SMART HY AWARE

Interreg Europe

European Union
European Regional Development Fund

Hydrogen and Fleet Decarbonisation

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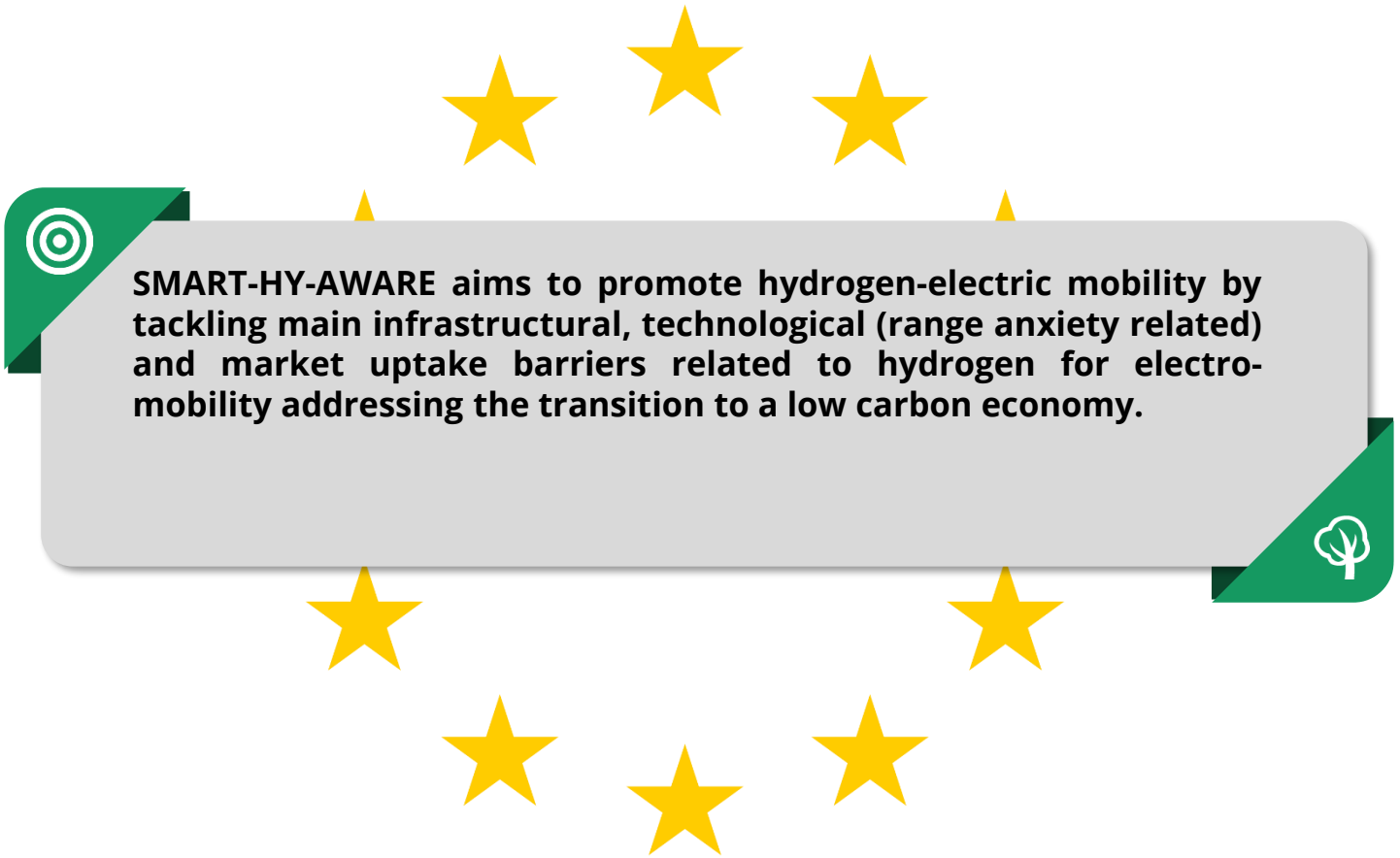
16.05.2023

- Smart HyAware
- Refuelling Infrastructure & Hydrogen Vehicles
- Types of Technologies
- North East Scotland Fleet Review (Hydrogen Demand)
- Considerations for Fleet Managers



SMART-HY-AWARE aims to promote hydrogen-electric mobility by tackling main infrastructural, technological (range anxiety related) and market uptake barriers related to hydrogen for electro-mobility addressing the transition to a low carbon economy.

