The role of FCEV fleets in future city plans and potential for replicability

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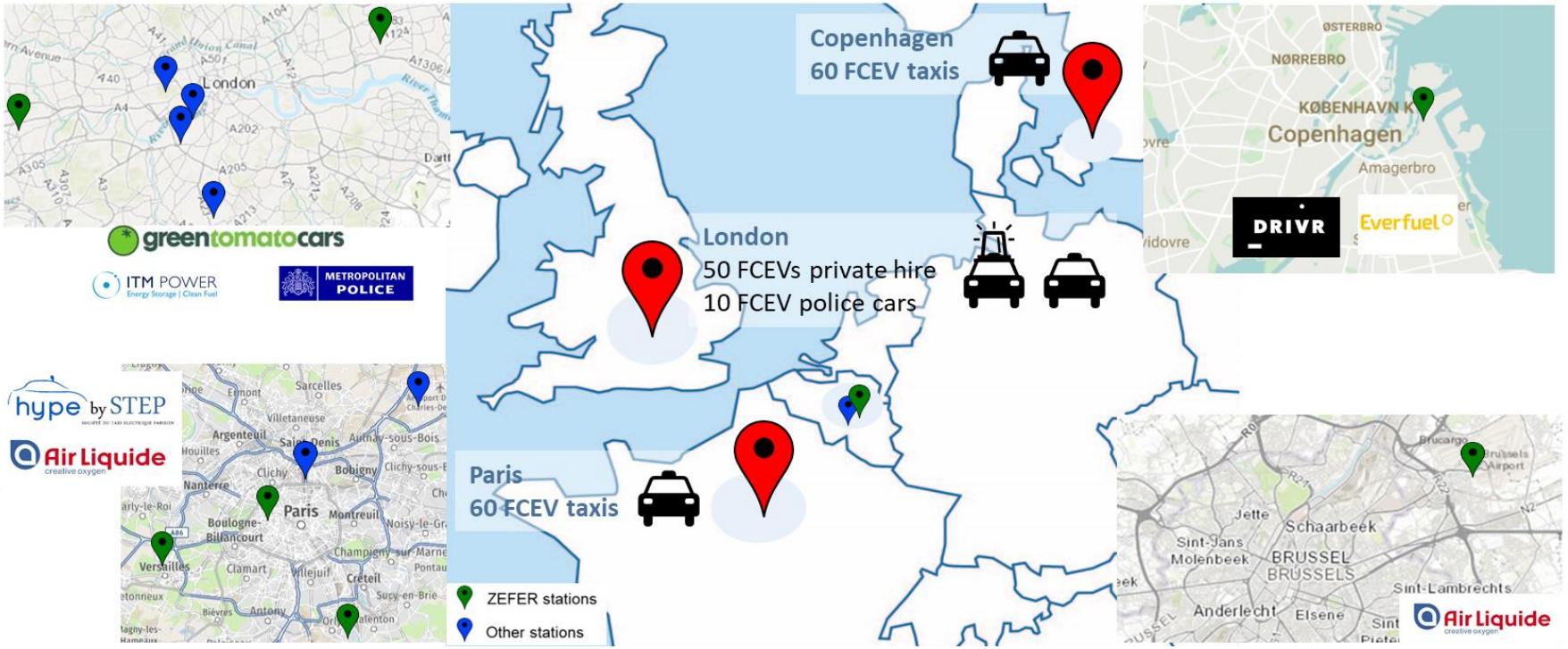
The business of sustainability

The ZEFER project will come to an end in 2023. The project has successfully delivered on its objectives and contributed to developing learnings for the sector

