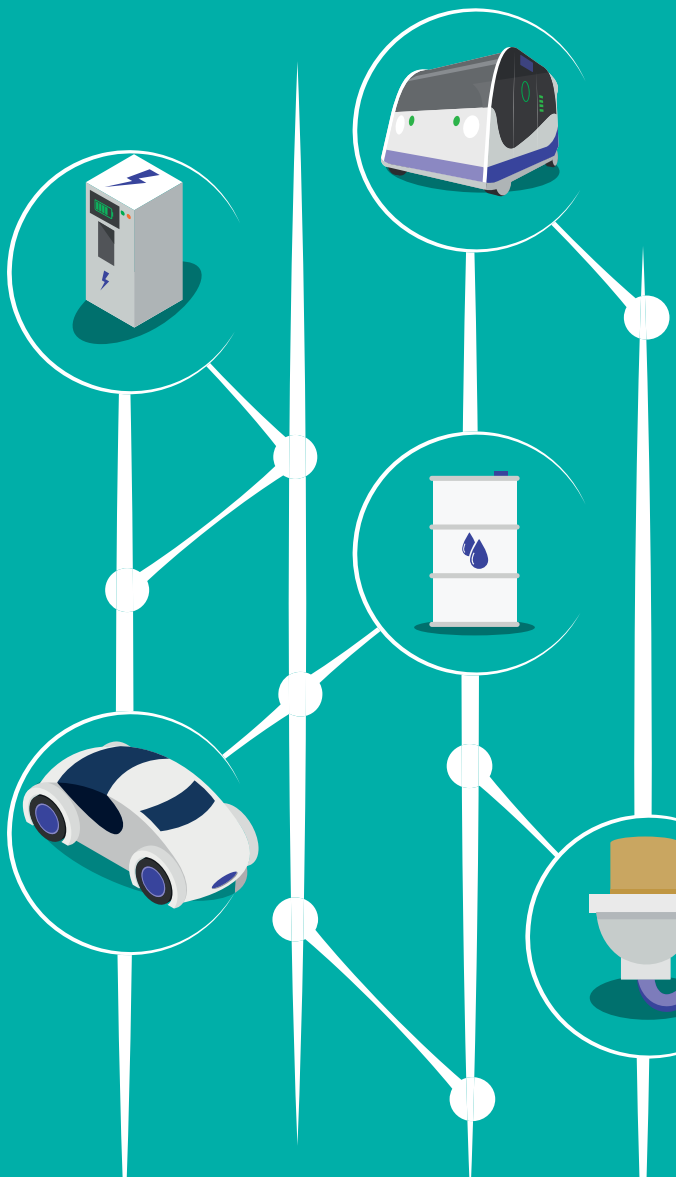
KPMG

Future fuels mix

The impact of the future transport fuel mix on the UK energy system



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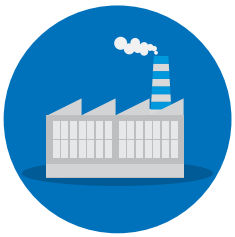
kpmg.com/uk

The rise in the UK's transport emissions needs to be reversed

GHG emission targets



5%

increase in UK transport emissions despite overall decline of 18% in GHG emissions in 2012-2016[1]

40,000

lives cut short annually across the UK as a result of air pollution, with the elderly, children and medically ill highest risk[2]

56%

of road transport emissions from passenger cars; 30% from medium and heavy goods vehicles

44%

reduction needed in surface transport and residential sectors in order to meet the UK's 5th carbon budget[3]

Current policy guidance

Petrol & Diesel Ban in 2040

End on the sale of petrol and diesel cars and vans to be implemented by 2040

UK ambition to lead ZEV development

Industrial strategy to become a leader in zero emission vehicle development and manufacture

Target of 12.4% biofuel by 2032

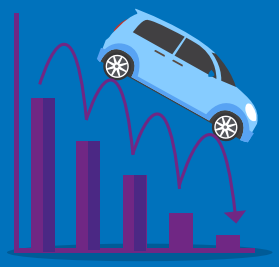
Changes to the Renewable Transport Fuel Obligation (RTFO) will near triple biofuel volumes by 2032[4]

1 European Environmental Agency.
2 Improving Air Quality, House of Commons, 4th Report of Environment, Food, and Rural Affairs Committee.
3 National Statistics: UK Department for BEIS (3) Carbon Brief spring budget 2017.
4 Department of Transport, Gov.uk.

