Energy Decarbonisation Opportunities for the UK Food Valley

Food logistics and transport

Introduction

The UK Food Valley (UKFV) in Greater Lincolnshire is one of the most significant food-producing and processing clusters in the UK, producing 1/8th of the UK's food as we drive to be a top ten global food cluster. Decarbonising the UKFV food system and creating sustainable supply chains is crucial on the path to net zero and maintaining national food security. The Greater Lincolnshire Local Enterprise Partnership (LEP) and the University of Lincoln (UoL) have co-commissioned a study to assess the scale of the decarbonisation challenge within the UKFV as a significant step towards achieving this.

We have focused on food logistics within the UKFV supply chain, to include heavy transport decarbonisation, analysis of the relevant infrastructure and policy environment, and suggested tools for businesses moving to lower-carbon transport options. For the LEP, local authorities, Distribution Network Operators, and central government, the study provides an indicative evidence base to support decision making in supporting infrastructure, policy development, and investment opportunities.

The findings of the study highlighted the difficulty in accessing granular data on the food supply chain within the UKFV, particularly within food processing, with the best data being available for the UKFV transport and logistics sector. As 30% of all UK food logistics travels through the Spalding cluster in south Lincolnshire, decarbonising food logistics within the UKFV would make a significant contribution to the UK's net zero targets and is fundamental to the UKFV aim of developing low carbon food chains.

For the calculations in this report, it is assumed that around 70 % to 90 % of the fuel requirements of the HGVs in the UKFV would be met in the depots in Greater Lincolnshire[1], and that 85 chargers of 150 kW rating are used per 100 trucks at the depots[2]. The average fuel consumption per truck is assumed to be 33 L/100 km based on stakeholder data.

[1] New National Grid-led analysis shows expanding Government's electric vehicle Rapid Charging Fund (RCF) would accelerate the decarbonisation of all road transport | National Grid Group, May 2022

[2] Zero Emission HGV Infrastructure Requirements (Ricardo Energy and Environment) - Climate Change Committee (theccc.org.uk), June 2019

Decarbonising UKFV logistics - the headlines

2,500-5,000
UKFV HGVs
50% of these are in the Spalding cluster

265-530,000 tonnes CO_2e
tailpipe emissions per year

330-660,000 tonnes CO_2e
well-to-wheel emissions per year

30%
of all UK food logistics move through the Spalding cluster

80,000
miles per year per HGV

200-400 million miles
per year travelled by UKFV HGVs

105-210 million litres
of diesel per year

0.35-0.85 TWh
annual electricity consumption if all UKFV HGVs were electric

0.67-1.84 TWh
annual hydrogen consumption if all UKFV HGVs were hydrogen

Transitioning to low-carbon logistics - the options

It is challenging for logistics businesses to navigate the complexities of policy, regulation, technology and available infrastructure. There is uncertainty about which technologies will ultimately dominate, as well as their cost-effectiveness, resilience and reliability, and whether and when the necessary infrastructure will be in place.

The study considered the full range of low-carbon and zero-carbon options for heavy transport, that are either currently available, becoming available, or in development. A technical comparison of the costs and emissions for the different options can be found in Annex A.

Electric Vehicles (EVs)

Battery Electric vehicles (BEVs)

Hydrogen Fuel Cell Electric Vehicles (H_2-FCEVs)

The selection of an appropriate technology depends on numerous factors such as the distance to be travelled, anticipated public refueling infrastructure and the capability to install suitable depot-based refueling facilities. BEVs and H_2-FCEVs have electric drive trains and zero tailpipe emissions. Although the BEV technology is more mature than H_2-FCEV and has lower refueling costs, refueling requires more time, making it more suitable for short-haul operations.

Internal Combustion Engine Vehicles (ICEVs)

Compressed Natural Gas (CNG)

Liquefied Natural Gas (bio-LNG)

CNG/LNG with higher biofuel content have lower overall emissions. These fuels could be used at locations aiming to transition to hydrogen. CNG vehicles require more onboard storage and refueling and are preferred for short-haul operations, whilst LNG vehicles may be used for long-haul operations depending on the refueling infrastructure.

Liquified Petroleum Gas (LPG)

Higher biofuel content in LPG reduces overall emissions. Diesel-LPG HGVs have lower emissions than diesel HGVs and can be used as a transition fuel while waiting for an appropriate low-emission option.

Hydrogen (H_2)

Some companies retrofit diesel HGVs to provide diesel-H_2 dual fuel HGVs. These types of vehicles have lower tailpipe emissions compared to diesel HGVs. However, burning H_2 in ICEVs emits NOx. Thus, H_2 may be used as a transition fuel in ICEVs for locations that would use H_2-FCEVs in the future.

Hydrotreated Vegetable Oil (HVO)

Biodiesel

Some HGV manufacturers offer a warranty on diesel blended with HVO and biodiesel. These fuels can be largely incorporated into existing diesel-based infrastructure with minor modifications and can be used as transitional fuels.

As most of the HGV manufacturers in the EU are planning to phase out ICEVs, alternative fuels for ICEVs cannot be considered as a long-term option.

The study determined that the transition to electric or hydrogen vehicles will be more likely in the longer term, as the technology, policy and supporting infrastructure is still in development. The remaining fuels could be considered transition fuels, to help reduce carbon emissions in the short to medium term, until the lower carbon alternatives of electric and hydrogen become viable.

The Annexes at the end of this report provide additional information and decision trees which are designed to help businesses begin thinking through the various options which may be available to support the transition to a decarbonised fleet:

Annex A: Comparison of costs and emissions for different fuels and technologies.

Annex B: Typical infrastructure costs for charging and refuelling at depots.

Annex C: Business decision flowchart – identifying appropriate fuel options.

Annex D: Business decision flowchart – switching to BEVs or H_2-FCEVs.

Annex E: Business Decision Flowchart – switching to CNG/LNG/LPG/H_2 ICEVs.

Annex F: Business Decision Flowchart – Switching to low emission HVO/Biodiesel ICEVs.

Supporting Infrastructure

Electricity

In 2023, the Greater Lincolnshire Infrastructure Group commissioned a study to assess the status of the current and forecast electricity infrastructure capacity across Greater Lincolnshire. The study demonstrated that in 2023, one seventh of primary electricity substations across Greater Lincolnshire were at capacity, with a forecast for this to rise to at least two thirds by 2032. This represents a significant challenge to decarbonisation, as many of the possible solutions require electrification of power that is currently provided by fossil fuel.

Our study estimates that if all HGVs in UKFV were to transition to electric vehicles, the network capacity to support those vehicles would require up to 1.3 times the existing demand headroom of the currently connected load. It is estimated that around half of this requirement would be concentrated in south Lincolnshire, where more than one third of the primary substations (South Holland and Boston) were at capacity in 2023. This is forecast to rise to at least three quarters of primary substations at capacity by 2032, before the requirement from heavy transport is considered.

Business's awareness of capacity constraints in their local area will be important to aid decision making. Improving energy efficiency will also be key, to alleviate current capacity issues and reduce the need for additional expensive and time-consuming network reinforcement. This is likely to require the implementation of flexibility markets and smart grid systems.