Deployment

180 Fuel Cell Electric Vehicles (FCEVs)
3 Hydrogen Refuelling Stations (HRS) upgrades
3 European capitals

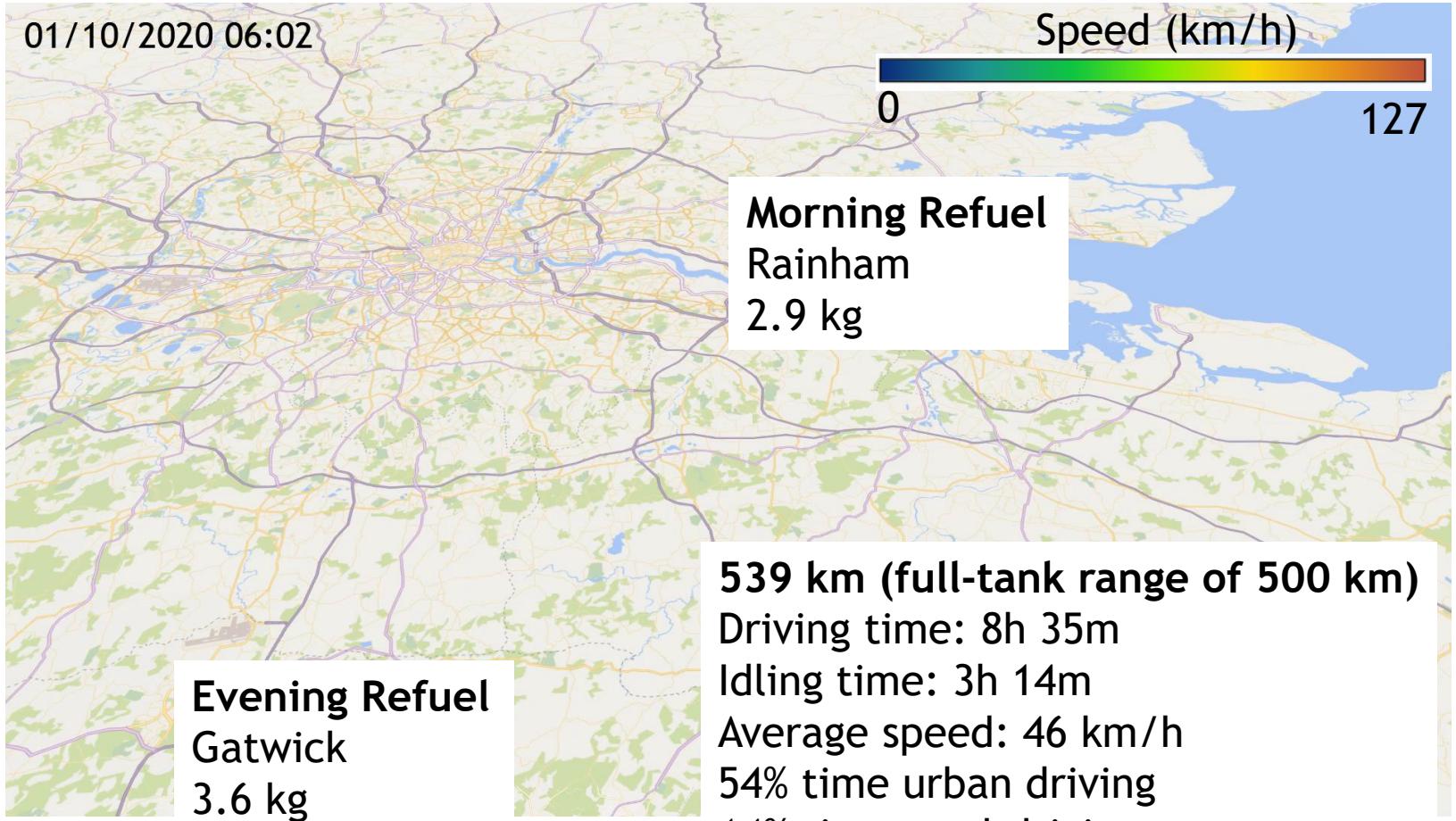


- Vehicles performances have been confirmed through questionnaire surveys and wide database of **11 315 000 kilometres** amassed since April 2018.
- While FCEVs come at a premium today compared to other vehicles, the **customer proposition is attractive for fleet operators.**
- **Early HRS network can cater for fleet demands** but attention must be put on reliability and redundancy.

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (now Clean Hydrogen Partnership) under Grant Agreement No 779538. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

Green Tomato Cars (GTC): Intensive operation in London achieved thanks to FCEVs

- The **average annual distance driven by each FCEV taxi is 44 000 km. This compares favourably to the fleet's petrol/diesel and plug-in hybrid vehicles,** which drive 39 000 km/year on average.
- The furthest driven by one of the vehicles in a month was 12 647 km over a busy Christmas month in 2019.
- Battery Electric Vehicles (BEVs) with specifications comparable to those of the Toyota Mirai have a range of 300 to 500 km and would require 30 to 45 minutes for a full charge on a high-power chargepoint.
- However, **the vehicle depicted on the map refuelled in only 3 minutes each time**, maintaining uptime at much higher levels than a comparable BEV.