Mobility trends will have disruptive effects and far reaching implications across the transport sector

Transforming the quantum and composition of the vehicle parc from passenger cars to urban commercial vehicles and freight

New passenger car sales will reduce....



Up to 30%

...due to high up take of Mobility as a Service and reduction in personal ownership

UK vehicle parc will constitute....

Up to 10%

...more highly utilised commercial fleets by 2030

Cost per mile could go down...

Up to 40%

...due to removing the driver cost, longer vehicle life, new technologies and mobility scaling

Future logistics will see....

...tech-enabled efficiency in bulk freight

Customer 'on demand trends and new technologies...

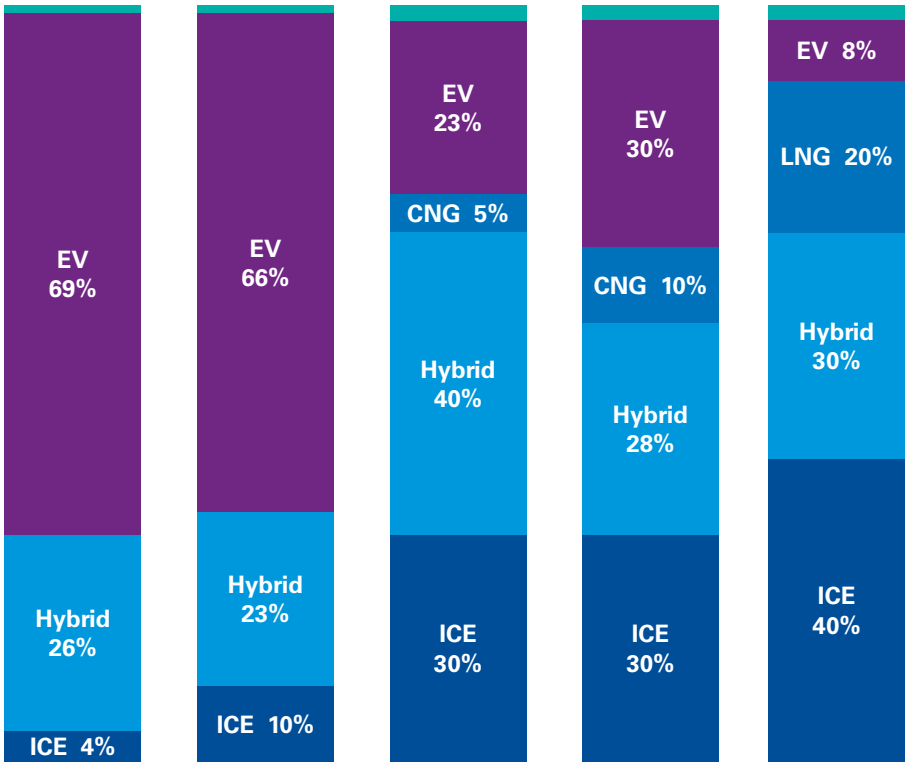
...will develop a sharing economy and complex last mile ecosystem

Urbanisation and AV....