GLLEP and local authority engagement with the Distribution Network Operators (DNOs) is critical to ensure they are aware of the potential requirement and can include this is in their infrastructure planning scenarios.

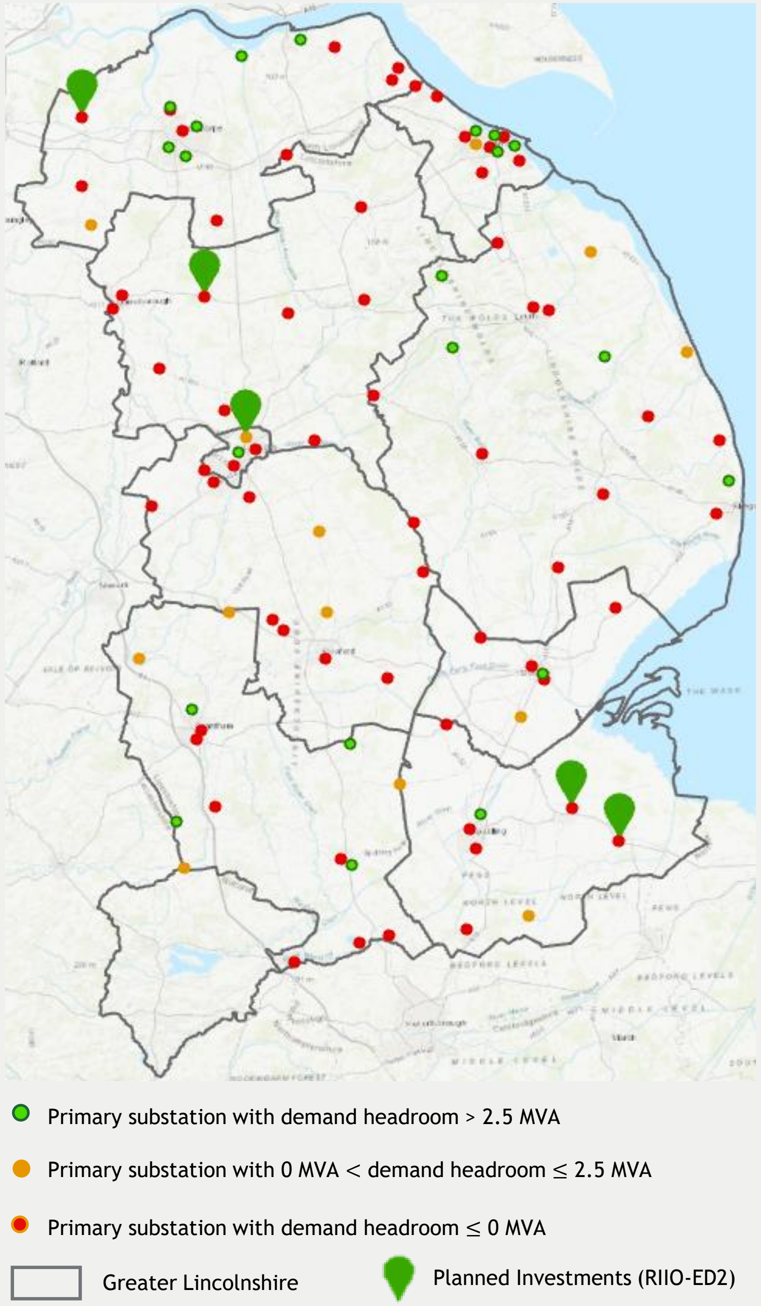


Figure 1: Forecast demand headroom on primary electricity substations by 2032.

Hydrogen

Currently, infrastructure to support hydrogen delivery into the UKFV does not exist, and hydrogen production facilities remain in development. The East Coast Hydrogen project, established by Cadent Gas, Northern Gas Networks and National Gas, proposes to develop the pipeline infrastructure to carry hydrogen from production and storage sites in Teesside and the Humber, to industrial sites across the Midlands and North-East. The initial phases of the pipeline have been planned to connect large industrial off-takers of hydrogen, and whilst a line is planned to come through central Lincolnshire (mid-2030s and beyond), it is not yet clear whether this could enable connections for Greater Lincolnshire businesses situated away from the Humber industrial cluster, although the East Coast Hydrogen Delivery Plan[3] does acknowledge the opportunity to provide hydrogen for heavy transport applications.

In addition, there are plans in development for at least two possible hydrogen generation projects within south Lincolnshire, which could potentially form the basis for a local hydrogen ecosystem to support agri-food logistics.

Our study estimates that if all the UKFV heavy transport switched to vehicles requiring hydrogen, the total annual demand would be in the range 0.67 to 1.84 TWh, half of which is estimated to be concentrated within south Lincolnshire. This compares to the estimated 10.80 TWh power demand for the south Humber industrial cluster, and the estimated 5.6 TWh transport demand for aviation connected to East Midlands Airport. In terms of hydrogen production, this would require up to 10% of the planned production in the south Humber region[3].

Whilst not on the scale of hydrogen demand for large industrial or aviation clusters, this study suggests there is still scope for the LEP and local authorities to work with East Coast Hydrogen, and Cadent Gas, to assess whether there is an investment case to be made for the development of hydrogen pipelines into south Lincolnshire, and the potential for a re-fuelling hub, which could also connect into any local hydrogen generation facilities that may be developed in the future.

