



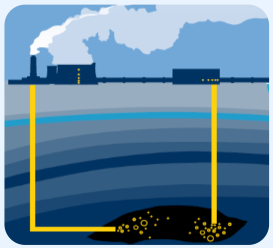



HYTEC

FCH
FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Hydrogen Transport in European Cities

Lifecycle cost analysis of fuel cell electric vehicles

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Acknowledgement

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- **Introduction**
- Lifecycle costs – consumer perspective
- Lifecycle costs – societal perspective
- Conclusions

Analysis of ownership costs of fuel cell vehicles relative to traditional cars can inform measures needed to enhance the offer to customers

Lifecycle cost analysis – introduction

- The HyTEC project demonstrated fleets of fuel cell electric vehicles (FCEVs) and hydrogen refuelling stations in urban environments in Copenhagen, London, and Oslo.
- As part of the data analysis and reporting work package, Element Energy assessed the lifecycle costs of selected fuel cell vehicles compared to comparable conventional vehicles. This report summarises the findings and forms deliverable 6.9 of the project.
- The outputs of this exercise supplement the analysis of empirical data collected through the project and the related environmental impact assessment undertaken by Fraunhofer and Matgas.
- The conclusions are aimed at vehicle producers and policy-makers and may inform targets for FCEV cost reductions / be used as evidence for support policies for hydrogen-fuelled vehicles respectively.

The lifecycle cost analysis considers the costs of a typical fuel cell passenger car from two different perspectives

Lifecycle cost analysis – overview of methodology

The lifecycle cost assessment has been undertaken focusing on the fuel cell passenger cars deployed and operated as part of HyTEC.* We have also included the results of some analysis of the lifecycle costs of fuel cell taxis in the *consumer perspective* section. Where possible real-world data from the vehicle trials have been used to inform the input assumptions to the modelling.

Costs are considered from two perspectives:

- **Consumer** – we have represented a new vehicle purchase as seen from a typical customer's perspective. Demand for FCEVs is expected to come mainly from business customers in the early stages of commercialisation (rather than private individuals), hence the analysis for OEM FCEVs focuses on the offer to a business customer. This involves representing lease payments over four years. We consider costs before VAT on the basis that VAT-registered businesses can reclaim this tax.
- **Society** – in evaluating costs from societal perspective we have captured the effects of externalities relevant to the general population. In particular, this involves putting a value on the costs of certain pollutants in accordance with EC Directive 2009/33/EC.

The analysis was undertaken in the UK and all costs are reported in GBP.

* The rationale for focusing solely on the OEM passenger cars rather than the other vehicle types in the project is that these are the vehicles closest to commercialisation and with the largest potential market.

- Introduction
- **Lifecycle costs – consumer perspective**
  - OEM passenger cars
  - Fuel cell taxis
- Lifecycle costs – societal perspective
- Conclusions

Calculating lifecycle costs from consumers’ perspectives

Lifecycle cost analysis from a customer’s perspective – methodology

A cash flow model has been used to calculate the lifecycle cost over four years, which is a a typical lease period for OEM passenger cars. The model accounts for the costs of acquiring and running an FCEV and an equivalent diesel (internal combustion engine) vehicle. Comparing the total costs of ownership over the lease period allows us to explore the relative lifecycle costs.

The costs included in the model are:

- **Capex** – total capital costs of the vehicle including any disposal costs and residual value. Capital costs are converted into annual lease payments spread evenly over the lease period.*
- **Financing cost** – cost of capital to finance the lease (based on an 8% annual rate).
- **Fuel** – diesel / hydrogen cost – based on assumptions regarding vehicle efficiency (tank-to-wheel) and fuel costs.
- **Maintenance** – servicing and repair costs, including costs of consumables.
- **Insurance** – an allowance for insurance is included. In practice insurance premiums can vary significantly depending on a range of factors.
- **VED** – vehicle excise duty, an annual tax levied on most motor vehicles in the UK.
- **Other** – a category to cover costs such as parking, congestion charge, etc.

The model represents the discounting behaviour of consumers with a discount rate of 10%.

The lifecycle costs of fuel cell taxis have been calculated in a similar way to those for the OEM passenger cars. The main difference is that rather than representing a lease, the vehicle cost is modelled as an outright purchase.

* Leases commonly involve an up-front payment of an amount equivalent to six months’ lease costs followed by equal monthly payments to the end of the term. This level of detail is not represented (the effect on overall results is small).

- Introduction
- **Lifecycle costs – consumer perspective**
  - **OEM passenger cars**
  - Fuel cell taxis
- Lifecycle costs – societal perspective
- Conclusions

The lifecycle cost calculations are based on a range of vehicle cost and performance assumptions

FCEV lifecycle cost calculation (consumer perspective) – baseline assumptions (Hyundai ix35)