...will transform distribution networks, from large centres to many smaller 'hubs'

By 2030, electrification will dominate in lighter vehicles, with a plural fuel mix for medium/heavy vehicles

2030	Passenger cars	LCV	Bus & coach	MCVs	HGVs
					
Total parc	32m	4m	75k	180k	375k
ULEV or low carbon % of parc	20%	25%	10%	14%	6%
Market share – UK sales % by drivetrain type	H2 fuel cell <1%	H2 fuel cell <1%	H2 fuel cell 2%	H2 fuel cell 2%	H2 fuel cell 2%



'Sustainable' **CNG/LNG** would use bio-gas

Biofuels currently constitute 4.75% of the fuel mix. By 2032, this will be mandated to be 12.4% by volume

Notes:
1 Commercial vehicle classes defined by weight as: 3.5t (LCV) 3.5t-16t (Bus) 3.5t-16t (MCV) >16t (HGV) >40t (Gigaliner).
2 Hybrid is non plug-in electric hybrid. (2) H2 Fuel Cells convert H2 to electricity in the vehicle.
3 EVs include BEVs and PHEVs only. (4) ICE include all vehicles using either petrofuels or biofuels.

Sources:
1 National Statistics: UK Department for BEIS
2 KPMG Mobility 2030 analysis
3 International Council on Clean Transport
4 SMMT
5 ACEA
6 TfL

As the five key requirements for a single/dual fuel mix to prevail across all segments will not be achieved by 2030

Key requirements ▶ Alternative fuels ▼	Technically feasible across segments	Receives initial government support	Economically viable (TCP parity)	Sufficient infrastructure	Sustainable even at scale
 **Electric**	Proven for cars and vans; not energy efficient for heavy-duty vehicles	ULEV grants 35% subsidy for EV car purchases; £40m in funds for 2,700 EV buses across the UK by 2019	TCO parity in early 2020s for lighter segments; late 2020s for heavy segments	150k public charging stations required for 7.7m light vehicles	Production/ giga-factories need to be sustainable
 **LNG/CNG**	Unlikely for passenger cars; but proven for trucks	LNG fuel duty differential from ICE (33p cheaper per kg/litre) aims to incentivise investment	CNG/LNG retrofitting and operating costs approaching ICE parity without government subsidies	400 public refueling stations required; majority of LNG stations will most likely be private hubs	LNG considered 30% cleaner, could be 'low carbon/ emission' if bio-gas is used
 **Hydrogen**	Technology proof of concept pending; only 2 car models currently available	UK, Germany, and France targeting hydrogen as dual alternative fuel investments	Potential TCO parity by 2025	100 stations per 1m vehicle required; currently has 50 in total in EU	If production of hydrogen utilizes renewable sources of energy
 **Biofuels (B10, E10)**	High blends will need drivetrain adjustments	Biofuel subsidies; RTFO investing £400m for biofuels 12.4% target in transport fuel mix[3]	Low blends applicable to most drivetrains No standards on sustainable blends	Penalties for fuel supplier if fuel mix target not achieved	Agricultural /plant based feedstock not sustainable; Targets may not achieve emission requirements

Key: Based on current state in the UK, addressing each solution will be:

- Achieved
- Highly Achievable (2-5Y)
- Likely to be achievable (6-10Y)
- May be achievable (12Y+)
- Unlikely to be achieved

Sources:
1 UK Department of Transport
2 https://www.theguardian.com/environment/2017/dec/25/electric-and-plug-in-hybrid-cars-3m-worldwide
3 RAE Engineering, Future of Biofuels report
4 SMMT
5 Biogas for Road Vehicles 2017, IRENA
6 EAFO
7 Hydrogen Mobility Europe