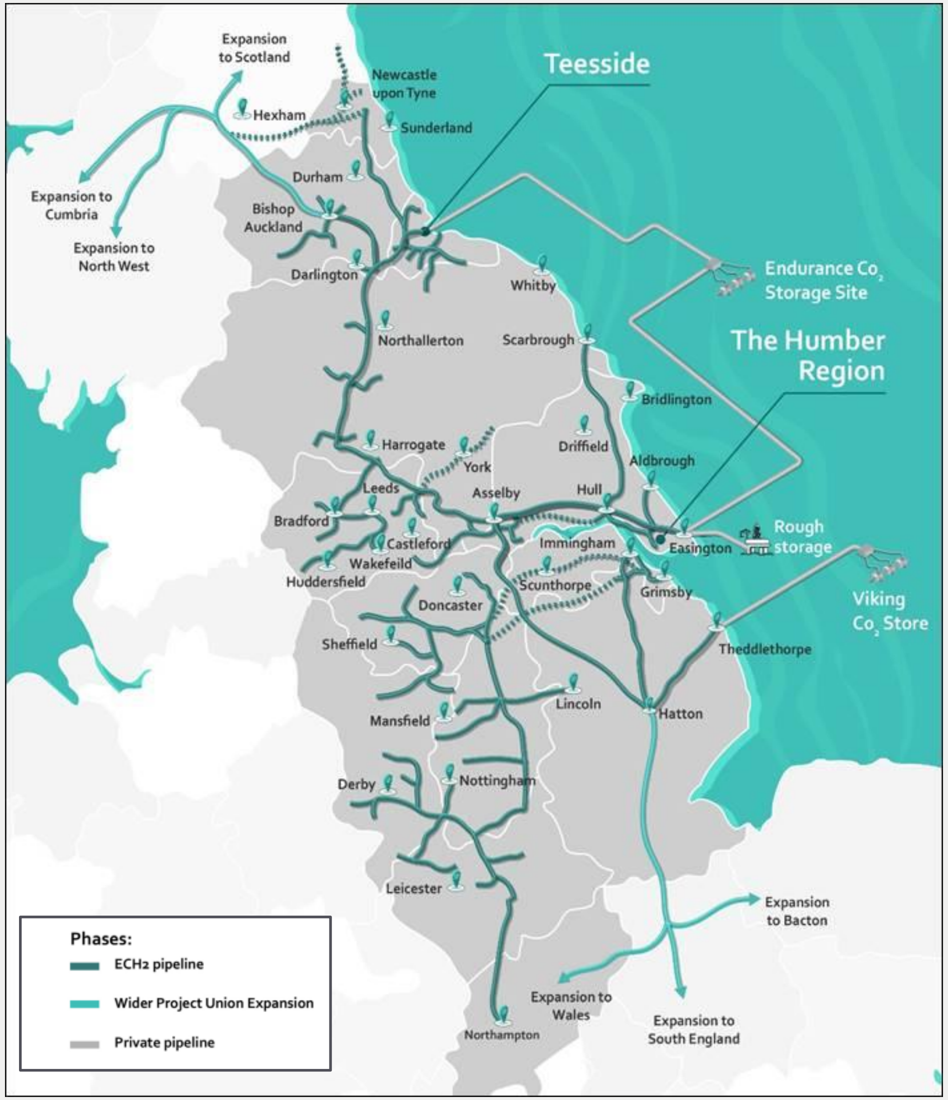


Figure 2: Proposed hydrogen pipeline network, East Coast Hydrogen[3]

[3] East Coast Hydrogen Delivery Plan, November 2023

Transition Fuels

Transition fuels such as biodiesel, HVO, LNG, and LPG are transported via the road network, and no change is anticipated to this structure. CNG (an alternative transition fuel) is transported through pipelines. Government incentives such as Renewable Transport Fuel Obligation, and Green Gas Support Scheme have increased the production and grid injection of biomethane. Further, increase in the green gas content of the network is expected with the relaxation in grid injection restrictions[4] and a new policy framework for biomethane production[5].

Digital & Communications

An increasing move to energy efficiency measures such as smart grids and demand flexibility markets will require the underlying support of secure, fast and reliable digital and communications infrastructure. Digital infrastructure may also be required to control, manage and monitor refuelling assets. It will be important for local authorities to consider this as part of whole system planning for infrastructure development, and work with providers to ensure network enhancements are made in the required places at the appropriate times.

[4] The Gas Safety (Management) (Amendment) Regulations 2023 (legislation.gov.uk), April 2023

[5] Future policy framework for biomethane production: call for evidence (publishing.service.gov.uk), February 2024

Policy Environment

The study assessed the policy environment for reducing carbon emissions from vehicles, and highlighted a number of areas in which changes or additional support may be beneficial.

Discount schemes for BEVs and H_2-FCEVs

Typically, the capital costs of zero emission vehicles are currently higher than that of diesel equivalents (see Annex A). To support early adopters of electric vehicles, plug in grants are available until 2025 for some HGVs. Extending plug-in grants to all BEVs and providing more discounts on UK-based HGVs would help support electrification of road freight. However, not all fleet operations may be suitable for BEVs. Introducing a discount scheme for H_2-FCEVs following the anticipated commercial roll-out by the end of this decade would further support logistics decarbonisation. A uniform discount scheme for all zero emissions HGVs would also assist logistics businesses in selecting the technology best suited to their individual needs.

Policy for public infrastructure

A resilient hydrogen supply chain is needed to support the development of a hydrogen fuelling network for HGVs, and public funding is likely to be required to support this. The recently announced Zero Emissions HGV and Infrastructure Programme will help Gridserve deploy 200 charging points on public motorways and ten depots by 2026. Depending on the outcome of the Rapid Charging Fund Consultation, further action could be needed to enable more charging hubs and strengthen the supporting electricity grid in Greater Lincolnshire.

Incentive for depot-based or local electric chargers and H_2 dispensers

Due to the longer charging time required by electric HGVs, it would be beneficial to focus on depots to meet most charging requirements. Extending the EV infrastructure grant scheme would help fleet owners transition to electric HGVs where appropriate. Additionally, introducing a support scheme for installing hydrogen dispensers would help reduce the dependency of fleets on public infrastructure.

Support for zero emission HGV trials

Various government-funded demonstrator trials are underway or have been completed in various locations across the UK, and the freight Innovation Fund – Connected Places Catapult provides trial funding for SMEs. These funds benefit the competition winners and can generate evidence based on the performance of the vehicles on trial. However, it is difficult to extrapolate the results to other business-specific or location-specific challenges. An incentive for businesses to run their own trials and upskill their drivers would support operators in the smooth transition to zero-emission technology. For BEVs, this could support overhead costs of optimising chargers and developing robust charging schedules. For H_2-FCEVs, this could include incentives to de-risk early adopters and support with upskilling of drivers and mechanics.

Policy for phasing the transition of road fuels to biofuel and e-fuel

A clear policy direction for timing the transition to lower-carbon fuels and away from diesel, leading to appropriate and timely regulation will assist in an orderly transition towards zero-emission technologies longer term.

Timescales

The current picture for the development of new low-carbon logistics technologies, supporting infrastructure, the policy and regulation environment is complex. The study assessed the timelines for introduction of relevant policies, regulations, finance schemes and technology rollouts for each of the main technology types (BEV, H_2-FCEV and ICEV).

