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Energy Strategy: Transport Research

Greening the Fleet

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Quality information

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1. Introduction

1.1 Introduction

1.1.1 A key focus within the Energy Strategy is the need to reduce emissions. Transport is the second largest emitting sector in Northern Ireland, comprising 23% of emissions (2018 data; agriculture is the largest at 27%).[1]

1.1.2 However, as agriculture only showed a 1% increase since 1990 due to increased livestock numbers, the transport sector had a 29% increase due to growth in demand for transport. Despite improvements in efficiency of new vehicles, per person, surface transport emissions are actually higher in Northern Ireland than the UK average.[2]

1.1.3 Public Sector vehicle fleets contribute to emissions and the sector must play its part in reducing transport's impact on climate change and air quality. Public Sector fleets in Northern Ireland currently comprise of (almost exclusively) conventionally fuelled vehicles, often with an older age profile than the UK average.

1.1.4 Many vehicles in the public sector are "tools of the trade" and may be used less intensively than private sector equivalents, due to different commercial pressures and operational needs. This traditionally means that some vehicles have a longer working life than if they were used in the private sector. The implication of this is that some of the fleet is still using older engine technology such as Euro 4 and 5 engines which are more polluting per mile than the modern Euro 6 diesel powered vehicles or alternatively fuelled equivalents.

1.1.5 The 'Public Sector Fleet' in this context means those associated with local authorities, emergency services and utilities but excludes those which carry passengers. Public Sector fleets in Northern Ireland comprise approximately 7,500 vehicles undertaking a variety of tasks. These vehicles can be very specialised and non-standard due to the tasks they need to perform.

1.1.6 Whilst public sector fleets elsewhere are beginning to transition to alternatively fuelled vehicles using greener and more efficient ways of working, the evidence suggests that those responsible for procuring and managing public sector fleets in Northern Ireland need support and information to aid them in transitioning to a greener fleet profile.

1.1.7 Recent technological advances mean that barriers to greening fleets are now less pronounced and there are more options for reducing vehicle emissions. There is a need to explore these changes to ensure that Northern Ireland's public sector fleet replacement policy and actions follow International Best Practice.

1.1.8 This research report discusses how fleets across the UK and internationally are transitioning to greener fleets, lessons learned so far and the required policy levers to encourage and / or mandate change.

[1] Northern Ireland and Net Zero, Research and Information Briefing Paper (2021)
[2] Northern Ireland and Net Zero, Research and Information Briefing Paper (2021)

1.2 Study Objectives

1.2.1 The objectives of this study are to:

- Undertake an international literature review presenting key findings in terms of good practice on the decarbonisation of public sector non passenger fleets, including the costs and benefits of relevant, schemes. In this study we have included several examples relating to passenger fleets as these can offer valuable lessons in how non-passenger public sector organisations can progress with measures to green their fleets.
- Benchmark Northern Ireland in terms of the investment to date in decarbonising the public sector non passenger vehicles fleets.
- Identify the main barriers and obstacles and opportunities/strengths in Northern Ireland in developing a greener public sector fleet including legislative, financial, operational, and cultural environments.
- Provide recommendations on short, medium, and longer-term practical measures to support the implementation of a greener public sector fleet. This includes setting appropriate indicators and measures, considering the Programme for Government Outcomes Based Accountability framework that applies in Northern Ireland.

2. Literature Review

2.1 Introduction

2.1.1 A review has been conducted of literature relating to reducing vehicle emissions through technology and behavioural change. This literature has been recommended by members of the project team, desktop research and/or provided or referenced during stakeholder engagement.

2.1.2 We have selected this literature based on its applicability to Northern Ireland, the extent to which it addresses knowledge gaps and helps further understanding of issues and opportunities associated with greening fleets.

2.2 Literature Review Summary

2.2.1 Further literature reviews and discussion can be found in the Annex, which also provides examples of Best Practice in relation to Greening the Fleet. We have grouped our analysis under five themes:

- Eco-driving – Eco driving is focused on using conventional vehicles more efficiently through better driving techniques. It can also be applied to EVs, which can be driven efficiently to extend battery life and distance range.
- Policy – Policy is vital in encouraging change in an organisation. We have reviewed relevant documents that set out how other agencies and Government departments have looked to encourage this.
- Lowering Emissions – We have reviewed literature related to decarbonisation and lowering pollutants, highlighting the benefits of greening fleets.
- Technology – Several documents cover emerging technology such as smart charging and vehicle to grid (V2G) systems, which assist in demand smoothing power requirements throughout the day and help fleet managers obtain energy when the price of electricity is lower usually in an off-peak period.
- Social Benefits of Electric Vehicles – We have reviewed literature examining the impact EVs have on society.

2.3 Eco-Driving[3]

2.3.1 'Eco-driving' can help improve fuel efficiency and therefore reduce carbon emissions, helping green fleets whilst transitioning to alternative fuels. Eco-driving is split into three categories: pre-trip, during the trip and post-trip. Within each category, techniques can be used that are considered eco-driving; Table 2.2 outlines examples of actions that can be taken.

[3] **Easy on the Gas: The effectiveness of eco-driving, 2012, RAC, 2012**

Table 2.1. Eco-driving Techniques

Pre-trip	During the Trip	Post-trip
Vehicle Well Maintained	Avoid unnecessary engine idling	Review trip data to improve driving style observing where sharp acceleration or severe braking occurs
Correct Tyre Pressure	Smooth driving and reasonable speeds	
Good Trip Planning	Changing up gear as soon as possible	

2.3.2 Challenges associated with eco-driving include maintaining initial benefits over longer periods of time, buy-in from fleet managers and drivers and ensuring training is effective.

2.3.3 Eco-driving can reduce emissions from vehicles, however there are drawbacks that can hinder the effectiveness of eco-driving unless continuous monitoring and periodic training are provided, and the driver remains engaged in the process. Therefore, it is crucial that drivers receive ongoing training that reinforces skills learned.

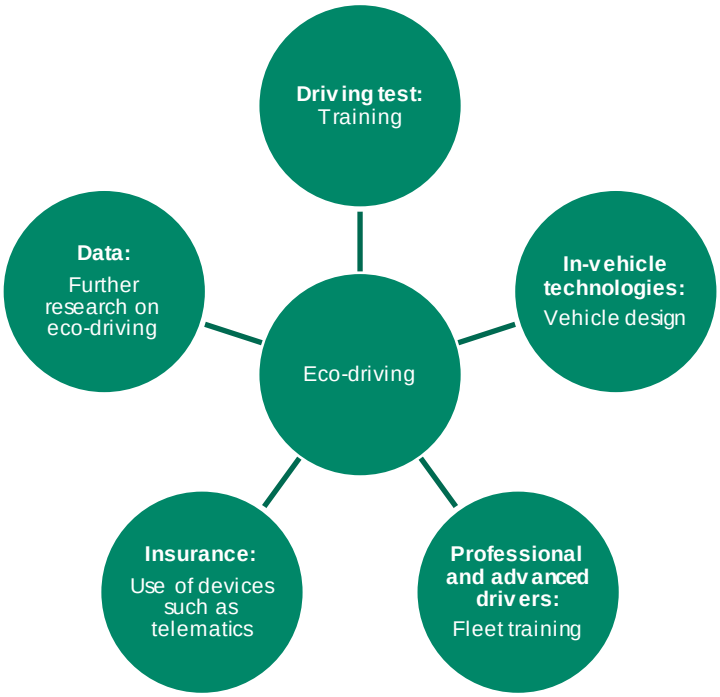
2.3.4 The benefits of eco-driving are also dependent on how drivers and organisations use fuel savings. If these savings lead to less efficient operations, then the net benefit will be reduced. To overcome this challenge and to maximise the opportunities from eco-driving, policies shown in Figure 2.1 should be explored.

2.3.5 Driver training on electric vehicles is something that is needed to optimise electrical power use. EV driver training courses can range from one to five days, and whilst costs are dependent on the training provider, a half-day session can cost £250 excluding VAT.[4] There will also be a requirement to train the maintenance staff, who are able to maintain ICE vehicles but less familiar with EVs and alternative fuels. These courses can range from £300-700.[5]

[4] https://advanced-driving.co.uk/ev-electric-vehicle-driver-training/

[5] https://autotechrecruit.co.uk/training/electric-and-hybrid-vehicle-training/

Figure 2.1. Eco-driving Recommended Policies



2.4 Policy[6,7]

2.4.1 The Hydrogen Roadmap 2020-30 outlines how hydrogen can be deployed in all of Ireland and how the benefits of hydrogen fuelled transport include it being a low carbon fuel and that it can be stored, which provides flexibility if the supply of other renewables are intermittent. The report shows that the development of hydrogen technology in other countries has reduced the cost of associated vehicles and infrastructure, whilst increasing the type and number of vehicles available.

2.4.2 The use of hydrogen as a fuel for cars and heavy-duty vehicles would enable zero-emission transport if hydrogen is produced sustainably (green hydrogen). A collaboration between Hydrogen Mobility Ireland Association, a group of leading industrial players and public sector bodies have come together for a coordinated strategy report for the deployment of hydrogen mobility in Ireland.

2.4.3 Hydrogen can deliver many benefits to Ireland, including:

- Cost competitive clean transport.
- No local pollutant emissions.
- Direct benefits for the Irish economy.
- Hydrogen from renewable energy.
- Effective solution for heavy duty transport, e.g. trucks.

[6] **A Hydrogen Roadmap 2020-2030, Hydrogen Mobility Ireland, 2019**

[7] **S&P Global, Source and scale are the biggest challenges as hydrogen interest grows**

S&P Global outline the difficulties in sourcing and scaling hydrogen as it is mostly produced from fossil fuels, including natural gas and coal, using a process called Steam Methane Reforming (SMR). A downside to this process is that carbon dioxide is emitted as hydrocarbons are broken up.

2.3.2 Hydrogen produced through SMR without Carbon Capture and Storage (CCS) is sometimes referred to as “grey” hydrogen, whereas that produced with CCS is known as “blue” hydrogen.

2.3.3 A greener production method is Proton Exchange Membrane (PEM) electrolysis, which uses electricity to separate hydrogen from water.[8]

2.3.4 To produce hydrogen cleanly it will be necessary to use renewable energy (e.g. from solar, wind, marine power) to create and transport it from production facilities. At present, hydrogen is often produced on-site where it is needed.

[8] S&P Global https://www.spglobal.com/en/research-insights/articles/source-and-scale-are-biggest-challenges-as-hydrogen-interest-grows

2.5 Lowering Emissions[9]

2.5.1 Vehicle-to-Grid (V2G) technology can help reduce emissions by helping meet the energy, environmental and commercial challenges faced by fleet managers. V2G technology enables the batteries of electric vehicles to store energy and discharge it back to the electricity network when required and can reduce the demand that EVs put on the UK's energy network.

2.5.2 The Low Emission Vehicle Taskforce Progress Report[10] outlines that the development of EV infrastructure is necessary to meet increasing demand. It analyses the range of measures and options that are available to accelerate the uptake of low carbon technologies in the road transport sector.

2.5.3 The report examined the role of fleet managers in companies meeting their emissions targets. Technologies such as V2G plays an important role in overcoming some barriers to new energy technology. This supports the goal of cleaner fleets and achieving environmental targets.

2.5.4 As vehicles will still need to be driven to fulfil their duties, the savings will depend on how long an average daily drive is.[11]

2.6 Technology

2.6.1 Technology is key to greening fleets. The *EV Smart Charging Whitepaper and Smart electric vehicle charging with the customer and grid in mind*[12] looks at the use of smart charging to charge EVs. The system manages the electricity required to charge the EVs that are plugged into the charging unit via cloud technology; the system then evaluates how much energy is required and whether it will put a strain on the grid network; it can then calculate whether to increase or decrease the maximum power outage to each charging vehicle in order to balance charging efficiency and prevent an overload on the power network. Some plugged in vehicles may have a delayed start to their charging based on other vehicles requirements at the depot and relative energy prices that fluctuate throughout the day.

2.6.2 DNOs (Distribution Network Operators) ensure that the local electricity network has the capacity and reliability to meet demands. Costs are passed to the end customer and vary depending on the characteristics of the network and weather conditions which affect wind and solar energy production levels.

2.6.3 Indicative connection costs, power requirements and the time it would take to install the charging points are shown in Figure 2.2.

[9] *Moving Towards More Sustainable Fleet Management with Vehicle-To-Grid (V2G) Systems, E-Flex, 2020*

[10] Low Emmision Vehicle (LEV) Taskforce Progress Report, Department of Transport, 2019

[11] *He, Y.; Bhavsar, P.; Chowdhury, M.; Li, Z. (2015-10-01). "Optimizing the performance of vehicle-to-grid (V2G) enabled battery electric vehicles through a smart charge scheduling model". International Journal of Automotive Technology.*

[12] *Whitepaper: Smart electric vehicle charging with the customer and grid in mind, K. Black, 2020*

Figure 2.2. Illustrative Examples of DNO Costs and Timescales

Small	Medium	Large
(up to 70kVA)	(200kVA - 1,000kVA)	(above 1,000kVA)
Number of charge points		
1-3 Fast or 1 Rapid	10-50 Fast, 4-20 Rapid or 1-6 Ultra-Rapid	50+ Fast, 20+ Rapid or 6+ Ultra-Rapid
Approximate Connection Time		
8-12 Weeks	8-12 Weeks	6 Months +
Approximate Connection Cost		
£1,000 - £3,000	£4,500 - £75,000	£60,000 - £2 million

2.7 Social Benefits[13]

2.7.1 Alternatively, fuelled vehicles can provide benefits at a societal level. Savings from reduced running costs can be invested elsewhere in public services and lower emissions result in health benefits with improved life expectancy and a healthier population.

2.7.2 This could help inform business cases for investment in greening fleets and balance higher purchase costs, as public health benefits can provide significant cost savings as well as wider societal impacts.

2.7.3 As discussed in the Section 2.5, EVs can also be used as a means of storing power as they may be able to return their charge into the electricity grid at times of high demand. Estimates show potential savings of $4,000 over the lifetime of a vehicle equipped with V2G capability.

2.7.4 This demonstrates that efficient charging and 'smart' charging can have financial benefits and improve the business case for investment in electric vehicles. Further assessment of societal benefits of greening fleets would help understanding of the wider impacts of green fleets and potentially encourage further investment of associated interventions.

2.8 Best Practice Examples

2.8.1 As part of this review we have investigated Best Practice Case Studies, such as Edinburgh City Council, outlined below. Further case studies, including opportunities for Hydrogen Powered buses (Aberdeen and Birmingham) and Electric Refuse Vehicles (Liverpool) which can bring significant benefits in relation to greening fleets are detailed in Annex B.

2.8.2 Edinburgh City Council introduced wireless charging technology for light commercial vans in Spring 2021 underlining the importance of charging infrastructure and removing barriers to alternatively fuelled vehicles through technological advances.

2.8.3 This makes Edinburgh one of the first in the UK to introduce this technology and brings many benefits. High-powered wireless electric vehicle charging is expected to have considerable benefits for commercial vehicle users:

- Faster starts to charging sessions with no downtime for plugging in to improve vehicle use can create bigger benefits from "opportunity charging" sessions (charging away from the home depot)
- No cables to cause trip hazards or ducting that requires maintenance
- Future proofing for the advent of autonomous vehicles (which will not have a driver to plug them in)[14]

[13] **Quantifying the Societal Benefits of Electric Vehicles, Ingrid Malmgren Vermont Energy Investment Corporation, 2016**

[14] Heriot-Watt University Website https://www.hw.ac.uk/ebs/news/wirelesschargingtech.htm

2.8.4 This has had the impact of encouraging further take up of EVs within the fleet and enabling Edinburgh to act as an exemplar for other cities.