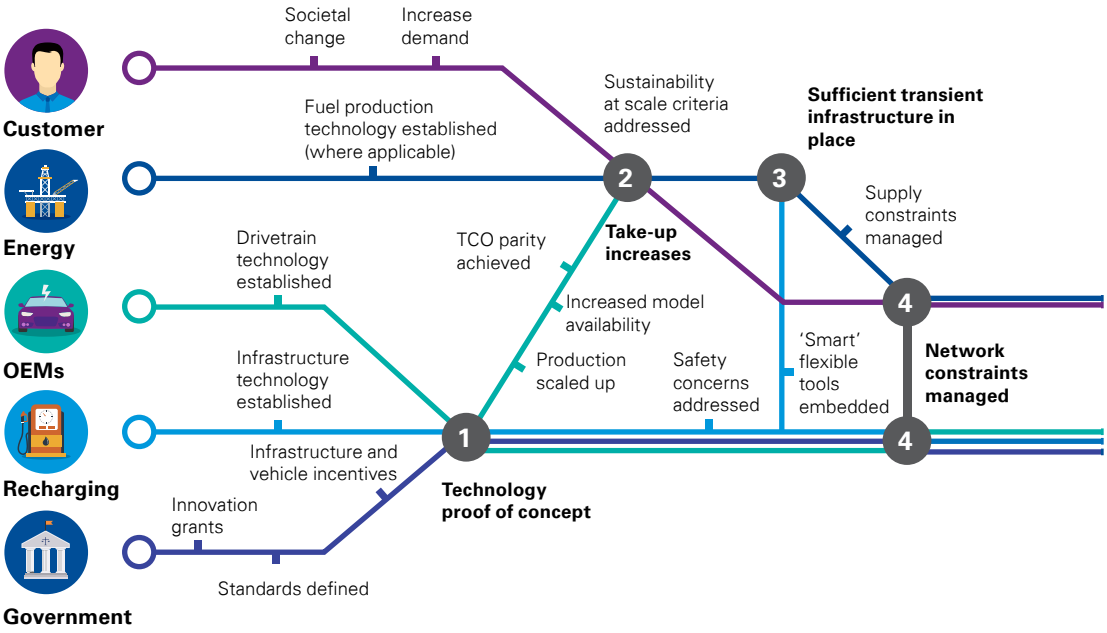
As a result, auto and energy players in EU have hedged bets on multiple drivetrains, 'experimenting' with technologies

	Passenger Cars	LCV	Bus & Coach	Trucks (MCVs and HGVs)	Infrastructure
					
EV	Nissan, VW, Tesla, Renault, BMW, Daimler, Toyota, Jaguar	Renault, Ford, Nissan, Peugeot, Daimler	Solaris, BYD, Volvo, Chariot, VDL, Skoda, Yutong	Daimler, VW, Tesla, E-Force, Nikola, DAF, Wrightspeed, Thor, Volvo, BYD	BP, Vattenfall, Shell, Innogy, Tesla
LNG/CNG	Ford, Honda	Iveco, Ford	Iveco, Solaris, Scania	Volvo, Scania, Iveco	BP, GasRec, Shell, ENN
Hybrid	Toyota, VW, BMW, Hyundai, Mercedes, Mitsubishi	Toyota, Ford, Nissan, Volvo, Honda	Toyota, Volvo	Toyota, Scania, Renault, Mitsubishi	N/A
Hydrogen Fuel Cell	Toyota, Honda, Hyundai	Renault	Toyota, Van Hool, Wrightbus	Nikola	Shell, Haskel, Engie, Total
Biofuels (B10, E10)	Toyota, VW, Ford, Citroën, Mercedes	Toyota, Ford	Scania, Volvo, Solaris	Daimler, Renault, Volvo, Ford, Scania	BP, Shell, Total, ExxonMobil

Key: Existing Planned

Sources: 1 National Statistics: UK Department for Business, Energy and Industrial Strategy
2 Press releases, general search
3 KPMG Mobility 2030 analysis

However, by 2050, this will need to converge to a single/dual fuel mix due to infra and sustainability requirements