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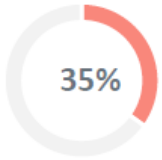
Fleet operators and drivers have high opinions of FCEVs in terms of reliability and performance

- Drivers and fleet operators are looking for solutions to transition to **zero-emission alternatives** for their operations.
- FCEVs have **exceeded driver and operator expectations** in terms of reliability and performance.
- **Long ranges** and **quick refuelling times** are essential to elevating the value of FCEVs above zero-emission alternatives.
- HRS have provided a good foundation for the ZEFER deployments but **limited infrastructure networks** and challenges with **reliability** have prevented the full operational advantages of FCEVs being realised.

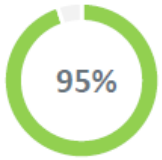
Motivation



Of drivers **did not consider petrol vehicles as a suitable** choice for their organisation in the next 5 years

Taxi drivers and fleet operators increasingly feel the necessity to decarbonate their activity and are turning to zero-emission alternatives such as FCEV to do so.

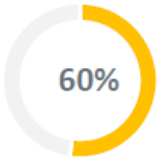
Appraisals



of drivers **defined their experience with the FCEV as positive** or very positive.

A vast majority of drivers was entirely satisfied with the performances of the FCEV, in particular their acceleration, top speed and noise level.

Improvements



of **drivers defined their experience with the HRS network as positive** or very positive.

Satisfaction with the HRS networks has differed significantly between sites. An overall improvement to the number of sites and reliability of stations have been pointed out as necessary to scale up the technology.

Methodology

1. *At the end of the ZEFER project, 180 vehicles have been deployed in Paris, London and Copenhagen. Drivers and fleet operators of vehicles deployed in ZEFER and other projects have been contacted to contribute to the survey campaign.*
2. *Overall 134 responses had been received for the pre-operation questionnaire (from GreenTomatoCars and DRIVR), and 343 for the during-operation questionnaire (from GreenTomatoCars, Hype, DRIVR and the Metropolitan Police) providing valuable insights into the customer value proposition.*

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Different strategy for developing and maintaining HRS can be adopted to support reliable operation

- HRS have provided a good foundation for the deployments but **limited infrastructure networks** and challenges with **reliability** can prevent the full operational advantages of FCEVs being realised.
- **Deployment of HRS should include redundancy** either at a site e.g "dual HRS" or by redundancy of sites to support first deployment, ideally both to ensure operators can plan their day around maintenance, if needed.
- The utilisation level is low relative to capacity, and is not sufficient to support a long-term business case. **This means HRS and FCEVs deployment must come hand in hand to support the development of viable business cases**

- The expansion of hydrogen refueling infrastructure should be based **on a smart approach to scaling up demand.** Strategies including **loading of stations with a range of local vehicle users, with a mix of heavy duty and heavy use vehicles** are recommended e.g. buses and trucks, in concert with local taxi or first responder fleets.
- **Fleet operators will expect high reliability and good redundancy in all segments.**

A business case analysis to compare the Total Cost of Ownership (TCO) of FCEVs was produced, particularly in fleet operations

- The business case analysis is calculated from two **European funded projects** (ZEFER & H2ME2) figures and **Element Energy's internal databases.**
- This is presented for **a 4-year leasing period** on a basis **of 45,000km per year** (particularly relevant for high-mileage fleet).
- The recent **increase in energy prices** was included in this comparison.

Assumption	Note	Petrol hybrid	Plug-in hybrid (PHEV)	Tesla model 3 (BEV)	Current FC vehicle	ZEFER FC vehicle	FC vehicle 2025
Annual mileage (km)		45,000	45,000	45,000	45,000	45,000	45,000
Lease cost (€/vehicle/yr)	*Excluding VAT*	5,207	5,909	8,000[1]	13,239	8,239[2]	5,207
Car maintenance costs (€/yr)		1,123	1,404	1,404	-[3]	-[3]	1,123
Insurance costs (€/yr)		2,500	2,500	3,000	3,000	3,000	2,500
Fuel consumption (l, kWh or kg per 100 km)		4.71 litres (60 mpg[4])	3.14 litres (90 mpg[4])	21.45 kWh	1.00kg [5]	1.00kg [5]	0.75kg
Fuel prices (€ per l, kWh or km)	*Excluding VAT*	€1.9/litre	€1.9/litre	€0.40/kWh[6]	€11/kg	€11/kg	€7.5/kg
Additional costs[7] (€/year)	*Congestion charge*	3,510	3,510	-	-	-	-