2.9 Key Messages

The following are the key messages from the literature review:

- Eco-driver training has positive effects on fuel consumption and reducing emissions and as traditionally fuelled vehicles are likely to be part of the fleet mix for the short-medium term this will remain important. However, benefits can be short-lived and hence repeat training or reminders may be useful. Fleets in Northern Ireland should consider ongoing eco-driving training.
- Hydrogen and other fuel sources are also likely to be part of the solution. However this is rapidly emerging technology and more suited towards heavy duty vehicles and those doing longer range journeys regularly. Local Authorities such as Glasgow City Council are introducing Refuse Collection Vehicles powered by the fuel. Fleets in Northern Ireland should consider use of hydrogen vehicles in the future especially for HGVs or other heavy duty vehicles that typically travel longer distances. But note that currently hydrogen vehicles are in their infancy and are very expensive to buy.
- Electric vehicles and most other alternative fuelled vehicles are currently more expensive to buy than the petrol/diesel equivalent, however prices are falling. Electric Vehicles are forecast to cost the same later this decade. If whole life costing is considered the daily cost of electrical power is much more economical than for an equivalent ICE (Internal Combustion Engine) vehicle. Additionally, the cost of maintaining an EV is less than an ICE vehicle as there are fewer moving parts. So, although the initial cost of the EV/Hydrogen vehicle is higher, lifecycle costs can be lower. To encourage greener fleets there need to be improvements in infrastructure and facilities. This would include dedicated maintenance areas and charging stations.
- Smart charging can prioritise charging between vehicles and the optimum time of day that charging should take place. This helps reduce the cost of electricity required for the vehicles.
- V2G and V2H (Vehicle to Home) charging should be considered when developing an electric fleet. The vehicle charges when the cost of electricity is low during an off-peak period and then the grid may draw power from the vehicle battery when it needs it most and prices are high. The vehicle owner in this case is a beneficiary and this can help to keep energy bills lower. As mentioned in the lowering emissions theme, the E-flex project aimed to test the real-world viability of V2G technology. V2G technology trials have been carried with E-Flex project partners which include Fruit 4 London, Gnewt Cargo and Plymouth City Council. Demonstrator trials in the US have shown that savings can be achieved in a 'real world' scenario15

[15] Fermanta Energy https://www.fermataenergy.com/news-press/proven-results-and-cost-savings-with-v2g-technology

- There are societal benefits to be gained from moving to low or zero emission vehicles as soon as possible. Incentives are needed towards the purchase price to encourage behavioural change.
- There is a need for an educational programme aimed at encouraging the use of low/zero emission vehicles.

3. Northern Ireland's Progress to date in Decarbonisation of the Fleet

3.1 Baseline

3.1.1 To determine the progress of Northern Ireland's fleets towards decarbonisation and low emissions, information and data from some public sector fleet managers and their organisations has been collected, as outlined in this section. As discussed, there are approximately 7,500 vehicles in the Northern Ireland Public Sector fleet.

3.1.1 Lisburn and Castlereagh City Council

3.1.1.1 Lisburn and Castlereagh City Council has a fleet of 128 vehicles, representing a variety of different vehicle types, from numerous Refuse Collection Vehicles (RCVs) and vans to more specialist vehicles. The vehicle age profile is also varied, with a significant proportion of the fleet over 10 years old. They do not currently have any alternatively fuelled vehicles.

3.1.1.2 Many vehicles are not used intensively with over 25 vehicles covering less than 5,000 miles per year, suggesting that issues associated with range would be less pronounced with these vehicles.

3.1.1.3 The Council reported that trials have been held using small car derived vans. They are actively liaising with manufacturers, but the main issues reported were high cost, short range, lower payload and lack of infrastructure.

3.1.1.4 They operate a rolling replacement schedule based on age/cost to replace against a pre-agreed budget model, with zero emission vehicles included in the business case if suitable types are readily available.

3.1.2 Ards and North Down Borough Council

3.1.2.1. Ards and North Down Borough Council has a fleet of 263 vehicles with mileages varying greatly across the fleet. They are investigating hydrogen as a fuel for large vehicles for the future as well as trialling Hydro-treated Vegetable Oil (HVO).

3.1.2.2. Advantages of using HVO include a large reduction in emissions. It can be used instead of diesel without any negative effects on engine wear and warranties, takes the same time to fill up as diesel and has a longer shelf life. The current disadvantages are that it has limited availability in Northern Ireland and is more expensive.

3.1.2.3. All vehicles are currently diesel powered, with a 7-year replacement cycle on HGVs and 10 years on light vehicles. Whilst they are aware of the potential for electric vehicles, they stated that the technology needs to work for them at an operational level.

3.1.3 Northern Ireland Water

3.1.3.1. The Northern Ireland Water fleet consists of approximately 600 vehicles, both Light Commercial Vehicles (LCVs) and HGVs. They have been actively considering how, when and where to upgrade to the various forms of alternative fuel technology as part of their fleet decarbonisation programme in taking action on the climate emergency ahead of the ban on the sale of new petrol and diesel cars from 2030.

3.1.3.2. They recently introduced four electric vehicles which will be operational early in 2022.

3.1.3.3. They are also considering the possibility of hydrogen powered vehicles, solely or as an extender option for EVs, once the technology is available in Northern Ireland.

3.1.3.4. For the next three years vehicles will be replaced on a like-for-like fuel basis, with targeted pilots of emerging vehicle technologies and will then look to a wider adoption of alternative fuel vehicles from mid-April 2024 onwards allowing time for pilots and anticipated price parity of ULEVs. 25% of new vehicles in 2024/25 will be alternatively fuelled, 50% of new vehicles in 2025/26, and 100% of new vehicles in 2026/27.

3.1.3.5. By the end of PC21 in their procurement cycle, NI Water anticipates having 200 alternatively fuelled vehicles within its fleet.

3.1.4 Belfast City Council

3.1.4.1 Belfast City Council's fleet is the largest local authority fleet in Northern Ireland. Pre-Covid, the fleet size was approximately 370 vehicles. They retained about 50 older vans to act as RCV support vehicles as the third crew member cannot be carried in the cab due to Covid restrictions. As a result, every RCV has a van in support for the extra worker. They have 12 small EV vans which have been in operation for just over a year and they are proving reliable and economical. The strategy for the future of the fleet is being currently reviewed and it is likely that more EVs will be ordered especially at the lighter end of the weight category.

3.1.4.2 Mileages associated with Belfast City Council fleet vehicles suggest many vehicles, particularly those that are older, travel relatively short annual mileages and as such there are fewer barriers to alternative fuels as vehicles can be refuelled/recharged at depots. Research also suggests the stop-start nature of certain types of vehicle operating means that carbon emissions can be higher per mile and that the benefits of transitioning these vehicle to alternative fuels can be significant.

3.1.5 Translink

3.1.5.1 Translink operate buses so are outside the scope of this study but have been included for completeness.

3.1.5.2 At the time of writing all Translink's vehicles are diesel fuelled, except three Hydrogen fuel cell vehicles (FCEV).

3.1.5.3 However, there is a further 20 FCEV as well as 80 Battery electric vehicles (BEV) under construction. These will all be delivered by March 2022. There are no plans for any other alternatively fuelled vehicle types. Translink explained how these buses form part of its Net zero emissions strategy, which is fundamental for cleaner and greener transport. Translink trialled the small FCEV fleet with funding from DfI16 and the Office for Low Emission Vehicles (OLEV). The current high cost of hydrogen and required additional investment for the vehicles (more expensive) and infrastructure are a barrier for roll out.

3.1.5.4 Translink replace vehicles in line with their fleet strategy, which sees Metro and Minibus replaced at 12 years, Ulsterbus at 18 years and Goldline coaches at 8 years.

3.1.5.5 They have a plan to move to a zero-emission fleet in Belfast, Foyle Metro (Derry/Londonderry) by 2030 and a full zero emission fleet (Bus and Rail) by 2040.

3.2 Summary

3.2.1. Whilst the responses received suggest an understanding of the need for change and alternative fuels are being considered and trialled, all the fleets reviewed are overwhelmingly conventionally fuelled. Whilst this is typical of public sector fleets across the UK, significant progress needs to be made to meet climate and environmental targets.

3.2.2. The wide range of vehicle types and long lifecycles for certain vehicles represents a barrier to a quick change of fleet profiles, especially when there are fewer or no alternatives to conventional fuels (e.g. for more specialist vehicles).

3.2.3. Therefore, there are challenges to surmount if Northern Ireland public sector fleets are to respond to the changes required to meet environmental targets. This is covered in Section 5.

[16] http://www.niassembly.gov.uk/globalassets/documents/raise/publications/2017-2022/2020/infrastructure/5720.pdf

4. International Best Practice – Green Fleets

4.1 Introduction

4.1.1 By providing examples of Best Practice elsewhere, lessons can be learned from how other organisations have successfully transitioned their fleet and the impact it has had.

4.1.2 This section outlines fleets outside of Northern Ireland that have made some progress towards having a sustainable public sector fleet.

4.2 Best Practice Case Studies

4.2.1 Police Scotland

4.2.1.1. Police Scotland has awarded two contracts worth more than £25 million to help achieve its aim to be the first emergency service in the UK with a fleet of Ultra-Low Emission Vehicles. BP Chargemaster will supply and install hundreds of electric vehicle charging posts (EVCPs) whilst almost 180 Hyundai Kona 64kWh cars will join the fleet.

4.2.1.2. Under the first phase, over 400 charging points will be installed at over 50 police sites across Scotland. BP Chargemaster will also provide annual maintenance. This will include 35 120kW ultra-fast chargers.

4.2.1.3. The initial focus will be on installing at police sites along the 'Green Corridor', the roads linking Prestwick, Glasgow and Edinburgh Airports ahead of the United Nations Climate Change Conference of the Parties (COP26), due to take place in Glasgow in November 2021.

4.2.1.4. Police Scotland[17] carbon emissions are currently 15,897 tonnes CO_2 per annum. Once the transition to ULEVs is fully executed it is anticipated that there will be an approximately a 61 per cent reduction by year 10. The impact of implementing their fleet strategy is 6257 tonnes of CO_2 each year. In terms of cost, there is a significant investment in infrastructure required to enable the transition towards ULEV. The charging points will be based on the number of vehicles, current guidance is one charging point for every three vehicles. The fleet strategy option will require a significant capital investment of £129.2 m over a 10-year strategy period.

4.2.2 South Central Ambulance Service, Berkshire, Buckinghamshire, Oxfordshire and Hampshire (NHS)[18]

4.2.2.1. The two Kia e-Niro vehicles have been designed and adapted by South Central Fleet Services to contain all the equipment, medication and supplies to allow first responder paramedics from SCAS to reach patients quickly under emergency driving conditions.

4.2.2.2. SCAS began looking at electric vehicles over 18 months ago but at that time there were only a limited number of manufacturers in the market and the driving range of the models available was not quite what was needed for an emergency response vehicle. With a greater number of vehicles available for

[17] https://www.scotland.police.uk/spa-media/vgdhkein/fleet-strategy.pdf
[18] https://www.scas.nhs.uk/scas-launches-first-electric-emergency-response-vehicles/

testing, combined with further advances in electric motoring technology, the technology became viable for the Trust.

4.2.2.3. The Kia eNiro has a manufacturer's driving range of up to 282 miles on a single charge well within the estimated 90-100 miles that an emergency response vehicle will cover in an average 10-hour operational shift.

4.2.3 Nottingham City Council

4.2.3.1 The population of Nottingham is around 790,000 and the council runs a fleet of almost 500 vehicles. They benefitted from being one of four cities to receive a grant from the Office for Low Emission Vehicles (£6.1m shared with Derby City Council and Nottinghamshire County Council). The other beneficiaries of the Go Ultra Low City fund were London, Bristol and Milton Keynes.

4.2.3.2 As a result of winning the grant and a positive council initiative they are on target to have 100% electric vehicles by 2028. The council have converted 196 of their vehicles to ULEV which equates to 40% of their overall fleet. This consists of 117 vans, 50 cars, 14 cage tippers, 8 sweepers, 5 minibuses and 2 RCVs.

4.2.3.3 The Council have also invested in their infrastructure in order to support the new ULEVs. The infrastructure investment includes 130 smart chargers across 4 sites, a new substation and their own ULEV MOT and service centre. To add to their vehicle procurement, the council have investigated other techniques to decarbonise, examples of these include, route optimisation and telematics to improve driver behaviour.[19]

4.2.3.4 By moving towards an all-electric fleet, the council hope that this will contribute towards Nottingham being a carbon neutral city by 2028. Reports show so far, two RCVs will save the council 52 tonnes of carbon dioxide annually.[20]

4.2.4 Oxford City Council

4.2.4.1 The population of Oxford is 152,000 plus an extra 32,000 students. Their fleet consists of 320 vehicles.

4.2.4.2 In their 4th Carbon Management Plan report published in 2021, Oxford City Council state how 27% of their emissions come from their fleet vehicles. At the time of writing the council had 46 electric vehicles which are mostly made up of cars, small vans and tippers trucks.21 Oxford City Council have also purchased their first electric refuse vehicle in 2021 by partly using funding from the £41m Energy Superhub Oxford project led by Oxford City Council and Pivot Power, part of EDF Renewables.22

4.2.4.3 The council aims to have over 25% of their 320 fleet vehicles electric by 2023. To reach zero carbon by 2030 the council plans to convert all 320 vehicles to electric. 23

[19] Freight in the City EXPO – ecollect Webinar, 2021
[20] https://www.nottinghampost.com/news/local-news/electric-bin-lorries-take-nottinghams-4834268
[21] https://www.oxford.gov.uk/download/downloads/id/7518/zero_carbon_plan_2030.pdf
[22] https://www.oxford.gov.uk/news/article/1753/oxford_s_first_electric_refuse_collection_vehicle_arrives_at_ods
[23] https://www.oxford.gov.uk/download/downloads/id/7518/zero_carbon_plan_2030.pdf

4.2.4.4 So far, the council has used funding from The Energy Superhub Oxford project which was announced in April 2019 and is designed to integrate and dramatically decarbonise energy, heat and transport systems across the city. The project received £10m from the government's Prospering from the Energy Revolution Challenge. 24

4.2.4.5 As the council have estimated that their fleet vehicles account for 27% of their emissions, by electrifying the fleet the council will be able to make significant progress towards their goal.

4.2.5 Other UK Fleets

4.2.5.1 A review of other fleets across the UK, including Leicester, Coventry and Network Rail suggests at present the number of alternatively fuelled vehicles is up to approximately 10% of the overall fleet. A breakdown of these fleets can be found in Annex C.

4.2.6 European Examples

4.2.6.1 Car-sharing provider **Share Now** has massively increased the number of electric vehicles in its European car-sharing fleet. The company now operates 2,900 BMW, Mini, Smart and Fiat electric cars at four all-electric and four partially electric locations.

4.2.6.2 Share Now relies exclusively on electric vehicles in Stuttgart, Amsterdam, Madrid and Paris, while a mixed fleet of electric and conventional cars is used in Hamburg, Munich, Copenhagen and Budapest. The 2,900 electric cars distributed among these eight locations account for a quarter of the total fleet.[25]

4.2.6.3 The Swedish-Swiss power and automation technology group **ABB** has announced that it will completely electrify its fleet of more than 10,000 vehicles by 2030. The company's climate protection goals also include using only renewable energy, as well as establishing energy efficiency targets and energy management systems. In Sweden, ABB has already begun converting its approximately 700 company cars to all-electric vehicles. [26]
An impressive example of greening the city is at **Vaxjo, Sweden**, which is claimed to be the greenest city in Europe. Here, there is buy-in from the public and private sector. The public sector uses electric vehicles and demonstrates good practice in not only their choice of transport mode but in how they operate. For example, all the schools use the same procurement method and their goods go to a well-used consolidation centre on the outskirts of the town. Then most of their needs can be delivered locally on an electric last mile urban friendly truck that operates straight to the school in and around the town centre. Similarly, many of the shops and offices also use the service, reducing the number of HGVs in the pedestrian and cycle friendly city.

4.2.6.4 The city had developed a holistic view on sustainability and careful consideration on all planning and development work. An example of reduction in emissions is recycling food waste and turning it into biofuel. Collaboration with Universities and Businesses has provided further support

[24] https://www.oxford.gov.uk/news/article/1753/oxford_s_first_electric_refuse_collection_vehicle_arrives_at_ods
[25] https://www.electrive.com/2021/06/08/share-now-sees-11000-electric-driven-trips-per-day/
[26] https://www.electrive.com/2021/06/03/abb-to-electrify-own-fleet-of-10000-vehicles-by-2030/

in efforts to reduce the CO_2 emissions and eliminate the use of fossil fuels in the future.

4.3 Impact of Changing Fleets – Lessons Learned

4.3.1 The case studies have shown that many public sector fleets have only recently begun transitioning to a 'greener' approach and fleet profile. Therefore, the impacts of these initiatives have only just begun to be felt, with lessons likely to emerge over the coming months and years.

4.3.2 However, there are international examples of public sector fleets where lessons have been learned and impacts felt. In the US, the **Port Authority of New York and New Jersey (PANYNJ)** responded to the city mandating a sustainability policy requiring 75% of all light duty vehicles being zero emission. This involved bulk purchases of EV cars and motorcycles, often used for site work and enforcement. Range was vital and before the availability of vehicles (in this case a Chevrolet Bolt with a 235 mile plus radius) with longer ranges the shift from ICE could not be made. PANYNJ calculated that cost per mile of EVs were less than 1/3 of ICEs over a three-year payback period.

4.3.3 When deciding how to purchase electric vehicles, estimated lifespan, preliminary maintenance analysis on labour and parts, estimated energy/fuel costs, and total cost of ownership, including the resale value of the vehicle at the end of its life-cycle were considered.

4.3.4 The fleet has saved more than 700,000 kg of greenhouse gas emissions. Based on historical data, the EVs save over 300 litres of fuel per month per vehicle and the division estimates it will save about $1,500 to $2,500 in maintenance costs per vehicle in the first five years.

