showed that the grid supplying Scot Blue's depot is currently constrained in both the upstream and downstream. Therefore, it is very likely that grid upgrades or substation installations will need to take place in order to install charging infrastructure.

Engagement outcomes for Scot Blue

As identified through the Green Finance Institute and Confederation of Passenger Transport, there are four main challenges operators such as Scottish Blue may face:

- High up-front costs associated with vehicle and infrastructure
- Residual value risks for both financiers and vehicle operators
- Insufficient real-world operational data on the costs
- Lack of policies associated with coaches

This project has investigated the above challenges to give operators such as Scottish Blue a real-world perspective on what transitioning means to them and their operations.

Due to the nature of Scottish blue's operations, its fleet requires specialist vehicle types. The unavailability of suitable vehicles will likely mean that Scottish Blue would need to continue using diesel vehicles until appropriate options become available. This will have a detrimental impact on reducing overall emissions throughout the Dundee and Angus region.

The short-term solution may be to transition the vehicles which currently have the most feasibility and similarity to the existing fleet. The operational savings could then be used to transition the rest of the fleet when vehicles become available. This will depend on the total financial savings from the initial transitions and the vehicle replacement periods.

The Road to an Electric Fleet

Vehicle and infrastructure analysis

Vehicles

The following vehicles were used to carry out assessments of the zero-emission potential within Scot Blue's fleet:

Diesel	Zero-emission
• Ford Transit (115 T430, 460 Trend Econetic) • Iveco Daily (50C14) • Peugeot Boxer (435 Pro L4H2)	• Ford Transit Trend Electric • Maxus eDeliver 9 • EVM Atlas E-Cityline

[5] ChargePlace Scotland (2022) Accessing the network

These were used to carry out a total cost of ownership (see financial analysis section below) of Highland Council's fleet. All zero-emission replacement vehicles a Zemo certified[6].

Infrastructure

For a full transition of Scot Blue's nine vehicles, it has been assumed that the installation of at least one charge point per vehicle would be required, plus an optional ultra-rapid charger for emergency top-ups if required.

It is therefore recommended that Scot Blue installs five double connection 43kW chargers and one 1200kW charger at its depot.

This would provide Scot Blue with the suitable infrastructure to ensure each vehicle can be fully charged in preparation for departing tours. Additionally, public charge point provisions must be considered along key routes. Dundee has over 100 public charge points that Scot Blue could make use of if required.

Financial analysis

A TCO analysis was carried out for each of the existing vehicles in Scot Blue's fleet. This was followed by an analysis of the potential transition options.

The TCO analysis takes the following information into account:

- **Vehicle costs**: the total purchase price, potential disposal price, and high-level funding. This is used to assess the potential annual cost of the fleet and compare the cost between diesel and zero-emission vehicles.
- **Operation and maintenance**: annual cost of maintenance, servicing, MOT, and tax.
- **Fuel cost**: utilises information on vehicle efficiency and tour mileage to determine the typical fuel cost of each tour.
- **Funding**: assumes the availability of funding for vehicles is up to £80,000 to reach diesel price parity and 75% of the cost of charging infrastructure, including installation and connection costs.

For a full description of the methodology used, please see appendix 1.

The findings from this analysis were used to assess the financial savings of transitioning to a zero-emission fleet. It should be noted that calculations have been carried out that include potential funding as well as the costs without funding.

Feasible transition

At present, Scot Blue could feasibly transition all of its vehicles but it may be best to start with a small percentage to kickstart the transition. If a few vehicles are transitioned first then the operational savings could then be used to transition the rest of the fleet. This will depend on the total financial savings from the initial transitions and the vehicle replacement periods.

Table 2 shows the maximum potential savings from transitioning the older vehicles first.

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[6] Zemo (updated 23.01.2023) Zero Emission Bus Certificates

Table 2 initial transition analysis

No. of vehicles	Years of ownership	TCO	Cost to Scot Blue without price parity of vehicles	Max potential savings with price parity of vehicles
3	5	£59,000	£225,000	£67,000

Transitioning these vehicles would require the installation of three charge points at the depot – two 43kW chargers and one 120kW charger. Table 3 shows the split of required infrastructure and the indicative costs for this.