Methodology

1. *This figure does not take into account grants which can be significant in some EU markets.*
2. *This figure include current public subsidies (from CH JU in this case).*
3. *For current FC vehicles maintenance costs are included in the lease costs.*
4. *Consumption figures derived from WLTC test cycle figures.*
5. *This figure was determined by taking into account WLTP figures and feedback from partners.*
6. *For BEV price for rapid chargers have been included.*
7. *Congestion charge, applicable in London only but many cities having increasingly ambitious plans to introduce similar incentives.*

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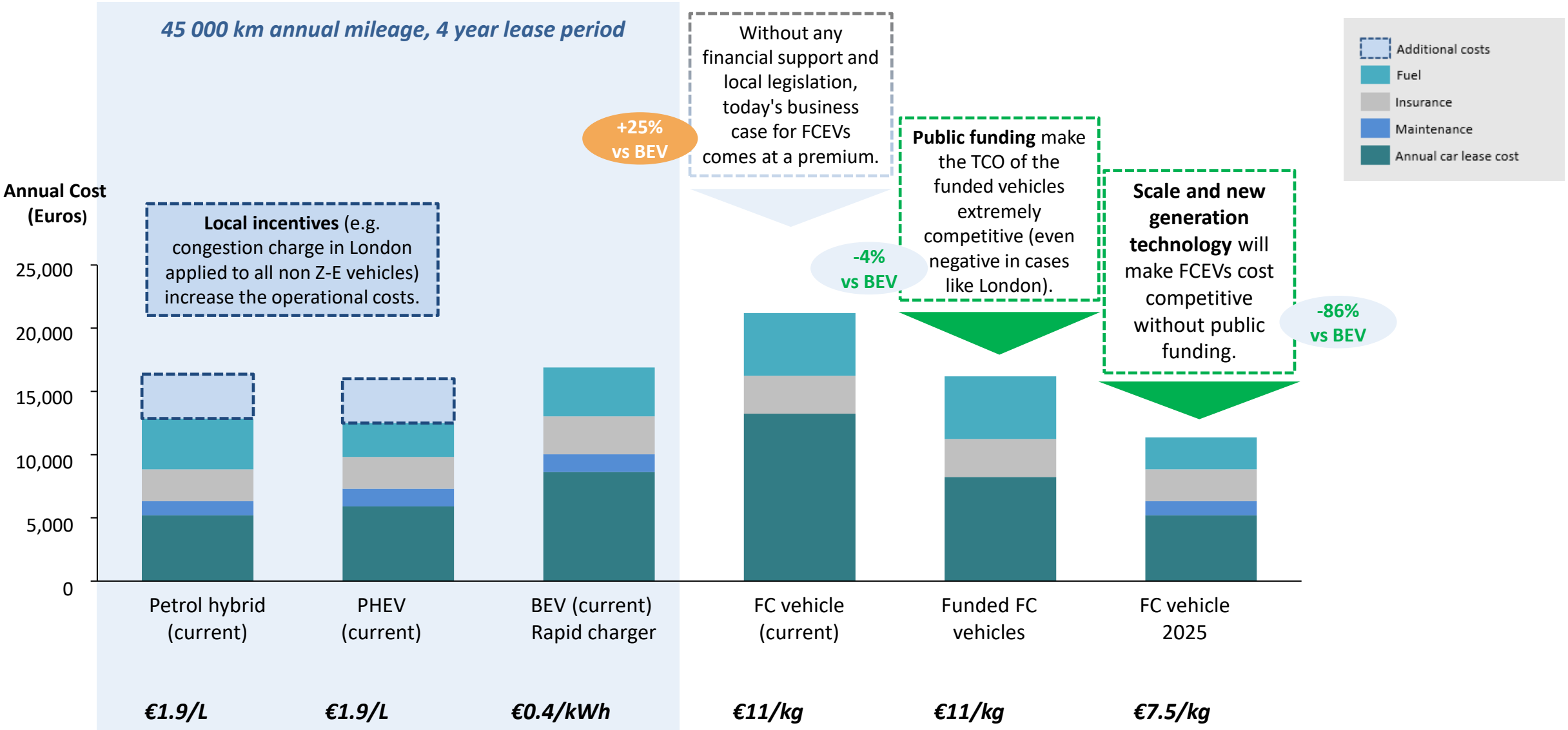
An unsubsidised business case could be just one generation away



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Conclusions : FCEVs can play a role in decarbonising transport and cities with high potential for replicability

Operators needs

- Increasingly, fleet operators are being driven to find low-emission and **even now zero-emission alternatives** for their operations.
- Compared to BEVs, **FCEVs have two main advantages**: A longer range (up to 650 kms) and a quicker refuelling time (3-5 minutes).

