ZERO EMISSION FLEET VEHICLES FOR EUROPEAN ROLLOUT

D3.4: Bi-Annual Technical Report on Vehicle and Refuelling Station Operation

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FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Executive Summary (1)

- ZEFER (https://zefer.eu/, 2017-2022) aims to demonstrate that operating fuel cell electric vehicles (FCEVs) in urban vehicle applications can be commercially and operationally viable.
- This report summarises the results of the operation **to the end of June 2020** of the Toyota Mirai FCEVs and hydrogen refuelling stations (HRS) that have been deployed by ZEFER:
  - **In London,** Green Tomato Cars (GTC) began operating 25 FCEVs as taxis in April 2018 and incorporated 25 more in November 2019.
  - **In London,** the Metropolitan Police Service (MPS) operates 10 Toyota Mirais as general purpose police vehicles, joining the existing 11 Mirais in its fleet.
  - **In Paris,** STEP (Société du Taxi Electrique Parisien), via its Hype joint venture with Air Liquide, has deployed 57 ZEFER-supported Toyota Mirai FCEVs taxis in Paris since August 2018. Hype now operates a 130+ strong FCEV taxi fleet.
  - The vehicles in London and Paris use a network of HRS across the cities.
- This is a **publicly available report** and is updated bi-annually.

Executive Summary (2)

- To the end of June 2020, the ZEFER FCEVs drove **4 225 000 km*.**
- HRS used by ZEFER vehicles in France and the UK dispensed **32 500 kg of hydrogen in 2018, 58 300 kg in 2019 and 23 000 kg in 2020 so far (Q1+2)**. Not all the hydrogen was dispensed to ZEFER vehicles – much of the hydrogen in France was dispensed to STEP FCEV taxis that are supported by the H2ME2 project (https://h2me.eu/).
- FCEV taxi driving and refuelling patterns in London and Paris are similar, with vehicles driving **~ 200km between refuels** and averaging just over 2 kg per hydrogen refuel (the Mirai has a 5kg tank capacity).
- Investigations of driving patterns to understand the possible influence of Clean Air Zone (CAZ) charging reveal that GTC taxis entered the current London Ultra Low Emission Zone (ULEZ) 64% of the days when they were driven, but this figure increases to 82% in the future 2021 ULEZ.
- There is a clear influence of driving style (GTC) and seasonal variance (GTC & STEP) on fuel economy.
- Analysis of granular telemetry data from GTC taxis suggests drivers spend about 5% of their driving time and 9% of the total distance driven on trips to HRS. Trips ending at HRS are on average 30 minutes long and 24 km, and taxis spend 7.5 minutes on HRS compared to the 45 minutes for a top up rapid charge on a comparator battery electric vehicle.
- The two London HRS located outside the M25 still get numerous trips that start in Central London due to their quick access via the motorway. This proves that drivers value more the time taken to drive to a HRS rather than distance.
- The impact of the Covid-19 pandemic is evident: in Q2 2020 only 6 000 kg of hydrogen were dispensed and 80 000 km driven.
- The FCEVs have proven to be reliable (**> 99% availability**), with a small amount of off-road time associated with normal taxi use (minor impacts and tyre replacements). The Toyota Mirais are serviced every 10 000 km.
- There were no vehicle or HRS safety issues recorded.

* Last data received from MPS Aug 2019.
Last data received from STEP Mar 2020 as taxis are not operating because of French regulations due to Covid pandemic.

Abbreviations

Abbreviation	Definition
CAZ	Clean Air Zone
CCZ	London Congestion Charge Zone
FCEV	Fuel Cell Electric Vehicle
FCH JU	Fuel Cells and Hydrogen Joint Undertaking
GTC	Green Tomato Cars
H_2	Hydrogen
H2ME	Hydrogen Mobility Europe
HRS	Hydrogen Refuelling Station
HyTEC	Hydrogen Transport in European Cities
LEZ	London Low Emission Zone
MPS	Metropolitan Police Service (London)
NEDC	New European Driving Cycle
NiMH	Nickel Metal Hydride
OEM	Original Equipment Manufacturer
PEM	Proton Exchange Membrane
STEP	Société du Taxi Electrique Parisien
ULEZ	London Ultra Low Emission Zone
ZEFER	Zero-Emission Fleet vehicles for European Rollout

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ZERO EMISSION FLEET VEHICLES FOR EUROPEAN ROLLOUT (2017-2022)

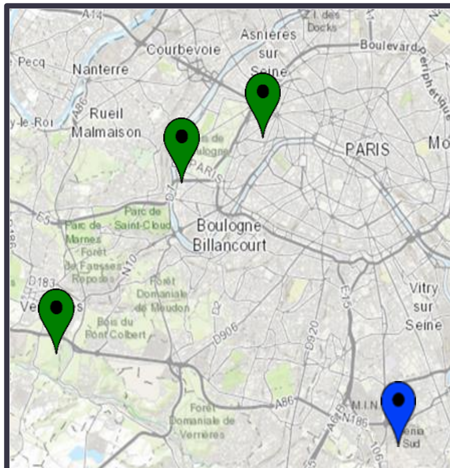
Introduction

- ZEFER (https://zefer.eu/) aims to demonstrate that operating fuel cell electric vehicles (FCEVs)* in urban vehicle applications can be commercially viable compared to diesel alternatives. The FCEV use cases that will be investigated by ZEFER are:
  - As taxis in intensive (up to 24/7) high-mileage operation, and
  - In inner-city fleets where their zero-emission characteristics are of particular value.
- ZEFER will deploy FCEVs and associated hydrogen refuelling stations (HRS) in three locations:

<table>
<tr><th>Location</th><th>No. of FCEV</th><th>No. of HRS**</th><th>Role of FCEV</th><th>User of FCEV</th></tr>
<tr><td>Paris</td><td>60</td><td>3</td><td rowspan="3">Taxi</td><td>STEP</td></tr>
<tr><td>Brussels</td><td>60</td><td>1</td><td>BREATH</td></tr>
<tr><td>London</td><td>50</td><td rowspan="2">2</td><td>Green Tomato Cars</td></tr>
<tr><td>London</td><td>10</td><td>Police vehicle</td><td>Metropolitan Police</td></tr>
</table>

* FCEVs use compressed hydrogen stored on-board to generate electricity in a fuel cell which is used to provide power. The vehicles emit only water.
** Number of HRS directly supported by the project. All locations already have additional HRS as shown overleaf.

ZEFER's FCEVs and HRSs will Complement Existing Activities in Belgium, France and the UK



Paris Sud

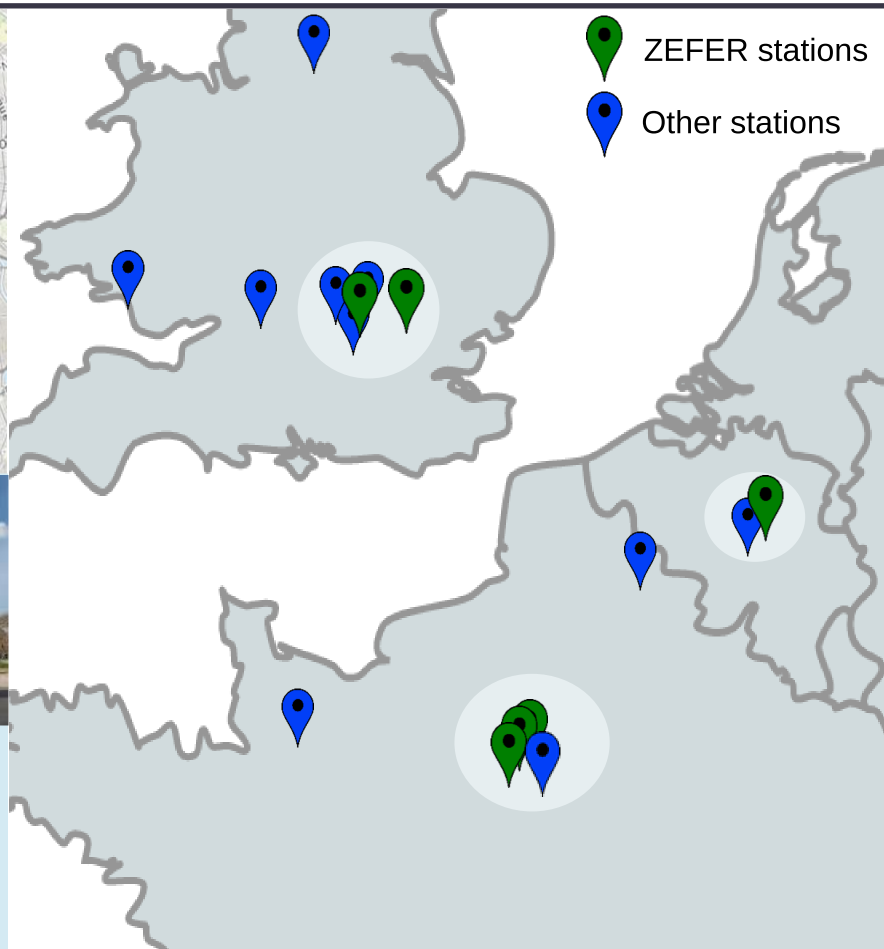
Versailles

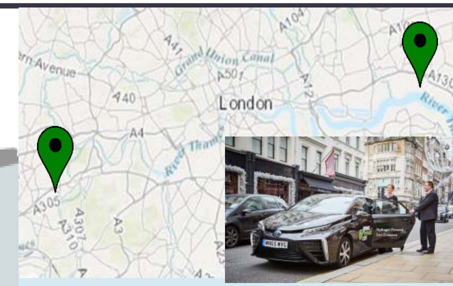
Paris Ouest

Pont d'Alma

hype by STEP

SOCIÉTÉ DU TAXI ELECTRIQUE PARISIEN





greentomatocars

Teddington

Rainham

MAYOR OF LONDON

OFFICE FOR POLICING AND CRIME

Zaventem

hype by BREATH

ZEFER
Vehicles Deployed (data to June 2020)

- 107 of ZEFER’s planned 180 FCEVs have reported data so far (50 from GTC, 50 from STEP and 7 from MPS)
- **In London:**
  - Green Tomato Cars deployed 25 Toyota Mirai FCEVs as private-hire taxis in London starting in April 2018 and added 25 more in November 2019.
  - The vehicles have joined Green Tomato Cars’ existing fleet of 600 low emission taxis.
  - MPS has deployed ten Toyota Mirais as general purpose police vehicles joining the existing 11 Mirais in its fleet.