Table 3 Charge points required for feasible transition

No. of chargers	Total charge points	Indicative install cost (without funding)	Indicative install cost (with funding)
3	5	£40,000	£10,000

Full transition

Transitioning the remaining vehicles could be carried out at a later date by Scot Blue using the financial savings from the initial transitions. Table 4 shows the potential savings a full fleet transition could offer Scot Blue.

Table 4 Full fleet transition analysis

No. of vehicles	Years of ownership	TCO	Cost to Scot Blue without price parity of vehicles	Max potential savings with price parity of vehicles
9	5	£287,000	£860,000	£123,000

Without funding to support the purchase of vehicles, it is likely Scot Blue will be unable to transition its fleet in time to meet net-zero targets. A full transition will also depend on the total financial savings from the initial transition and the vehicle replacement periods.

Transitioning all nine of Scot Blue's vehicles would require up to five charge points at the depot. Table 5 shows the split of required infrastructure and the indicative costs for this.

Table 5 Full fleet transition analysis

No. of chargers	Total charge points	Indicative install cost (without funding)	Indicative install cost (with funding)
6	9	£53,000	£13,000

Due to commercial sensitivity, full TCO analysis can be provided to Transport Scotland upon request.

Feasibility of a step-by-step transition

Conditions

Vehicles

Although a high-level zero-emission TCO analysis has been carried out for of Scot Blue's fleet vehicles, it is likely that a phased transition is the most suitable approach.

The short-term solution may be to transition the vehicles which are currently most suitable to be transitioned to zero-emission. have the most feasibility and similarity to the existing fleet. If a few vehicles are transitioned first then the operational savings could then be used to transition the rest of the fleet. This will depend on the total financial savings from the initial transitions and the vehicle replacement periods.

Infrastructure

Transitioning three vehicles in Scot Blue's fleet would require the installation of three private chargers within the existing depot. High-level figures provided by charge point providers suggest that this will likely cost an additional £40k to Scot Blue.

Collaboration Opportunities

Taking a collaborative approach with other operators allows for the sharing of costs and risks associated with the purchase of vehicles and associated infrastructure. This will, in turn, assist in achieving a just transition of a range of operators. Additionally, findings could be used to replicate across other businesses.

As Scot Blue currently carries out a number of contracts for Dundee City Council, a collaboration could be formed with the council and other similar operators in the area. Dundee City Council has been transitioning its internal fleet vehicles to zero-emission since 2011 and aims to have a fully zero-emission car and van fleet by 2028. By working alongside the council, Scot Blue could provide zero-emission vehicle services that support the council's aims.

Next steps required

To successfully to a zero-emission fleet, there are several steps to take and considerations to be made. These can be broken down into a three-step process focusing on vehicles, infrastructure, and people.

Vehicles	Infrastructure	People

Vehicles

To ensure more operators are able to transition their vehicles to zero-emission, it will become increasingly important that manufacturers release additional options. This is particularly important for operators that have a range of vehicle types and sizes.

To kickstart the transition to zero-emission vehicles, Urban Foresight recommends that Scot Blue looks to first transition 20% - 30% of its vehicles over the next few years. To achieve this first step of the transition, it is important to carry out the following steps:

1. Further engagement with vehicle manufacturers of feasible replacements as outlined in the TCO tool to fully assess feasibility.
2. Obtain direct quotes from manufacturers for vehicle purchases

Recommended next steps:
Urban Foresight recommends up to 30% of Scot Blue's existing fleet be transitioned at present. High-level costs suggest that this would require between £200k and £720k in capital finance. This is between £165k and £670k more than the cost of existing diesel vehicles.

Infrastructure

If Scot Blue decides to purchase the recommended zero-emission vehicles to kickstart the transition of its fleet, private charging infrastructure should be installed at the depot for overnight charging. Dundee also has over 100 public charge points that Scot Blue could make use of if required.