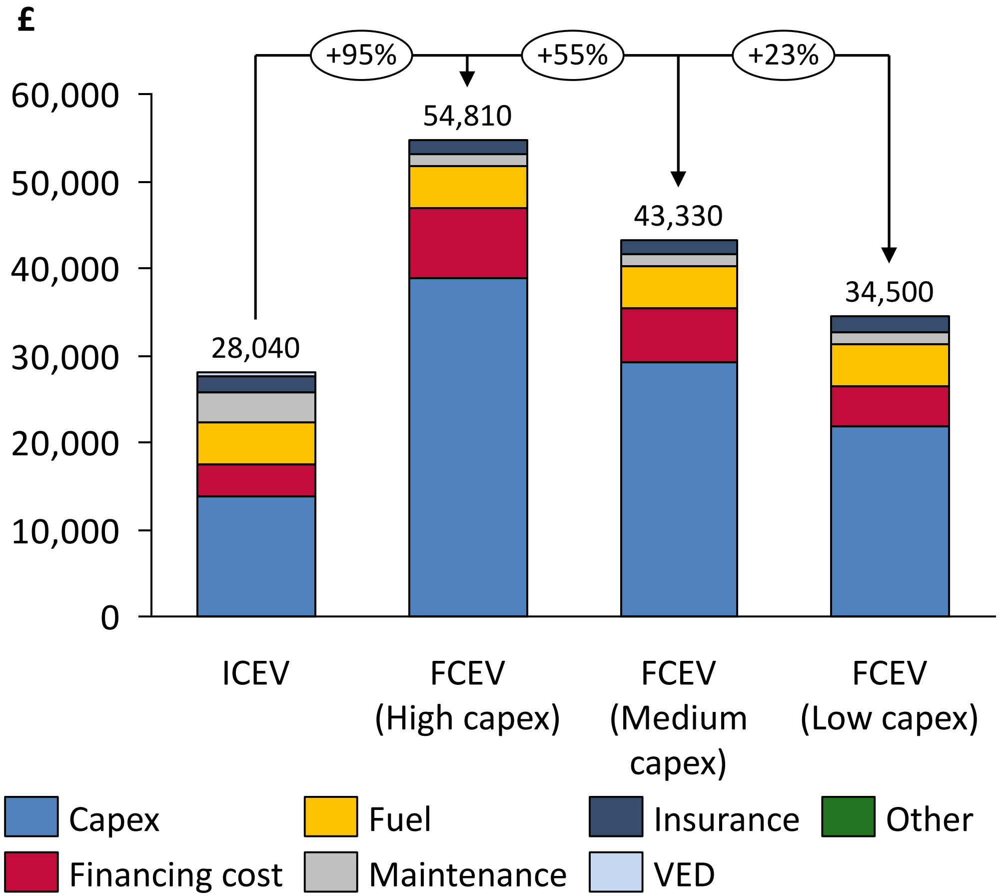
Input assumption	ICEV	FCEV	Notes
Capital cost (ex. VAT)	£20k	£25k, £33.3k, £44k	A scenario approach to FCEV price has been used. The highest figure corresponds to an on-the-road price of around £53k, which is the price for the ix35 FC published by Hyundai UK in 2015.
Residual value after four years	25%	0%	RVs for FCEVs are not yet known with a high degree of certainty. As a conservative assumption the base case includes no RV for FCEVs.
Fuel consumption	7 litres/100km	1.25 kgH_2/100km	ICEV consumption corresponds to around 40mpg, a typical real-world figure for a diesel ix35. FCEV consumption based on real-world trial results.
Fuel price (ex. VAT)	£1.00/litre	£5.50/kgH_2	Hydrogen price selected to give a small fuel cost saving (p/km basis) relative to diesel. This price is consistent with the €10/kg target of pre-commercial demonstration projects. Note that this hydrogen price is indicative – at the time of writing there is no real market for hydrogen as a transport fuel, hence prices tend to be agreed on a bilateral basis between suppliers and consumers.
Mileage	20,000km/yr	20,000km/yr	Typical average annual mileage of 12,500 miles/yr.
Maintenance	£1,000/yr	£400/yr	ICEV figure is a typical amount for servicing, repairs, and consumables. The FCEV maintenance figure is lower as the capital / lease cost includes servicing.
Insurance	£500/yr	£500/yr	Indicative allowance for vehicle insurance, based on the assumption that there is little difference between ICEVs and FCEVs.*
VED	£140/yr	£0/yr	Assumption that VED exemption for zero emission vehicles will continue to apply to FCEVs.

* There is a chance that insurance premiums for FCEVs will be higher than for equivalent ICEVs due to the higher prices of these vehicles in the early years of commercial deployment.

The FCEV lifecycle cost premium is c.25%–95% over a conventional car for the three capital cost levels considered in the baseline

Lifecycle cost analysis (consumer perspective) – baseline results

Total cost of ownership of FCEVs of different capex vs. a traditional diesel car (four year lease)



- While FCEV capital costs are high there will be a significant lifecycle cost premium for these vehicles relative to conventional ICEVs.
- The capital costs of FCEVs tend to dominate the lifecycle costs – e.g. in the "High" case (FCEV capex of c.£44k ex. VAT) capex is 70% of the total ownership cost over four years. When financing cost is also included this rises to 85%.
- Policy interventions can be used to reduce the cost to consumers (see below).

"Other" is a category used to cover costs that are specific to a particular end user (e.g. parking charges, congestion charges, etc.).

Options for reducing FCEV capital costs to end users include lower price levels, underwriting residual values, and grant funding

Residual value and capital grant scenarios – introduction

The baseline results presented above include a residual value of the internal combustion engine (diesel) vehicle of 25% after four years, whereas the FCEV is assumed to be depreciated to zero value over this period. This conservative assumption is included as there is a lack of certainty regarding the potential used market for FCEVs.

The results below show the impact of more favourable assumptions regarding the residual values of FCEVs – we consider three scenarios:

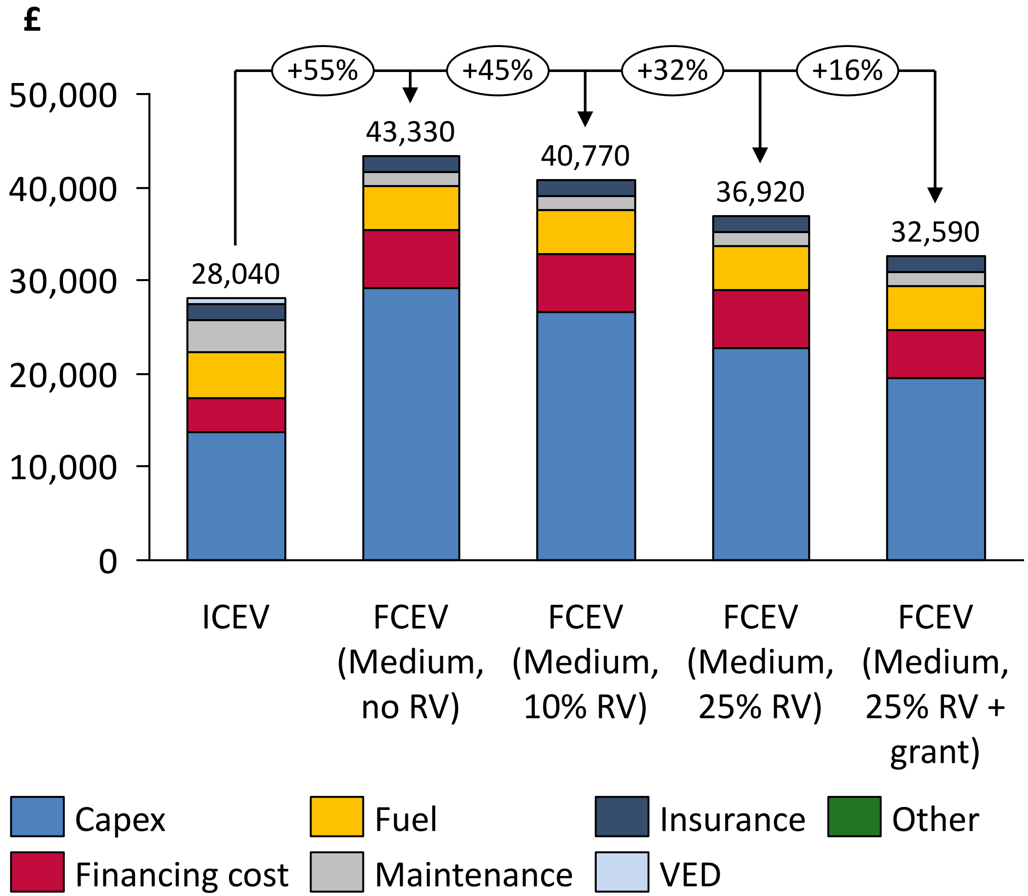
- **10% RV** – a residual value of 10% of the initial capital cost is factored in at the end of the four year lease period.
- **25% RV** – a residual value of 25% of the initial capital cost is factored in at the end of the four year lease period.
- **25% RV + grant** – this scenario includes a residual value of 25% of the initial capital cost and a £5,000 capital grant that reduces the FCEV cost to the end user.