- **In Paris:**
  - STEP (Société du Taxi Electrique Parisien), via its Hype joint venture with Air Liquide, began deploying ZEFER-supported Toyota Mirai FCEVs taxis in Paris in August 2018.
  - The most recent data report (until June 2020) included 120 vehicles: 50 deployed through ZEFER (all Mirais) and a further 70 supported by the H2ME2 project (mainly Hyundai ix35s).
  - French regulations stopped the taxi operation in March 2020 due to the ongoing Covid pandemic and it has not been resumed yet.

ZEFER
Vehicle Technical Specification

	Toyota Mirai
Vehicle	
Vehicle architecture	Battery/fuel cell parallel hybrid
Top Speed	179 kph
Seats	4
Acceleration 0 → 100 km/h	9.6s
Range (NEDC)*	550 km
Stack Technology	PEM**
Stack Power Rating	113 kW
Tank Capacity	5 kg H_2
Tank Pressure	700 bar
Battery Pack Size	1.6 kWh NiMH***

* New European Drive Cycle
** Proton Exchange Membrane
*** Nickel Metal Hydride

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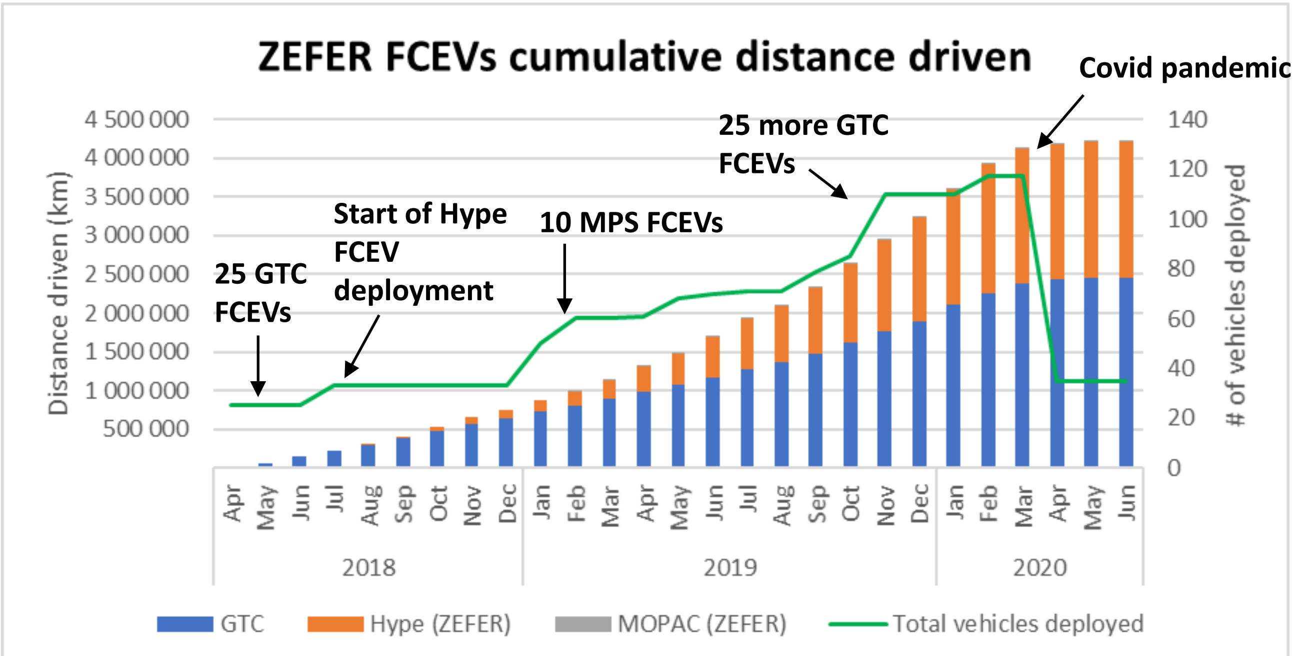
- FCEV safety and reliability
- HRS operation
- Conclusions

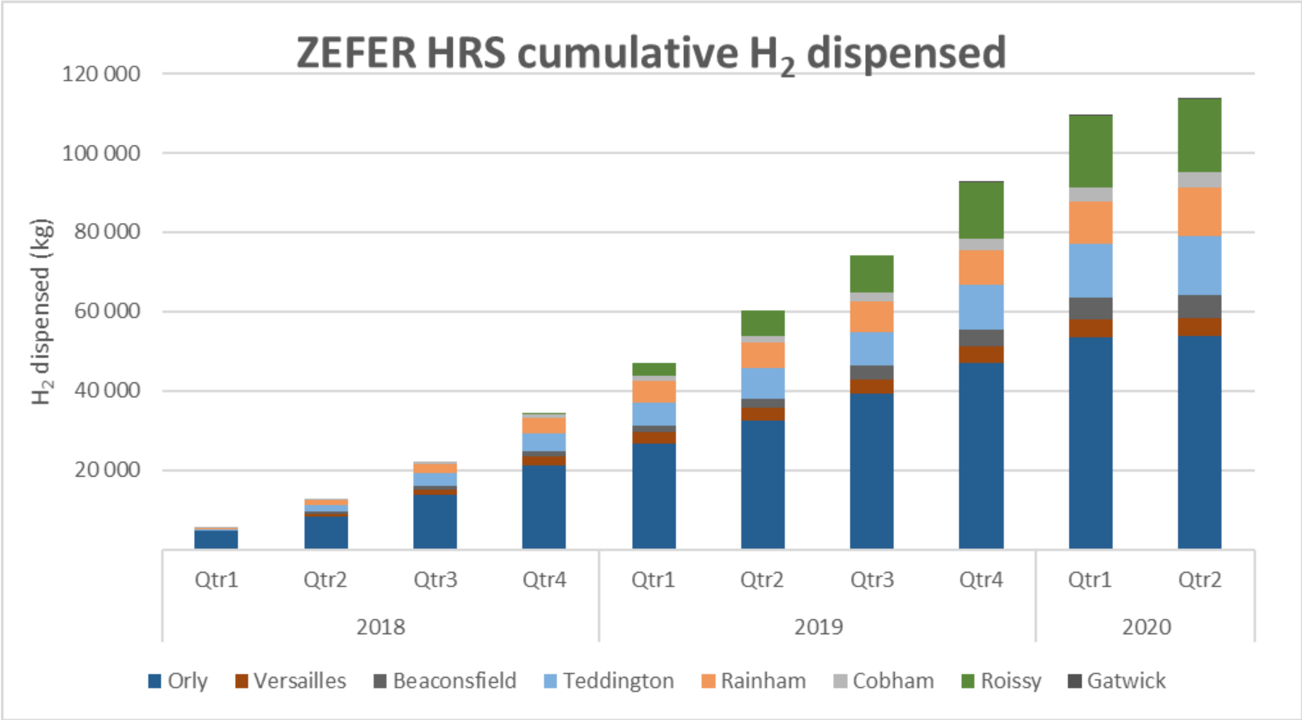
FCEVs
Cumulative Distance Driven and Vehicles Deployed



- ZEFER FCEV taxis in London and Paris, plus the MPS police vehicles in London, have reported **4 225 000 km** driven since April 2018*.
- Hype taxis deployed by H2ME2 in Paris have reported an additional 4 310 000 km driven since June 2017.
- MPS H2ME vehicles reported a further 278 000 km driven since 2017 (pending update).

* Last data received from MPS Aug 2019.
Last data received from STEP Mar 2020 as taxis are not operating because of French regulations due to Covid pandemic.