Key outcomes

Ultra low emission fuel mix produced sustainably at scale

Economically viable

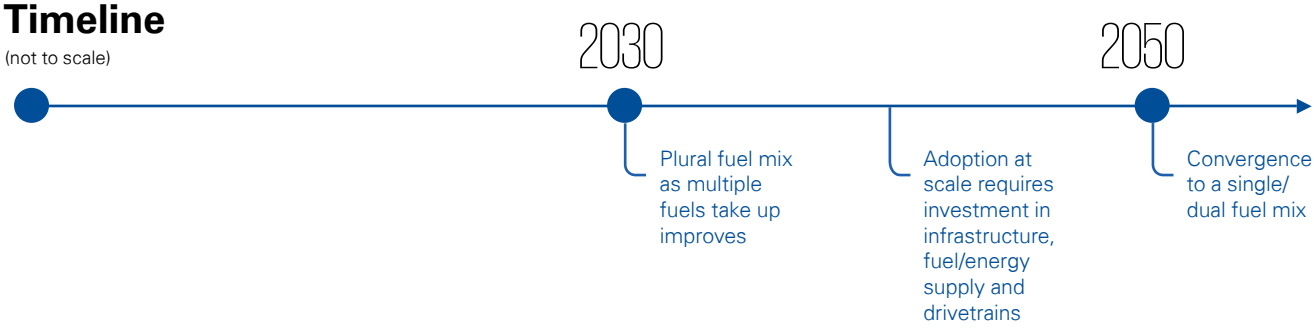
[32]m cars, [4]m vans and [600]k trucks

Supported by sufficient transient infrastructure and a

Reasonable taxation scheme

Timeline

(not to scale)



UK governement position and policy stance will be critical in determining the 2050 future fuel mix

Current National policy/ direction

Clean Growth Strategy
Reduce road transport emissions by 44% by 2032

UK Low Carbon Strategy
25 year plan to improve local air quality and health outcomes

EU Vehicle Standards
UK Contingent on EU vehicle standards

Proposed 2040 UK petrol/diesel ban
Cars and vans; mild and full hybrids applicable

UK Renewable Transport Fuel Obligation (RTFO)
12.4% of transport by 2032

UK Draft AV/EV Bill
Power to mandate charge points

Fuel/ Drivetrain	Selection of current policy levers			International case studies
	Drivetrain adoption incentives	**Infrastructure development incentives**	**Standards**	
 **EV**	**Plug-in EV grant** 35% of price[3] **London congestion fee exemption for ULEVs** **Research/ development grant** £100m for ULEVs	**Charging infrastructure investment fund** £400m, home/ workplace charging	ULEV classification Applicable for grant if under 75gCO_2[3] **Interoperability standard under EV/AV bill** European vehicle standards	**Norway** – EV purchase incentives active since 1990; generous subsidies pushed down price of EVs to compete with ICE vehicles – 2017 new sales market share for EVs is 40% – Government non-binding target set for 100% no emissions vehicles by 2025
 **LNG/CNG**	**Fuel duty differential** Natural gas is currently priced 33.25p cheaper than ICE per 1 kg/ litre[1]	**OLEV funds for gas infrastructure** £4m	**UK sandards include multiple CNG dispensing pressures** 200 bar (buses) and 250 bar (HGV), which are not cross-compatible[6] **No UK specific LNG standard**	**Japan** – World's largest NG importer due to lack of domestic energy resources; currently has 55,000 trucks running on CNG – Gov't to offer $10bn to service LNG infrastructure in Asia region; LNG HGVs have launched domestically by OEMs – Japan Gas projects 500,000 vehicles running on LNG/CNG (2030)[4]
 **Hydrogen**	**H2 Fuel Cell Bus pilots** 20 buses to be trialled in Birmingham from March 2019[2]	**H2 Fuel Cell Refuelling Station Infrastructure Grant** 12 stations	**Hydrogen safety standard compliance mandate** £10,000 fine for each point not meeting the ISO standard[7]	**China** – 2nd largest fuel-cell importer after Japan, likely to overtake soon by pure volume – Comprehensive plan and targets for hydrogen by 2030, including: – 1m HFCVs, of which 10,000 are commercial vehicles, by 2025 – Over 100 refilling stations
 **Biofuels (E10, B10)**	Incentives exist for biofuel producers that meet RTFO sustainability standards, but not for industrial application	**RTFO** £22m of funding to develop waste-based biofuels	**Sustainable cap for crop feedstock** 4% in 2018 **Sustainability criteria** Must deliver 35% of GHG savings compared ICE, must be sourced from areas of high biodiversity	**Brazil** – Long history of using ethanol in vehicles (1975); currently, most cars can run on E20-E25 Sugarcane is main feedstock; mandated standards are E27 and B7 – Introduced certification system in 2018 to mandate fuel distributors to increase their biofuel mix; target for 2030 is 18% of energy mix