All scenarios are based on the “Medium” capex level for FCEVs.

Factoring in a residual value (RV) for FCEVs could be worth £000s over the lifecycle and thus help to bridge the ownership cost gap

Lifecycle cost analysis (consumer perspective) – effect of residual values of FCEVs

Total cost of ownership of FCEVs vs. a traditional diesel car (four year lease)



- These results demonstrate that while factoring in a residual value for FCEVs improves the economic offer to customers, this alone is insufficient to fully close the TCO gap relative to ICEVs.
- To get close to TCO parity with ICEVs, FCEVs will need a combination of measures, e.g. a price reduction (from an OEM discount or capital grant, if available) and some level of residual value guarantee.
- Residual values of vehicles are usually factored in to lease rates offered to customers.

"Other" is a category used to cover costs that are specific to a particular end user (e.g. parking charges, congestion charges, etc.).

In some circumstances discounts on local charges for zero emission vehicles could significantly enhance the FCEV offer

Parking / congestion charging costs – introduction

On-going running costs of vehicles in the UK typically include fuel, insurance, servicing / maintenance, and taxes such as vehicle excise duty. Some end users are exposed to additional costs that tend to vary depending on the usage profile of the vehicle – e.g. parking charges, congestion charge (for operating in central London), tolls for using certain roads, bridges, etc.

Providing reductions in / exemptions from these types of charges is one method of lowering the cost of ownership of zero emission vehicles such as FCEVs and thus enhancing the offer to potential customers.

To understand the scale of the impact of changes to such charges on ownership costs we have defined the following scenarios:

- **C-Charge discount** – baseline assumptions but with an additional annual cost of £2,100 for the ICEV, which corresponds to operating in London's Congestion Charge zone 200 days per year (at £10.50/day). FCEVs are exempt from the Congestion Charge.
- **Parking discount** – assumptions are as per the baseline case, but with an additional annual cost of £4,630 / £1,434 for parking for ICEVs / FCEVs respectively.*

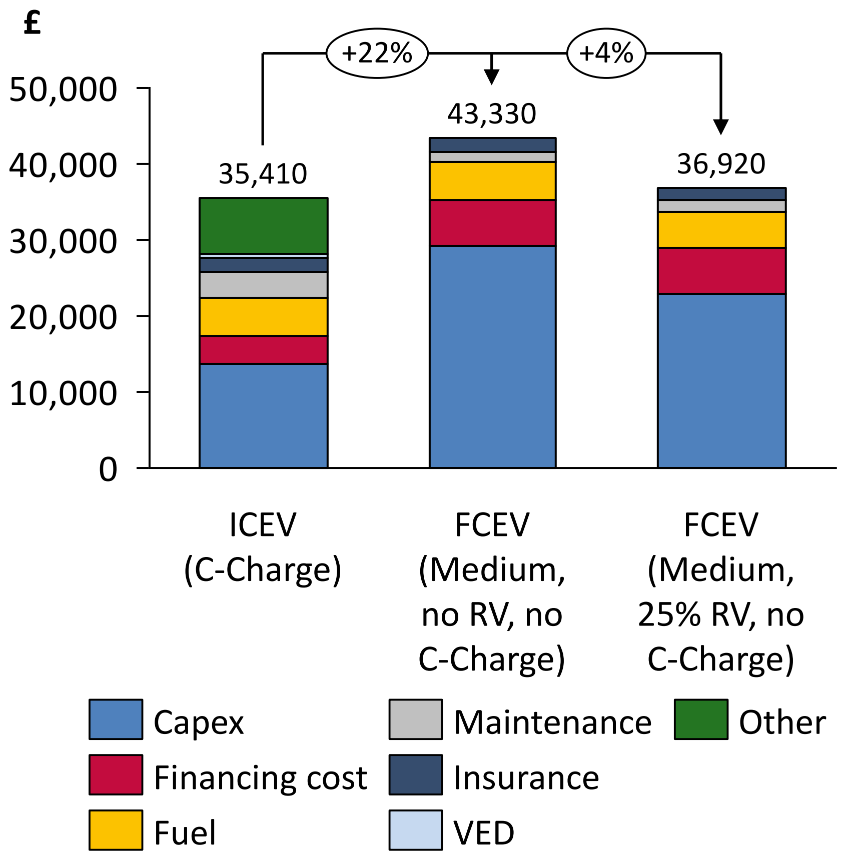
Both scenarios are based on the "Medium" capex level for FCEVs and results are given with residual values (RV) of 0% / 25%.

* These figures are based on the costs of an annual season pass for parking in a central London car park. One car park operator offers a discount for zero emission vehicles, as indicated in these assumptions.

Exemption from London's Congestion Charge significantly improves the case for FCEVs for companies that regularly pay the charge

Lifecycle cost analysis (consumer perspective) – effect of congestion charges

Total cost of ownership of FCEVs vs. a traditional diesel car (four year lease)