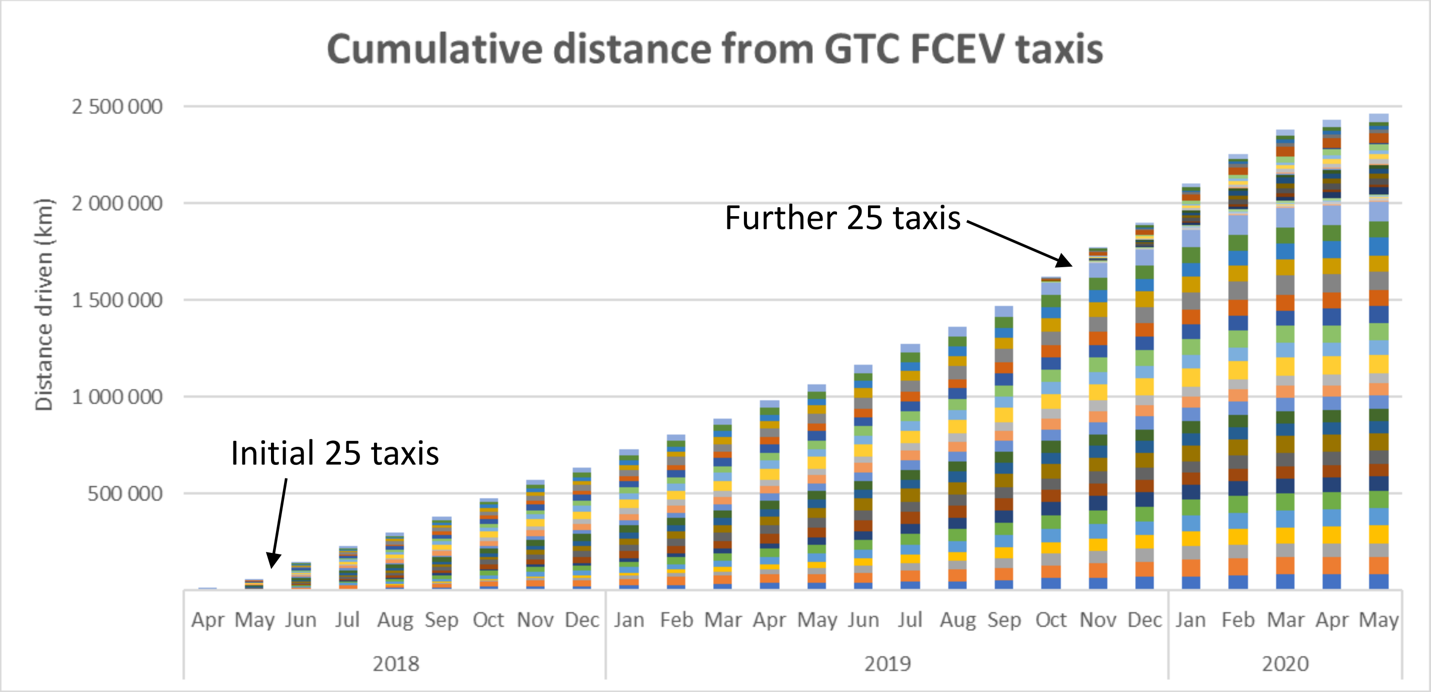
HRS
Cumulative Hydrogen Dispensed



- HRS in France and the UK used by ZEFER vehicles have dispensed **113 800 kg H_2**. The Orly station alone has dispensed 53 800 kg (47%).
- Due to the Covid pandemic, only 6 000 kg of hydrogen were dispensed in Q2 2020.
- Not all the hydrogen was dispensed to ZEFER vehicles – for example, much of the hydrogen in France was dispensed to STEP FCEV taxis that are supported by H2ME2.

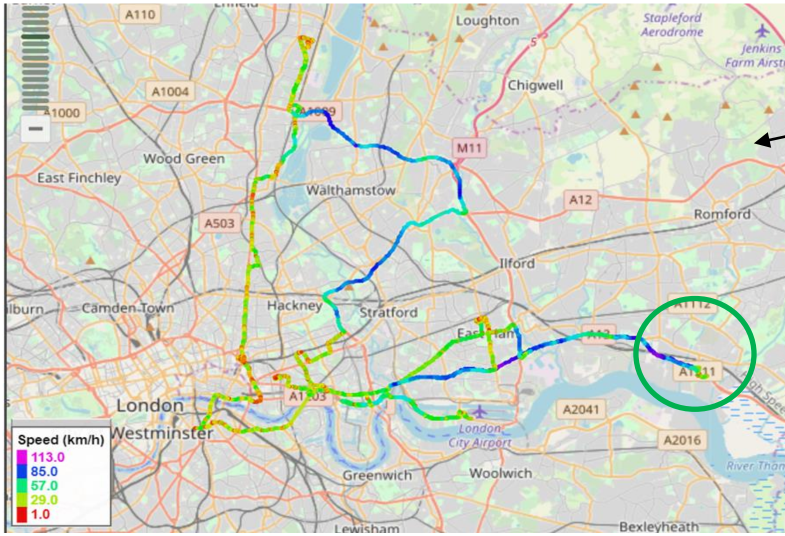
Content

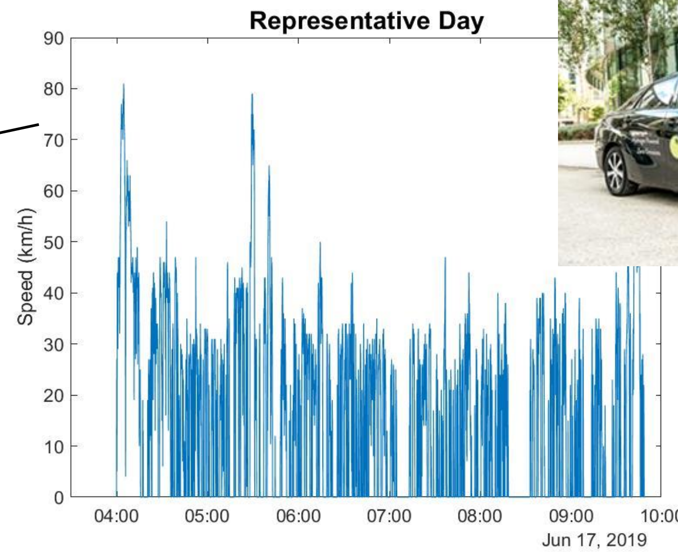
London
FCEV Taxi Operation to end of May 2020



- GTC's 50 FCEV taxis have driven 2 461 000 km since April 2018 (the different-coloured bars on the graph represent the distance driven by individual vehicles).
- The average distance driven by each taxi per month is 3 800 km (~175 km/day).
- The average annual distance driven by each FCEV taxi is 45 500 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 9 940 km.

London
How FCEV Taxis are Being Driven (1)
5 GTC Taxis With Telematics





**A new journey starts after the vehicle has been stationary for more than 1.5 mins.*

- The FCEV taxis predominantly operate in an urban environment (i.e., London) as evidenced by their average speed and number of stops, but also drive on major roads and motorways.
- The green circle shows the Rainham HRS where the vehicle refuelled.
- Please note that the statistics on the right and in the next slides are only for the 5 taxis with telematics, and may differ to the total for the whole fleet.

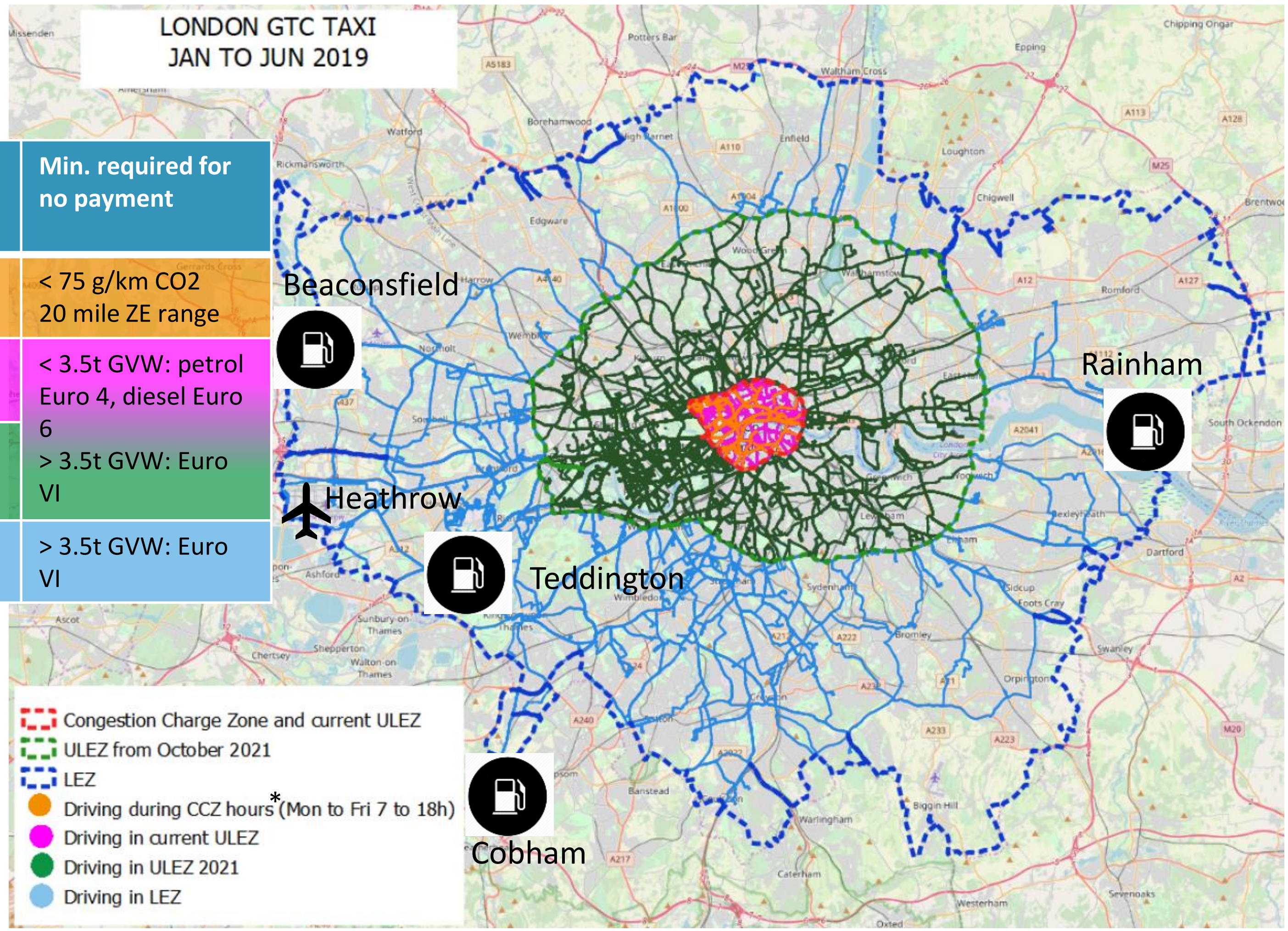
Average daily distance (km)	**110**
Max. daily distance (km)	**516**
Average journeys per day*	**15**
Average days/week of usage	**5**
Average daily driving time	**3h 34min**
Average speed (km/h)	**31**
Urban driving %	**47**
Road driving %	**36**
Motorway driving %	**16**

London
How FCEV Taxis are Being Driven (2)
Clean Air Zones

- Clean Air Zones (CAZ) are being introduced in a number of cities. CAZ charges can help reinforce the **business case for city-based FCEVs** compared to petrol/diesel vehicles.
- To explore the impact of current and future CAZ charging, Cenex data screening algorithms were used to establish the boundaries of the different **London Clean Air Zones** and the amount of time that GTC's vehicles spend in them:
  - Central London Congestion Charge Zone (CCZ) and current Ultra Low Emission Zone (ULEZ): both have the same boundaries.
  - Future ULEZ from October 2021: approximately London's North-South Circular Road.
  - Current Low Emission Zone (LEZ): approximately up to M25.
- We analysed the data from the 5 GTC taxis (10% of GTC's fleet) with Cenex's Clear Capture telematics from May 2018 to May 2020.
- Our algorithms calculated the average distance and number of days entered in the different areas:
  - The taxis entered the current ULEZ **64%** of the days when they were driven.
  - The taxis entered the 2021 ULEZ **82%** of the days when they were driven.
- The map on the next slide shows all the driving data from one taxi in the different CAZ during six months.