Refuelling Infrastructure

- 2 stations delivering 130 and 360kg/ day
- 350 & 700 bar capable
- Refuel cars, vans, buses, large vehicles
- Both ‘green tariff’ stations

H2 Aberdeen Vehicles

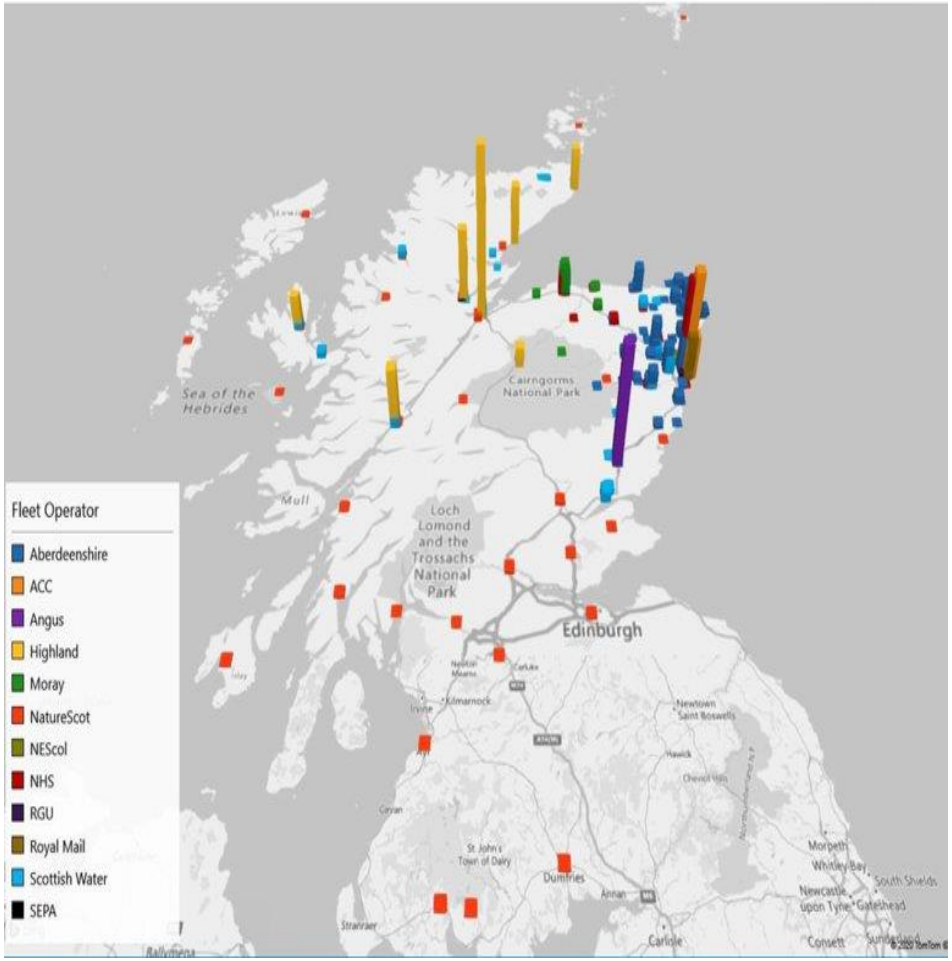
One of the most varied fleets in Europe

Types of Technologies

Battery Electric Vehicle (BEV)	Derives all its power from electricity provided by an external electrical source such as a chargepoint and stored in an on-board battery. Examples: Nissan Leaf, Nissan e-NV200 van.
Fuel Cell Electric Vehicle (FCEV)	Derives its power from the conversion of hydrogen and oxygen to electricity in a fuel cell. Typically has a small hybrid battery to capture regenerative braking energy and provide peak power support to the fuel cell. Examples include the Toyota Mirai and Hyundai Nexo cars.
Fuel Cell Range Extended Electric Vehicle (FCREEV)	Have larger batteries which can be charged with electricity from a chargepoint, as well as a fuel cell which runs on hydrogen. Either or both power sources can be used. Examples: Symbio (now Renault) Kangoo ZE H2 light duty van.
H2 Internal Combustion Engine (H2ICEd) aka dual-fuel	These vehicles co-combust hydrogen and diesel in a conventional engine. Examples: van and refuse collection vehicle (RCV) conversions by ULEMCo.