BEVs

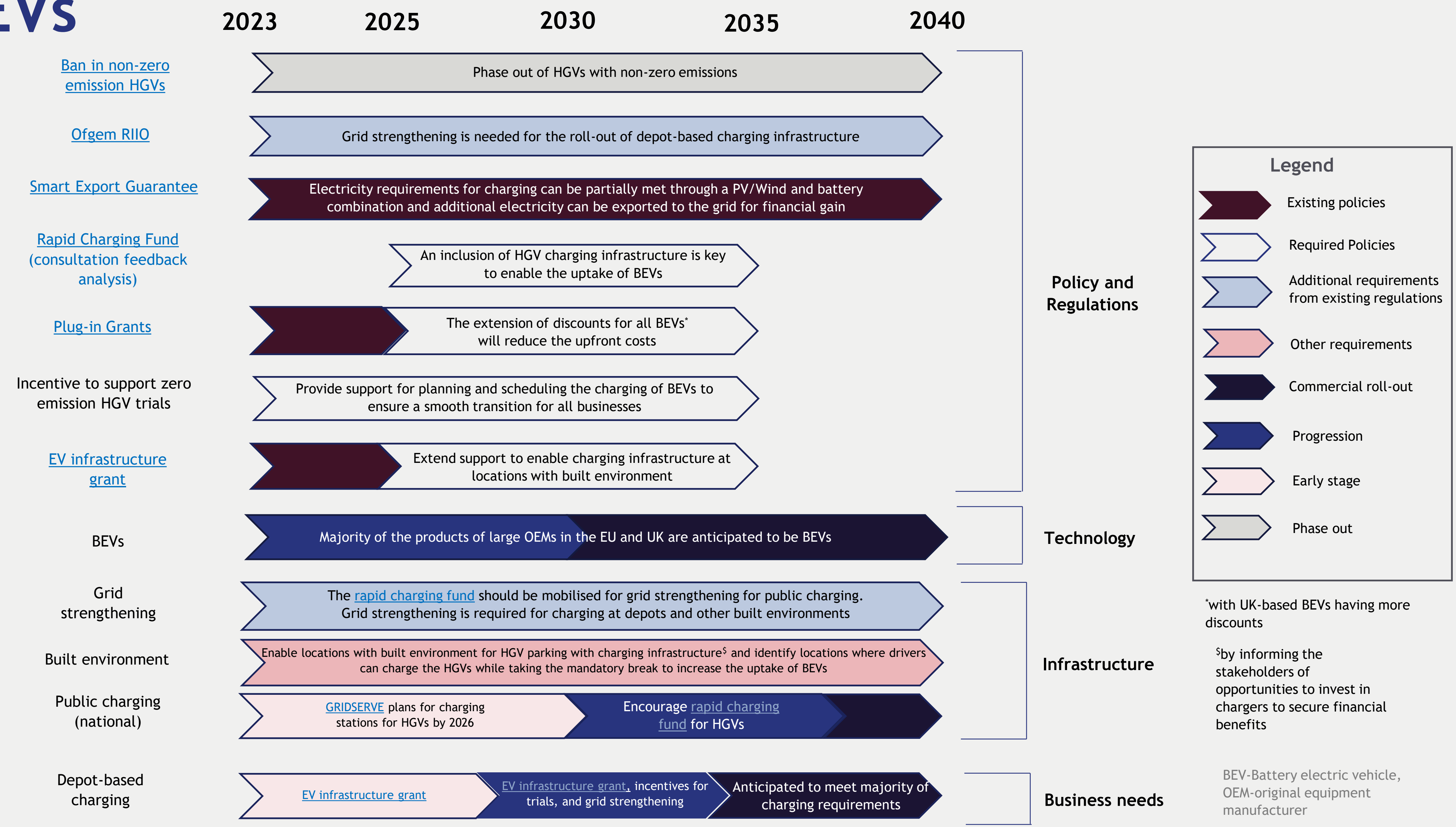


Figure 3: Policy, technology, and infrastructure timelines for the uptake of BEVs.

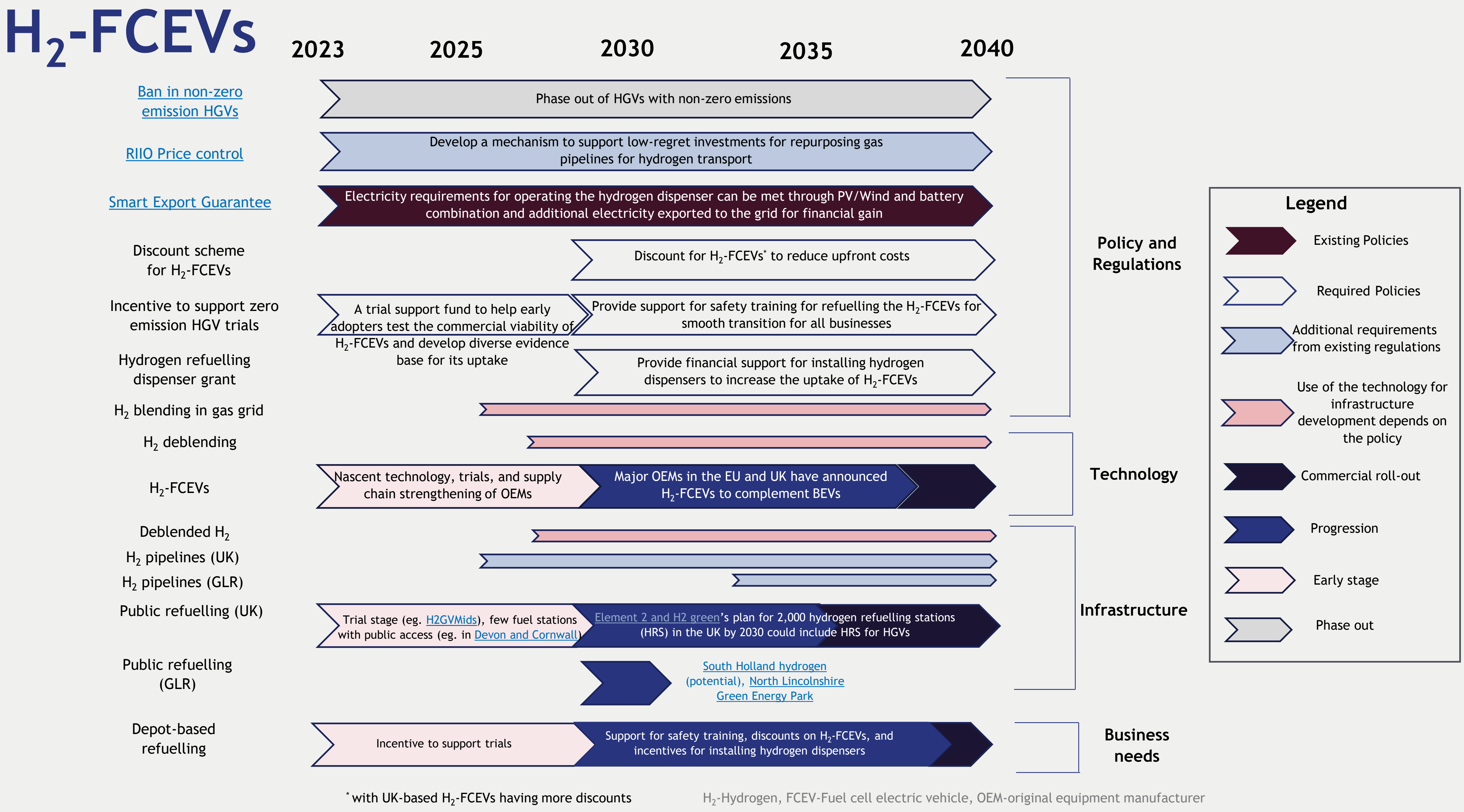


Figure 4: Policy, technology, and infrastructure timelines for the uptake of H_2-FCEVs.