4.3.5 Fleet managers are advised to train their technicians and mechanics for high-voltage maintenance before EVs arrive into the fleets, which reduces maintenance dramatically. The authority has seven auto repair shops strategically placed in New York and New Jersey with 100 trained mechanics to work on equipment. They also make sure new EVs arrive at the same time charging stations open, so neither the stations nor vehicles sit idle. This requires departments and stakeholders to work together on timelines. [27]

4.3.6 Early adoption can also lead to issues. **The City of Durham, North Carolina**, procured EVs in 2012, opting for 10 Nissan Leaf models which had a range 70 miles. They were not well received by users and therefore not widely used. They are now educating users and placing EVs in relevant departments.

4.3.7 The fleet management director for the City of Durham also recommended that fleet managers equip their vehicles with telematics, as City of Durham did in early 2019. The accumulated detailed data can help managers make real time decisions on EV usage, performance, and weather-related conditions. Weather conditions, can limit the performance of EVs, so buyers should plan and get models with the right battery sizes and capacities. [28]

[27] https://www.chargedfleet.com/10133604/when-is-your-fleet-ready-for-electric-vehicles Accessed 26/8/21
[28] https://www.chargedfleet.com/10133604/when-is-your-fleet-ready-for-electric-vehicles Accessed 26/8/21

4.3.8 In May 2017 **Cyfoeth Naturiol Cymru/Natural Resources Wales** introduced three electric cars across three sites and introduced six charging points across six different locations. The total cost of the vehicles (not including OLEV grant) and charging points was approximately £70,000. An onboard charger of 6.6kW was chosen, which reduces charging times to 4-6 hours. EVs are available to staff to book through a central pool fleet car booking system (Cyfarch). As part of the strategy for integrating the vehicles into day-to-day use, launch events were held at the three NRW offices to introduce staff to the electric cars and charging procedures.

4.3.9 User guides and FAQ documents were also produced bilingually and made available in each car and on the organisation's intranet. In addition, keyrings were made and attached to the vehicle keys as a quick guide with reminders of the range, that the car is automatic and electric, and with the assistance telephone number for the fleet.

4.3.10 Benefits to staff included:

- As an environmental organisation, their staff have a passion for the environment and to drive sustainability. The electric vehicles gave staff an opportunity to select a more sustainable transport option, where using a vehicle was essential.
- As EVs are automatic, this has increased opportunities for staff who cannot drive manual cars, e.g. for health or licence reasons, to use a pool car rather than hiring vehicles (which then has cost saving implications).
- Providing guaranteed, convenient parking spaces for the vehicles when visiting offices (where parking can be challenging), has further incentivised the use of the vehicles.

4.3.11 The success of the pilot has resulted in a further 3 electric vehicles being purchased in 2018, to maximise the availability of the charging infrastructure installed as part of the pilot. [29]

4.3.12 The **Metropolitan Police, London** has also been investigating how their fleet can be more sustainable. They started trialling hydrogen vehicles in 2017, with help from EU funding. Findings from the trial concluded that, whilst the operation, performance and how these vehicles were received by officers was a success, the limiting factor was the low number of hydrogen-refuelling stations in London.

4.3.13 The Met's zero-emission capable fleet, which covers electric and plug-in hybrid vehicles, has travelled more than 16.5 million miles since its first operation a few years ago. The Met's zero-emission capable fleet, which covers electric and plug-in hybrid vehicles, has travelled more than 16.5 million miles since its first operation a few years ago. Most of the electric use within the fleet has been in support cars, rather than the emergency response units, which are not used 24 hours of the day so there is time during the day to put those vehicles on charge.

4.3.14 The Forensic Support department, for instance, have deployed some Nissan e-NV200 vans, so they use these to support the forensic operation in

[29] Carbon Positive Project, Natural Resources Wales //cdn.cyfoethnaturiol.cymru/media/686738/case-study-7-electric-vehicles-and-charging-infrastructure.pdf Accessed 26th August 2021

London, which involves gathering forensic evidence from crime scenes. These electric vans have been well received by drivers and tend to be lower-mileage vehicles as the operative is generally at a scene for several hours.

4.3.15 The biggest limitation the Metropolitan Police has encountered when adopting more electric vehicles is payload. The fleet's Protected Carrier vehicle division, for example, requires a minibus to be modified and capable of protecting officers in particularly violent situations. There are significant payload requirements and there is a need to identify an electric van that would meet mileage requirements, which in practice means several days of usage before exhausting the battery.[30]

4.4 Summary

4.4.1 The Best Practice examples show what can be achieved with investment in fleets and associated infrastructure. Public sector fleets can act as an example for commercial operators and encourage take-up, with charging/refuelling infrastructure able to be used by the private sector fleet and some public sector organisations able to generate revenue by providing maintenance services to users of alternatively fuelled vehicles.

4.4.2 Based on lessons learned so far, benefits for Northern Ireland's public sector fleets are likely to include:

- Lower fuel costs
- Lower maintenance costs
- Lower emissions
- Staff buy-in and support for green initiatives
- For EVs, better accessibility for those with automatic licences

4.4.3 However, issues to overcome and required interventions can include:

- Lack of 'buy-in' for new ways of working and unfamiliar technology
- Insufficient charging/refuelling infrastructure to enable operations to be undertaken effectively
- Limitations of technology (e.g. range)
- Providing information to staff on requirements of operating alternatively fuelled vehicles
- Training of maintenance teams

4.4.4 However, funding is key to this and the examples show the scale required to deliver meaningful change quickly. This is explored further in section 6.

[30] Business Car https://www.businesscar.co.uk/analysis/fleet-profile/fleet-profile-metropolitan-police Accessed 26th August 2021

5. Barriers and opportunities for Northern Ireland

5.1 Introduction

5.1.1 There are several problems and issues that would need to be considered with Northern Ireland's transition towards greener fleets. This section sets out these challenges.

5.2 Key Challenges

5.2.1 Some of the key challenges of low emission electric vehicles include a lack of policy levers, lack of availability of suitable vehicles, range anxiety over the distance travelled (being unable to complete a journey as beyond an EVs range), location (lack of charging/refuelling infrastructure in certain areas) and public sector procurement arrangements as discussed in the following sections.

5.2.1 Policy for Greener Fleet

5.2.1.1 There is a need to have dialogue with stakeholders to provide greater awareness on the benefits of lower emission vehicles. Furthermore, a lack of policy levers could prevent advancements in lower emission vehicles and technology. Therefore, it is necessary to develop policies which encourage the adoption of low emission vehicles for public sector fleets across Northern Ireland.

5.2.2 Availability of Vehicles

5.2.2.1 Availability of suitable vehicles is a concern for fleet managers and the development of vehicles which are reliable and meet the demands of fleet operators are also challenges. Vehicles such as electric vans and cars are becoming widely available, however more specialised vehicles (e.g. roadsweepers) may be less easy to source.

5.2.2.2 By funding and facilitating trials, the Department for Infrastructure can help prove the case for alternative fuels, particularly those of specialist vehicles.

5.2.3 Distance Travelled

5.2.3.1 The distances able to be travelled by ULEV or EV vehicles reduce when required to carry heavier weights, which places more pressure on the battery and reduces its charge and therefore range.

5.2.3.2 Evidence suggests that:

- There is need for more data to be gathered on distances travelled by specialist EVs through trials and further investigation may be required on the reliability of transporting heavy equipment over longer distances.For example, Dennis Eagle electric RCVs have recently been trialled in Cheshire to make sure their capability and range is suitable for urban and rural collection rounds. The answer was that they are suitable for the standard round length in that county.

5.2.4 Location

5.2.4.1 Location affects the suitability of alternatively fuelled vehicles. Certain areas may lack charging infrastructure (such as rural or remote areas). To overcome this challenge, policy makers should encourage the introduction of charging points in areas with less coverage (often rural areas). This may require grant aid funding to ensure that it is possible to install the EV charging infrastructure in more remote areas.

5.2.5 Charging Point Infrastructure

5.2.5.1 As discussed, it is necessary to have charging infrastructure available in the right locations to allow fleet operators to easily locate and use the charging points for their vehicles. However, the choice of location for charging points may be undesirable and complex in some areas due to the cost of providing a connection or difficulties in finding a suitable space.

5.2.5.2 In 2011, The Department for Infrastructure led a consortium which installed a network of over 337 fast and rapid chargepoints at 176 locations in Northern Ireland. These chargepoints are fully interoperable with the network in the Republic of Ireland providing a cross-border, all-island solution for users. These are owned and operated commercially by the Electricity Supply Board. The Department for Infrastructure's Ecar team provides support to consumers and the private and public sectors to promote ultra-low emission vehicle growth. They have facilitated the installation of a further 54 chargepoints in the Public Sector Estate.

5.2.5.3 There is a map that shows the number of public electric vehicle charging devices in the UK. Data on charging devices was provided by the charging platform Zap-map, showing rapid devices reported as operational on 1 July 2021. The map was developed by the Department for Transport and is published alongside the Electric vehicle charging device statistics July 2021.

5.2.5.4 This map shows the density of charging devices by local authority. Viewing options cover all devices, devices per 100,000 population (Population figures are the ONS Population Estimates for mid-year 2020) and rapid devices. Where a device has more than one speed of connector, it is classified as the highest-speed available.

5.2.5.5 Each map follows the same colour scale, with the bottom 20% of local authorities (the ones with the lowest number of devices) in pale yellow, and the top 20% in dark blue. An image of the map has not been shown as it is regularly updated and is worth using the link provided see http://maps.dft.gov.uk/ev-charging-map/.

5.2.5.6 Table 5.1 shows the number of public charging devices by Local Authority in Northern Ireland as of July 2021.

Table 5.1. NI Local Authority Public Charging Points

ONS code	Local Authority	Public charging devices	Public rapid charging devices	Charging devices per 100,000 population
N09000001	Antrim and Newtownabbey	37	4	25.7
N09000011	Ards and North Down	19	0	11.7
N09000002	Armagh City, Banbridge and Craigavon	31	1	14.3
N09000003	Belfast	52	5	15.2
N09000004	Causeway Coast and Glens	28	1	19.3
N09000005	Derry City and Strabane	26	1	17.2
N09000006	Fermanagh and Omagh	38	2	32.4
N09000007	Lisburn and Castlereagh	16	1	10.9
N09000008	Mid and East Antrim	28	2	20.1
N09000009	Mid Ulster	24	2	16.1
N09000010	Newry, Mourne and Down	31	2	17.1
Total		330	21	-

5.3 Operational Challenges

5.3.1 The operational challenges of transitioning to a greener fleet in Northern Ireland are shown in Table 5.2.

Table 5.2. Electric Vehicle Issues

EV Issue	Description
First Mover Disadvantage	An early commitment to alternatively fuelled vehicles could result in having a fleet that becomes outdated or obsolete, due to changes in the EV marketplace.
Operational Requirements	Non-standard vehicles may not have an EV option available.
Costs	Unknown maintenance costs and procedures related to EV fleet. Furthermore, the unit costs of ULEV can be significantly more than petrol or diesel equivalents. Despite this, newer ULEVs with advancement in battery technology will result in lower lifecycle costs.
Purchasing	Identifying an optimum 'lease' or 'buy' model for alternatively fuelled vehicles in a changing marketplace may be difficult with uncertain lifecycle costs and resale values.
Charge Point Infrastructure	Charging point performance may not be able to keep up with improvements in battery and vehicle performance. Also, there are not enough publicly available charge points to support the projected growth of EVs. Another issue is that power supply/grid capacity could be insufficient to meet the local demand, which may compromise the performance of the charging point and the vehicles that use it.

5.4 PESTLE Analysis

5.4.1 As seen in Table 5.3, a PESTLE analysis has been undertaken to address Political, Economic, Social, Technological, Legal and Environmental factors which may influence Northern Ireland's transition towards greener public sector fleets.

Table 5.3. PESTLE Analysis

Impact	Discussion
Political	• Government schemes in Northern Ireland to encourage the purchase of lower emission vehicles • Policy change to support the transition to greener fleets • Promotion of eco-driving through workshops and fleet driver training

Economic	• Initial purchase costs of alternatively fuelled vehicles are currently higher than for conventionally fuelled vehicles • Running costs for an EV can be lower – however it is important to consider whole life costing • Lower maintenance costs of EVs • Interest from investors for the development of EVs, Hydrogen and other refuelling technology plants
Social	• EVs and Hydrogen powered vehicles have noiseless motors and also waste compaction is moving from hydraulic to electric on EV RCVs - as a result there is less noise pollution and disturbance • Concerns about safety for vulnerable road users (quieter vehicles) • Positive perception of EVs from general public • Health benefits of lower emissions
Technological	• Performance of EVs (such as range) has improved in recent years • Potential early obsolescence of older alternatively fuelled vehicles • Hydrogen vehicles are being developed to meet a range of applications from police cars in London to RCVs in Glasgow, but not all vehicles have a right-hand drive market ready option available yet e.g. large lorries • There is now more investment being made into the advancement of alternative fuel vehicles. For example, the UK Government has recently announced several projects in conjunction with Innovate UK to consider battery electric lorries, hydrogen HGVs and electrification of the roads with overhead wires going up on a section of the M180 near Scunthorpe • Environmental implications arising from the disposal of batteries
Legal	• Legislation and policy surrounding hydrogen mobility; legal constraints may restrict the development of more efficient and advanced hydrogen technology • Tax change; reduction in taxes for ULEV • Challenging to implement policy change, need more research and trials conducted to present data
Environmental	• Reduction in noise • Eco-friendly, but there are concerns about the battery life, and with all vehicles still concern about particulate matter from brake and tyre wear • Zero-emissions; electric engine of EV operates in closed circuit • Hydrogen has a positive impact on air quality because of zero NOx, SO^2, CO^2 and THC emissions • Data needs to be presented to policy makers and society on positive impact from greener fleet

5.5 SWOT Analysis

5.5.1. A further analysis has been examined in Tables 5.4 – 5.7: SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats) for Northern Ireland's transition towards a greener fleet. This has grouped findings under three headings, electric vehicles, use of hydrogen and eco-driving.

5.5.2. Although it contains some of the same points as in the PESTLE Analysis, it is useful to see them grouped differently under positive and negative factors. SWOT analysis can illustrate the potential risks through the identification of weaknesses and threats, whilst maximising the positive impact from strengths and opportunities, thus improving the strategy and decisions that would follow.

Table 5.4. SWOT Analysis - Strengths

Strengths
Electric Vehicles: • Reduction in noise: reduction in engine decibel levels due to fewer moving parts. • Running costs: save money spent on fuel, a full charge for an EV can cost significantly less than conventional fuel. • No emissions from vehicles[31]: the electric engine of an EV operates on a closed circuit, therefore an electric vehicle does not have emissions that are linked to polluting the environment. • Low maintenance: EVs have less maintenance requirements due to having fewer moving parts in comparison to petrol and diesel engines which require expensive engine maintenance. • Performance: the performance of EVs has improved significantly in recent years with significant increase in global sales between 2019 – 2021. • Availability: many leading manufacturers entering the market as demand increases. • Popularity: increasing demand for EVs from consumers and companies with fleets.
Hydrogen Powered Vehicles: • Hydrogen technology is developing rapidly. • Hydrogen has a wide range of storage options that include seasonal, strategic, and large-scale. • Hydrogen is zero emission in relation to NOx, SO_2, CO and THC emissions[32]; positive impact on air quality, this is beneficial for human health as there are less pollutants in the air. • Hydrogen powered vehicles allow a reduction in greenhouse gas emissions because of the high efficiency of electric drive and fuel cells. • There are inexhaustible sources of hydrogen production around the world; hydrogen can be produced in a wide range of ways. • Filling time comparable to conventional vehicles; not much more typically 3-5 minutes. • Hydrogen powered vehicles have noiseless motors, causing less disturbance. • Electromotor provides good hydrogen vehicle driving dynamics; no need for motor to warm up, the electric motor ensures good driving dynamics, smoother and more accurate.

[31] https://www.goodenergy.co.uk/blog/2017/09/28/driving-change-the-advantages-of-electric-vehicles/
[32] https://www.hytep.cz/images/dokumenty-ke-stazeni/Study-Use-of-Hydrogen-Powered-Vehicles-in-Transport-in-the-Czech-Republic.pdf

• Several methods for hydrogen production including use of sustainable power; reduction on the dependence on a single market for resources and raw materials, less risk of high increase or fluctuations in price.
Eco-driving: • Improves fuel efficiency, therefore reduction in carbon emissions. • Adopting eco-driving methods could make the roads safer and support environmental goals such as with the reduction of CO_2 emissions and other pollutants. • Cost effective. • Reduction in noise levels and wear and tear on vehicles.