Fleet Review

- Independent fleet review: 5 Local Authorities, 5 public & 2 private sector entities
- Comprises ~4,000 vehicles
- 89% fleet is ZEV compatible (57% BEV, 32% FC only)
- Annual h2 demand: 745 tonnes, 92% of which from 7.5t or larger
- OEM FC availability is a challenge to 2025



All NE Scotland Fleets - ZEV Compatibility

	# of vehicles	BEV % Compatible	% FCEV Only Compatible	% Not ZEV Compatible	Annual Electricity (MWh)	Annual H_2 (tonnes)
Small Car	302	95%	2%	3%	575	1
Medium Car	195	85%	7%	8%	318	1.7
Medium MPV	35	71%	17%	11%	63	0.2
Midsized SUV	7	100%	0%	0%	15	0
Midsized Commercial SUV	9	67%	33%	0%	23	0.8
Large Car	14	100%	0%	0%	31	0
Large 4x4 / SUV	122	59%	33%	8%	206	15
Small Van	905	53%	34%	12%	2,106	12
Medium Van	318	60%	28%	12%	1,197	6
Large Van (< 3.5t GVW)	1,000	66%	24%	10%	4,023	17.5
Large Van (> 3.5t GVW)	263	53%	20%	27%	814	4
Rigid Truck 2 axles (7.5t GVW)	88	14%	86%	0%	54	82
Rigid Truck 2 axles (18t GVW)	275	48%	47%	4%	1,516	153
Rigid Truck 3 axles (26t GVW)	321	12%	74%	13%	418	403
Rigid Truck 4 axles (32t GVW)	35	11%	63%	26%	37	46.5
Tractor Unit 4 x 2 (40t GCW)	1	0%	0%	100%	0	0
Tractor Unit 6 x 2 (44t GCW)	9	0%	11%	89%	0	2
Tractor Unit 6 x 4 (44t GCW)	3	0%	0%	100%	0	0
Total	**3,902**	**57%**	**32%**	**11%**	**11,396**	**745**