London
How FCEV Taxis are Being Driven (3)
Clean Air Zones

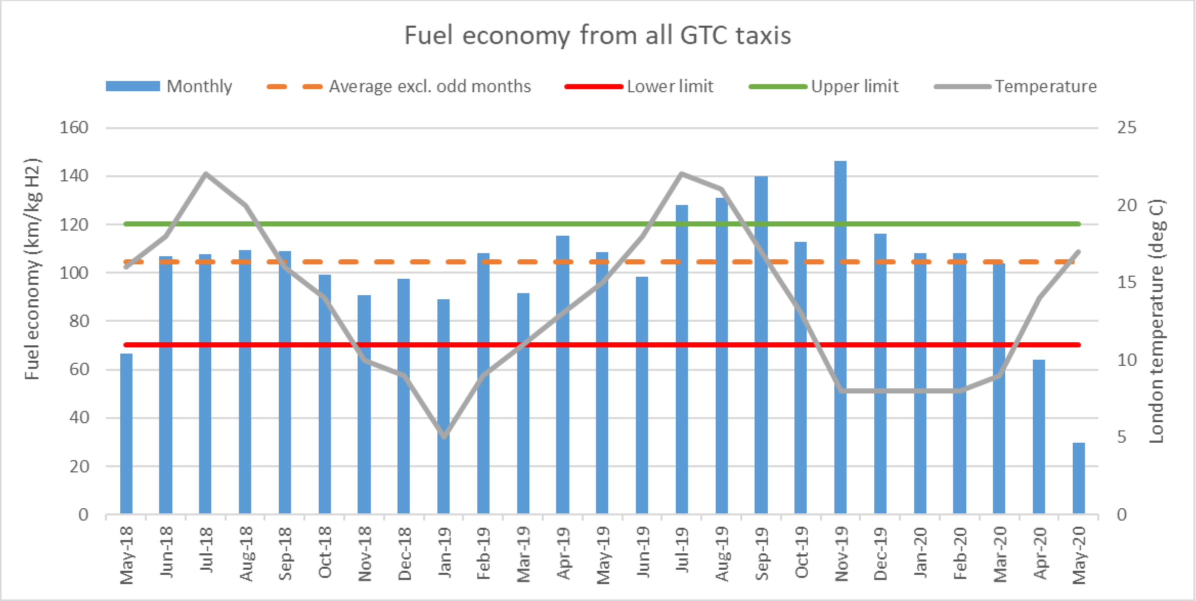
Zone	% days entered in zone	% distance in zone	Min. required for no payment
CCZ (Mon to Fri 7am to 6pm)*	30%	2%	< 75 g/km CO2 20 mile ZE range
Current ULEZ	64%	6%	< 3.5t GVW: petrol Euro 4, diesel Euro 6 > 3.5t GVW: Euro VI
ULEZ 2021	82%	38%	
LEZ	98%	74%	> 3.5t GVW: Euro VI



* Recently changed to everyday from 7 am to 10 pm, to be considered in future iterations of this report.

London
How FCEV Taxis are Being Driven (4)
Fuel Economy

- GTC taxis show an average fuel economy of **105 km/kg H2**. This average was calculated by excluding any months with an unreasonable fuel economy outside the limits indicated in the graph: 70 and 120 km/kg (considering the NEDC value of 110 km/kg).
- The reason for unreasonable fuel economy values could be gaps in the refuelling records or odometer readings.



- Generally, temperature has a negative correlation with vehicle energy consumption (i.e., fuel efficiency is lower in winter) due to factors including:
  - reduced battery and mechanical efficiency.
  - greater use of cabin heating during the winter.
  - increased rolling & wind resistance.
- There is an evident seasonal variance in fuel economy, with a 23% difference between the worse value (89 km/kg in Jan-19) and the best (116 km/kg in Apr-19). However, there is only a 3% difference between the average for the coolest months (104 km/kg from November to April) and the warmest months (106 km/kg from May to October).

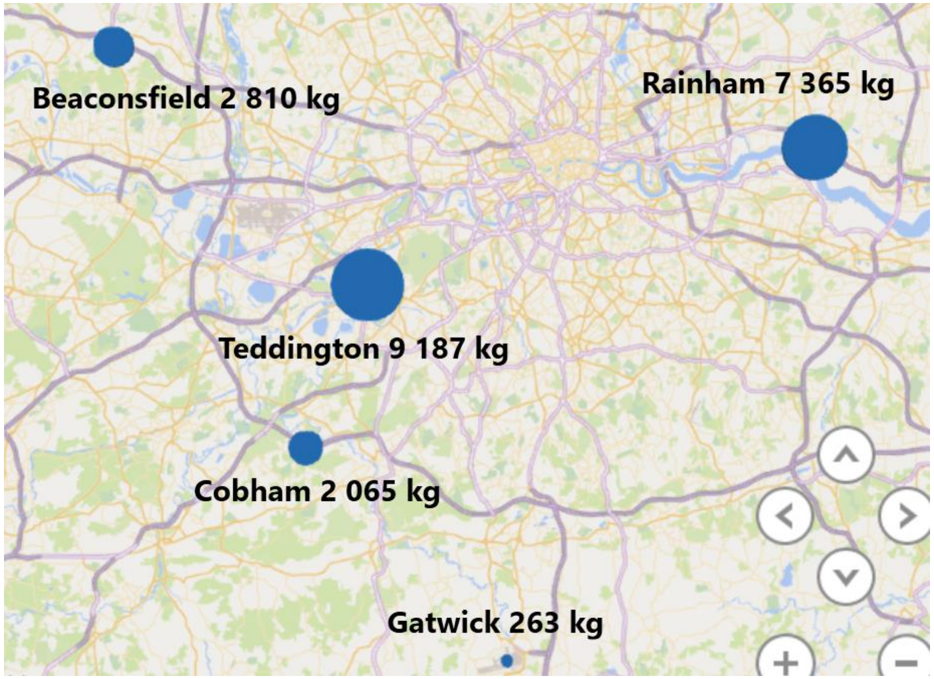
London
How FCEV Taxis are Being Driven (5)
Fuel Economy

- We calculated the average fuel economy from each of the 5 GTC taxis fitted with Cenex telematics excluding any odd months as per the previous slide.
- We then calculated the driving performance statistics that are relevant to fuel economy and correlated them to the fuel economy as per the table below, where the colour scaling is done by row:

Vehicle ID	1	2	3	4	5
Fuel economy (km/kg H_2)	**104**	**107**	**101**	**102**	**103**
% trips max speed > 120 km/h (out of all trips with max speed > 100 km/h)	24%	11%	44%	23%	15%
Acceleration (m/s2)	0.70	0.64	0.71	0.69	0.71
Deceleration (m/s2)	-0.50	-0.49	-0.52	-0.47	-0.50
km/trip	6.6	8.5	6.4	8.0	6.4
% idle	30	30	31	31	33
Stops per trip	8.5	9.1	8.0	8.0	8.7
Urban driving distance %	51	46	50	39	55

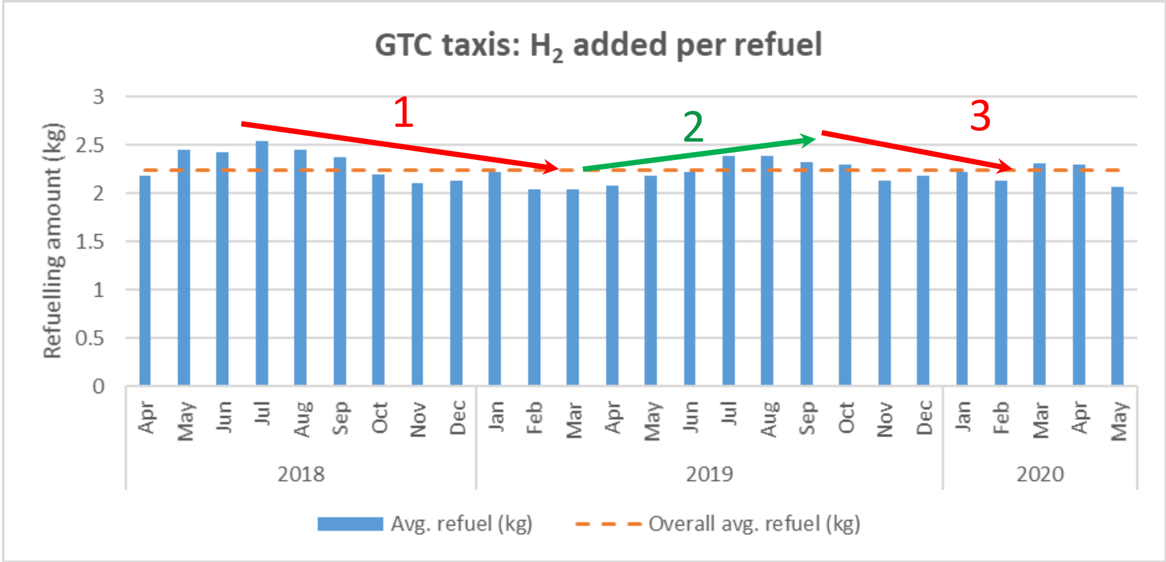
- Although the difference between the vehicles with best and worst fuel economies is only 6%, we can observe that the top 4 factors that affect fuel consumption the most are:
  - Max speed (related to harsh driving)
  - Acceleration
  - Distance per trip (longer trips better)
  - Stops per trip (more stops better due to regen)
- Caveat: the rest of the factors on the table could have an impact on fuel economy, but their variance across vehicles was not big enough to extract conclusive results.