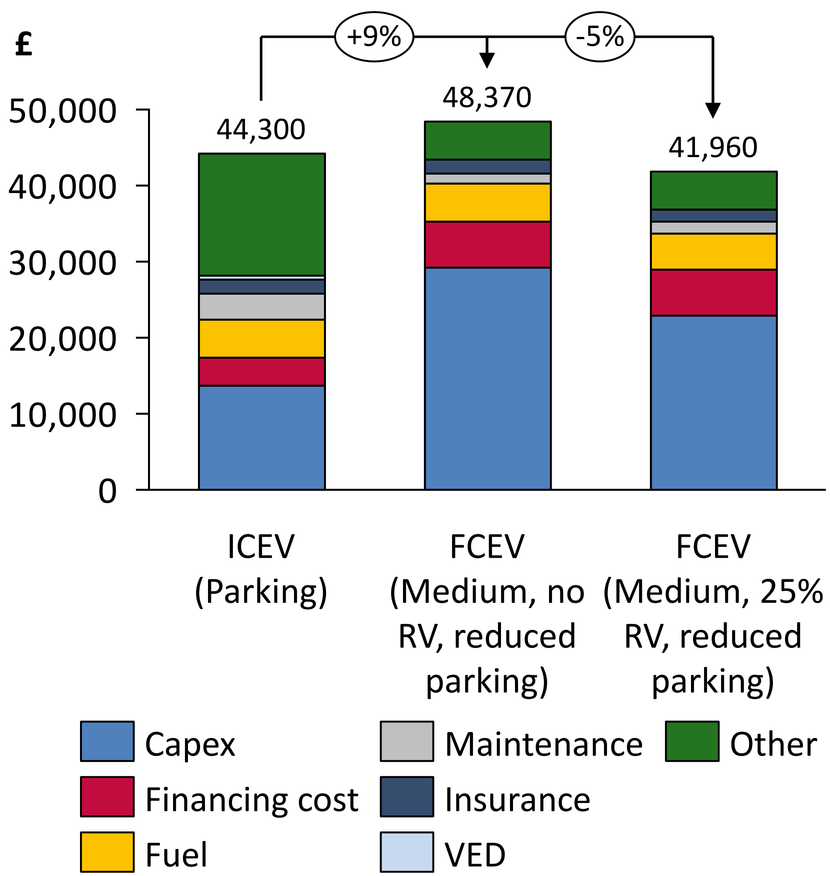
- These results correspond to a car that enters the Congestion Charge zone around four days per week on average.
- At the current rates, this adds £000s to the total running costs over four years.
- Exemption from this charge for FCEVs reduces the cost premium, but Congestion Charge relief alone is insufficient to reach parity with ICEVs at the capital cost levels considered here.
- Other ultra low emission cars also quality for C-Charge exemption and the choice of FCEVs over alternatives would be influenced by a range of factors (vehicle specification, duty cycles, availability of recharging / refuelling infrastructure, etc.).

"Other" is a category used to cover costs that are specific to a particular end user (e.g. parking charges, congestion charges, etc.).

Reductions in local taxes / charges (e.g. parking costs) offer another potential mechanism for improving the FCEV offer

Lifecycle cost analysis (consumer perspective) – effect of parking charges

Total cost of ownership of FCEVs vs. a traditional diesel car (four year lease)



- In these *parking* scenarios the cost of an annual pass for a central London car park is added to the vehicle running costs.
- Some car park operators offer significant discounts on season passes for parking for zero emission vehicles.
- These results demonstrate that in some (extreme) cases relief from these types of local costs could be sufficient to nearly fully offset the additional capital cost of an FCEV.
- Any customer factoring in such discounts would need to seek assurances that they will be available over the whole lease period – i.e. it may not be sustainable to continue offering large discounts to zero emission vehicles once uptake reaches a certain level.

"Other" is a category used to cover costs that are specific to a particular end user (e.g. parking charges, congestion charges, etc.).

- Introduction
- **Lifecycle costs – consumer perspective**
  - OEM passenger cars
  - **Fuel cell taxis**
- Lifecycle costs – societal perspective
- Conclusions

Calculation of lifecycle costs of fuel cell vs. diesel taxis is based on a range of input assumptions

FC taxi lifecycle cost calculation (consumer perspective) – baseline assumptions

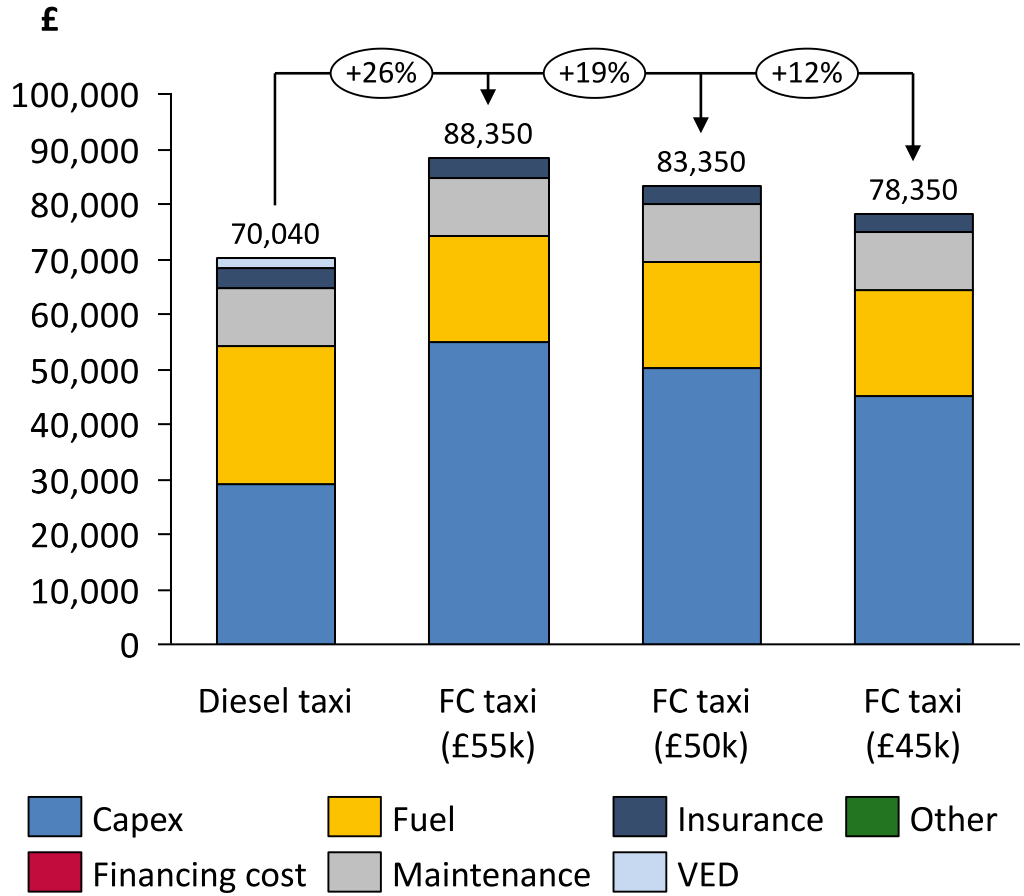
Input assumption	Diesel taxi	FC taxi	Notes
Capital cost (inc. VAT)	£36k	£55k / £50k / £45k	Diesel taxi figure based on the TX4. Note that the FC taxi cost range is an indicative estimate that is consistent with an assumption used in the *Hydrogen Transport Strategy for London* (Element Energy, June 2014). Actual cost data for FC taxis are not available as no such vehicles are currently being produced for sale.
Residual value after four years	25%	0%	RVs for FCEVs are not yet known with a high degree of certainty. As a conservative assumption the base case includes no RV for FCEVs.
Fuel consumption	10.25 litres/100km	1.43 kgH_2/100km	ICEV consumption corresponds to around 27mpg, a typical real-world figure for a diesel taxi and consistent with HyTEC trial results. FCEV consumption based on real-world trial results. These figures are tested as a sensitivity.
Fuel price (ex. VAT)	£1.00/litre	£5.50/kgH_2	Hydrogen price based on indicative figure assumed for the OEM FCEV analysis above. Note that this hydrogen price is indicative – at the time of writing there is no real market for hydrogen as a transport fuel, hence prices tend to be agreed on a bilateral basis between suppliers and consumers.
Mileage	70,000km/yr	70,000km/yr	Average annual mileage of c.44,000 miles/yr, which is typical for a well-used London taxi.
Maintenance	£3,000/yr	£3,000/yr	Indicative maintenance for taxis covering c.70,000km/yr, with an assumption of little difference in costs between the two types of powertrain.
Insurance	£1,000/yr	£1,000/yr	Indicative allowance for vehicle insurance, based on the assumption that there is little difference between ICEVs and FCEVs.*
VED	£490/yr	£0/yr	Assumption that VED exemption for zero emission vehicles will continue to apply to FCEVs.