Total Cost of Ownership

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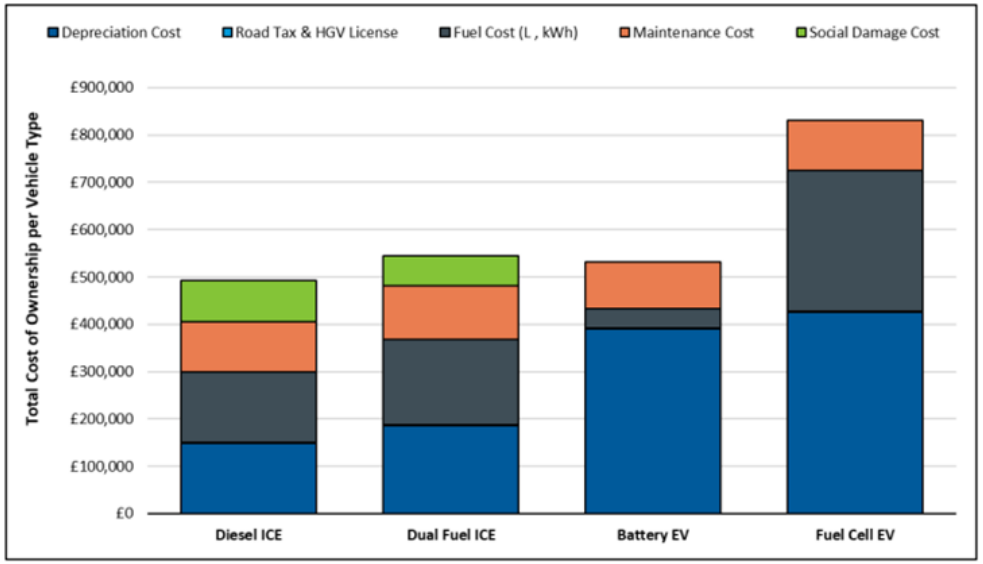
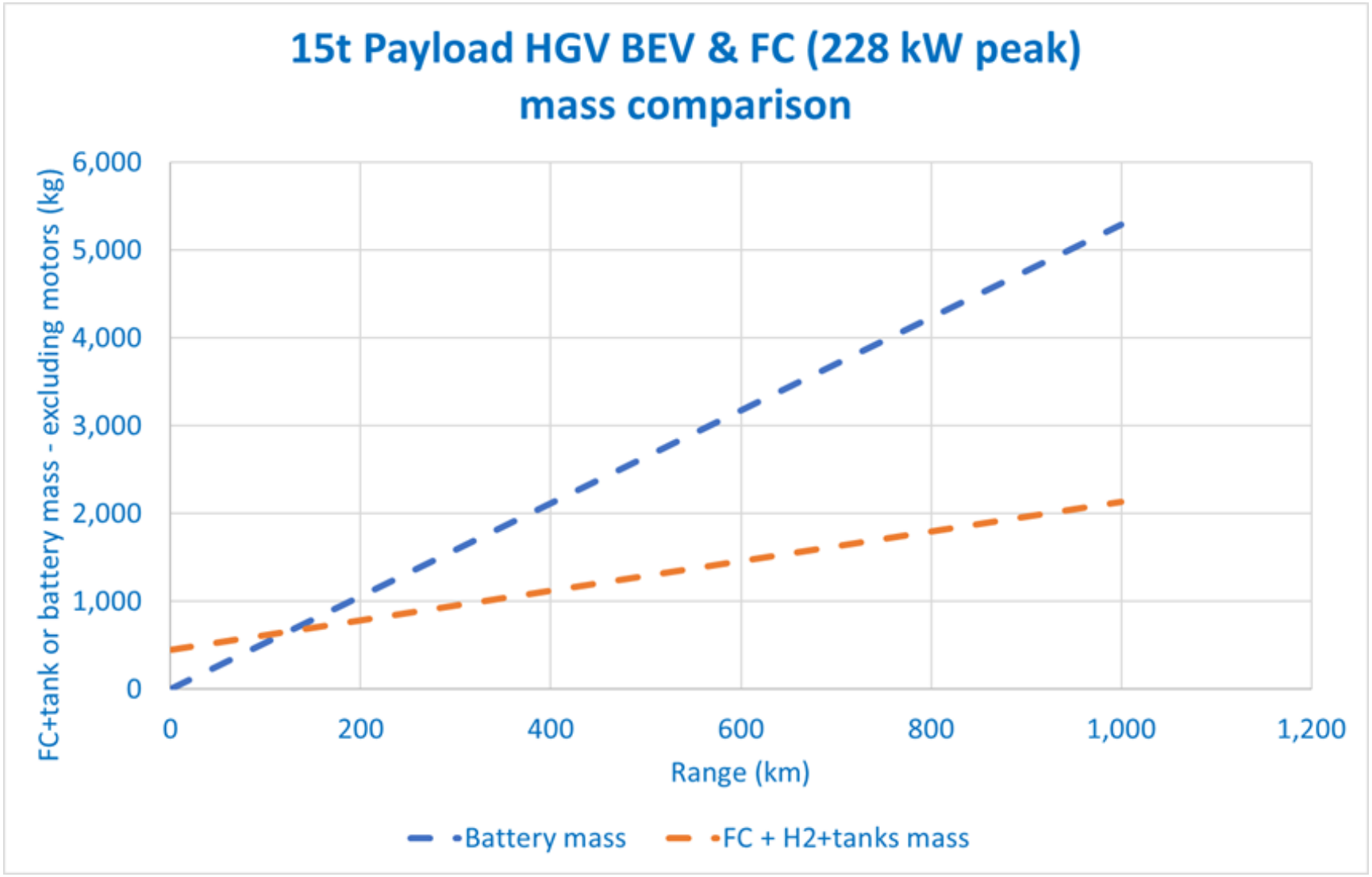
Total Cost of Ownership Analysis

- Due to high fuel prices, hydrogen vehicles are at a cost disadvantage when compared to the diesel and battery electric vehicles (both dual fuel and fuel cell alternatives).
- Thanks to the zero tailpipe emissions from the EVs there are negligible social damage costs.
- Fuel savings can produce overall cost savings from BEVs, if the rounds are lengthened.



Long-term fuel costs: diesel = 1.48 £/L ; hydrogen = 15 £/kg ; electricity costs = 0.21 £/kWh.

Operational Suitability



BEVs or FCEVs?