Technology performances

- FCEVs **exceed drivers and operators' expectations** in terms of reliability & performance.
- **Long ranges** and **quick refuelling times** are essential to elevating the value of FCEVs above zero-emission alternatives.
- HRS have provided a good foundation for the deployments but **limited infrastructure networks** and challenges with **reliability** can prevent the full operational advantages of FCEVs being realised. Planning for redundancy is key to ensure smooth operation.

Costs reduction

- At low levels of demand (<200kg/day) the cost of supplying H2 can be high. **Network planning** is key to ensuring **economies of scale** and **adequate proposition to customers.**
- FCEVs still have a significant cost premium compared to diesel vehicles but can **reach parity.**
- An unsubsidised business case could be just **one generation away.**

Public support

- **Success stories** are linked to **financial incentives/tax exemptions** for zero emission vehicles, as well as **support from local authorities** and **restrictions placed on diesel vehicles.**
- **Operational advantages are key part of the decision process for fleet operators, thus can be powerful levers.**

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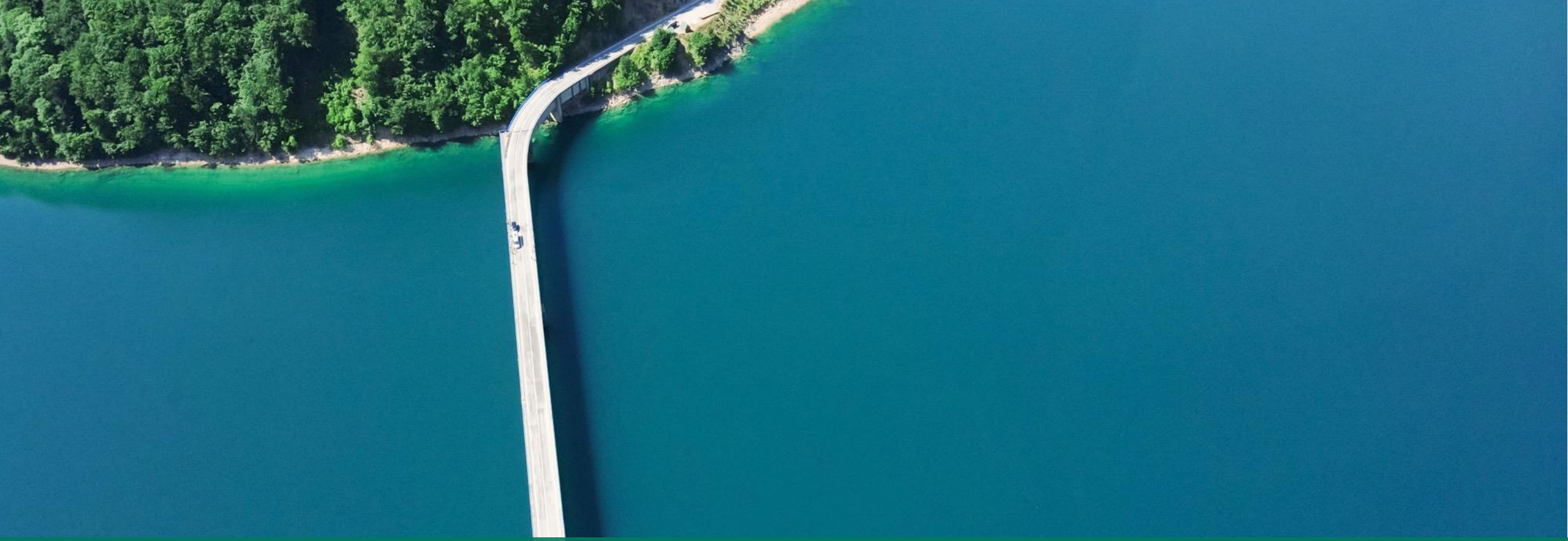

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