* There is a chance that insurance premiums for FCEVs will be higher than for equivalent ICEVs due to the higher prices of these vehicles in the early years of commercial deployment.

The FC taxi lifecycle cost premium is c.25%–12% over a conventional taxi for the three capital cost levels considered in the baseline

Lifecycle cost analysis (consumer perspective) – baseline results for FC taxi

Total cost of ownership of FC taxis of different capex vs. a traditional diesel taxi (four year ownership period)



- Under the assumptions summarised above the higher capex of the FC taxi is partly offset through lower running cost.
- This is due to fuel cost savings and exemption from VED.
- However, fuel cost savings are highly sensitive to hydrogen price and these results are based on a price of £6.60/kg (inc. VAT). Higher hydrogen prices, which may be seen in the near term as hydrogen fuelling infrastructure is under-utilised, would reduce / eliminate this benefit.

"Other" is a category used to cover costs that are specific to a particular end user (e.g. parking charges, congestion charges, etc.).

Average fuel efficiency is sensitive to a range of factors and we have taken a scenario approach to understand the effect on lifecycle cost

Fuel efficiency sensitivity testing – introduction

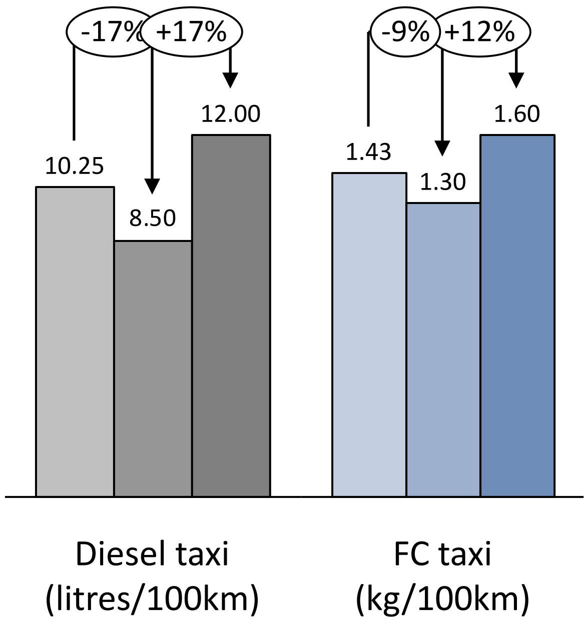
The average fuel efficiency of taxis can vary significantly depending on the types of route and traffic conditions encountered.

To explore the impact of this on lifecycle costs we have defined two further scenarios in which fuel efficiency assumptions are based on results of real-world trials of taxis operating in London in summer 2014.

- **High fuel consumption** – all assumptions are as per the baseline apart from fuel efficiency of the diesel and fuel cell taxis, which are changed to 12 litres/100km and 1.6 kgH_2/100km respectively. These figures correspond to the worst case (highest) figures seen in the trial results and correspond to urban driving with low average speeds (27km/hr).
- **Low fuel consumption** – as above, but with fuel efficiency assumptions set to 8.5 litres/100km and 1.3 kgH_2/100km respectively. These figures correspond to the best case (lowest) figures seen in the trial results and correspond to driving with little stopping and relatively high average speed (47km/hr).

Both scenarios are based on the £55k capex level for FC taxis.

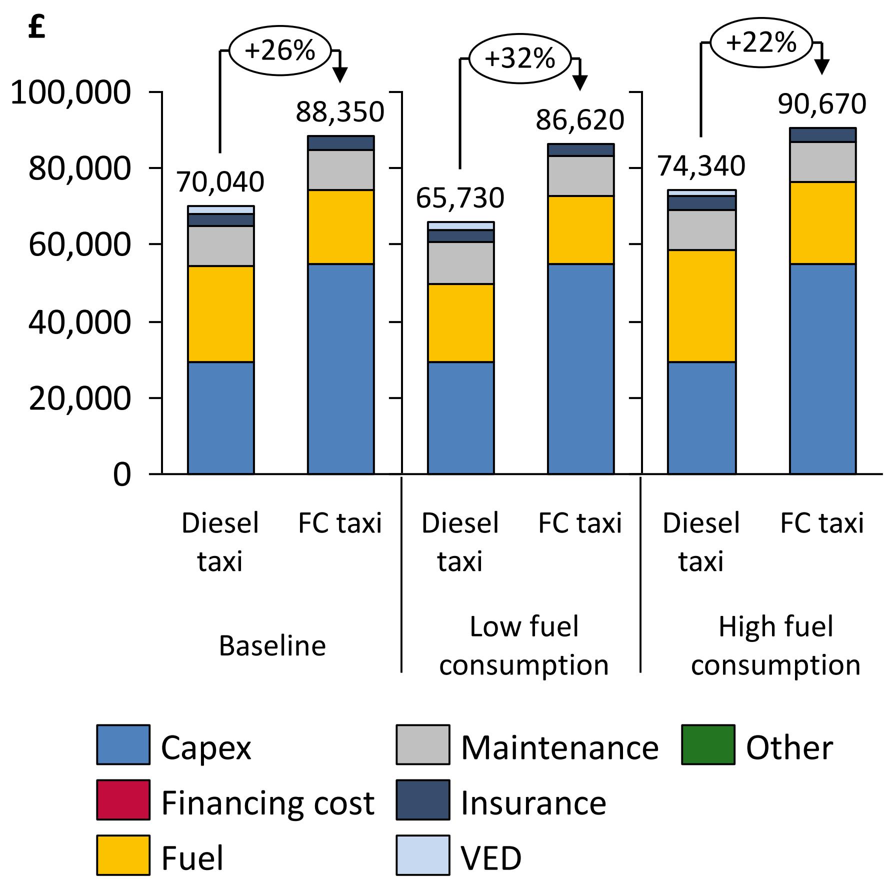
Fuel efficiency assumptions: baseline / low / high