Types of H2 vehicles available in the UK today

Hyundai Nexo

£	69 k
Seats	5
Range	414 miles
H2	6.3 kg (3 tanks)
H2 P	700 bar
Bat	40 kWh
FC Stack size	95 kW

Toyota Mirai Gen2

£	65 k
Seats	5
Range	400 miles
H2	5.6 kg (2 tanks)
H2 P	700 bar
Bat	1.24 kWh
FC Stack size	128 kW

Symbio RE Kangoo

£	Vehicle 18 k(+ 60/month battery/H2 rental)
Seats	2
Range	100 EV, 250 EV-H2 miles
H2	1.8 kg
H2 P	350 bar
Bat	22kWh
FC Stack size	5kW

ULEMCo dual fuel H2ICed - diesel Ford Transit

£	POA
Seats	2
Range	95 - 135 miles
H2	3.2 kg (2 tanks)
H2 P	350 bar
Engine size	2.2 litre
Engine type	Euro 5

Vehicles

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Hyundai Xcient

Switzerland (2019)

£	lease
GVW/GCW	19t / 36t
Config/Cab	4x2 / Day
Range	248 miles
H2	32 kg (7 tanks)
H2 P	350 bar
Bat	73 kWh
FC Stack size	190 kW

Scania

Asko demonstration (2020)

£	demo
GVW/GCW	??/ 27t
Config/Cab	4x2 / Day
Range	310 miles
H2	33 kg
H2 P	350 bar
Bat	56 kWh
FC Stack size	90 kW

Nikola Tre (CNH/IVECO)

1 prototype only (2023?)

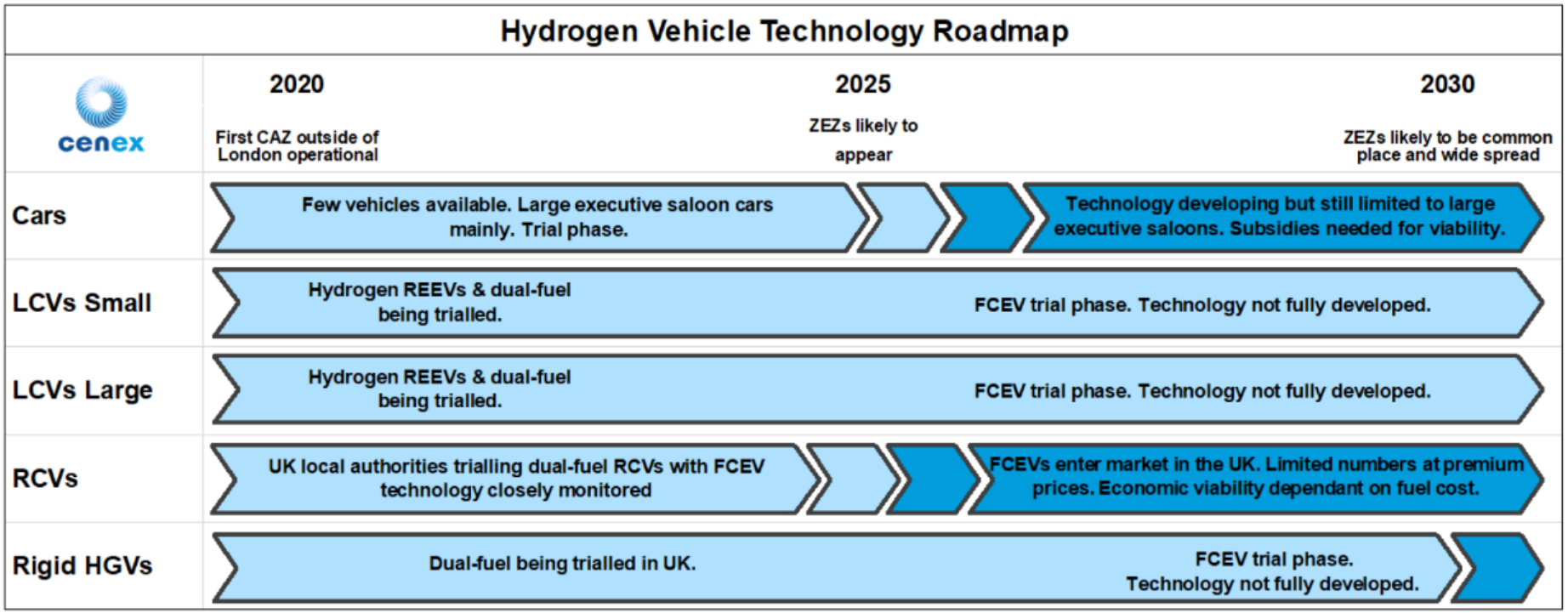
£	Lease?
GVW/GCW	TBA
Config/Cab	6x4/ Sleeper
Range	500 miles +
H2	TBA
H2 P	TBA
Bat	TBA
FC Stack size	120 kW (TBC)