ICEVs

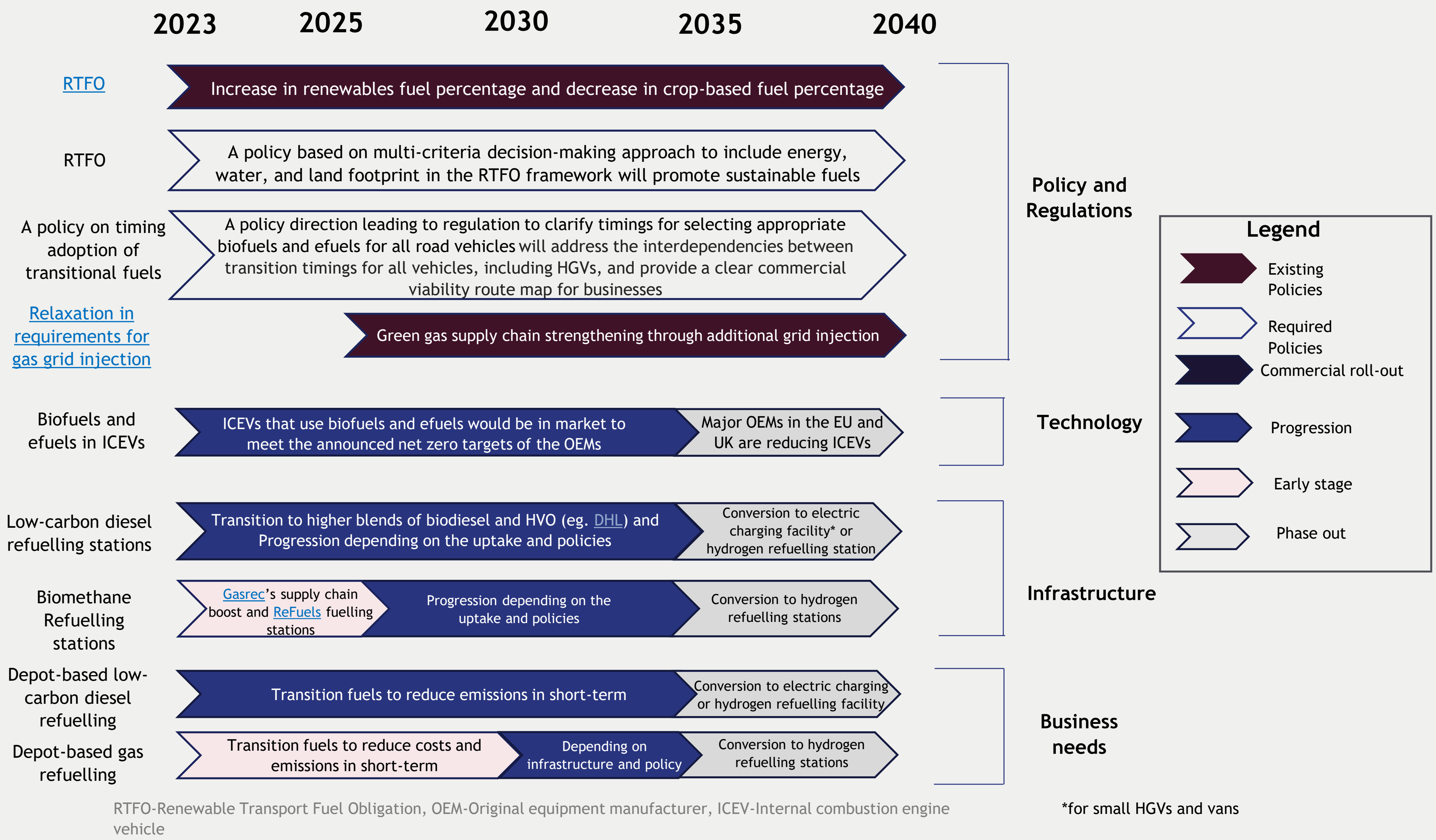


Figure 5: Policy, technology, and infrastructure timelines for the adoption of biofuel and e-fuel in ICEVs.

Recommendations

The evidence and analysis from this study supports a series of recommendations which could be implemented to further support the decarbonisation of UKFV supply chains. Some of these actions will also have the additional benefit of reducing business costs and therefore increasing profitability, and others will contribute towards reducing power demand and hence the need for costly and lengthy infrastructure reinforcements.

Key recommendations:

1. Support a programme of energy audits for businesses that could help reduce their energy costs (e.g. diesel costs) through energy efficiency measures or technology/fuel replacement (e.g. switching to low emission HGVs and load sharing) and help local authorities understand the barriers and opportunities associated with energy-based decarbonisation for businesses.

2. Encourage businesses to follow the decision tree tools (see Annexes), to support the identification of opportunities for fleet decarbonisation.

3. Increase awareness of how smart meters and demand side response can help reduce electricity demands at substations without major investment and increase onsite production (solar, wind, etc), battery/hydrogen storage and application efficiency measures.

4. Early engagement of businesses with the distribution network operators for future connections resulting from the technology switch could help the distribution network operators with the timely delivery of the infrastructure.

5. Work with distribution network operators, businesses, local authorities and other stakeholders to determine the potential requirements for supporting infrastructure in hydrogen and electricity and develop solutions.

Optional next steps

This study has highlighted areas in which greater understanding needs to be developed if the right choices about decarbonisation options are to be made and supported.

The findings of the study highlighted the difficulty in accessing granular data on the food supply chain within the UKFV, particularly within food processing, with the best data being available for the UKFV transport and logistics sector.

Further work could include:

Investigating the opportunity for bridging data gaps: a third-party data collection platform could be developed to encourage businesses to perform energy audits and upload the outcomes. This could support businesses in identifying decarbonisation options and provide local authorities and DNOs with data required for local area energy planning.

A study to identify infrastructure “pinch points” along main routes. This could help the distribution network operators identify where additional electric grid capacity and/or entry/exit connections for natural gas and/or hydrogen are required.

Consideration of a trial to look at multi-modal shifts for long-haul/distribution options including road/rail, battery electric/hydrogen and international road/rail/ferry.

A trial to demonstrate charging/refuelling while loading/unloading goods at supermarkets/depots could help in the electrification of fleets by providing additional range.

Development of a work stream assessing the potential for circular economy approaches and/or clusters, and co-location of businesses with complementary resource needs.

Extending this study to other sectors in Greater Lincolnshire. This could include:

- Conducting workshops to inform stakeholders of possible routes for energy decarbonisation in buildings.
- Estimating the potential of hydrogen in hard-to-decarbonise (heating and transport) applications.;
- Improving understanding of the barriers and opportunities for heat networks and boiler replacement.

Conclusion

This study highlights the data gaps in our understanding of the decarbonisation challenge for UKFV, and the difficulties in filling those gaps. There is further work to do in understanding how non-transport elements of UKFV can move forward with reducing carbon emissions and how that may fit in with decarbonisation of other sectors in Greater Lincolnshire.

The focus on transport and logistics, and in particular, diesel replacements, was driven by the availability of data for that sector and the analysis showing the impact of logistics on the overall carbon emissions for UKFV. The study has showed that selecting an appropriate low-carbon technology is far from straightforward, and there is much to do in further clarifying policy, providing financial support for the transition, developing the supporting infrastructure, and ensuring the right skills are in place. This report attempts to provide the first assessment of the scale of the challenge and sources of trusted information for businesses to begin to engage with decarbonisation planning for their fleets and participate with other stakeholders across the whole energy system to identify collaborative solutions.