Variations in fuel efficiency may affect the relative lifecycle costs but the changes are small relative to the overall cost premium of FC taxis

Lifecycle cost analysis (consumer perspective) – fuel efficiency sensitivity testing

Total cost of ownership of FC taxis vs. a traditional diesel taxi (four year ownership period)



- Under the *low fuel consumption* scenario the TCO premium for the FC taxi over the standard diesel taxi increases relative to the baseline results. This is due to a greater reduction (in % terms) in assumed fuel consumption for the diesel taxi compared to the FC taxi (see previous slide).
- The opposite is true in the case of the *high fuel consumption* scenario.
- The lower variation in average fuel consumption with type of drive-cycle for the FC taxi compared to the diesel vehicle (roughly +/- 10% vs. +/- 17%) could be a positive selling point – i.e. drivers should have greater certainty over expected real-world efficiency (and hence fuel costs) if using a hydrogen fuel cell taxi.

"Other" is a category used to cover costs that are specific to a particular end user (e.g. parking charges, congestion charges, etc.).

- Introduction
- Lifecycle costs – consumer perspective
- **Lifecycle costs – societal perspective**
- Conclusions

Calculating lifecycle costs from society's perspective

Lifecycle cost analysis from society's perspective – methodology

The cost analysis from a societal point of view is carried out in accordance with **Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles**, which *"requires contracting authorities, contracting entities as well as certain operators to take into account lifetime energy and environmental impacts, including energy consumption and emissions of CO_2 and of certain pollutants, when purchasing road transport vehicles with the objectives of promoting and stimulating the market for clean and energy efficient vehicles and improving the contribution of the transport sector to the environment, climate and energy policies of the Community."**

This Directive sets out a methodology for calculating the following over the lifetime of a vehicle:

- **Energy consumption** – based on fuel consumption per km (MJ/km) multiplied by *the lower of the cost per unit of energy of petrol or diesel before tax when used as a transport fuel*.
- **Emissions** of CO_2, NOx, non-methane hydrocarbons (NMHC), and particulate matter (PM).

For the purposes of calculating lifecycle costs from a societal point of view we consider only the capital costs of the vehicles and the lifetime costs associated with these metrics. Details assumptions are summarised below.

* Directive 2009/33/EC, Article 1, Subject matter and objectives.

Lifecycle cost calculations from society's perspective – overview of assumptions

FCEV lifecycle cost calculation (society's perspective) – baseline assumptions (Hyundai ix35)

Input assumption	ICEV	FCEV	Notes
Capital cost (ex. VAT)	£20k	£25k, £33.3k, £44k	A scenario approach to FCEV price has been used. The highest figure corresponds to an on-the-road price of around £53k, which is the price for the ix35 FC published by Hyundai UK in 2015. The residual value at end of life is assumed to be £0 for both drivetrain types.
Fuel consumption	5.6 litres/100km	1.0 kgH_2/100km	Figures based on NEDC test results – Directive 2009/33/EC states that "*fuel consumption (…) shall be based on standardised Community test procedures*".
Fuel cost	£0.043/kWh	£0.043/kWh	This is the pre-tax cost of diesel in the UK (based on an average pump price of 121p/litre in mid-2015)*, which includes duty of 57.95p/litre and 20% VAT. Article 6 of Directive 2009/33/EC states that *a single monetary value per unit of energy shall be used. This single value shall be the lower of the cost per unit of energy of petrol or diesel before tax when used as a transport fuel*.
Lifetime mileage	200,000km	200,000km	From Table 3 of the Annex of Directive 2009/33/EC.
CO_2 emissions	147g/km	0.0g/km	Tailpipe emissions (NEDC).
NOx emissions	0.180g/km	0.0g/km	Tailpipe emissions – based on EURO V standard, which the diesel version of the ix35 meets.
NMHC emissions	0.000g/km	0.0g/km	Tailpipe emissions – based on EURO V standard, which the diesel version of the ix35 meets.
PM emissions	0.005g/km	0.0g/km	Tailpipe emissions – based on EURO V standard, which the diesel version of the ix35 meets.

* Source: www.theaa.com/motoring_advice/fuel/

Directive 2009/33/EC provides factors for calculating the cost to society of emissions from road transport

Cost of emissions – baseline assumptions

Input assumption	EURO/g (2007 prices)	£/kg (2015 prices)	Notes
CO_2 emissions	0.000035	0.028	EURO/g values from Table 2 of the Annex of Directive 2009/33/EC, converted to £ (2015) using CPI inflation* and a conversion factor of 1.4 EURO/GBP.
NOx emissions	0.0044	3.582	
NMHC emissions	0.001	0.814	
PM emissions	0.087	70.818	