London
Where GTC FCEVs are Refuelling



- The figure shows the location of ITM Power HRS around London and the number of kg of hydrogen dispensed to GTC FCEVs between Apr 18 and May 20.
- The FCEVs use all the ITM London HRS, but the two most popular stations are the more centrally-located ZEFER stations: 76% of the total fleet hydrogen is dispensed by the Rainham and Teddington HRS.
- The mean distance between refuels for the GTC taxi fleet is 234 km.

London
How GTC FCEVs are Being Refuelled (1)
Driver Refuelling Behaviour



- Overall average refuelling amount is 2.2 kg (44% of tank capacity of 5 kg). This compares to 57% of the tank refuelled in GTC's petrol/diesel taxis and 71% in plug-in hybrid taxis.
- Three periods of drover refuelling behaviour are noted on the graph above:
  1. Drivers in late 2018 and early 2019 were refuelling more frequently than necessary: unnecessary trips to refuel reduce the economic efficiency of the drivers.
  2. ITM's app and HRS status info provided to drivers. Also, GTC changed the FCEV drivers from contracted to self-employed which incentivises them to increase productivity and reduce unnecessary refuelling trips.
  3. Refuelling efficiency dropped again from September 2019. 25 new vehicles were introduced to the fleet: new drivers with no experience in refuelling FCEVs were recruited so needed to be trained.

London
How GTC FCEVs are Being Refuelled (2)
Stem Mileage and Stem Time

- Analysing the data from the 5 GTC taxis which are fitted with Cenex telemetry devices, we estimated the distance and time that it takes to drive to HRS on trips to refuel the vehicle but not to carry passengers. This is also known as stem or dead distance and time.
- The table below shows the average distance and time of the trips that finished at a HRS. We did not include trips starting at HRS because it is likely that these are to pick clients up, as opposed to trips ending at a HRS. Gatwick was left out of the analysis because there were not enough trips for meaningful analysis:

Trips ending at	Beaconsfield	Cobham	Rainham	Teddington	**Overall**
Average trip distance (km)	33	37	24	15	**24**
Average trip duration (hh:mm:ss)	00:32:16	00:34:14	00:28:54	00:28:02	**00:29:51**

- If we assume that drivers do not take passengers to the HRS, we can say that these trips seem quite long compared to an assumed working day of eight hours. However, the two most central HRS (Teddington and Rainham) may be on the way of trips to pick clients up, which we cannot determine without "free taxi/busy taxi" telematics data. Therefore, we cannot guarantee that all trips ending at HRS are stem trips.
- The trips ending at the two most central HRS are 45% shorter in distance compared to the outer HRS (Beaconsfield and Cobham), but only 14% shorter in duration. This happens because the outer HRS are located on motorways with relatively high average speeds, while the central HRS are at the end of more congested city-based trips, showing that the closest HRS (in terms of distance) is not necessarily the quickest to get to, as discussed further on the next slide.

London
How GTC FCEVs are Being Refuelled (3)
Time Spent Refuelling

- The table below shows the percentage of distance/time on the trips ending at a HRS as a proportion of the total driving distance/time.

Vehicle ID	1	2	3	4	5	**ALL**
% stem distance	5%	11%	10%	7%	10%	**9%**
% stem time	3%	6%	6%	5%	6%	**5%**

- Although we cannot guarantee that all trips ending at a HRS are stem trips, the % figures are quite high and are a reflection of the detours that the drivers need to take to refuel, specially in the outer London HRS. It also seems that drivers value more the time taken to drive to a HRS rather than the distance.
- The table below shows the average time the vehicles spent at the HRS.

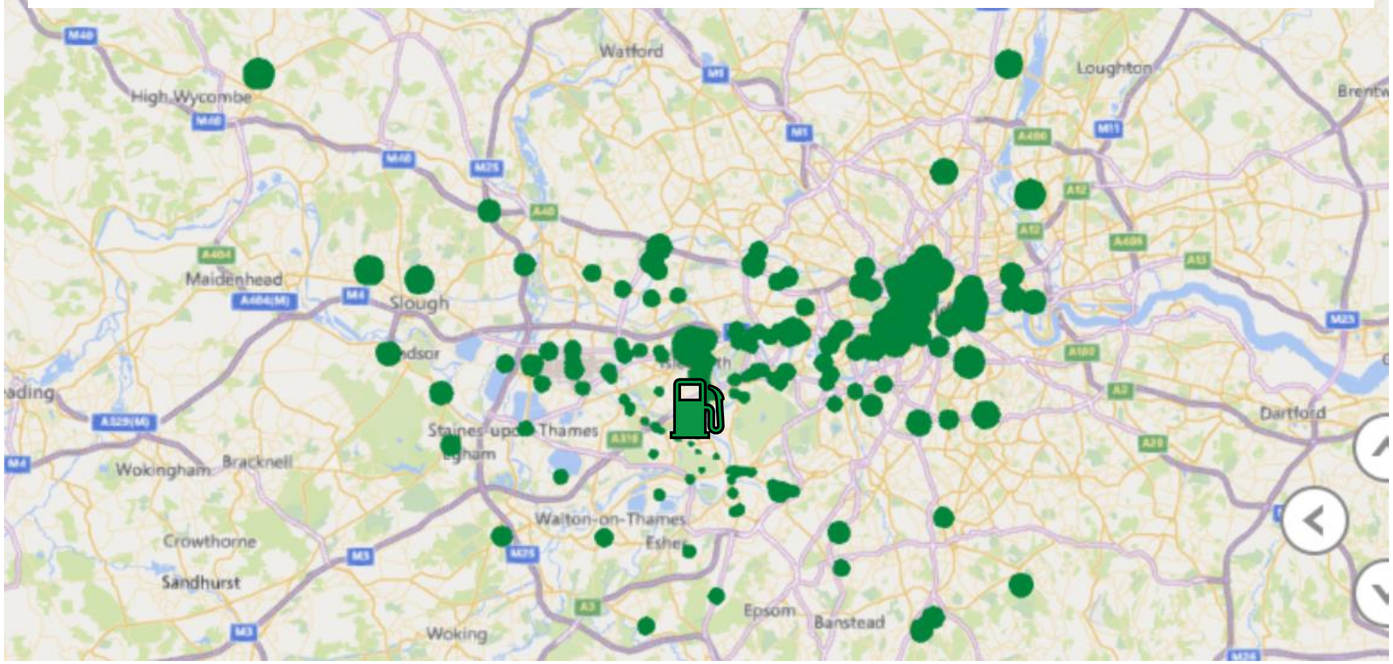
	Beaconsfield	Cobham	Rainham	Teddington	**ALL**
Time spent at HRS (hh:mm:ss)	00:07:19	00:07:27	00:07:58	00:07:13	**00:07:29**

- On average, the refill rate is around 1 kg/min and the GTC vehicles refuel 2.2 kg, so the average refuelling time is 2 minutes and 12 seconds. The other 5 minutes that the vehicles spend at the HRS could be set-up time (nozzle connection and removal, pressure balancing between HRS and tank) or time spent at service stations. Even though Beaconsfield and Cobham are located at motorway services with amenities and the others are not, there is no noticeable difference between the HRS.
- The average time at the HRS is much shorter than would currently be required for a 50% top-up rapid charge with a 50 kW charger on a 75 kWh comparator battery electric vehicle, i.e. around 45 minutes.

London
How GTC FCEVs are Being Refuelled (4)
Origin of Trips to Refuel

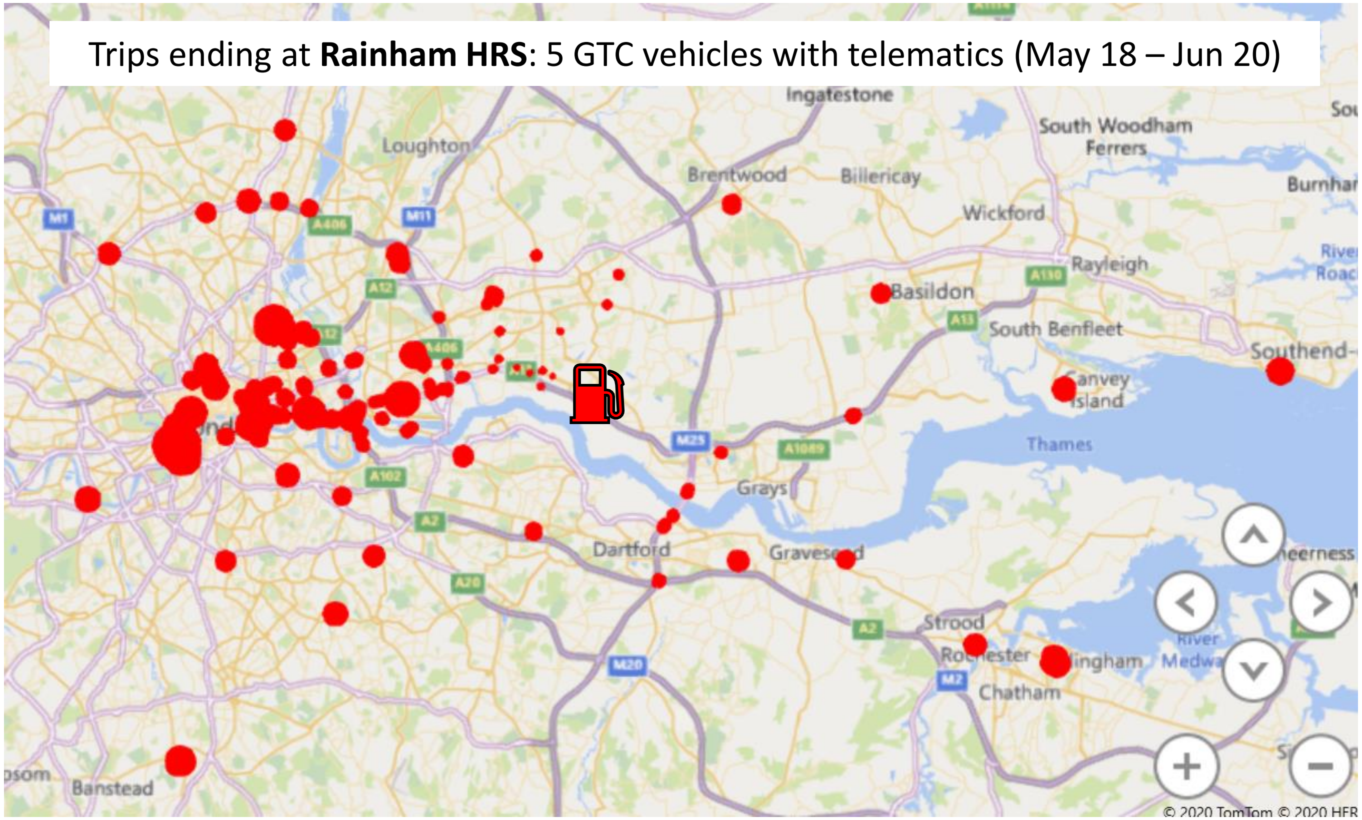
- The following maps show the locations where the trips that ended at HRS started, with the bubble size representing the distance of the trip. The maps with trip duration "bubbles" looked similar to the distance ones and were omitted.
- Teddington is within the M25, therefore it attracts numerous trips from Central and West London. We can see how trips from Central London are longer, probably due to detours to avoid congestion or consecutive non-stop trips carrying passengers. There are not many passenger trips outside the M25.