Annexes

Annex A: Comparison of costs and emissions for different fuels and technologies

	Renewable or biofuel content^	Cost of Vehicle compared to a diesel truck	Maintenance costs of vehicle	Depot Infrastructure	Typical fuel requirements for heavy-duty HGVs	Current fuel cost (2023)	Tailpipe emissions (g CO_2e/mile),[6,#] *including CO2 offset from absorbing sources	Well-to-wheel emissions (g CO_2e/mile)[6]
BEV	NA	2.2 to 2.8 times higher[7]	10 % lower (batteries operate for 1,000 cycles)[8]	See Annex B	144 kWh/100 km[8]	£ 0.27/kWh[9]	0	640
FCEV	-	2.2 times higher[7]	10 % lower (fuel cells have a life of 10,000 hours)[8]	See Annex B for infrastructure costs of refuelling CNG, LNG, and hydrogen at depots	9 kg/100 km[8]	£ 15/kg[10]	0	1880[@,11] 45-5330[12]
Diesel-H2 (50 % H2^)	-	unknown			16.5 L of diesel and 5 kg of H_2/100 km[!]		770[13]	930[@,11]
LNG	0 %	1.25 times higher [14]	Up to 25 % higher[14]		57 L/100 km[!]	£ 0.6/L [15,&]	1075	1450
	50 %				55 L/100 km[!]		540*	955
CNG	0 %				26 kg/100 km[!]	£ 1.2/kg[15]	1065	1285
	50 %				25 kg/100 km[!]		533*	765
Diesel-LPG (25 % LPG^)	0 %	Up to £8k to retrofit[14]	Higher by a few hundred £s per year due to service costs[14]	LPG suppliers may install infrastructure as a part of the fuel supply contract[14]	37 L/100 km[!]	£ 0.8/L[16,17] for LPG	1300	1580
	25 % (LPG)						1000*	1295
Diesel+	0 %	-	-	-	33 L/100 km	£1.5/L[18]	1335	1660
Biodiesel	30 %	Similar for some manufacturers[19]; up to £8k to retrofit[14]	May need frequent filter replacements[14]	Similar to diesel[14]	34 L/100 km[!]	Similar to diesel, in some cases[20]	965*	1266
	100 %			Requires cooling equipment compared to diesel[14]	36 L/100 km[!]		100*	350
HVO	100 %	Similar for some manufacturers[19]	Similar to diesel[14]	Might require more storage tanks than diesel[14]	34 L/100 km[!]	£1.8/L[21]	20*	175

^ Based on energy provided by the fuel. ! Estimated based on the densities and energy contents of the fuels assuming the same performance as a diesel truck. & Estimated based on the cost per kg and its density in the fuel tank. @ Based on the global average emissions from hydrogen production. + Average blend. # Assuming complete combustion (real-life emissions can be acquired from ULEMCo: Hydrogen retrofit solutions for commercial vehicle applications, LowCVP: Low Emission Freight & Logistics Trial (LEFT) Key Findings, CENEX: An Innovate UK Research Project to Assess the Viability of Gas Vehicles, CENEX: Low Carbon Truck and Refuelling Infrastructure Demonstration Trial Evaluation).

[Footnote references on next slide]

Annex A: Comparison of costs and emissions for different fuels and technologies

[6] Greenhouse gas reporting: conversion factors 2023 - GOV.UK (www.govl.uk)

[7] Element Energy: Analysis to provide costs, efficiencies and roll-out trajectories for zero-emission HGVs, buses and coaches (2019)

[8] Fuel cells vs. batteries – How will truck fleets decarbonise? | SynerHy

[9] Business Electricity Prices & Rates - December 2023 (aquaswitch.co.uk)

[10] First new UK hydrogen fuelling hub to open in 2024 | Autocar

[11] Executive summary – Towards hydrogen definitions based on their eissions intensity – Analysis - IEA

[12] Well-to-Tank | Zemo Partnership

[13] Life cycle assessment of hydrogen and diesel dual-fuel class 8 heavy duty trucks – ScienceDirect

[14] RenewableFuelsGuide_email-web-copy.pdf (cenex.co.uk)

[15] LPG/CNG Conversion - Diesel Vehicles | CRD Performance

[16] AA: Fuel Price Report (2023)

[17] Biolpg_flyer_2018.pdf (calor.co.uk)

[18] Weekly road fuel prices - GOV.UK (www.gov.uk)

[19] Renewable Fuels Guide - Appendix (zemo.org.uk)

[20] Renewable Fuels Guide - July 2023 (zemo.org.uk)

[21] LUBIX: HVO Price comparison with diesel

Annex B: Typical infrastructure costs for charging and refueling at depots

Fuel Type	Capacity	Capital Cost per station (1,000 £)	Installation Cost per station (1,000 £)	Operating Cost per station per year (1,000 £)
Electricity[22] (2019)	150 kW	64	64	2
CNG[23] (2011)	500 kg/day	160	50	36
	1,000 kg/day	200	60	42
	2,000 kg/day	250	80	60
LNG[23] (2011)	500 kg/day	73	10	22
	1,000 kg/day	93	12	27
	2,000 kg/day	350	20	30
Hydrogen[22] (2019)	400 kg/day	2,565	100	106
	800 kg/day	3,420	180	144
	1,200 kg/day	4,275	180	178

The costs of electric network connections can be estimated from the Guide Prices and Timescales | Northern Powergrid and National Grid - Interactive costing tool. The network costs are around £97,500 for a hydrogen refuelling station and around £350/kW for electric chargers[22]

Some costs are estimated based on the data from the references and the capacities in column 2 of this Table

[22] Zero Emission HGV Infrastructure Requirements (Ricardo Energy and Environment) - Climate Change Committee (theccc.org.uk)
[23] LowCVP Biomethane Report_Part 1 Final.pdf (zemo.org.uk)

Annex C: Business decision flowchart – identifying appropriate fuel options

1. Reducing emissions of my fleet in a cost-effective manner
2. Perform energy audit to estimate the current fuel consumption and emissions of your fleet
3. Identify the options for zero emission vehicles (BEV, H_2-FCEV), gas (LNG, CNG, LPG, H_2)-ICEVs, and diesel-ICEVs accepting higher blends of liquid biofuels (HVO, Biodiesel)
4. Understand the policies related to the weights of the zero and low emission options while sizing the truck
5. Review the policy, infrastructure, and technology timelines for BEVs, H_2-FCEVs, and biofuel/efuel in Figure 3, Figure 4, and Figure 5 respectively for additional insights
6. Refer to Annex D, Annex E, and Annex F for making decisions related to the transition to zero emission vehicles, low emission gas-ICEVs, and low emission diesel-ICEVs respectively
7. Having gone through Annex D-Annex F, choose authentic low carbon fuel suppliers approved by the Renewable Fuels Assurance Scheme
8. If a zero emission option has not been selected, then revisit the decision trees in 3 months

Step 2 note:

Measure the fuel consumption through fuel gauge readings

At the end of the audit period, use Greenhouse gas reporting: conversion factors to estimate the emissions

Step 3 note:

Commercially available H_2-FCEVs use hydrogen as fuel, while BEVs require electricity

H_2-FCEVs and BEVs are categorised as zero emission vehicles due to zero tailpipe emissions

H_2-ICEVs do not have zero tailpipe emissions

The LoCity Low Emission Commercial Vehicle Finder provides numerous options for zero and low emission vehicles

Some free resources that can assist the fleet operators in identifying options are: LoCity Fleet Advice tool, Fleet Advice and Consultancy