DAF (with Shell/Toyota)

1 prototype only

£	H2SHARE
GVW/GCW	28t
Config/Cab	6x2
Range	250
H2	30 kg
H2 P	350 bar
Bat	72 kWh
FC Stack size	88 kW

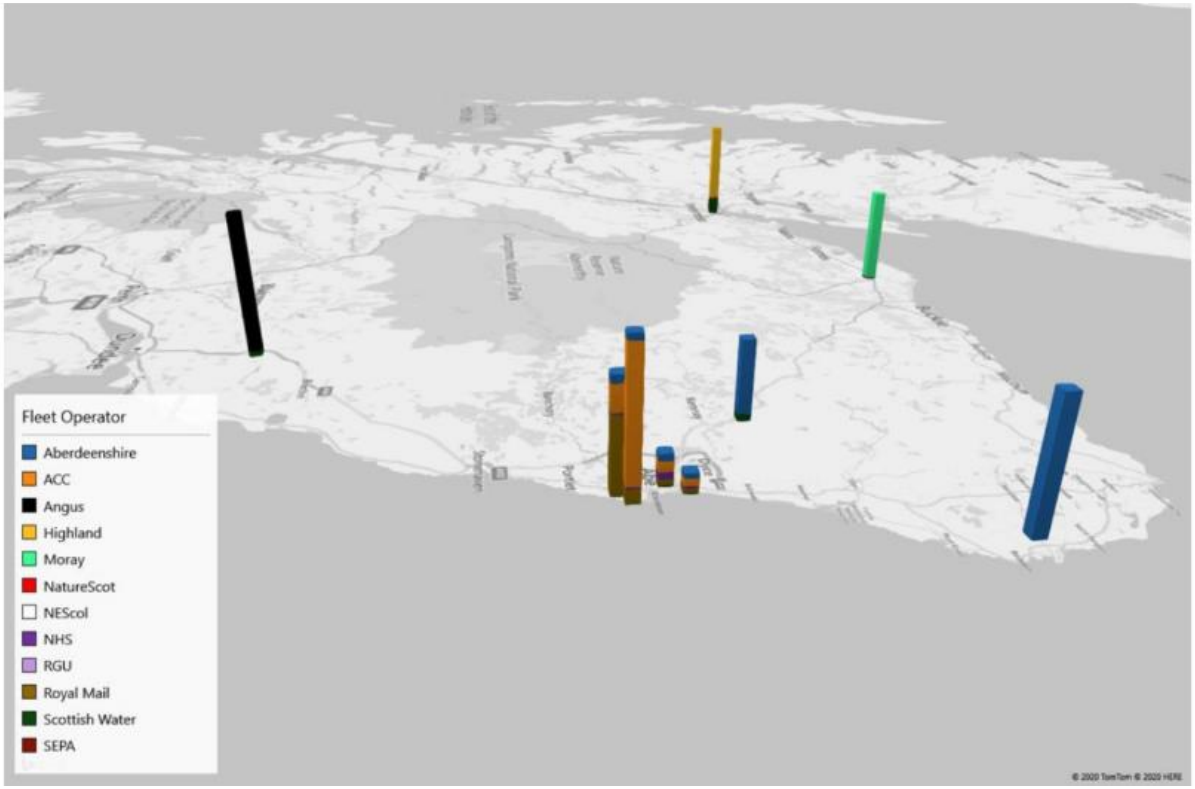
	Trial & early stage demonstration
	Transition to main-stream technology
	Commercial/large-scale deployment



Public Sector Fleet

Ultra-low emission public sector fleet and buy-in by private sector partners by 2025

H2 Demand Mapping. All Fleets. Current/Potential NE HRS Locations Based on Demand



- **(Map oriented E-W for visibility)**
- Two current and two potential H_2 sites in Aberdeen
- Two Aberdeenshire sites (Inverurie and Peterhead)
- One in Inverness
- One in Elgin
- One in Forfar

Fleet Opportunities

- Hydrogen Refuelling Network
- Lower market maturity
- Whether hydrogen works for your fleet depends on many factors:
  - location: city or rural
  - capital outlay
  - daily duty cycle, payload, distances covered, mileage
  - shorter refuelling times
  - availability of chargepoint or refuelling infrastructure
  - turnaround in drivers/ shifts
  - back to base or onward journey
- Learning and collaboration with the public and private sector

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