Trips ending at **Teddington HRS**: 5 GTC vehicles with telematics (May 18 – Jun 20)



London
How GTC FCEVs are Being Refuelled (5)
Origin of Trips to Refuel

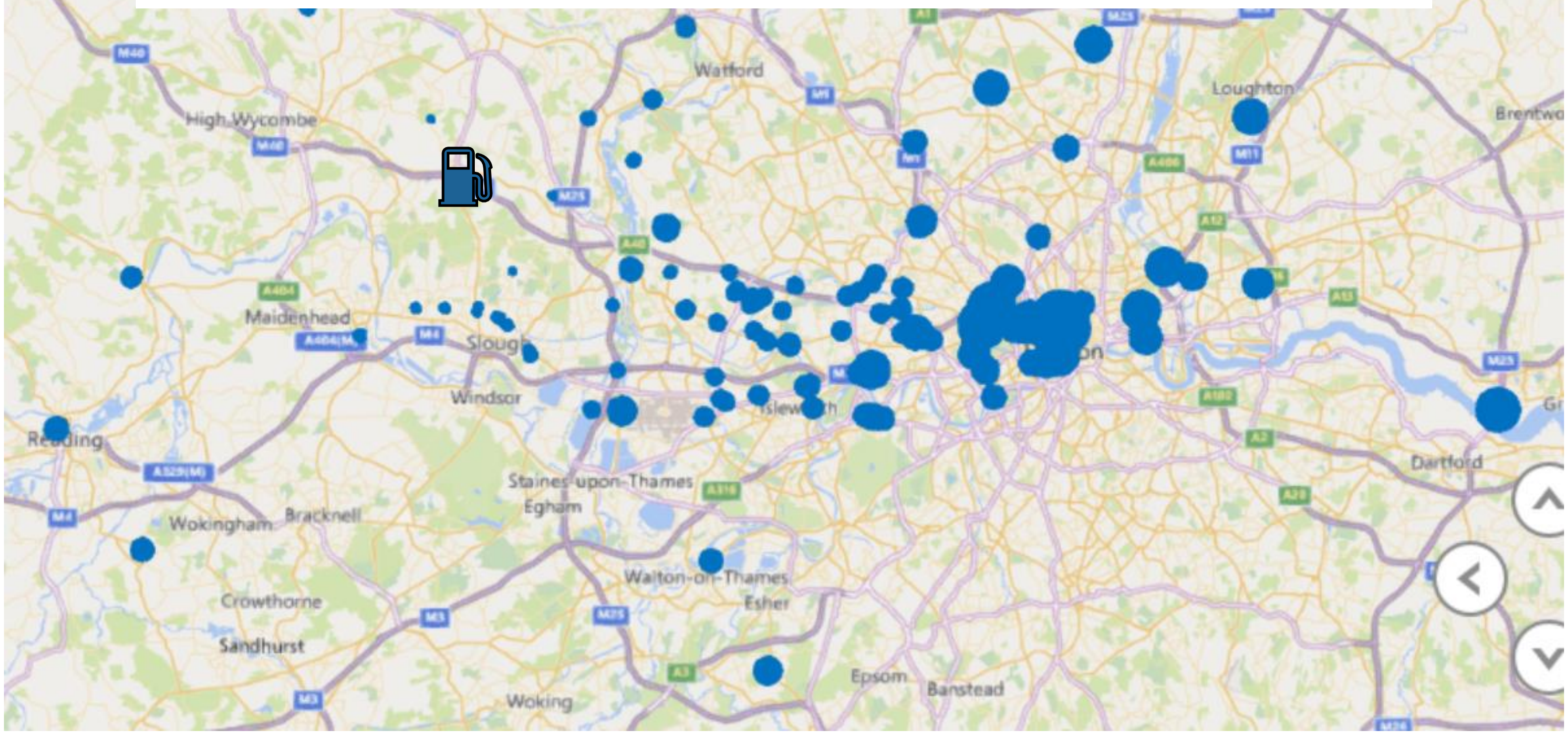
- Rainham is the other "central" station and shows a similar pattern to Teddington but in East London. There are not many passenger trips outside the M25.



London
How GTC FCEVs are Being Refuelled (6)
Origin of Trips to Refuel

- Even though Beaconsfield is outside the M25, it still gets numerous trips from Central and West London due to its easy access via the motorway. There are not many passenger trips from North London.

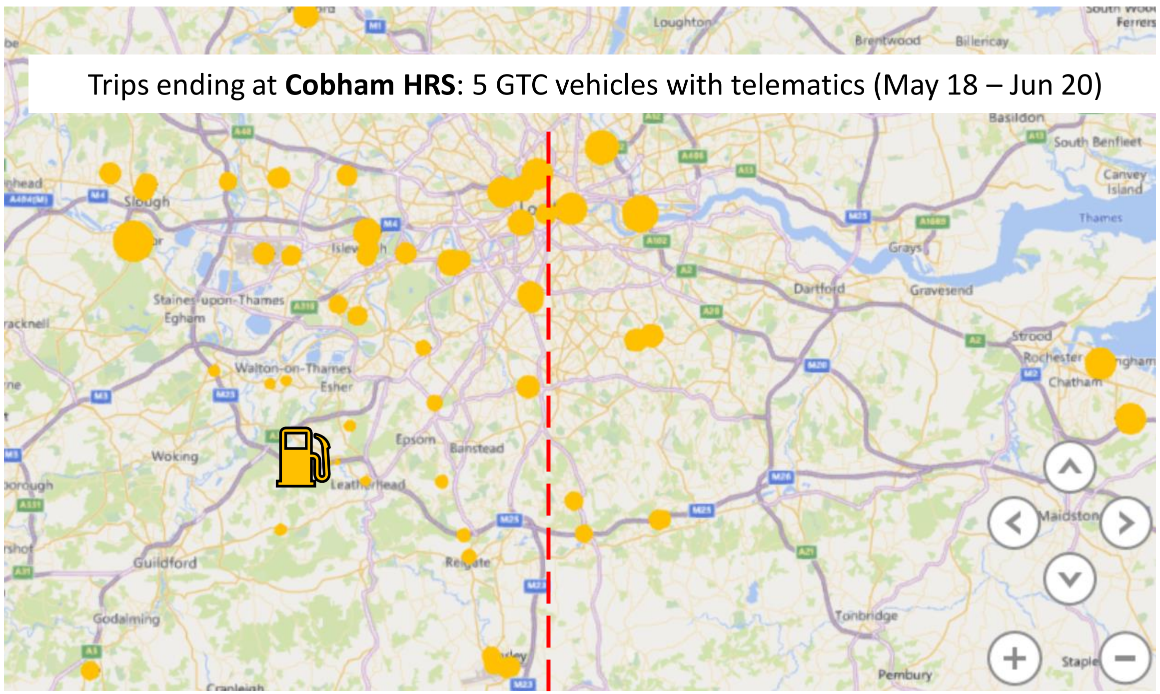
Trips ending at **Beaconsfield HRS**: 5 GTC vehicles with telematics (May 18 – Jun 20)



London
How GTC FCEVs are Being Refuelled (7)
Origin of Trips to Refuel

- Cobham is located on the M25 but, like Beaconsfield, it still gets trips from Central and West London due to its easy access via the motorway. It also attracted several trips from South London, including Gatwick airport before its HRS opened in October 2019.

Trips ending at **Cobham HRS**: 5 GTC vehicles with telematics (May 18 – Jun 20)



- Out of all the trips that ended at HRS in the west, 83, 93 and 94% of the trips (Cobham, Teddington and Beaconsfield respectively) started to the west of the red dotted line on the map.
- Out of all the trips that ended at Rainham (the only HRS in the east), 92% of the trips started to the east of the red line.
- This reflects the importance of having a back-up HRS in the East and, more generally, well-distributed HRS across several locations in the city.