Step 4 note:

Licence

Class B Licence (previously valid for 3.5-t vehicles) is valid for alternate fuel vehicles that weigh up to 4.25-t after the driver completes appropriate training (check The Motor Vehicles (Driving Licences) (Amendment) Regulations 2018)

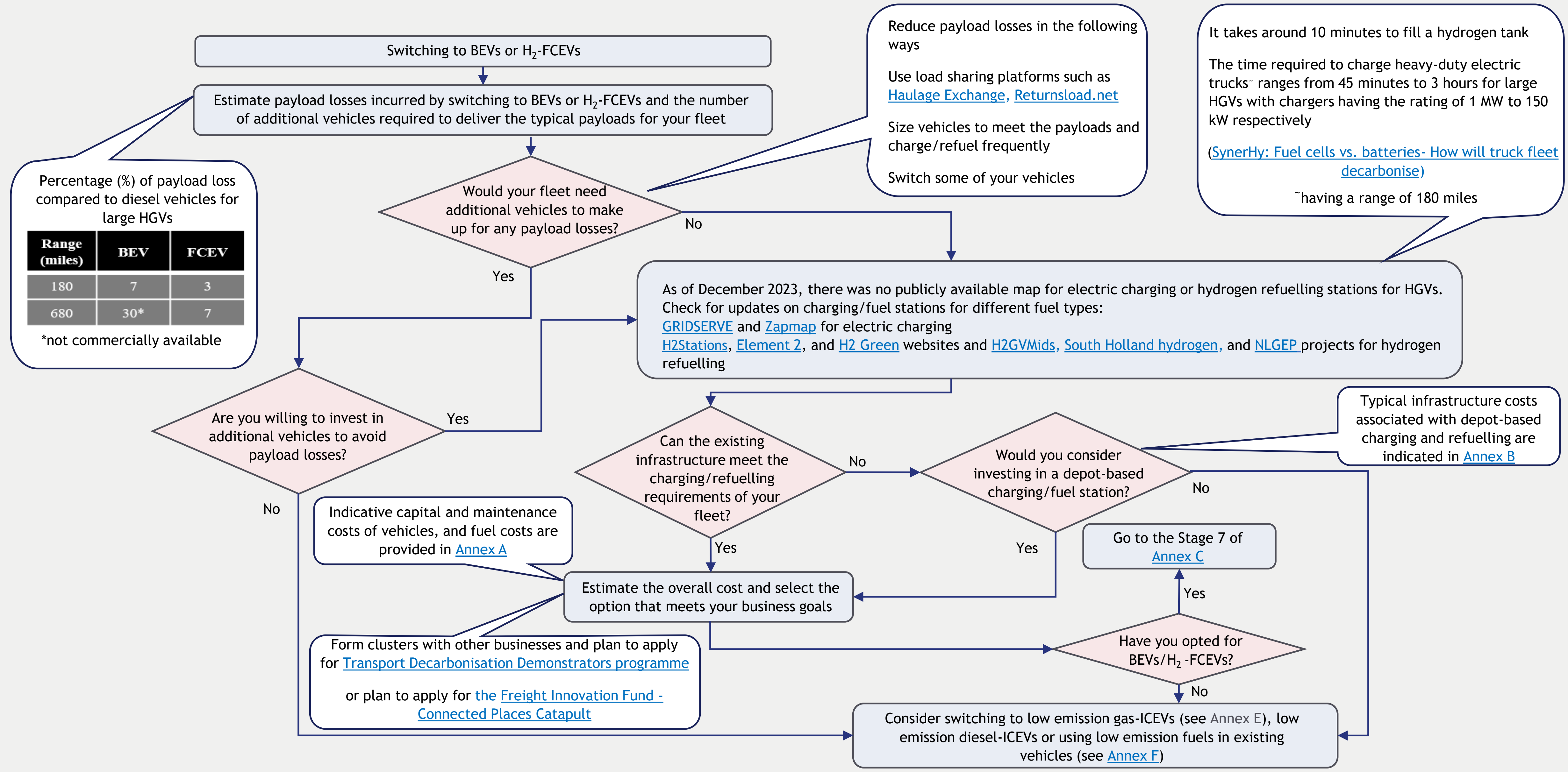
HGV Levy and Vehicle Excise Duty Rates for HGVs can be identified from the Driver & Vehicle Licensing Agency's document for Rates of vehicle tax (effective from August 2023)

Maximum permissible weight

The Road Vehicles (Authorised Weight) (Amendment) Regulations 2023 increased the maximum authorised weights (for vehicles listed in items 4, 8, 9, 11 and 12 of Table 3 in The Road Vehicles (Authorised Weight) Regulations 1998-Schedule 2) for alternate fuel vehicles by 1-t and for zero emission vehicles by 2-t.

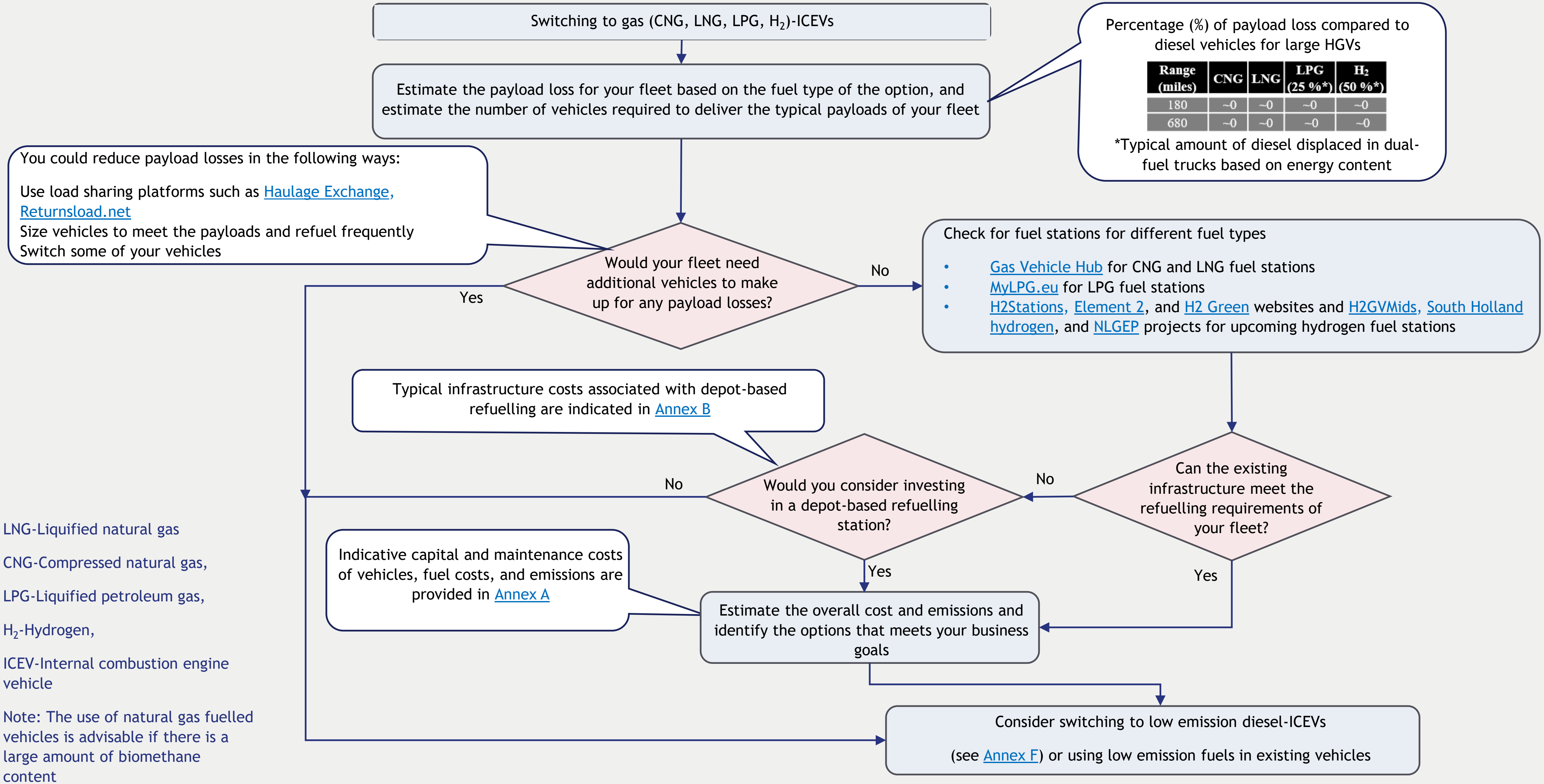
BEV- Battery electric vehicle, H_2-Hydrogen, FCEV-Fuel cell electric vehicle, LNG-Liquified natural gas, CNG-Compressed natural gas, LPG-Liquified petroleum gas, ICEV-Internal combustion engine vehicle (eg. diesel trucks), HVO-Hydrotreated vegetable oil