It is recommended that the following steps are carried out to assist in the installation of suitable electric vehicle charging infrastructure:

1. Engage with charge point providers to obtain a full site assessment and quotation to have charging infrastructure installed at the depot.
2. Work with local authorities and private businesses to have suitable public charging infrastructure installed along main tour routes.

Recommended next steps:
Urban Foresight recommends that Scot Blue install the following charge point configuration at its depot to support a 30% transition:

- Two 22kW chargers with two connection points
- One (optional) 150kW charger for top-up charging

High-level costs suggest that this will require £40k in capital finance.

People

As zero-emission vehicles have fewer moving parts than their internal combustion engine (ICE) equivalent. Therefore, the maintenance and servicing costs of zero-emission vehicles are often lower. However, the unique components associated with zero-emission vehicles must also be considered. For example, during maintenance and servicing of electric vehicles, work on oil, spark plugs and drive belts is not necessary, but battery packs, electric motors, and regenerative braking systems will require work.

In addition, training will be required for mechanics and drivers[7]. The following training is required for electric coaches:

- **Drivers**
  - Ensuring drivers are aware of how to efficiently use the vehicle, making use of regenerative braking to conserve energy.
- **Maintenance**
  - Upskilling staff by providing training on the maintenance of electric-specific components. This can be carried out by vehicle OEMs.
- **Depot management**
  - Providing training on safely and efficiently recharging vehicles.
  - Training is required for staff to work with high-voltage systems.
- **Operation**
  - Ensuring staff are aware of locations for opportunity charging where necessary.
  - Telematics can support this in the long term by assessing routes and mileage.

[7] Zemo (10.2022) Zero Emission Bus Guide

Appendix 1: TCO Methodology

TCO Methodology

Urban Foresight's Electric Mobility team has designed its own in-house total cost of ownership tool. This is used to assess and compare the cost of a fleet of vehicles across a variety of fuel types.

The tool allows an analysis to first be carried out on the existing vehicles within a fleet to determine the total cost of ownership before a potential transition to zero emissions. Fleet replacement options can then be established and a TCO analysis can be carried out on these vehicles using operational data from the existing fleet.

Information required

Existing fleet

To carry out the initial fleet analysis, the following information was requested from the operator:

1. Vehicle details
    a. Vehicle type, number of seats, purchase cost, residual value (where known), average age of vehicles
2. Operation and maintenance data
    a. Servicing and maintenance schedules and costs, MOT and road tax rates
3. Fuel usage data
    a. Annual vehicle mileage (or mileage per trip), vehicle efficiency (MPG), and/or litres of fuel consumed annually or per trip
4. Trip information (optional)
    a. Number of trips carried out annually (for those who provided fuel data per trip)

Zero-emission fleet

For zero-emission vehicles, the following data was gathered to compare to the existing fleet:

1. Purchase price of vehicle
    a. Including available grants and residual value
2. Maintenance and servicing costs
    a. Price per kilometre or mile of travel based on real-world data where available
3. Fuel costs
    a. Miles/kWh or kWh/km
    b. Electricity cost – split between required use of private and public infrastructure

Results of analysis

Analysis of the information provided by operators and gathered on zero-emission options allows the following conclusions to be drawn:

1. Total annual ownership cost of each vehicle (and overall fleet)
    a. Vehicle cost
    b. Operational and maintenance costs
    c. Fuel costs
2. Total lifetime ownership of each vehicle (and overall fleet)
    a. Vehicle cost
    b. Operational and maintenance costs
    c. Fuel costs

Assumptions:

The following assumptions have been made in the TCO analysis for this project:

1. Fuel costs
    a. Diesel cost determined by the average cost at the time of analysis (£1.69 per litre at time of writing)[8].
    b. Electricity cost determined to be 35p per kWh for private infrastructure and 55p per kWh for public infrastructure.
2. Private vs public infrastructure use
    a. Established through the range of the alternative vehicle option and required range per trip (e.g a vehicle travelling 300 miles with 200 miles of range will require 34% public charging).
3. Servicing and maintenance
    a. Determined to be between £0.03 and £0.10 per km from real-world data[9].

[8] Fleet News (03.2023) Regional fuel prices
[9] Ember Buses Dundee

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