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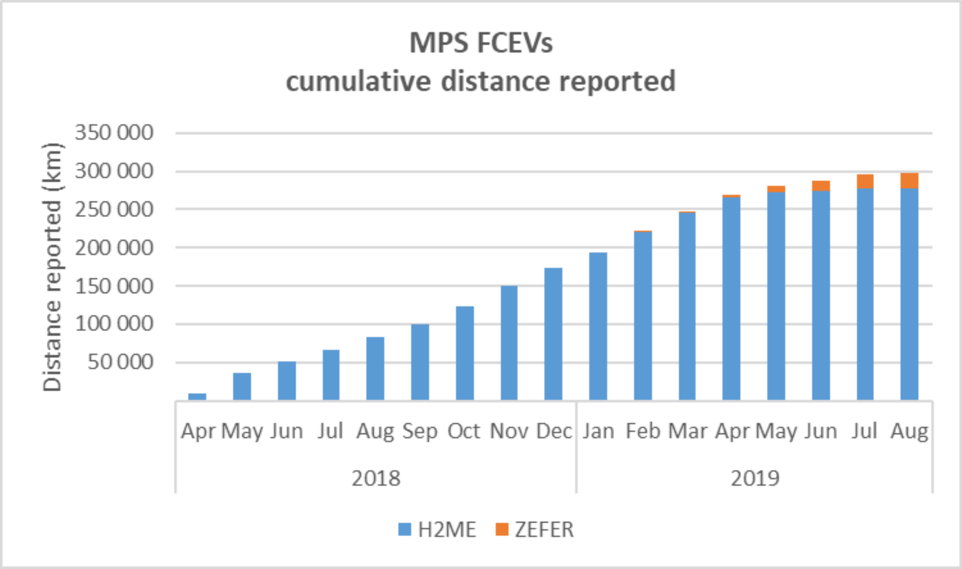
London
MPS FCEV Operation to end of August 2019



- MPS has deployed 21 FCEVs under H2ME and ZEFER.
- The vehicles have reported a total of 300 000 km driven (21 000 km for ZEFER)*.
- The cars operate in two roles:
  - ZEFER: 10 General Purpose Vehicles used for general duties.
  - H2ME: 11 Response Vehicle used to respond to emergency calls.

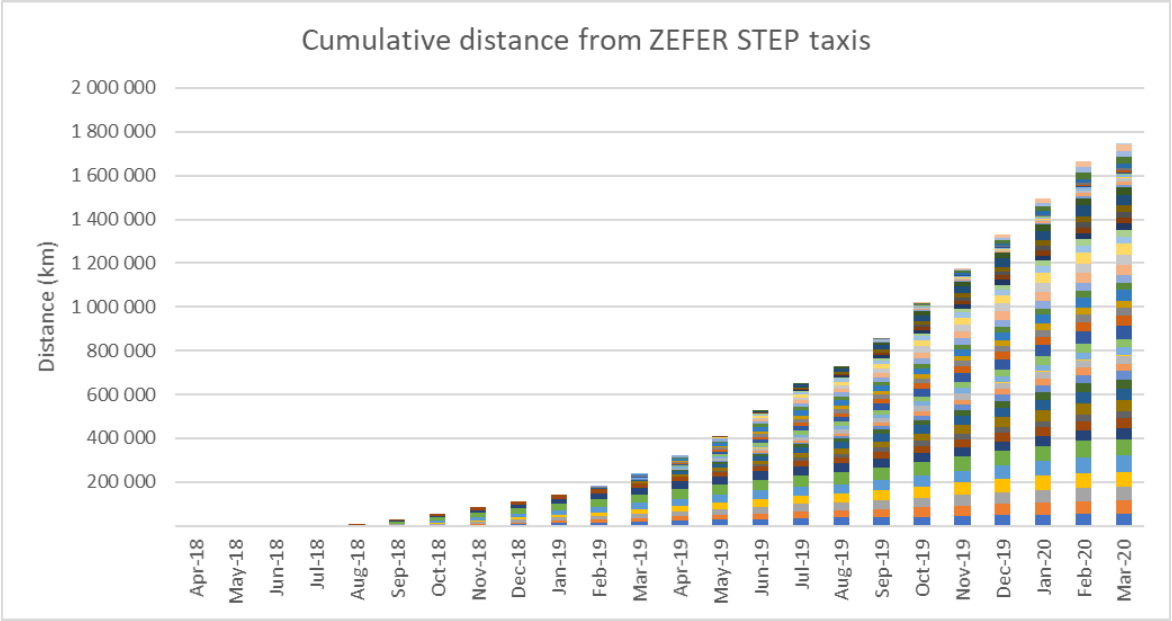
* Last data received from MPS Aug 2019.

London
Where MPS FCEVs are Refuelling

- The figure shows the amount H2ME and ZEFER MPS vehicles have refuelled so far:
  - In West London, vehicles use multiple refuelling stations (even Beaconsfield and Cobham, which are both outside the M25 therefore increasing stem mileage and time, see GTC section)
  - In East London the vehicles only use the Rainham station
  - On average, each ZEFER vehicle uses 118 kg/year, while each H2ME vehicle uses 327 kg /year
- An additional HRS will be located in Barking (East London) with an expected opening in Q4 2020. This will provide an additional local option for vehicles in the area.

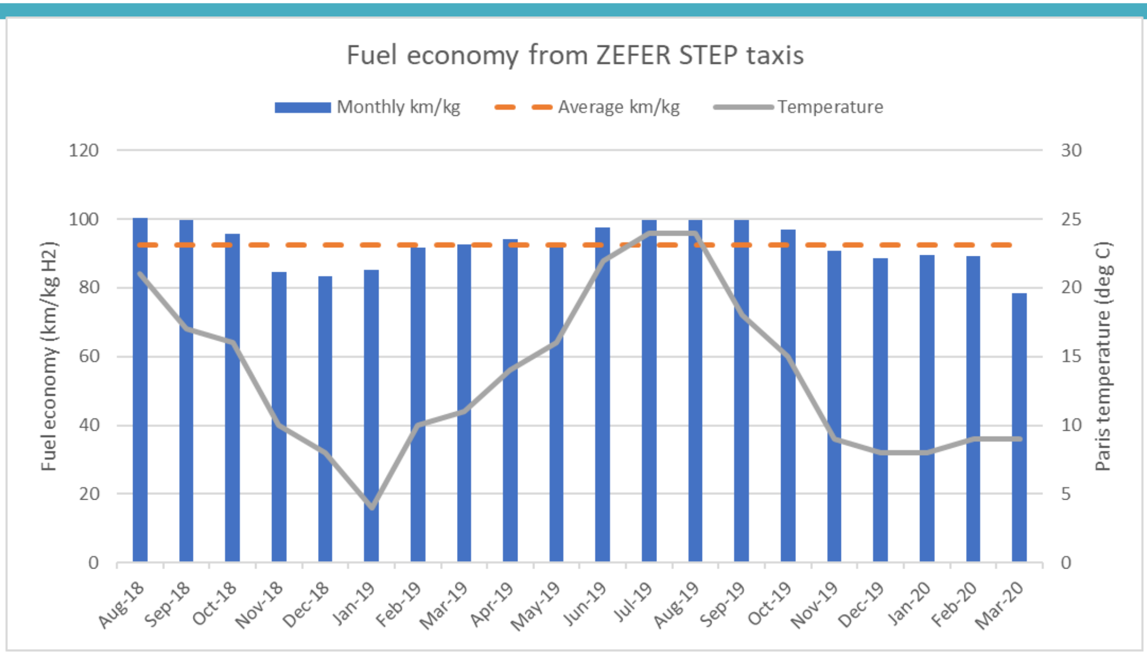
Content

Paris
FCEV Taxi Operation to end of March 2020



- French regulations stopped the taxi operation in March 2020 due to the ongoing Covid pandemic and it has not been resumed yet.
- The ZEFER Hype/STEP FCEVs have reported a total of 1 743 000 km driven (FCEV taxis supported by H2ME2 have accumulated an additional 4.31m km since June 2017).
- The ZEFER taxis drive an average of 3 260 km per month (150 km per day).
- The furthest driven by one of the vehicles in a month was 7 470 km.
- During the period, the ZEFER STEP taxis refuelled 18 900 kg of hydrogen.