Annex D: Business decision flowchart - switching to BEVs or H_2-FCEVs



BEV-Battery electric vehicle H_2 -FCEV-Hydrogen fuel cell electric vehicle   ICEV-Internal combustion engine vehicle

Annex E: Business decision flowchart - switching to CNG / LNG / LPG / H_2 ICEVs



Range (miles)	CNG	LNG	LPG (25 %*)	H_2 (50 %*)
180	~0	~0	~0	~0
680	~0	~0	~0	~0

LNG-Liquified natural gas

CNG-Compressed natural gas,

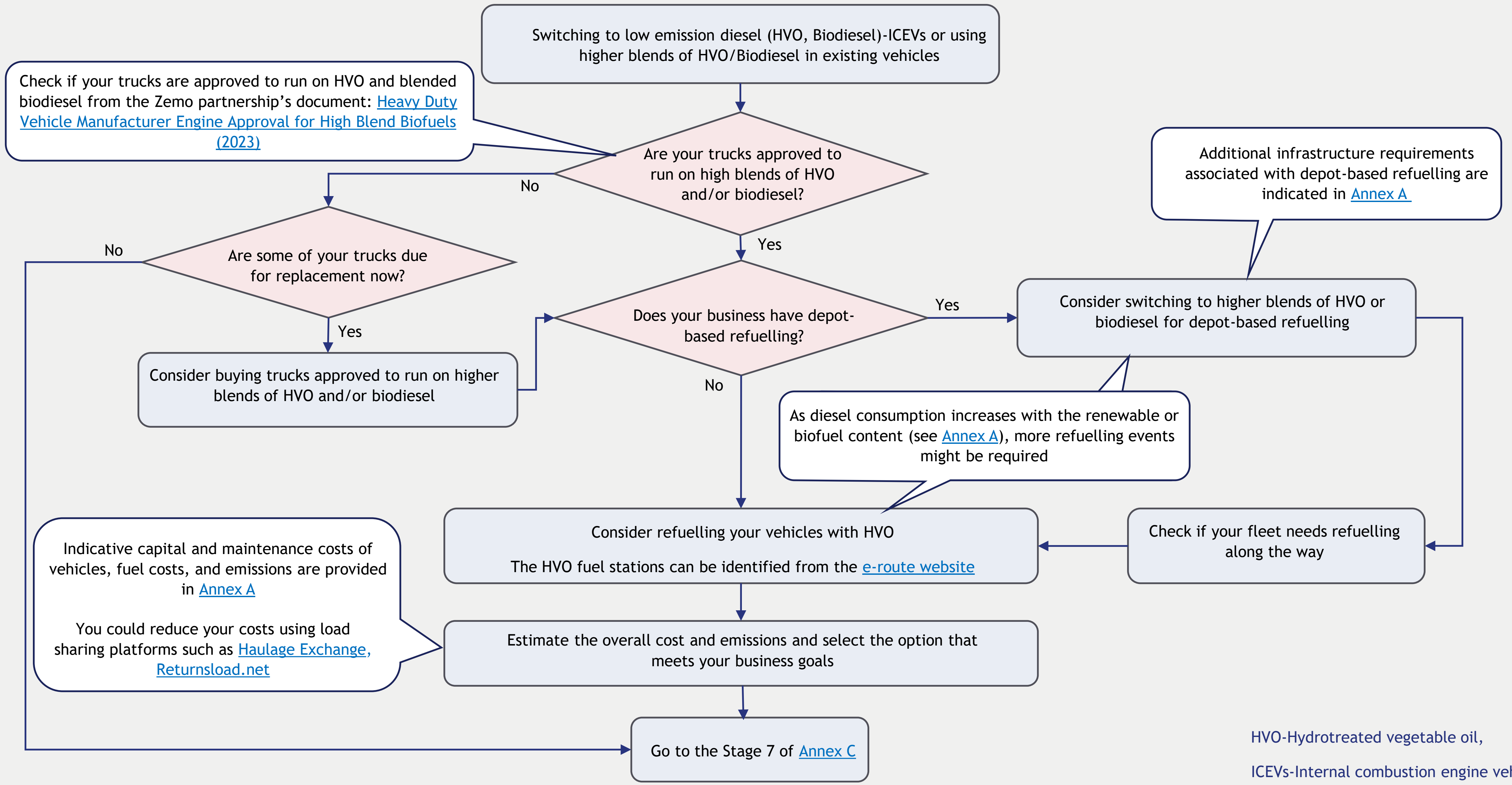
LPG-Liquified petroleum gas,

H_2-Hydrogen,

ICEV-Internal combustion engine vehicle

Note: The use of natural gas fuelled vehicles is advisable if there is a large amount of biomethane content

Annex F: Business decision flowchart – switching to low emission HVO / Biodiesel ICEVs



HVO-Hydrotreated vegetable oil,

ICEVs-Internal combustion engine vehicles

UK FOOD VALLEY

Greater Lincolnshire Local Enterprise Partnership
Lancaster House | 36 Orchard Street
Lincoln | LN1 1XX
T 01522 550540
E greaterlincslep@lincolnshire.gov.uk
GreaterLincsLEP

UNIVERSITY OF LINCOLN
Brayford Pool
Lincoln, LN6 7TS
T: +44 (0)1522 882 000