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DIRECTIVES

DIRECTIVE 2009/33/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 23 April 2009

on the promotion of clean and energy-efficient road transport vehicles

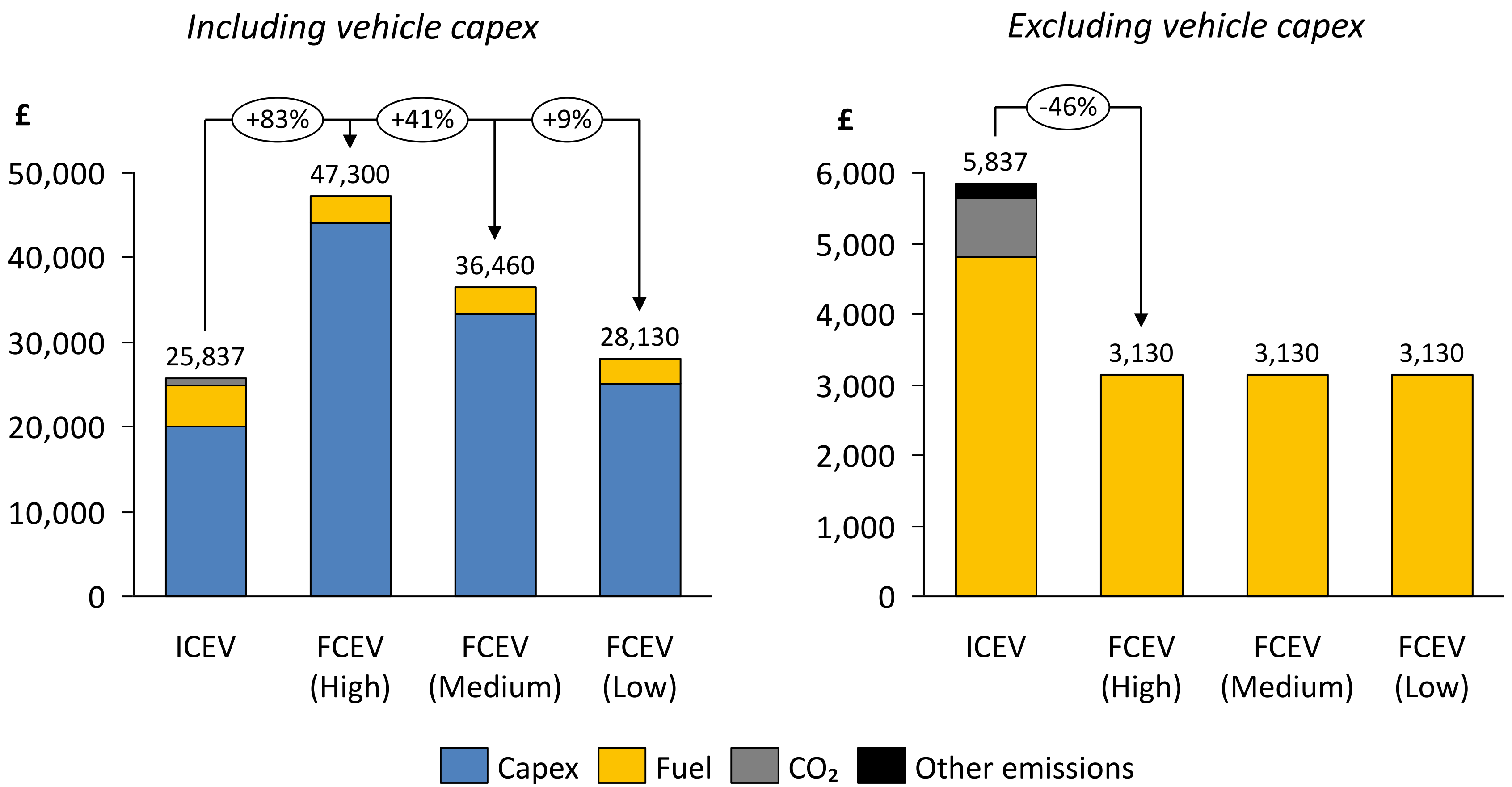
(Text with EEA relevance)

* Historical inflation rates from www.rateinflation.com.

Under the above assumptions FCEVs have a lower cost to society on a running cost basis, but the savings do not offset the higher capex

Lifecycle cost analysis (societal perspective) – baseline results

Lifetime costs of FCEVs of different capex vs. a traditional diesel car according to 2009/33/EC



We have also explored the impact of the gap between certified emissions levels and real world performance

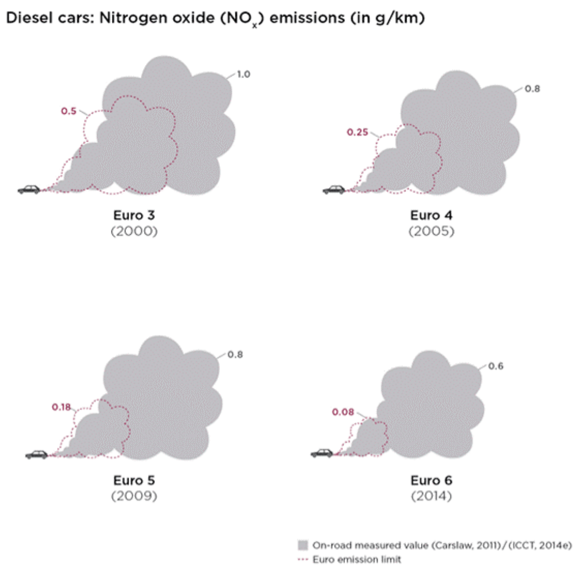
Lifecycle cost analysis (societal perspective) – sensitivity testing

The baseline results above are calculated on the basis that the internal combustion engine (diesel) vehicle has emissions in line with standardised test results (the New European Drive Cycle) and EURO V standards.

However, there is increasing evidence of a significant difference between test cycle and real-world emissions – e.g. the International Council on Clean Transportation (ICCT) has published a number of studies on this topic.

We have therefore investigated the impact of real-world emissions on the lifecycle costs of ICEVs compared to FCEVs. The following results correspond to the "Medium" capex FCEV for two scenarios:

- **Baseline** – assumptions as set out above, including tailpipe emissions in line with EURO V / NEDC levels (147gCO_2/km, 0.18g/km NOx).
- **Real world** – assumed emission levels for ICEVs increased to represent real-world values. For the purposes of sensitivity testing we have assumed 196gCO_2/km (an increase of one third on the NEDC value) and 0.80g/km NOx. Fuel consumption figures also increased (to 7 l/100km / 1.25 kgH_2/100km).