Table 5.5. SWOT Analysis - Weaknesses

Weaknesses
Electric Vehicles: • Driving Range[33]: Fossil-fuelled vehicles are generally more capable of travelling greater distances • Recharge time: Charging electric vehicles takes much longer, often this charging occurs over night • Battery life: Batteries needs to be replaced every 5-10 years and battery disposal issues • Cost of the Vehicle: Often there is a significant premium on purchase price which can range from 20% to 100% more, which is as a result of high (but falling) battery prices and lower levels of production than traditionally fuelled vehicles (again falling) • Need for Charging infrastructure: Public charging points are coming on stream, but many domestic properties may not easily be fitted with charging points and hence this requires drivers to plan their charging regime using the nearest public facilities • Lack of supporting ecosystem such as parts, servicing, as well as skills
Hydrogen Powered Vehicles: • Hydrogen fuel technology has not yet gained the trust and support from members of the public

[33] https://www.goodenergy.co.uk/blog/2017/09/28/driving-change-the-advantages-of-electric-vehicles/

• Legislation and policy surrounding hydrogen mobility; legal constraints and policy may prevent the development of more advanced and efficient hydrogen technology vehicles • Difficult to source hydrogen at larger scale • Hydrogen refuelling infrastructure: lack of fuelling stations across Northern Ireland • Cost of the Vehicle: Often there is a significant premium on purchase price which can range from 50% to 200% more
Eco-driving: • Fleet drivers may change their driving methods after a period of time which means the training may only have a temporary effect

Table 5.6. SWOT Analysis - Opportunities

Opportunities
Electric Vehicles: • Government schemes in Northern Ireland to encourage purchase of lower emission vehicles • Policy levers to encourage/mandate the purchase of electric vehicles • Increasing the number and charging infrastructure • Dedicated public sector fleet facilities for recharging (including away from depots) • Exploiting new technology such as wireless charging • EVs have an opportunity to play a key role in Northern Ireland's transition to greener fleets, benefiting the environment and the economy. The Energy sector, industrial companies, oil and gas companies, auto manufacturers, would need to collaborate more to maximise the positive impact EVs could have in Northern Ireland
Hydrogen Powered Vehicles: • Production of hydrogen as a by-product; chemical industry could help with the reduction in the costs of hydrogen production. • Hydrogen is a zero-emission resource, improves environmental goals; aligned to Northern Ireland's energy strategy of achieving net-zero target in the future. • Hydrogen production does not require the use of existing raw materials; water is not dependent on raw materials such as oil or gas • Interest from investors for the development of hydrogen powered vehicles. • "Green" hydrogen produced from sustainable means such as from renewable power sources (solar, wind etc.) is what environmental leaders and CSR managers want.

Eco-driving: • Fleet training on eco-driving • Vehicle design development • Promotion of eco-driving through workshops and campaigns • Eco-driving programs that outline the required eco-driving behaviours

Table 5.7. SWOT Analysis - Threats

Threats
Electric Vehicles: • Electricity costs increasing • Time taken to adapt to electric vehicles; the transition towards EV fleet may take between 1-15 years • Electrification of road transport shifts the energy requirements from oil to electric power systems, putting pressure on the grid[34] • EV demand spikes in the morning or evening could cause power generation inadequacy on certain days such as when there is low wind power production • Distribution of electricity could be another challenge, although power plants and cross border connections may have enough capacity, it may become more difficult to distribute to individual areas
Hydrogen Powered Vehicles: • Safety concerns; lack of awareness from public and fleet operators in Northern Ireland regarding the emerging hydrogen sector • Lack of knowledge on market; negative or lack of information available on the importance of transitioning to greener forms of fleet such as hydrogen • Hydrogen market price; uncertainty on hydrogen price changes, although it is currently low this could change due to potential shortages in the future • Inadequate hydrogen infrastructure; lack of available infrastructure would prevent development of the hydrogen powered fleet across Northern Ireland • Could become obsolete in a changing market, technological advancements in alternatives; concerns over long distances capable by electromobility. There may be a better solution given the competitive nature of the alternative fuel market

[34] https://www.weforum.org/agenda/2020/08/could-electric-vehicles-pose-a-threat-to-our-power-systems/

5.6 Conclusions

5.6.1. To deliver greener fleets, it is necessary to address the potential barriers and obstacles identified here. This will require research, education and support from all levels of Government. What is positive is that barriers are now less pronounced than they were even a few years ago and experiences of early adopters can be utilised to learn lessons and exploit the latest technological advances.

5.6.2. Further investment into areas such as training and development programmes for fleet eco-driving and maintenance of alternative fuel vehicles would ensure that fleet management and drivers are able to adapt more easily to greener forms of transport. Similarly, incentivising the purchase of low emission vehicles such as EVs and those powered by hydrogen could be implemented through Government schemes, tax reductions and congestion charge reductions.

6. Green Fleet Procurement Toolkit

6.1 Introduction

6.1.1 This section provides a toolkit for those charged with greening fleets at an operational level. It provides guidance on what needs to be considered and the measures required to transition fleets to a greener profile.

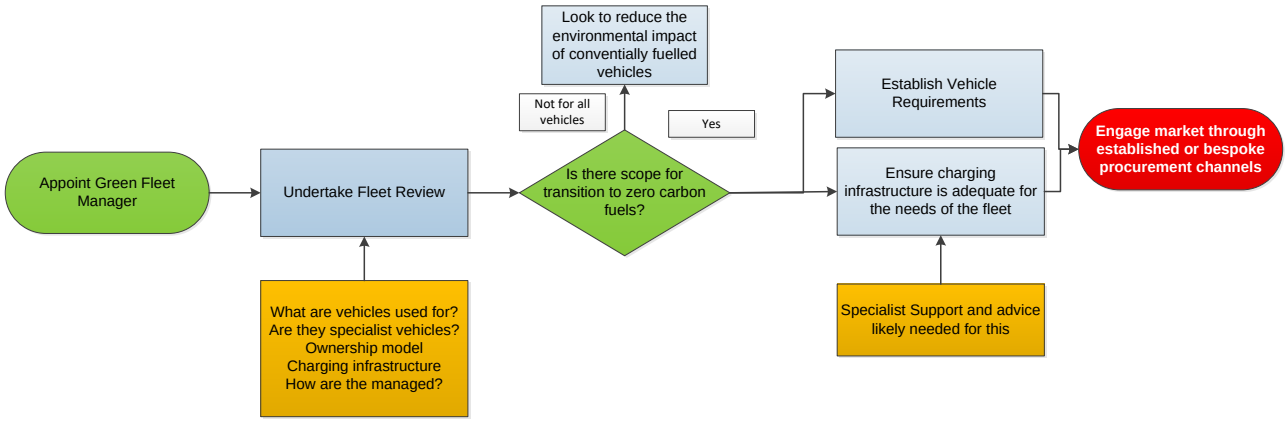
6.1.2 The UK government recently set out its ambition to bring forward phasing-out sales of new internal combustion engines from 2040 to 2030. The approach will mean that new cars and vans sold between 2030 and 2035 will have to be capable of "significant" mileage on zero emissions, such as plug-in or full hybrids. By 2035, all new cars and vans will need to be fully zero-emission at the tailpipe. Vehicles are part of a wide-reaching programme to deliver carbon net-zero for the country.

6.1.3 This section has been developed to outline how the procurement process can be used to green Public Sector fleets. It outlines what needs to be done to transition to a green fleet and how to access the information and support needed.

6.2 Appointment of a Green Fleet Manager and Travel Policy

6.2.1 The first step is to construct a travel policy which dictates the direction for transition to greener transport including use of public transport and active travel modes where possible. Best practice would usually see Operations, HR, Finance and Commercial departments as the main stakeholders in an organisation coming together to work on this task of developing this policy so that it can have both boardroom and general support.

Figure 6.1. Procurement Process



6.2.2 Where there is an in-house fleet it is recommended that a manager or champion is appointed to plan and coordinate the transition. The diagram above demonstrates the process that should be followed when considering transitioning your fleet.

6.2.3 The Green Fleet Manager will be the main point of contact and must be consulted before any new vehicles are leased or purchased. They should be

a person in a position of authority with operational knowledge, who is enthusiastic and dedicated to developing and maintaining a green fleet. Responsibilities can include:

- Assessing the options and ensure each department and contractor follows the green procurement process and criteria.
- Checking with the leasing company the best eco-friendly vehicles on the market and where alternative technologies can bring significant financial and fuel savings and reduce emissions.
- Re-evaluating the criteria/standards every 6 months based on market and technology advancements.
- Proposing and encourage use of low emission and zero emission vehicles to teams.
- Advising staff of terms and conditions associated with using eco-friendly fleet vehicles.
- Overseeing collection of management information relevant to eco-friendly vehicles.
- Developing standards, procedures, and other documentation.
- Develop a clear communications plan to promote the use of ULEVs that incorporates input from each of the key internal stakeholders.
- Obtain the latest maps of available and suitable public charging points in each of the zones and make sure that the preferred charging points are communicated to staff. Could consider using a chargepoint location app such as ZAP MAP. Although there needs to be an option check if the chargepoint is compatible to the vehicle as not all chargepoints use the same charging system.

6.2.4 The Green Fleet Manager should always be consulted and involved in the leasing and procuring of fleet vehicles. Each department should agree the process with the Green Fleet Manager. All Directorates should be involved in the transition process and be required to implement each of their actions.

6.3 Undertake Fleet Review

6.3.1 Before engaging with any suppliers, it is vital to understand how your vehicles operate and analyse information such as their routes and annual mileage. A fleet review will ensure that an organisation understands the scope for shift to greener vehicles and working practices.

6.3.1 What are your Vehicles used for?

6.3.1.1 Work with department leads, operators and drivers to understand the fleet and how it is used. This will include specific requirements such as duty cycles, dwell times and frequency of use.

6.3.1.2 If vehicle trip distances are short and average daily / annual mileages are low, then issues such as range anxiety and off-site charging/refuelling pose less of a problem and the transition to EVs or alternatively fuelled vehicles will have fewer barriers.

6.3.1.3 This will include grey fleet and Human Resources need to consider revising current Terms and Conditions for grey fleet vehicle users. Benefit-in-Kind (BiK) points are particularly important, including reduced tax, environmental and health benefits.

6.3.2 Are They Specialist Vehicles?

6.3.2.1 Vehicles such as vans and cars now have a wide range of EV alternatives available with provision by multiple manufacturers. The cost price of these vehicles has reduced and range and understanding of lifecycle costs have improved significantly in recent years.

6.3.2.2 However, many public sector organisations have highly specialised vehicles such as road sweepers and ride on lawnmowers for which there are fewer (if any) EV counterparts. Where there are not currently alternatives in the market the short-term focus will be on using these vehicles as efficiently as possible or converting them to run on an alternative fuel.

6.3.2.3 There is interest in running heavy duty vehicles on Compressed Natural Gas (CNG) or Hydrotreated Vegetable Oil (HVO). The infrastructure for these fuels did not exist on the island of Ireland but interest in them is expanding.

6.3.2.4 For example, in March 2021 Gas Networks Ireland (GNI) launched a €2.9 million compressed natural gas (CNG) vehicle grant scheme to support hauliers in opting for cleaner fuel. They are also expanding a network of CNG fuelling stations. It is known that two NI hauliers have invested in new CNG engined trucks, Woodsides and McCulla Transport. The latter has 10 vehicles and they produce their own biomethane from an anaerobic digester plant in Lisburn. HVO is of interest to several companies due to its environmental benefits (85-90% better on GHG) but without the need to procure new vehicles. The fuel can be used instead of diesel with no damage done to diesel engines and hence no warranty issues. Although it is currently about 20-30 pence per litre dearer, if volumes increase then this difference may reduce.

6.3.2.5 EV solutions for heavier vehicles such as HGVs are less feasible as the weight of the batteries precludes their practical and economic use at the heavier end of the market. But there are mid-range electric rigid vehicles now available, such as a 16 tonne Warburton's bread lorry operating in London and EV road sweepers being demonstrated in places such as Edinburgh.

6.3.2.6 The mapping of vehicles should be conducted in a phased approach with transition Group 1 (cars, easiest to convert first), Group 2 vans second, Group 3 LGVs third, Group 4 HGVs fourth, Group 5 ancillary and specialist equipment fifth. Electric vehicle options are becoming widespread for Groups 1 and 2. There are a smaller number of options for Group 3 and few alternatives currently for Group 4. Hydrogen is being considered as a realistic option for Group 4 vehicles, but as yet right-hand drive models are not readily available.

6.3.3 What Ownership Model were Vehicles Procured Under?

6.3.3.1 If vehicles are being leased over a period of time (for example 3 years) then the scope for vehicles to be replaced may be affected. This will be dependent on the nature and length of the contract.

6.3.3.2 Public sector organisations often keep vehicles for many years (when owned) as they can have lower mileages than commercial fleets and can be maintained in house. The cost of a large increase in vehicle lease/purchase costs can be significant if a large number of vehicles are involved. A thorough assessment of lifecycle costs by replacing older vehicles with new can, demonstrate savings, particularly in lower fuel and maintenance costs.

6.3.4 What Charging Infrastructure will you need?

6.3.4.1 The alternative fuel charging/refuelling network is growing rapidly but does not match the coverage of conventional fuels both at depots and across the highway network. Where the use of public charge points does not represent a practical solution, depot charging may provide a better fit for your organisation. Where this is the case, an important consideration to factor into any investment calculations will be the cost of civil works to install cables for charge points. Another important consideration will be to do with the number and type of charger you will install (slow, fast or rapid). Whilst electric vehicles can be charged by conventional 'slow' chargers, this takes much longer than a rapid charger and the practicality of this type of equipment will be dependent on vehicle dwell times.

6.3.4.2 If there is not charging/refuelling infrastructure at depots or near where your vehicles are operating, then the scope for greening the fleet is reduced until such time as new charging infrastructure can be installed. Introducing this infrastructure should be part of any Greening the Fleet Initiative.

6.3.4.3 Some questions that will need to be answered include:

- Where will you charge the vehicles (public, depot, home, other)?
- How many charge points will you need now and in the future?
- What types of charge points will be required (slow, fast, rapid)?
- Is the site suitable for installing a "Smart charging" system?
- If depot charging is chosen:
  - Is there space on site to charge the vehicles?
  - Where will the charge points be located?
  - Have you considered the cost of civil works to install cables?
  - Is there charge capacity available from the grid to allow you to charge your vehicles or will you need to install a new substation?
- If home charging is chosen:
  - Do staff have suitable conditions at home to allow for the charging of their vehicle (such as off-road parking)?
- If public charging is chosen:
  - Are there enough charge points available to support your fleet?

6.3.5 How are your Vehicles Managed?

6.3.5.1 Vehicles are often managed separately by different departments within an organisation. It is important to ensure that efforts are co-ordinated across

various teams so that economies of scale are realised. A Green Fleet Manager can help achieve this.

6.3.5.2 Where vehicles are kept (e.g. depot/employee homes) may also influence the scope for alternative fuels as certain homes may not be suitable for electric charging points due to them having no off-road parking for instance.

6.4 Procuring Vehicles

6.4.1. Once you understand your current usage, you can begin to plan for the future. The electrification and greening of your fleet is a programme of change and as with managing any "change programme", stakeholder engagement is key. Keeping all interested parties engaged and informed from the earliest possible moment is the best route to ensuring their buy-in.

6.4.2. In addition to engaging with employees, it is vital that you consult with your sustainability, finance and property teams. HR will also be an important partner if you are considering options such as vehicle salary sacrifice schemes.

6.4.3. As discussed, the strategy will need to include a scope for your vehicle charging infrastructure.

6.4.4. To develop a specification that the market can respond to, you will need to provide vehicle requirements such as:

- Fuel type (e.g. Electric/hybrid or other)
- Equipment needed
- Range required
- Recharge/refuel dwell times
- Maintenance support
- Weight Category

6.4.5. If this cannot be achieved through existing procurement channels, developing a Green Fleet framework with other similar organisations would be a good way to encourage economies of scale and a more competitive arrangement with a greater number of suppliers.

6.4.6. Any recently procured hybrid or full electric vehicles as an interim measure should be closely monitored and their impact on helping reduce the carbon footprint recorded. It is also required to regularly assimilate and analyse metrics to inform a dashboard to assess the transition to ULEVs. This will enable comparisons to be made both against recent trip metrics and against historical data. Analysing the impact of ULEVs on day-to-day transport operations to ensure a smooth transition can be made. Changes to staff working patterns and schedules could assist with charging regimes.

6.4.1 Procuring Charging Infrastructure and Grant Funding

6.4.1.1 The technical requirements and considerations of charging infrastructure are highly complex, and it is likely that you will need the support of suppliers. The Office for Zero Emission Vehicles (OZEV) and the Energy Savings Trust have programmes and grants to help support organisations provide charging infrastructure.

6.4.1.2 The Zemo Partnership, which is backed by the DfT is also a good source of information and support (www.zemo.org.uk/).

6.4.1.3 It is important to ensure procurement of ULEVs is possible in the quantities necessary in light of the increasingly strong demand for EVs. It is necessary to explore the likely cost of ChargePoint installation at staff homes and compare to the cost of installing workplace charging systems.