Paris
How FCEV Taxis are Being Driven

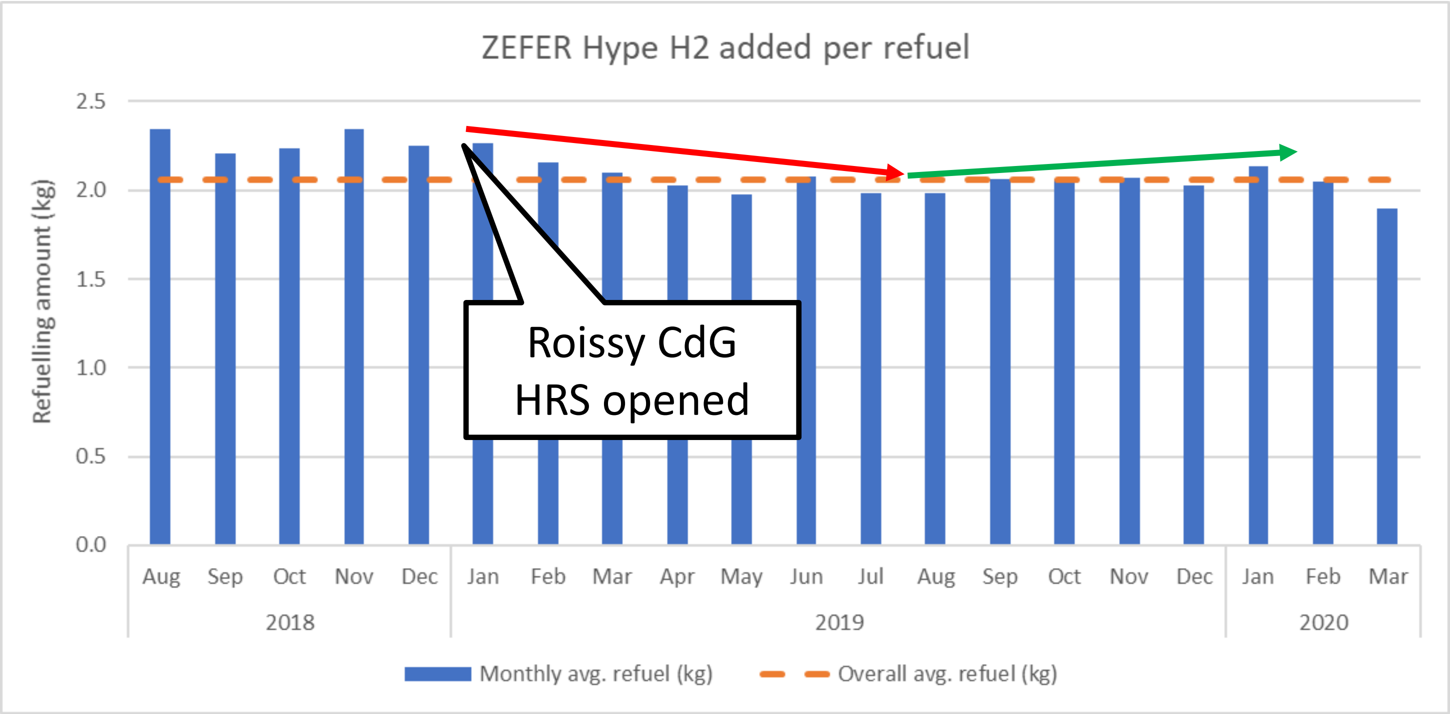


- The average fuel economy across all STEP (ZEFER) vehicles and months is **92 km/kg**, as opposed to GTC's 105 km/kg in London.
- The values for all months were within the considered reasonable range of 70 to 120 km/kg, probably because the data comes from vehicle telemetry rather than manual odometer readings or refuelling records.
- There is an evident seasonal variance in fuel economy, with a 22% difference between the worse value (78 km/kg in Mar-20) and the best (100 km/kg in Aug-18). However, there is a smaller difference of 9% between the average for the coolest months (89 km/kg from November to April) and the warmest months (98 km/kg from May to October).

Paris
Where FCEVs are Refuelling

- The figure shows the location of Air Liquide HRS around Paris and the number of kg of H_2 per year dispensed to H2ME2 and ZEFER Hype FCEVs.
- The FCEVs use all the Paris HRS, but the most popular stations are then ones located in the airports (Orly and CdG/Roissy), as the taxis refuel when they leave and pick up passengers.
- The mean distance between refuels for the ZEFER STEP taxi fleet is 197 km.

Paris
How FCEVs are being refuelled



- The overall average refuelling amount is 2.1 kg (42% of the tank capacity of 5kg).
- Amount of H_2 per refuel decreased since the opening of the Roissy/CdG HRS, likely due to drivers accessing an additional HRS in their airport jobs.

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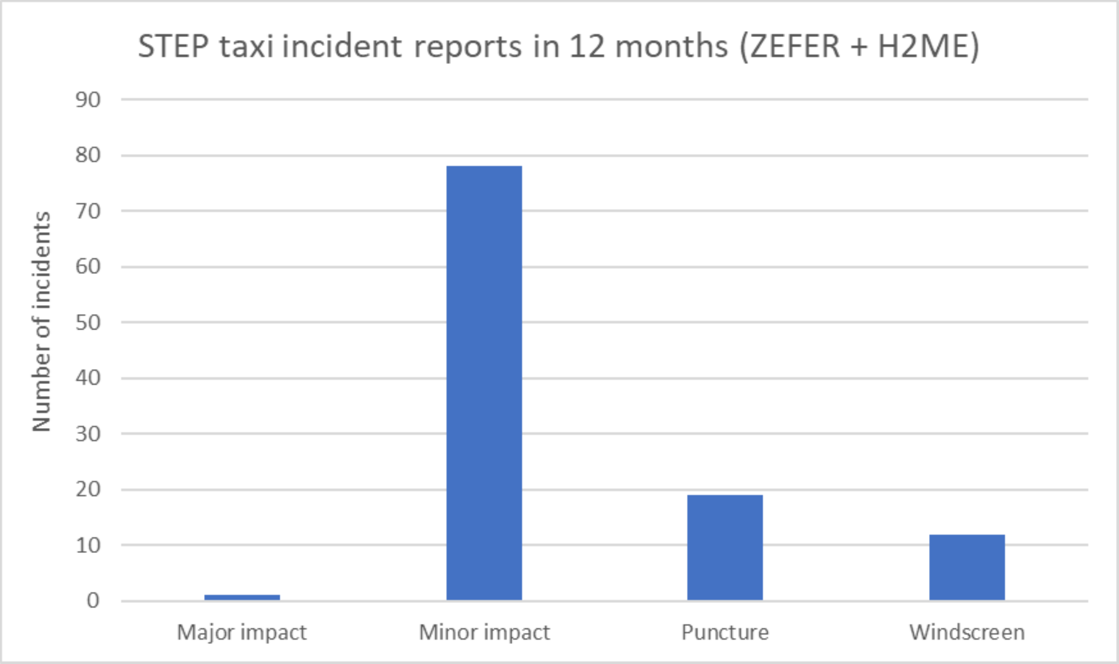

- The STEP taxis drive a lot. Inevitably, they are involved in incidents.
- The taxis have the same types of incidents as normal taxis.
- The photograph shows the scale of the major impact incident shown in the graph.
- **None of the incidents involved release of hydrogen or problems with the fuel cell system.**

FCEVs
Reliability

- Toyota Mirais are serviced every 10 000 km (or 10 000 miles in the UK):
  - 10 000 km/mile service comprises general check plus H_2 leak test.
  - Deionising filter changed every 30 000 km/miles.
  - Battery and fuel cell coolant is topped up at 100 000 km*.
- Vehicles have in practice proven to be very reliable (> 99% availability).

*Source: Toyota UK

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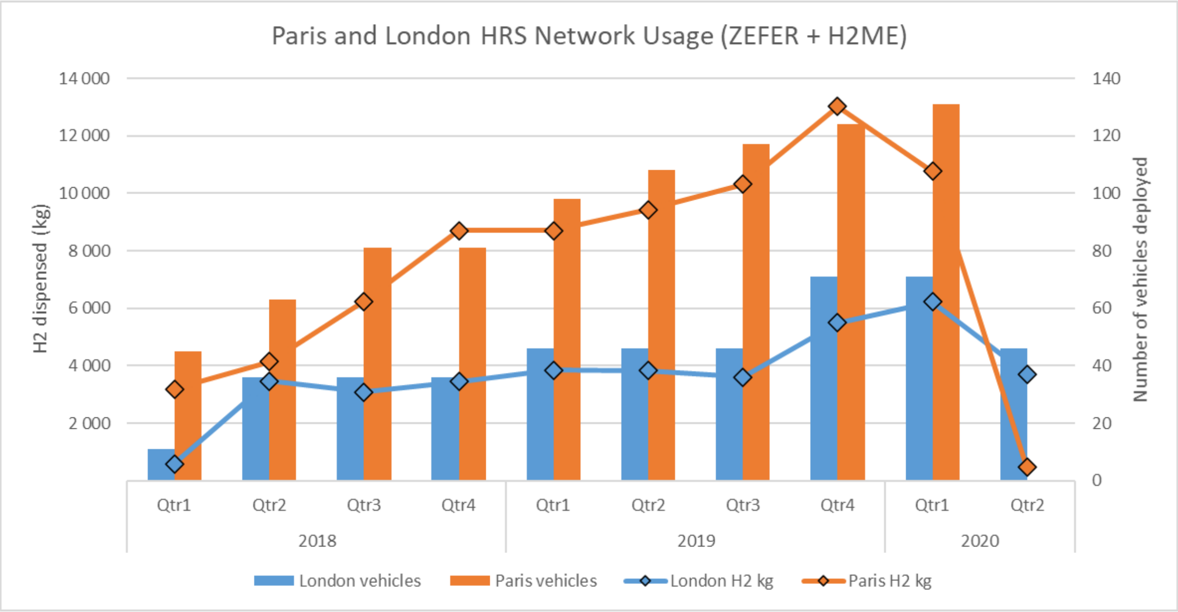
HRS Operational Monitoring

Growth in usage of the Paris and London HRS



- The graph above shows that the increase in usage and load of the London and Paris HRS network closely follows the increase of FCEV deployment as part of H2ME and ZEFER.
- The taxis in Paris stopped their operation in March 2020 due to the Covid pandemic so no hydrogen was dispensed to cars, while a small amount was dispensed to buses.
- The GTC fleet reduced operations by 50% causing a decrease in hydrogen dispensed in London.
- London HRS network: Rainham, Cobham, Teddington, Beaconsfield, Gatwick
- Paris HRS network: Orly, CdG/Roissy, Versailles

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ZEFER
Conclusions

- Toyota Mirai fuel cell electric vehicles are operating effectively as zero tailpipe-emission taxis and police vehicles in London and Paris.
- Taxis are an excellent use-case to test the high utilisations of FCEVs, and placing number of taxis in a network of multiple HRS increases station usage which helps the business case for the stations.
- Since 2017, H2ME and ZEFER FCEV taxis have driven **8.5 million km**.
- Using FCEVs as taxis requires only minor operational adjustments to keep journeys within reasonable range of refuelling stations.
- The FCEVs have proven to be reliable (> 99% availability). They are serviced every 10 000 km/miles. The vehicles have been involved in several accidents and collisions. **None of the incidents involved the release of hydrogen or problems with the fuel cell system.**
- **There have been no project HRS safety incidents reported.**
- Quantitative analysis during this project, feedback from drivers and partnership working with vehicle and station providers is being used to improve the operational efficiency of the vehicles and refuelling infrastructure.

Acknowledgements

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

ZEFER

elementenergy

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BMW

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hype

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MAIRIE DE PARIS

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