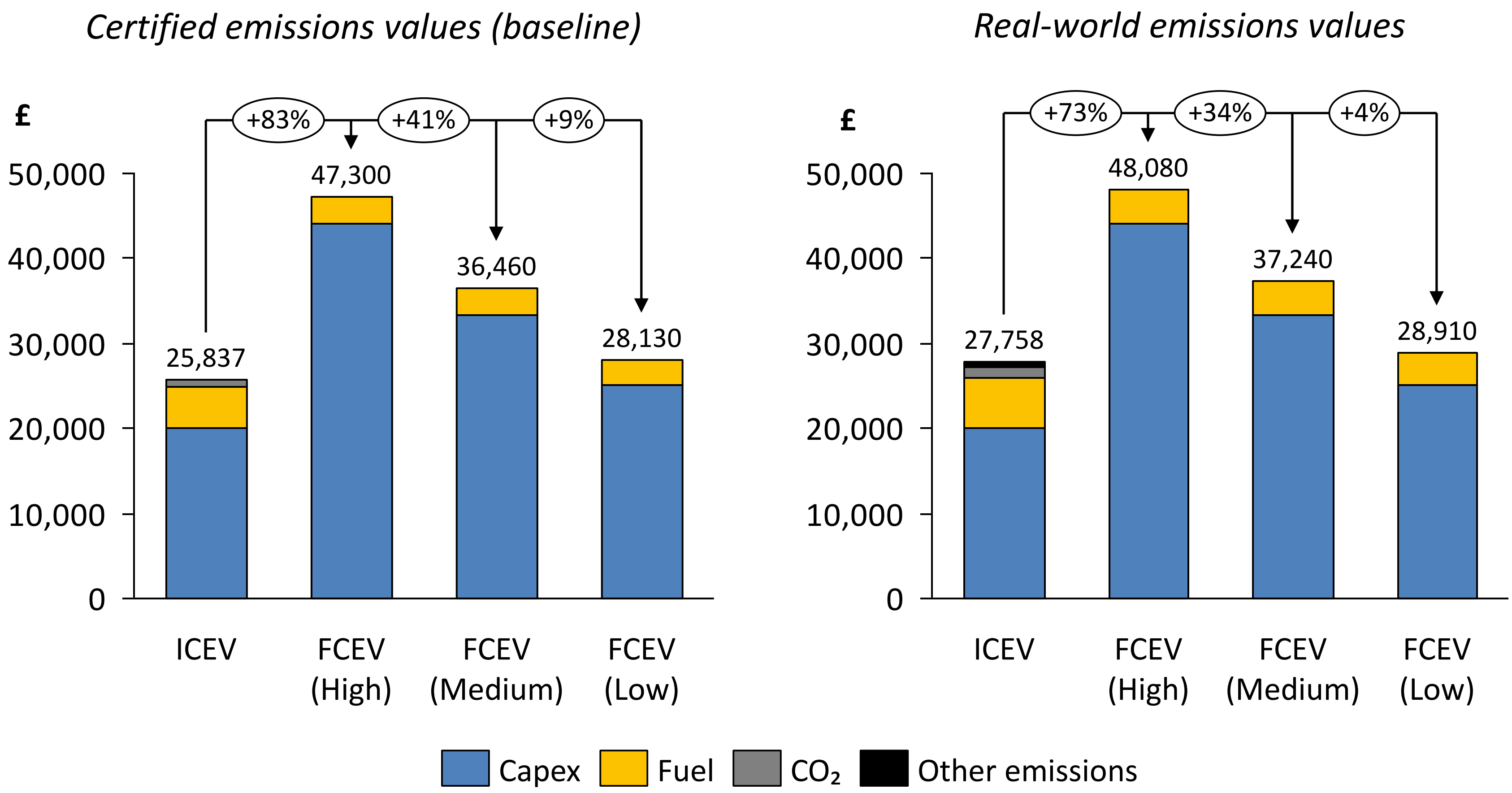


Source: www.theicct.org/news/press-release-new-icct-study-shows-real-world-exhaust-emissions-modern-diesel-cars-seven-times

Accounting for real-world fuel consumption and emissions levels, the low priced FCEV is close to cost parity with the ICEV over its lifecycle

Lifecycle cost analysis (societal perspective) – real-world emissions

Lifetime costs of FCEVs of different capex vs. a traditional diesel car according to 2009/33/EC



- Introduction
- Lifecycle costs – consumer perspective
- Lifecycle costs – societal perspective
- **Conclusions**

While high cost FCEVs are likely to lead to a lifecycle cost premium over ICEVs, various measures can be used to reduce the gap

Lifecycle cost analysis of fuel cell electric vehicles – conclusions (1)

- The analysis above suggests that at pricing levels announced by some of the vehicle OEMs first launching FCEVs in the UK there is likely to be a **significant gap in lifecycle costs** from the perspectives of consumers and society as a whole when compared against traditional vehicles.
- This is in line with other studies and is consistent with the early commercial phase of other low emission technologies – i.e. FCEVs have not yet benefited from development of multiple generations of series production vehicles or the economies of scale associated with widespread deployment.
- Under baseline assumptions the lifecycle cost premium for a zero emission FCEV priced at around £44k (ex. VAT) over an equivalent diesel car is close to 100% – i.e. consumers are faced with the prospect of **double the ownership costs** of an ICEV for an FCEV. When viewed from a societal perspective there is also a significant premium (c.+80%) at this price level, with the higher capital cost being the main cause.
- There are various ways in which the cost premium for FCEVs to consumers can be reduced, e.g. **discounts** / **residual value guarantees** from the OEMs, **capital grants** from governments seeking to encourage the uptake of zero emission vehicles, and preferential rates for FCEVs on local costs such as **congestion charges**, **parking rates**, **road / bridge tolls**, etc.
- Depending on the profile of the vehicle end user, such measures could significantly reduce the cost premium, or even eliminate it altogether.*

* NB: in this study's analysis no account has been taken of the penalty associated with a lack of hydrogen refuelling station coverage in the early years of FCEV commercialisation, although we acknowledge that this is a relevant factor.

Lower in-use costs of FCEVs are insufficient to offset higher capex at current price levels, but may be a factor if cost reductions are achieved

Lifecycle cost analysis of fuel cell electric vehicles – conclusions (2)

- At current price levels, the increased tank-to-wheel efficiency and reduced tailpipe emissions of FCEVs, when valued from a societal perspective, are insufficient to offset the vehicles' additional capital costs.
- However, if FCEV prices fall – e.g. to within around 25% of the price of an equivalent ICEV – then the benefits of increased efficiency and lower emissions may offset the capex premium and justify procurement on a lifecycle cost basis.
- In the meantime, public authorities following the guidance of Directive 2009/33/EC in making vehicle procurement decisions are unlikely to be able to justify FCEV procurement on the basis of costs alone; wider benefits such as economic development, creation of new jobs / high value industries etc. may also be considered.
- This study's analysis suggests that vehicle OEMs will need to continue seeking customers willing to pay a premium for FCEVs on a total cost of ownership basis. Providing some level of cost reduction, e.g. through capital discounts / residual value guarantees, helps reduce the TCO gap but the scope for such savings is limited for first generation, low volume production cars.
- Focusing on customers for whom zero emission vehicles lead to a cost saving from reduction in local charges (e.g. exemption from London's Congestion Charge) is another strategy for securing demand for FCEVs during the early commercial phase of the rollout.