6.4.2 Supporting Measures

6.4.2.1 As discussed, in the short term it may not be possible for all vehicles in the fleet to transition to EVs or be powered by another alternative fuel. Regardless, it is important to consider how all vehicles can be used in a greener way. Questions that could be asked include:

- Is this vehicle needed? Can working practices be changed to reduce the need for vehicles of this type (e.g. greater reliance on online meetings to reduce travel requirements), more efficient operations or sharing between different organisations
- Can staff be trained to drive and operate these vehicles more efficiently – e.g. eco driving courses
- Can vehicles be adapted to be less polluting or more fuel efficient?

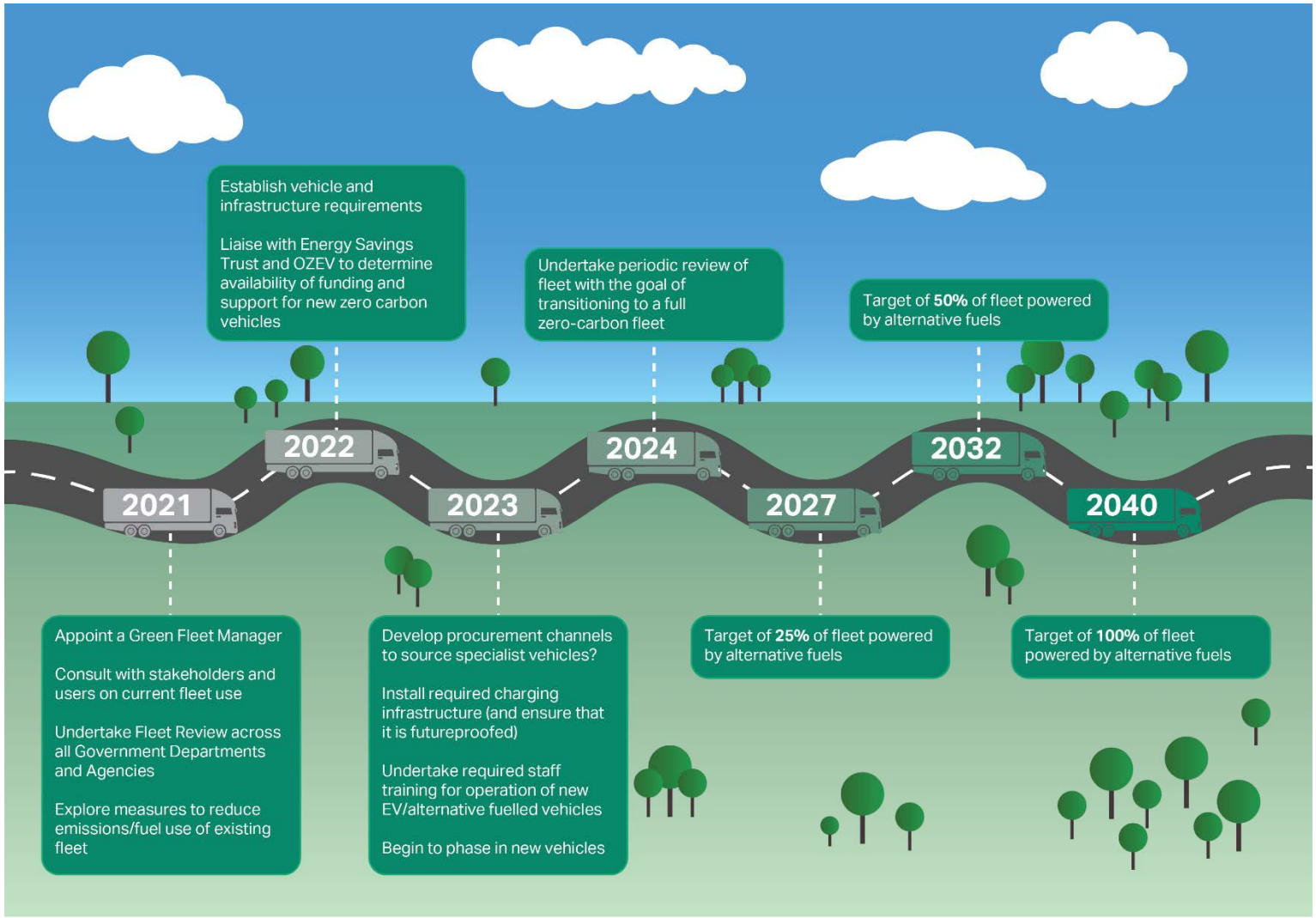
6.4.2.2 Where the change can be made to alternative fuels it is important that those tasked with driving these vehicles are trained to use them to maximise their benefits and ensure the safety of all road users.

7. Road Map to Decarbonisation & Carbon Calculations

7.1 Road Map to Decarbonisation

7.1.1. Figure 7.1 outlines a Road Map to achieving decarbonisation. It shows that by putting in place the measures highlighted in the toolkit and developing policy which encourages a shift to greener fleet profiles and operations, then a zero-carbon future is possible for public sector fleets in Northern Ireland.

Figure 7.1. Road Map to Achieving Decarbonisation of Northern Ireland Government Fleets



7.2 Carbon Footprint Calculations for Northern Ireland Fleet

7.2.1 To understand the impact of Greening Public Sector fleets in Northern Ireland it is necessary to estimate current emissions. We have used detailed fleet data obtained from Belfast City Council and combined it with other fleet information provided by the various public sector bodies. Belfast City Council's fleet profile has been used as an assumption for the overall Local Authority fleet mix, given its likely similarities across other fleets.

7.2.2 Tables 7.1 and 7.2 have been calculated using the average annual mileage and the average annual total of litres used for each vehicle type. From this, CO2 has been calculated by a factor of 2.62 kgs/litre for Euro 4-6 engines.

7.2.3 Table 7.1 includes the estimated 2,000 vehicles from Northern Ireland's local authorities' fleets. Based on the percentage of carbon per vehicle type, the Particulate Matter (PM) emitted and NO_2 emitted, the total emissions for fleets have been calculated. As part of this non-passenger vehicle study the totals for additional Public Sector fleets have been included in Table 7.2, which have a different fleet mix (e.g. cars or vans). As the scope of this report is non-passenger we have not included Public Service Vehicle (PSVs).

Table 7.1. Indicative Total Emissions of Northern Ireland Local Authorities Fleet

Calculator				
Vehicle type	**Number of Vehicles**	**Total CO2 Emissions (Kg)**	**Total PM Emitted (Kg)**	**Total NO2 Emitted (Kg)**
RCV	357	4,664,926	326.82	10.25
Sweeper	247	3,439,171	107.15	3.36
Van	934	1,158,004	434.26	13.62
HGV >=7.5t	52	108,511	24.87	0.78
Ancillary	346	242,256	49.57	1.56
Electric Vehicles	63	0	0.00	0.00
Totals	**2,000**	**9,612,868**	**943**	**30**

Table 7.2. Total Emissions of Northern Ireland Public Sector Fleets:

Public Sector Fleet	Vehicle Type	Number of Vehicles	Total CO2 Emissions (Kg)	Total PM Emitted (Kg)	Total NO2 Emitted (Kg)
Northern Ireland Water	LCV, RCV, Mixed	600	991,938	282	9
Police Service Northern Ireland	LGV/HGV	2,700	3,346,176	1,255	39
Education Authority	Cars	1,000	2,067,137	474	15
Health and Social Care Trusts	PSV	300	620,141	142	4
Northern Ireland Ambulance Service	PSV	427	529,192	198	6
Northern Ireland Housing Executive	Ambulance + cars	85	105,343	40	1
Northern Ireland Fire & Rescue Service	PSV	364	752,438	172	5
Total		**5,476**	**8,412,365**	**2,563**	**80**

7.2.4 As shown in Table 7.3, the total CO^2 emissions associated with Public Sector Fleets is over 18,000 tonnes per year, with over 4 tonnes of Particulate Matter and over 130 kgs of NO2. If a stable fleet mix is assumed and there is progression against the roadmap (Figure 7.1) this will result in a halving of associated CO^2 emissions by 2032 (9 million Kg of CO^2 emissions), zero emissions of CO^2 by 2040.

7.2.5 It should be noted that the suggested Roadmap for Northern Ireland is much less onerous than the recently suggested timescale by the Westminster Government in their Decarbonising Transport document. In this they specify that Government fleets should aim to be zero emission by 2027. This date has been brought forward by three years from 2030. It will be important to consider the ramifications of this tighter timescale and the response to this from a Northern Ireland perspective.

Table 7.3. CO_2 Emissions based on Roadmap

Total CO_2 Emissions (Kg)	Number of Vehicles	2022 (Total CO_2 Emissions (Kg)	2032 (Total CO_2 Emissions (Kg)	2040 (Total CO_2 Emissions (Kg)
Northern Ireland Local Authorities Fleet	2,000	9,612,868	4,806,434	0
Northern Ireland Public Sector Fleets	5,476	8,412,365	4,206,182	0
Total	**7,476***	**18,025,233**	**9,012,616**	**0**

*This figure has been arrived at by totalling the combined Local Authority estimate (2,000) provided to us by the Department for Infrastructure and combining this with the aggregated total from other public sector bodes (Northern Ireland Water, PSNI etc)

8. Recommendations

8.1 Introduction

8.1.1 In greening the fleet, the research work and case studies have identified that there are several actions required to assess the most suitable operations and vehicle types for the transition to a greener fleet.

8.1.2 A staged approach is recommended that assumes the quick wins are addressed first to initiate change. This will then gather traction and needs to be accompanied by behavioural change. It is likely that greening the fleet is not the only approach and that the need for travel and the ways that certain activities are done requires a review. This assumes that a green champion is appointed to manage the Road Map and Recommendations within each organisation.

8.2 Interventions

8.2.1. The interventions shown in Table 8.1 can be implemented to transition the fleet. All of these interventions are feasible and appropriate for introduction in Northern Ireland.

Table 8.1 Interventions for Greening the Fleet

Intervention Theme	No.	Potential problems	Proposed Solution	Timescale	Justification
Suitability	1	Concerns about range and infrastructure	Education, training, seminars and trials	Short - Medium	Case studies have shown that concerns about greener fleet initiatives can be a barrier to introducing measures and new vehicles.
	2	Inclusive communications plan	Clear communications plan of all of the benefits	Short - Medium	

	3	Record mileage and driving style	In order to assess the true impact of the switch to EVs, telematics hardware and software will need to be used. The introduction of SAFED will also help with range of EVs	Short term and on-going if appropriate	Data can help develop a compelling case for greening the fleet initiatives
	4	Tax benefits of ULEVs and EVs	To be included in communications and engagement plan	Medium	Tax relief on alternatively fuelled vehicles can help enhance the business case for transitioning fleets.
	5	Getting detractors to want to switch to EVs	Conducting a trial with one detractor from each department to help convert them into an EV "champion"	Medium	As 1&2. Having a committed individual can help drive change in an organisation.
	6	Suitability for those without suitable infrastructure	An analysis of the suitability of getting those without suitable infrastructure to transition to a Hybrid	Long	Lessons learned by public sector fleets show that a lack of suitable charging/refuelling infrastructure can significantly reduce the scope for transitioning fleets. Interim solutions such as hybrids can help fleets become greener without this infrastructure
Ensuring "business as usual" can be maintained	7	Monitor for a drop off in-service work levels	Conduct a trial, to assess the impact of a switch to ULEVs	Medium	It is vital that public sector fleets perform the service required by end users. Monitoring a smaller trial before a full roll out can address any issues before they arise.
	8	Change in staff work patterns and schedules	An analysis of the impact on staff schedules will need to be made to ensure service levels continue	Short	As 7. It is vital that the services required can still be provided at a high level, post transition

Ensure suitable infrastructure is in place before switch to electric vehicles	9	Operational impact of transition	Conduct a trial to assess the impact of a switch to ULEVs	Medium	See 7.
	10	Charging points at staff homes if they take company vehicles home	A thorough assessment and costing will need to be done for each staff home	Medium	Taking vehicles home, potentially away from charging infrastructure may bring challenges to transitioning fleets. Certain types of homes do not have driveways or access to a charger.
	11	Charging points at operational sites	A thorough assessment and costing will need to be done at each operational site	Medium	To provide an effective service and infrastructure able to support EVs/ULEVs charging points need to be provided at depots and operational sites
	12	Public charging points	An assessment of the location of suitable charging points	Short	As 11. Public charging points can also be used to ensure vehicles are sufficiently charged and can recharge en-route if required
Smart Charging	13	Having more charging points than necessary	By considering Smart Charging you can tailor the infrastructure to suit the operation	Medium	Optimising charging can reduce capital required to green fleets.
	14	Missing out on opportunity to save money	Smart Charging allows a company to buy electricity at an off-peak price and sell back to the grid V2G Vehicle to Grid system	Medium - Long	V2G can reduce the running costs of green fleets, furthering the business case for transitioning to alternative fuels/greener ways of operating
Overcoming procurement issues	15	Impact of the COVID-19 pandemic and Brexit may have on supply chains	An analysis of the procurement process and other organisations will need to be completed to ensure that demand for ULEVs can be met	Medium	Supply chain issues may affect availability of vehicles, affecting the transition to greener fleets

	16	Lease agreements	Need to renegotiate lease agreements with suppliers	Medium	Long leases can delay transition from ICE to alternative fuels
Vehicles	17	Alternative fuel vehicle options are limited in certain weight categories	Investigate the range of vehicles available and assess based on whole life costings	Short	Supply chain issues may affect availability of vehicles, affecting the transition to greener fleets
	18	Making sub-optimal longer term acquisition decisions whilst technology is changing so fast	Consider the different rental or lease options. Need to negotiate purchase/lease agreements with suppliers	On-going	Flexible leases can reduce barriers to transition from ICE to alternative fuels

8.2.2. Whilst the list of interventions is a guide it does not necessarily cover all the issues and indeed some of the interventions may not be appropriate for every fleet. What is clear is that for organisations to push forward with greening the fleet it needs someone to own the process and be given sufficient senior management backing and resources to transition the fleet in a positive and productive way.

8.3 Questions that the Department for Infrastructure needs to Address

8.3.1 How do we Facilitate a Charging and Refuelling Network that Enables the Public Sector Fleet to Function?

8.3.1.1 There is a need for a countrywide appropriate charging and refuelling network. Without this, public and private sector fleets will not fully be able to transition to greener vehicles without experiencing significant operational difficulties. Therefore, it is vital that the current network is expanded to ensure that any greener fleet rollout will be supported.

Policy Recommendation A: The Department for Infrastructure to continue to provide guidance and support on the charging and refuelling infrastructure, working with bodies that have been established to support the transition to low and zero carbon fleets. This includes ensuring there is sufficient charging infrastructure across Northern Ireland not forgetting rural locations.

8.3.2 How do we Advise and Support Fleet Managers and their Organisations in Greening Fleets?

8.3.2.1 All fleets, both public and private sector, have only recently begun transitioning to alternative fuels. This is due to a reduction in the cost of alternatively fuelled vehicles and advancements in technology, which have seen them become feasible from an operational perspective.

8.3.2.2 As a result, there is requirement to ensure that Fleet Managers (and/or Green Fleet Managers), who may not understand the operational requirements and opportunities afforded by alternative fuels are fully trained on how to develop and manage Green Fleets. Part of this is understanding which organisations are useful sources of information and some of these are described next.

8.3.2.3 Energy Saving Trust (EST) is an organization devoted to promoting energy efficiency, energy conservation, and the sustainable use of energy, thereby reducing carbon dioxide emissions and helping to prevent man-made climate change[35]. Energy Saving Trust is an independent, not-for-profit organization funded by the Government and the private sector. It is a social enterprise, and also has a charitable foundation. EST has regional offices in Northern Ireland. It maintains a comprehensive website, and a network of numerous local advice centres.

8.3.2.4 Zemo Partnership (formerly the Low Carbon Vehicle Partnership) has been established to help reduce emissions associated with vehicles in the UK. It facilitates cross-sectoral engagement between industry and other stakeholders and provides guidance, advice and support such as retrofit guides and industry events.

[35] https://en.wikipedia.org/wiki/Energy_Saving_Trust_-_cite_note-dawson-1

8.3.2.5 The Office for Zero Emission Vehicles (OZEV) is a team working across government to support the transition to zero emission vehicles (ZEVs). They provide support for the take-up of plug in vehicles, as well as funding to support charge point infrastructure across the UK.

Office for Zero Emission Vehicles

Policy Recommendation B: The Department for Infrastructure will disseminate and promote use of resources set up to assist those looking to migrate to alternative fuels such as Zemo (formerly Low Carbon Vehicle Partnership), the Energy Savings Trust and OZEV.

8.3.3 How do we Overcome Technological Barriers to Greening Fleets?

8.3.3.1 Currently, the limitations of alternative fuels preclude their uptake, with issues such as limited range or not being suitable for certain vehicle types meaning it is often easier to simply replace vehicles with a conventional ICE, resulting in a postponement in the transition to a 100% green fleet.

8.3.3.2 Whilst it is not in the gift of the Department for Infrastructure to develop solutions to these issues it can support efforts to make alternative fuels more viable for fleet managers.

Policy Recommendation C: Work with alternatively fuelled vehicle manufacturers and associated technology providers to ensure that Northern Ireland public sector fleets take advantage of the latest technology

8.3.4 How do we mitigate the cost impacts of transitioning to alternative fuels?

8.3.4.1 As discussed, the initial purchase costs of alternatively fuelled vehicles are often higher than conventionally fuelled vehicles, with any savings experienced over the whole vehicle lifecycle.

8.3.4.2 To help mitigate this, grants or loans could be offered by to ensure upfront costs are not a barrier to uptake, this includes funding of charging and refuelling infrastructure.

Policy Recommendation D: It is recommended that the Northern Ireland Executive requires (where there is an alternatively fuelled option) all new public sector cars and vans to be alternatively fuelled by 2025. All cars and vans should be low emission by 2027 as per central government target from Decarbonising Transport 2021. Or, if this is deemed unachievable in NI, work towards 2030 instead which was the 2018 DfT Road to Zero target.

Introduce alternatively fuelled Light and Heavy Goods Vehicles as soon as suitable models become available and a positive business case based on whole life costing and the wider benefits on the environment and society are factored in.

8.3.5 How Quickly can Fleets be Transitioned?

8.3.5.1 The barriers and issues discussed here could delay the transition to greener fleets. To ensure the transition is undertaken in a timely manner, policy should reflect the need for the public sector to expedite this process.

8.3.5.2 The DfT Road to Zero document 2018 included a commitment to "Leading the way by ensuring 25% of the central Government car fleet is ultra-low emission by 2022 and that all new car purchases are ultra-low emission by default. Committing to 100% of the central Government car fleet being ultra-low emission by 203036."

8.3.5.3 This has been tightened up even further with the 2021 Decarbonisation programme saying that 100% of the government car and van fleet will be zero emission by 2027. To achieve these two targets many Government departments are actively looking to procure EVs.

8.3.5.4 Many UK local authorities have also decided that due to many (over 400) declaring a "Climate Emergency" action should be taken to decarbonise their own fleets by typically 2030. As fleets cannot be replaced all in one year, it requires a phased programme of vehicle replacements to achieve this target.

8.3.5.5 The UK Government announced that new diesel and petrol cars and vans would no longer be sold from 2030, and that all new cars and vans must be fully zero emission at the tailpipe from 2035. Alongside this there is consultation on ending the sale of all non-zero emission HGVs from 2040, with lighter HGVs from 2035.

8.3.5.6 Fleets can be transitioned quicker if there is support from policy makers and technology providers to ensure those charged with procuring and operating greener fleets are aware of their requirements and there are fewer technical and technological barriers.

8.4 Decarbonisation in the Wider Public Sector

8.4.1 Many local authorities and the wider public sector are also taking action to decarbonise their own fleets. For example, NHS England, as part of their "Net Zero National Health Service" plan has set a long-term commitment that 90% of the NHS fleet must use low, ultra-low and zero emission vehicles by

[36] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf

2028, and pledged to go beyond this with the entire owned fleet of the NHS eventually reaching net zero emissions[37].

8.4.2 The Mayor of London's Environment Strategy commits that all new cars and vans, including response vehicles, in the GLA group (encompassing Transport for London, the London Fire Brigade and the Mayor's Office for Policing and Crime, among others) must be zero emission capable from 2025.

8.4.3 Although we have covered some questions there will no doubt be others that arise as Northern Ireland works on decarbonising the fleet. The most important thing is to start taking some action as the Climate Emergency is even more pressing. This will be the subject of much discussion in the COP 26 International environment event in Glasgow in November.

[37] https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2020/10/delivering-a-net-zero-national-health-service.pdf

9. Annex

9.1 Annex A – Literature Review

Table 9.1 Literature reviewed

Document Group	Document Title	Author(s)	Theme
Report	Easy on the Gas: The effectiveness of eco-driving	RAC (2012)	Benefits
Report	"Actual Results May Vary": A Behavioural Review of EcoDriving for Policy Makers	National Center for Sustainable Transportation (2015)	Benefits
Report	Eco-Driving Scoping Study	Energy Efficiency and Conservation Authority (2011)	Benefits
Report	A Hydrogen Roadmap 2020-2030	Hydrogen Mobility Ireland (2019)	Policy
Report	Energy Strategy for Northern Ireland - Consultation on Policy Options	Department for the Economy (2021)	Policy
White Paper	Commercial viability of V2G: Project Sciurus White Paper	Cenex (2021)	Lowering Emissions
Report	Moving Towards More Sustainable Fleet Management with Vehicle-To-Grid Systems	E-Flex (2020)	Lowering Emissions
Report	The Low Emission Vehicle Taskforce Progress Report	Government of Ireland (2018)	Lowering Emissions
Report	General procurement guidance for electric vehicle charging points	Evans, R et al. (2019)	Technology
White Paper	EV Smart Charging Whitepaper	GreenFlux (No date)	Technology
Report	Summary of State-of-the-Art Assessment of Smart Charging and Vehicle 2 Grid Services	Ghanim, P et al. (2018)	Technology
Report	Eco-efficient feedback technologies: Which eco-feedback types prefer drivers most?	Institute of Technology Management, St. Gallen University (2011)	Technology
White Paper	Smart electric vehicle charging with the customer and grid in mind	Delta-EE, Kaluza and UK Power Networks (2020)	Technology
Report	Quantifying the Societal Benefits of Electric Vehicles	Ingrid Malmgren (Vermont Energy Investment Corporation) 2016	Social

9.1.1 Benefits

"Actual Results May Vary": A Behavioral Review of EcoDriving for Policy Makers, National Center for Sustainable Transportation, 2015

Overview

The report investigates what eco-driving actually is and what it entails, whilst also assessing the effectiveness of eco-driving by providing findings from various research sources. The key findings from the report include that the function of eco-driving has the following benefits: increased on-road fuel economy, emission reductions and safety. The report highlights that there is not a framework that has been developed on the eco-driving, which would support policy makers.

Analysis

What eco-driving is and in particular the different eco-driving behaviours are examined in the report. The report categorises behaviour into two separate categories and analyses how each one affects behaviour. Firstly, a behaviour analytical approach, which looks at the function (its effect/what it does), topography (observable form/what it looks like), and context (who emits what behaviour, under what conditions). Secondly, a psychological approach to defining and classifying behaviours as seen in Table 9.1: Eco-driving's functions, topographies and contexts. This categorises behaviour in terms of function as what it does and topography which is its observable form.

Table 9.2 Eco-driving's Functions, Topographies and Contexts

Topography
• What a driver should do to develop behaviour change
Context
• Operational, tactical and strategic behaviours
Function
• Policy and personal goals

Methodology

The report investigates using a variety of different literature to establish how much eco-driving saves in terms of fuel consumption. The findings from the literature show that eco-driving can save on fuel consumption, but the findings showed savings of varying amounts depending on the conditions of the experiments. In order to gain a true understanding the variables require benchmarking and moderating.

Finally, the report looks at how eco-driving can be promoted by assessing the various methods and offers improvements.

Are there common themes with other documents reviewed?

The document has a similar theme with the 'Eco-Driving Scoping Study' as both look at the policy element of eco-driving. Both documents analyse how eco-driving can be used by policy makers to reduce emissions.

Gaps in document

The report is very thorough and goes into great depths on driving behaviour for eco-driving, however it is likely to be too complex for the average reader to fully understand and therefore the information may get lost. Moreover, the

report addresses the issue with defining eco-driving and the need for there to be a more holistic framework.

Conclusion

Eco-driving can assist with the improved fuel efficiency and therefore reduce emissions, however more real-world studies need to be conducted in order to get a clearer picture of the benefits.

This report reviewed four fundamental areas that surround eco-driving, these consisted of:

- Why eco-driving?

Reducing on-road emission and engaging in achieving social, economic and environmental goals set to reach lower emissions.

- What is eco-driving?

The review demonstrated that there is not a definition or classification of eco-driving behaviours, the literature highlighted that various definitions emphasised ends (functions) or means (topographies) across eco-driving.

- How much does it save?

Drivers can make a difference in efficient fuel consumption and the reduction of emissions.

- How can it be promoted?

Policy makers are recommended to include elements of eco-driving such as functions, forms and contexts when comparing and designing interventions for eco-driving. Additionally, there is need for consideration of safety implications and contextual factors in eco-driving programs such as for training of drivers. To successful implement this further research is required on behavioural theories to improve the eco-driving interventions.

Eco-Driving Scoping Study, Energy Efficiency and Conservation Authority, 2011

Overview

The study provides the details and findings from Transport Engineering Research New Zealand (TERNZ) on the potential of eco-driver training as a means to improve fuel efficiency in New Zealand. The study looks into what eco-driving is, the existing eco-driving schemes available at that time and how it could be best implemented in New Zealand. The study explains how there is lack of public awareness on eco-driving, hence there should be promotion of the benefits of the driving style. This is supported by policy makers as there is not much technology that is needed to be developed, it gives immediate financial gains for drivers and organisations.

Analysis

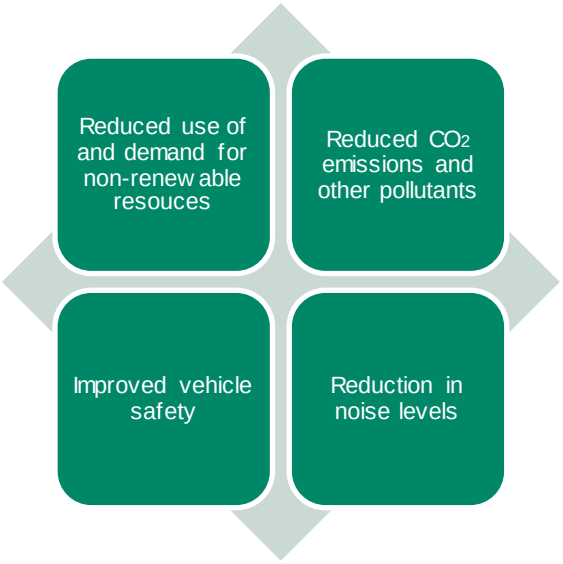
Firstly, the study assesses the benefits of eco-driving, examples include fuel consumption and efficiency, road safety and community/population health impacts.

The study then examines the current eco-driving schemes. This analysis is done via regions such as Europe, United States and Canada. When looking

at Europe, Finland, Germany, Netherlands, Switzerland and United Kingdom are used as case studies.

The study also assesses the eco-driver training provided by multinational companies such as Ford, Nissan and Toyota.

Figure 9.1 - Eco-driving Benefits



Methodology

After providing examples of eco-driving techniques across countries and multinational companies, the study analyses the effectiveness of eco-driving schemes. The study does this by analysing the fuel consumption, vehicle emissions and cost effectiveness.

The findings from the study for fuel consumption and vehicle emissions show that eco-driving has positive affects across all studies analysed with varying ranges of success. The results show short-term and mid-term results, with the most successful being in the short-term with fewer results in the mid-term. However, this study recognises that the schemes require further research to gain on eco-driving initiatives. The study acknowledges that although there is literature that supports the success of reduction in fuel consumption, there is a lack of data available on more rigours and scientific evaluations.

The cost effectiveness results showed that across all studies the benefits of eco-driving were moderate to high when compared against other interventions.

Figure 9.2 - Cost effectiveness analysis of Eco-driving (International Energy Agency)

Consensus estimates for comprehensive ecodriving campaigns

	Japan/ RK	IEA Europe	US/ Canada	Australia/ NZ	Total
Fuel saved per day (million litres)	16.2	43.7	91.3	4.1	155.2
Fuel saved per day (thousand barrels)	102.1	274.9	574.1	25.5	976.6
Road transport fuel saved (%)	5.0%	5.0%	5.0%	5.0%	5.0%
Total fuel saved (%)	2.7%	3.1%	3.7%	3.4%	3.4%

This study provided encouraging indications about the potential of eco-driving, as shown in Figure 9.2, although the estimates were based around reducing oil consumption.

Are there common themes with other documents reviewed?

As mentioned in the previous literature review section, this document has a similar theme with 'A Behavioral Review of EcoDriving for Policy Makers' as both look at how eco-driving can be implemented at a policy level.

Gaps in document

The report provides a comprehensive view across numerous studies and provides both a balanced argument for and against eco-driving. However, the report has been conducted for eco-driving in New Zealand and therefore a large section of the report is how eco-driving can be implemented in New Zealand, therefore, readers from other countries may not be able to fully relate.

Conclusion

The report finds that eco-driving does provide benefits for both fuel consumption and vehicle emissions as well as being cost effective. The report explored the potential of implementing various eco-driving training schemes to improve the fuel efficiency in New Zealand. However, the outcomes are encouraging for other destinations as there the evidence from the review demonstrated several benefits as shown in Figure 3: Eco-driving benefits. There has been a wide range of eco-driving schemes that have been implemented across Europe that have been successful, to gain further support and promotion of eco-driving to the public there needs to be more partnerships between various stakeholders such as government, charities and private organisations.

9.1.2 Lowering Emissions

Commercial viability of V2G: Project Sciurus Paper, Cenex, 2021

Overview

This document discusses Cenex "Vehicle-to-Grid technology", known as the Indra V2G charger and supporting technology such as Kaluza's intelligent energy platform. The charger can draw power from the electric grid (via the charger) when electricity is at its cheapest and supply electricity back into the grid when required, assuming that it has not been used by the vehicle. Vehicle to grid technology has been considered as an emerging technology in recent years and was first trialled in the UK in 2015. Following this in 2018, Project Sciurus which consists of experts across energy, transport and infrastructure have developed a real-world domestic solution for V2G.

Analysis

The document showcases the benefits of the Vehicle-to-Grid (V2G) and the cost savings that this method can yield for the user of this technology. The report highlights the importance of V2G as seen in Figure 9.3.

Figure 9.3 – The Importance to V2G

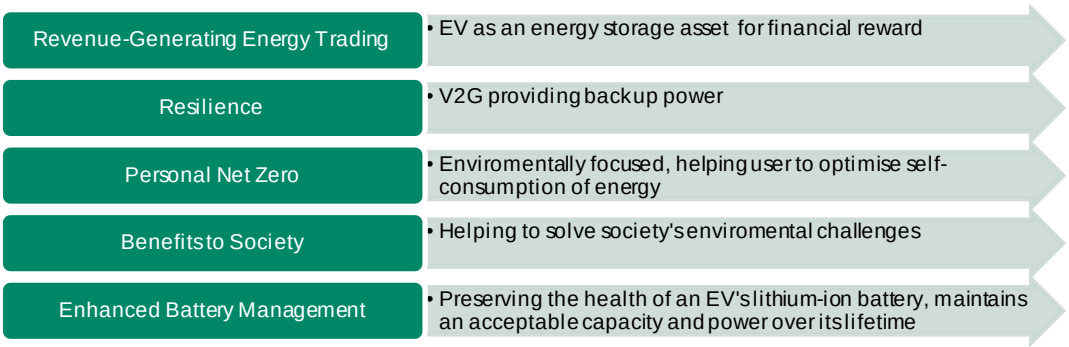


Figure 9.4 – Annual Revenue for Smart and V2G Charging (Cenex 2021)

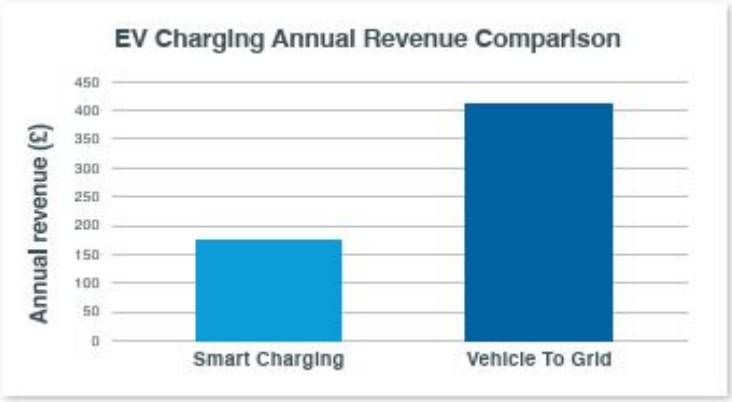


Figure 9.5 – Projected V2G Charger Premium (Cenex 2021)

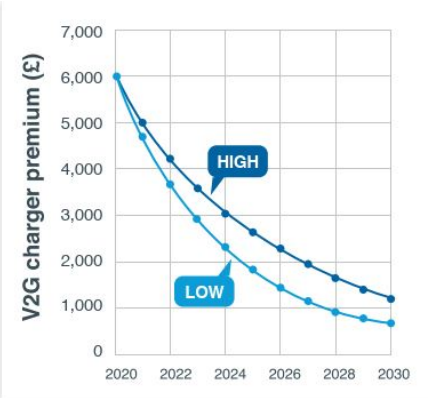


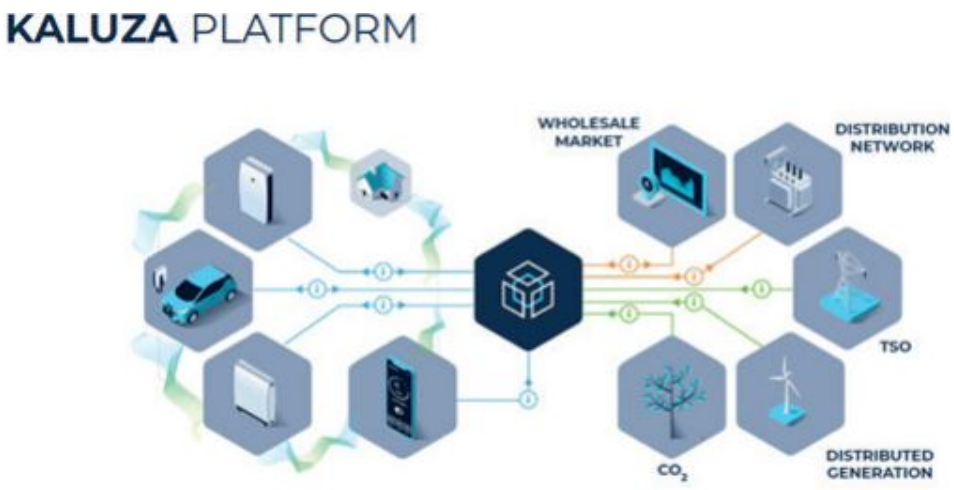
Figure 9.4: Annual Revenue for Smart and V2G charging shows that based on modelling performed by Cenex from a previous trial, V2G has the potential to make around £410 per year when compared to unmanned charging. In comparison smart charging using the same data set could only make around £172 per year.

Whereas Figure 9.5: Projected V2G charger, shows that if the revenue streams remain constant there will be further improvements for V2G and is much more capable than smart charging. The document shows that whilst Cenex admit that the cost of the charger is currently relatively high, with more widespread adoption that cost will come down.

Methodology

The document discusses the software platform that manages this process. Effectively the platform monitors when electricity is at its cheapest and when it is at its most expensive. If then, the vehicle is plugged into the charger at any given time, it will give the "user" the option of either drawing from the grid or sending energy back into the grid.

Figure 9.6 – Kaluza Platform



The Kaluza platform as seen in Figure 9.6, is an intelligent energy platform that can monitor all the chargers and then decide the best charging schedules that should be followed based on the needs of the customer,

energy wholesale and balancing markets. The platform enables immediate response to real time market signals and customer schedules, and this optimises the EV charging time.

Are there common themes with other documents reviewed?

The document has similar themes with 'Moving Towards More Sustainable Fleet Management with Vehicle-To-Grid Systems' and 'Summary of State-of-the-Art Assessment of Smart Charging and Vehicle 2 Grid Services' as all documents assess V2G technology. The document has greater similarities with 'Summary of State-of-the-Art Assessment of Smart Charging and Vehicle 2 Grid Services' as both documents look in depth at the positive and negatives of V2G, whilst 'Moving Towards More Sustainable Fleet Management with Vehicle-To-Grid Systems' looks closer at the impacts on fleet managers.

Gaps in document

Although this document shows the benefits of the V2G technology, it is not critiqued, and the drawbacks are not highlighted. Further exploration of the flaws in the technology are needed.

Conclusion

The V2G technology is an innovative approach to electric vehicle charging and can be used for true sustainability if paired with a "green" electric energy source such as "wind powered turbines". The report provided insight into the important role that V2G technology has in the future, its benefits for users and the energy market. As the switch towards EVs increase over the years, the resulting impact of such a switch will be significant due to an additional electricity demand. In order to overcome this challenge smart coordination and flexibility would avoid or at least reduce the cost of these impacts. Therefore, V2G will be an effective way to maintain EVs as the V2G charging prevents the EV sitting at extremes for longer periods and returns it to a mid-position.

The Low Emission Vehicle Taskforce Progress Report, Government of Ireland, 2018

Overview

The Report considers that the development of EV infrastructure is necessary in order to meet increasing demand. In terms of the public sector, the LEV taskforce which consists of the Department for Transport, Tourism and Sport (DTTAS), the Department for Communications, Climate Action and Environment (DCCAE) recommends; the development of a procurement framework contract to improve the efficiency and effectiveness of public sector bodies purchasing EVs; and public sector/commercial fleet trials to enable bodies to trial EVs.

Analysis

The report analyses the range of measures and options that are available to accelerate the uptake of low carbon technologies in the road transport sector. In Ireland there has been several incentives that have been introduced to stimulate the growth of EVs.

Incentives to stimulate growth of EVs:

- In April 2011 an incentive programme consisted of €5000 grant towards the purchase of a new EV, as well as relief of up to €5000 Vehicle Registration Tax (VRT)
- EVs being made eligible for the lowest rate of motor tax and EVs
- Charging equipment being included on the list of products qualifying for accelerated capital allowances

Methodology

Existing fiscal incentives were reviewed to stimulate the growth of EVs in Ireland. The LEV taskforce had three working groups:

- Working group 1: Focused on the market growth stimuli, visibility and the public leadership in LEV uptake in Ireland
- Working group 2: Concerned with infrastructure, energy regulation and pricing
- Working group 3: Planning legislation and building regulations. This includes EVs and other LEVs

Are the common themes with other documents reviewed?

The document has similarities to 'Commercial viability of V2G: Project Sciurus White Paper' and 'Moving towards more sustainable fleet management with Vehicle-To-Grid systems' with the theme of lowering emissions.

Gaps in document?

The report considered the benefits and effectiveness of EV incentive programmes over the past few years. Although more trials could be examined to understand the impact it had on the environment and society.

Conclusion

The LEV taskforce provided recommendations that included taking into consideration the deployment of incentives as a key feature in the development of the EV market globally. Further public awareness campaigns on EVs are required such as through commercial fleet trials.

9.1.3 Technology

EV Smart Charging Whitepaper, Greenflux

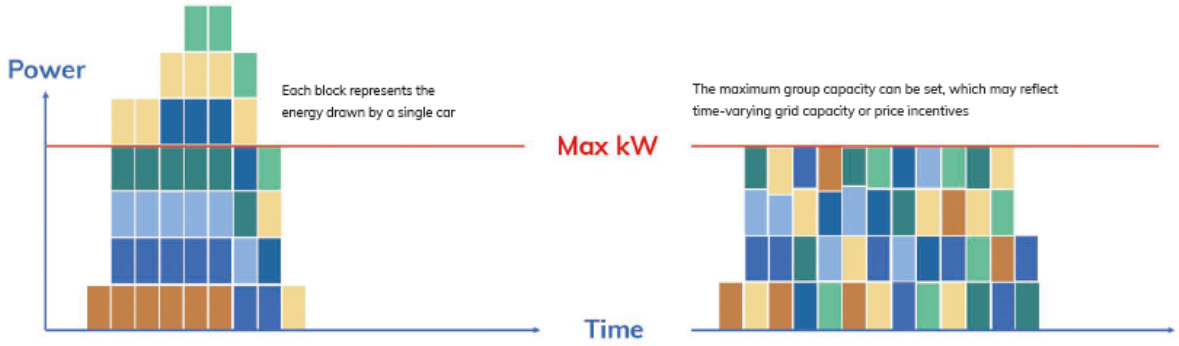
Overview

The document looks at the use of smart charging to charge EVs. The document looks at what smart charging is and how it works, the implications within the energy ecosystem and provides a case study of using the technology as a trial. The four key drivers for smart charging discussed in the report were grid constraints, dynamic energy prices, user requirements and local renewable energy.

Analysis

Smart charging is described as 'optimising the dispersion of power and leads to considerable savings for grid operators, charge point operators, charge point owners and EV drivers. The smart charging technology is said to control the maximum charge of an electric vehicle by increasing or decreasing the maximum charge rate as shown in Figure 9.7.

Figure 9.7 – Smart Charging



Methodology

The management system of the technology is described within the document. The system manages the electricity required to charge the EVs that are plugged into the charging unit via cloud technology; the system then evaluates how much energy is required and whether it will put a strain on the grid network; it can then calculate whether to increase or decrease the maximum power outage to each charging vehicle in order to balance charging efficiency and prevent an overload on the power network.

The document describes the usability of the technology by highlighting that users can download an application to be able to select charging times and to request 'priority' if they require it.

Are there common themes with other documents reviewed?

The document has a similar theme as the 'Smart electric vehicle charging with the customer and grid in mind' document as both look at the role of smart charging for electric vehicles. Both documents look at what smart charging is and how it can be applied to individuals and business to provide optimum charging.

Gaps in document

The document highlights several benefits of smart charging but does not provide any drawbacks to the technology; therefore, it is not clear how effective it is, especially on a large-scale basis as the document provides an example of a trial conducted across England between 2016 and 2019. A more in-depth trails and results would help support a stronger case for the use of smart charging.

Conclusion

The smart charging technology appears to be a useful piece of technology that would help consumers, in particular large-scale users such as businesses as they scale up their EV charging capabilities centred on the cloud-based system used. The technology could be of particular use as more EVs are purchased and a greater strain is put onto the power grid. Smart charging becomes easier when information is shared such as when the EV driver will arrive and energy requirements for the EV. The report emphasised the rapid growth of EVs and the significant impact that this has on the electricity network. The implementation of smart charging optimises the dispersion of power and leads. This results in greater savings for the grid operators and EV drivers.

Summary of State-of-the-Art Assessment of Smart Charging and Vehicle 2 Grid Services, Ghanim, P et al, 2018

Overview

The document assesses the technologies smart charging, Vehicle to Grid (V2G), Vehicle to House (V2H) and Vehicle to Building (V2B) and looks at the positives and negatives of each technology, such as their impact on the electricity grid. The report also provides business models for both sets of technologies in order to offset the additional cost of installing both systems.

Analysis

The document provides analysis of the technologies using a variety of sources. The main area of focus is the impact the technologies on the electricity grid, these include; state-of the art on plug-in, fully battery electric vehicles (BEVs), smart charging and vehicle to grid (V2G). The document also goes on to assess the possibility of energy autonomy and the role that V2H and V2B play in achieving this. It states how EVs can act as the storage system using their batteries to store and provide the energy, as required.

Business cases for each technology are also provided, the overarching theme for both is the ability to provide energy services to the grid which would provide a revenue stream to the owner. Further to this, battery degradation is also considered with both technologies, for example as V2G is in early stages with few hardware systems available in the European market, there is need for business cases for technology development to understand the impact and allow social barriers to improve, resulting in an increase in uptake. Therefore, the development of these technologies and the need to promote them with business models and services for EVs to enable environmental improvements such as with a net CO2 reduction and higher efficiency.

Methodology

The document is written as a review from outside sources not involved with either technology and therefore uses a variety of sources to incorporate facts, statistics and findings from other studies to provide a full picture on the pros and cons of the technologies.

Are there common themes with other documents reviewed?

As mentioned in previous literature review section, this document has a similar theme to 'Moving Towards More Sustainable Fleet Management with Vehicle-To-Grid Systems' and 'Commercial viability of V2G: Project Sciurus White Paper' as they all assess the V2G technology. However, this document is unique in that it also provides information on V2H and V2B technologies.

Gaps in document

The document provides a balanced argument that uses a variety of sources and gives a wide range of conditions to be considered when using both technologies. The report provides an overview of EVs and charging infrastructure. EVs system technologies have several benefits, but there would need to more trails and data available on the in individual impacts on the electricity grid. Hence further analysis on the impact of increased peak load, feeder and transformer overloading, voltage fluctuations and reverse

power flow and the impact on the economy and grid system would give better insight into the implementation of recommended EV technology.

Conclusion

The report provides numerous points about the use of smart charging and V2G, V2H and V2B technologies, and the impacts they may have on the electricity grid. The document concludes that both technologies are in their infancy and still need work to increase their reliability but are both possible solutions to the greater electricity required for EVs. The services that these technologies support would need to be considered as business models focusing on environmental and economic benefits to incentivise EVs technology systems to policy makers.

9.1.3.1 Eco-efficient feedback technologies: Which eco-feedback types prefer drivers most? Institute of Technology Management, St. Gallen University, 2011

Overview

The report analyses how Information Communication Technologies (ICTs) contribute to environmental sustainability and, how Eco feedback technologies can aid drivers in achieving more sustainable driving behaviour.

Analysis

The different types of automotive feedback are examined, these include, feedback on momentary driving behaviour, accumulated feedback, offline feedback and prior to driving advice. For each type of feedback, assessment is provided that looks into what specific feedback entails and the pros and cons of each one in terms of driver behaviour.

The study used various research methods to determine how those partaking in the study interacted with technology. The methods used included on-line surveys and interviews.

Methodology

The on-line survey was used to gain insights of drivers' understanding and disposition towards the systems. The interviews provided a more in-depth analysis of the relationship between driver behaviour and driver feedback.

The study found that feedback technologies alone are not able to enforce sustainable driving behaviour, as even highly sophisticated feedback systems would not work if drivers ignore them or are unaware of their indications. The study recommends that more suitable and unobtrusive systems should be used so the feedback system does not pose additional workload and frustration. Also, the feedback system should be customisable so drivers can adapt them according to their own preferences, thus improving the chance of engagement.

Are there common themes with other documents reviewed?

This document does not have any common themes with other documents. This is a unique document as it analyses behavioural change using feedback systems in order to improve driver's driving habits to reduced carbon emissions.

Gaps in document

The report provides sufficient background to the study and referencing other pieces of work to provide a balanced argument. Although the report does provide some intriguing findings the research has been conducted via on-line surveys and interviews which may not always best represent real world scenarios and results.

Conclusion

The report finds that feedback systems alone are not effective when trying to improve driver behaviour. The feedback systems need to be more customisable and personable to the user for greater interaction to occur and thus improve driver behaviour. To achieve maximum results and efficiency there is a requirement for better guidance on the interaction between drivers and feedback technologies. Furthermore, measures should be takes to reinforce improvements in environmental conditions through training and education on eco-driving.

Smart electric vehicle charging with the customer and grid in mind, Delta-EE, Kaluza and UK Power Networks, 2020

Overview

The report looks at the opportunities, challenges and the potential value of Smart Charging technology from an operator's point of view by using various research sources and a trial conducted by Kaluza.

Analysis

The document firstly describes Smart charging to give the reader an understanding of what the technology is and how it works. It then goes on to provide the challenges faced from a provider's perspective and a network operator perspective, examples include design and process challenges.

The report then states the potential that smart charging can provide for the future; these include financial savings with reported savings of £3bn and £6bn per annum by 2050 for network operators. Other potential benefits include reducing the capacity of need in the future and spreading the time of usage in order to flatten peaks in usage. Kaluza, one of the authors of the report, detail their trials undertaken across London and south-east England to demonstrate the efficacy of a time of use networking pricing mechanism for optimising the use of existing network capacity through EV smart charging, the graphs below demonstrate their findings.

Methodology

Figure 9.8 – Consumption for Unmanaged EVs

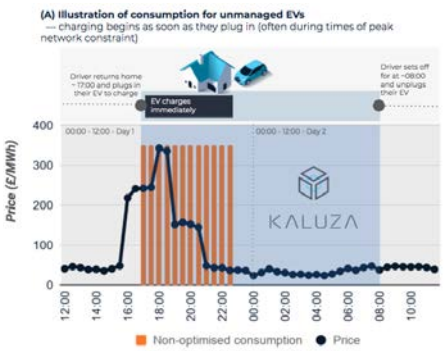
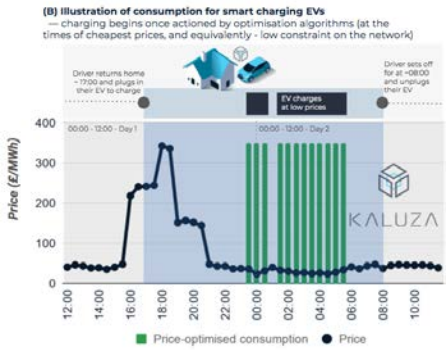


Figure 9.9 – Consumption of Smart Charging EVs



Kaluza ensures that the mobility needs of customers are met, drivers are able to set their desired ready-by time for when they require their EV to be charged. Figure 9.8 and 9.9 illustrates an unmanaged EV that charges as soon as it plugs in and an EV that is managed through smart charging which optimises against price signals. This avoids the peak prices, hence more reliable and cost effective. The report is informative and sets out clear arguments for and against the technology. It is not too technical and therefore provides detailed but concise points throughout the document. The information provided in this report is particularly useful for operators looking into the benefits of smart charging.

Are there common themes with other documents reviewed?

The document has similar themes with 'EV Smart Charging Whitepaper' document as they both focus on smart charging. Both provide evidence on how smart charging can assist users gain optimum charging for their vehicles without putting pressure on the electricity grid.

Gaps in document

This is a good document for operators to read in order to gain an understanding of smart charging. The only drawback that could be noted is the lack of alternative sources used which could have provided further points to the document.

Conclusion

Smart charging seems to be a key piece of technology that will allow more vehicles to be charged and avoid any high rates in electricity prices and to spread the load on the network. Although the technology is available and ready to be used, the report does state the market is 'still a way off' from being a mass adopter. Despite this there is much potential for smart charging which involves different elements of the energy system collaborating to provide greater flexibility and demand management form end consumers of EVs. There needs to be continued co-operation amongst various sectors of the smart charging value stream and policy makers to overcome barriers.

9.1.4 Social

9.1.4.1 Quantifying the Societal Benefits of Electric Vehicles, Ingrid Malmgren Vermont Energy Investment Corporation, 2016

The study assesses the benefits of electric vehicles (EVs) on a societal level ranging from economic savings and cost to environmental and health improvements. The study analyses the fuel savings, operations and

maintenance, impact of carbon emissions on the environment, health impacts and using EVs as a grid source.

Methodology

Numerous sources are used within the study providing results from different research projects. The study found that EVs are cheaper to fuel as electricity is cheaper than traditional fuels such as petrol. Also, maintenance costs are significantly cheaper due to EVs having fewer moving parts that would otherwise need replacing.

The findings for health impacts show that there are significant savings over the life of a vehicle due to a reduction in pollution that could have caused health issues such as cancer. Finally, the study looks into the use of EVs being used as a grid resource due to the possibility of power storage or generation able to be put back into the electricity grid. The estimates show significant savings of $4,000 over the lifetime of a vehicle.

Are there common themes with other documents reviewed?

This document has no similarities with other documents in this literature review as it is the only document that focuses on how electric vehicles can provide social benefits individuals and communities.

Gaps in document

The study shows evidence from other research which provide a wider ranging argument. However, the savings provided are only estimates and the savings will be determined on individual circumstance and where in the world the EV and owner are situated.

Conclusion

The study shows how EVs have a wide range of benefits ranging from economic to health, all of which can provide greater value to the wider society in one way or another. A key challenge in the EV market is the incremental cost of the vehicles, to increase awareness of benefits to human health, air quality and the environment. Further assessment of these benefits would help policy makers determine the investment levels required to gain the full value from electric vehicles and have a positive impact on society. The study recommends ideas for future research that consists of a geographical analysis that incorporates electricity generation into the mix and better represent the range of values within each estimate through high-case/low-case scenarios to highlight the range of benefits.

9.1.5 Policy

9.1.5.1 Energy Strategy for N. Ireland, Department for the Economy, 2021

Overview

The document sets out Northern Ireland's consultation plans in the development of a new Energy Strategy for Northern Ireland.

Analysis

The document focuses on a wide range of areas from growing a green economy, doing more with less, replacing fossil fuels with renewable energy, and creating a flexible and integrated energy system. For transport, an area of focus is on encouraging behavioural change using newer technologies and better communication on how to make changes. This is to support the

decarbonisation of the transport sector by using electric vehicles and other alternative fuel vehicles.

Methodology

The document uses several different sources to provide external information to develop potential polices that could form the basis of a new energy strategy. The various documents address key issues and solutions to develop a better strategy. This includes growing a greener economy, creating a more flexible and integrated energy system, replacing fossil fuels with renewable energy and doing more with less. Hence a wide range of approaches should be taken over the following decades to meet net zero carbon goals.

Are there common themes with other documents reviewed?

The document has a similar theme with 'A Behavioral Review of EcoDriving for Policy Makers' and 'Eco-Driving Scoping Study' as they look at how eco-driving or behavioural change can be implemented at a policy level. However, the differences between the documents are that the 'Energy Strategy for Northern Ireland' document does not go into any detail on the benefits or how they could be achieved.

Gaps in document

The document offers viable options on how to improve the green technologies and the attitudes towards them in Northern Ireland.

Conclusion

The report focuses on possible policy options that could be implemented as part of the new energy strategy. This needs a wide range of different approaches such as eco-driving to be considered. Although there is not a section that provides detailed explanation of the benefits of eco-driving, there are urgent energy issues related to cost and efficiency. Affordable methods such as eco-driving is aligned to the overall vision of the energy strategy.

9.2 Annex B - Examples of Best Practice – Greening the Fleet

9.2.1 Aberdeen: Hydrogen Powered double decker buses[38]

- 15 Hydrogen powered buses entered service in January 2021 in Aberdeen. The vehicles are from the Wrightbus factory in Belfast and are operated by First Aberdeen
- World's first hydrogen-powered double decker bus
- First zero emission buses, showing Aberdeen's commitment to the transition of green energy from oil and gas part of the Net Zero vision
- Part of a new £8.3 million project the buses have been funded by Aberdeen City Council, Scottish Government and the European Union

[38] https://www.intelligenttransport.com/transport-news/109315/aberdeen-becomes-home-to-worlds-first-hydrogen-powered-double-decked-bus/

- The UK's first hydrogen production and bus refuelling station were opened in Aberdeen in 2015 as part of £19 million green transport demonstration project
- The Aberdeen City Council led project is part of a £19 million green transport demonstration project. The Aberdeen council-led project tested the economic and environmental benefits of using hydrogen technology for alternative fuel vehicles
- The buses represent the start of a hydrogen leading economy, making significant improvements to the economy as it will increase investment and create more jobs
- Hydrogen buses in Aberdeen aim to accelerate the progress towards zero emissions and achieve decarbonisation of fleet targets

9.2.2 Birmingham: Hydrogen Buses[39]

- Birmingham City Council has added 20 hydrogen double decker buses to its fleet as part of its clean air hydrogen bus pilot
- The buses made by Wrightbus are the world's first double decker buses, these were introduced with National Express West Midlands in April 2021
- It was intended to be a catalyst for the next generation of hydrogen buses and hydrogen production
- Hydrogen consumes four times less fuel in comparison to standard diesel buses
- Birmingham City Council, "Fuel cell buses offer a practical solution for cities to decarbonise public transport and immediately improve air quality"
- The clean air hydrogen bus pilot will be monitored and reviewed to analyse and ensure the ongoing commercial and operational viability of hydrogen buses, this is intended to encourage the roll out of hydrogen technology within bus fleets, resulting in cleaner air

9.2.3 Liverpool: Gas-powered Mercedes refuse trucks[40]

- Liverpool commissioned a new fleet of Mercedes-Benz refuse collection trucks that run on biogas, demonstrating that greening fleets through alternative fuels does not need to be restricted to hydrogen or electrically powered vehicles, something for Green Fleet Managers to consider when charting a path to a more sustainable fleet
- The Econic NGT 2630 L models are expected to make a significant contribution towards the reduction of the council's carbon footprint
- The gas-powered fleet will cover more than 150,000 miles per year mostly in the Liverpool city centre

[39] https://www.electrive.com/2020/10/06/20-h2-fuel-cell-buses-for-birmingham-uk/#:~:text=The%20English%20city%20of%20Birmingham,Clean%20Air%20Hydrogen%20Bus%20Pilot.
[40] https://www.commercialfleet.org/news/truck-news/2020/03/10/liverpool-council-introduces-20-gas-powered-mercedes-refuse-trucks

- Liverpool City Council has calculated they will produce less than 80% carbon and 90% less nitrogen oxide compared to diesel-powered refuse trucks while also cutting fuel costs by 35%
- Powered by in-line six-cylinder engines are designed to burn compressed natural gas (CNG), these 7.7 litre powerplants generate 302PS and drive through six-speed Allison automatic transmissions
- LSSL's head of service Refuse and Recycling Harvey Mitchell said "These gas-powered trucks are much cleaner, quieter than traditional refuse collection vehicles, so we're very confident they'll make a real difference to the local environment"
- The vehicles have a high level of reliability, safety and user-friendly design that their older engine econics have been delivering for years
- Mayor of Liverpool Joe Anderson said, "Our investment in this new fleet of refuse vehicles is a great statement of intent in our goal to make Liverpool a cleaner and greener city. These safe and efficient vehicles give collection teams the right tools to ensure residents receive a reliable service."
- Liverpool's transition towards greener fleet has achieved an 18% reduction in carbon emissions since 2012 and is on course to hit 35% by the end of 2020
- This has resulted in Liverpool City Council being on track to meet its climate change targets, three years ahead of schedule

9.2.4 Edinburgh: Charging Technology trial[41]

- First trial of wireless charging technology for light commercial vans (LCVs) launched in Edinburgh in spring 2021
- Heriot-Watt University, flexible Power systems (FPS) and the city of Edinburgh Council have been awarded £1.6m to explore how wireless charging at shared logistics hubs could reduce the cost of decarbonising last-mile transport
- The consortium will also test how shared infrastructure, fulfilment equipment at urban hubs at large scale can enhance vehicle and staff productivity
- This includes the development of a large-scale simulation of the behaviour of charging hub users using real world data to understand the impacts on their business
- If the project is successful both the infrastructure and the technology behind it could be adopted by fleets across the UK
- Scott Millar, fleet and workshops manager for the City of Edinburgh Council, said: "Providing charging infrastructure like shared hubs has the potential to play a key part of removing barriers to uptake for both the council and the community. We're excited to take a leadership role here

[41] https://www.cittimagazine.co.uk/news/buses-commercial-vehicles/uks-first-wireless-charging-technology-trial-for-lcvs-to-launch-next-year.html

as a successful project in Edinburgh could present a model for other councils to use to reduce transport emissions in cities."

- "Productivity drivers and longer journeys mean commercial vehicles may need to charge away from the depot or at high speeds during the day," said FPS managing director, Michael Ayres. "Rapid and ultra-rapid chargers required for a fast turnaround currently make up less than 25% of publicly available chargers and can be difficult to access if they are in use or out of service.
- "High-power rapid chargers can be expensive both in terms of the chargers themselves and the electricity network infrastructure required to support them," he continued. "Splitting the cost of chargers and the connection through a shared charging hub can mitigate a portion of these costs."
- Charging Trial project is funded by the office for Low-emission Vehicles and delivered through Innovate UK

9.2.5 London: Electric Fleet:[42]

- London borough of Waltham Forest (LBWF), has unveiled a new fleet of electric vehicles supplied by Urbaser, this includes an Electra 26t refuse collection vehicle, tow tenax international MaxVac electrical mechanical sweepers, four MaxVac Vanuguard vacuum sweepers 12 Nissan e-NV200 vans
- 48 items of fully electric equipment such as hedge trimmers and leaf blowers for the ground's maintenance service
- Councillor Clyde Loakes, Waltham Forest Council deputy leader and cabinet member for environment, said: "We are taking the climate emergency extremely seriously and are looking at ways to reduce carbon emissions and minimise our impact on the environment across our key services. Introducing these vehicles to our fleet is a great step towards a cleaner, more energy-efficient and resilient borough."
- Other charging points for the fleet have been installed at the council's Low Hall depot
- Javier Peiro, managing director of Urbaser, said: "Introducing this number of electric vehicles at Waltham Forest is a milestone and sets a precedent for other local authorities across the UK. We will continue to stay at the forefront in promoting sustainable technologies for environmental services, to address the climate emergency, reduce pollution and improve air quality locally."

[42] https://fleetworld.co.uk/liberty-charge-launches-national-ev-infrastructure-rollout-in-london/#:~:text=Liberty%20Charge%20has%20announced%20the,as%20future%20locations%20are%20determined.

9.2.6 Kent: Chargers in remote areas[43]:

- Electric vehicle specialist Connected Kerb is working with Kent County council in a project that hopes to provide blueprint that should be used across the UK for sustainable fleet
- In the first phase, Connected Kerb is installing 40 Charging devices across 20 Kent Parish sites, this is to improve accessibility for EV motorists and encourage the shift towards EV fleet
- It improves the local economy as all the income from the chargers goes to the community
- **Chris Pateman-Jones, CEO of Connected Kerb, said**: "Access to charging infrastructure is one of the biggest barriers to the uptake of EVs. Although demand for chargers is higher in dense urban areas, the lack of infrastructure in out-of-town communities leaves people concerned about switching to EVs. It is vital that access to public charging is equitable across the entire country and we bring an end to the EV charging postcode lottery. Nobody should be left behind by the EV revolution because of where they live. Our partnership with Kent County Council shows that the economics of installing EV charging in non-urban areas is much more favourable than many believe. This is a recipe for success for local authorities across the UK.

[43] https://fleetworld.co.uk/connected-kerb-project-to-bring-ev-charging-revolution-to-hard-to-reach-areas/#:~:text=Supplier%20Directory-,Connected%20Kerb%20project%20to%20bring%20EV,to%20hard%2Dto%2Dreach%20areas&text=A%20new%20project%20said%20to,helping%20to%20tackle%20EV%20inequality.

9.3 Annex C - Fleet Data

Data is presented on the makeup of the following Council fleets:

1. Leicester City Council
2. Coventry City Council
3. Oxford District Services (for Oxfordshire County Council)
4. Bristol, Leeds, Watford, Brighton & Hove and Maidstone, Sheffield - data is currently incomplete and will be submitted shortly.

Notes: there currently appears to be a lack of consistency in defining the body type. Going forward, The Department for Transport definitions[44] are recommended to be used as per the table below. Some LAs have added sub-categories to cars (eg city car, SUV and 4x4 pickup) and to vans (eg. large and small) or different weights. This makes direct comparisons more difficult at first glance, but the trends are what is important.

► **Cars**	4-wheel vehicles including people carriers and all passenger carrying vehicles that can carry no more than eight passengers (excluding the driver). Includes private hire taxis (PHV – Private Hire Vehicles) that are car based. Hackney Carriages are in the 'Other vehicles' group	► **Heavy goods vehicles**	Larger vehicles constructed for transporting goods. Must have a gross weight more than 3.5 tonnes.
► **Motorcycles**	2-wheel vehicles powered by an engine, including Scooters and Mopeds, as well as powerful electric bikes	► **Buses and coaches**	Includes minibuses (which can carry no more than sixteen passengers) and all other passenger carrying vehicles with nine seats or more (excluding the driver's seat).
► **Light goods vehicles / light vans**	Small van - less than 3.0 tonnes Large van - 3.0 to 3.5 tonnes	► **Other vehicles**	All vehicles not mentioned above. Includes rear diggers, lift trucks, rollers, ambulances, Hackney Carriages, three wheelers, tricycles and agricultural vehicles

		Leicester City Council				Coventry City Council				Oxford District Services			
Body types (see DfT definitions)	**ZE alternatives**	**ICE**	**PHEV**	**EV**	**Total**	**ICE**	**PHEV**	**EV**	**Total**	**ICE**	**PHEV**	**EV**	**Total**

[44] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/917624/vehicle-licensing-statistics-notes-definitions.pdf

► **Cars**	Yes	43	2	11	56	45			45	19		11	30
Pick Up (4X4)	Yes	25			25	1			1	16			16
► **Motorcycles**				5	5	4			4				0
► **Light goods vehicles / light vans**		321			321	119		33	152				0
Small van - less than 3.0 tonnes	Yes	122		18	140	26		21	47	45			45
Large van - 3.0 to 3.5 tonnes	Not Currently					206		12	218	84			84
► **Heavy goods vehicles**	H2 but some e-RCVs	137			137	101			101	70			70
► **Buses and coaches**						111			111				0
► **Other vehicles**						0	3	6	9				0
Not suitable for EV conversion	No	19			19	52			52	75			75
	Total fleet size	**667**	**2**	**34**	**703**	**665**	**3**	**72**	**740**	**309**	**0**	**11**	**320**

Comparison with other example other fleet operators

	Network Rail				CLC NHS Trust			
Body types (see DfT definitions)	ICE	PHEV	EV	Total	ICE	PHEV	EV	Total
► Cars	1,247			1,247	187	35	22	244
Pick Up (4X4)	840			840				0
► Motorcycles				0				0
► Light goods vehicles / light vans				0	7			7
Small van - less than 3.0 tonnes	2,418			2,418				0
Large van - 3.0 to 3.5 tonnes	4,249			4,249				0
► Heavy goods vehicles	166			166				0
► Buses and coaches				0				0
► Other vehicles				0				0
Not suitable for EV conversion				0				0
	8,920	**0**	**0**	**8,920**	**194**	**35**	**22**	**251**

In addition to the numbers of vehicles by body-type, further information is being collated on:

1. ownership versus leasing
2. average daily mileage.

This will assist generating a plan for progressive migration of the fleets towards zero emission.

	Oxford	Network Rail	CLC NHS Trust	Leicester	Coventry
Owned	0	31.36%	61.35%		
Leased	100	68.64%	38.6 5%		
Average daily mileage	29	41	26		