Sources:
1 Taxation of road fuels, House of Commons briefing paper, April 2018
2 SMMT
3 Low-emission vehicles eligible for plug-in grant, Gov.uk
4 Why Japan's Liquefied Natural Gas Demand Will Increase, Forbes, 2016
5 DfT Vehicle Certification Agency
6 Gas Refuelling Infrastructure in the UK, Element Energy
7 Alternative Fuel Infrastructure Regulations 2017, legislation.gov.uk

The impact of this future transport fuel mix will be on downstream power as well as mid and downstream O&G

Impact on UK's energy sector	EV	LNG/CNG	Hydrogen	Biofuels (E10, B10)	Hybrid
Oil and gas	Fuel and lubricants consumption reduction	Significant change in operations to produce, store, and supply natural gas	Hydrogen production will require significant change in operations from oil and gas players and increased power from power generators	Significant change in operations to accommodate blending and feedstock supply	
Power generation	Additional energy demand of ~18TWh[2]	No significant impact		No significant impact	No significant impact on existing energy supply operations
Distribution network	Increase in peak time consumption of up to 18GW[2]	Moderate spend in retrofitting existing pipelines	Significant infra spend required for H2 transport (pipelines, trucks)	No significant impact	
Energy retail	Integration needed with other smart energy applications	Retrofitting spend needed per refueling station (~£500,000[4])	Infra spend needed to meet safety requirements for hydrogen production onsite	No significant impact	
Key takeaway:	**New energy demand for power sector**	**Infrastructure modification for oil & gas and retail**	**Significant impact to all energy sub-sectors**	**Upstream impact mainly for oil & gas**	

Sources:
1 KPMG Mobility 2030 analysis
2 Future Energy Scenarios, National Grid, July 2017
3 ICCT Report, Developing Hydrogen Infrastructure
4 Cost analysis of LNG refuelling stations, EU Commission

Even outside energy, the future fuel mix will create challenges and opportunities for multiple other sectors

Automotive

- **Vehicle design** to adapt to consumer use cases
- **Consumer access to fuel/ energy** will become integral to the buying process (ex. Bundling propositions)
- Opportunity **partnerships and acquisitions** to provide seamless customer experience

Logistics

- **Increased convenience in consumer buying preferences** will shift focus to maximizing value of miles travelled
- Cheaper and more sustainable fuel/energy types to **maximise cost savings**
- **Partnerships** to drive infrastructure needs

Government

- Opportunity to improve city **congestion** and **air quality**
- **New laws** governing sustainability and interoperability standards required
- **Taxation** of new energy/ fuel types is likely to evolve significantly

Infrastructure

- **Transport infrastructure** must address demand from competing fuel types
- **Power infrastructure** will need to address grid weak-points to support mass-EV charging
- **Physical infrastructure** such as parking and road-side curbs have to be **retrofitted or repurposed**

Financial Services

- Novel approaches to **asset securitisation** to fund infrastructure demands
- Business models will need to adapt to serve **large fleets** rather than individual customers
- **Increasingly volatile fuel prices** likely to impact commodity trades

Start-ups

- Increasing **niche expertise** needed in the fuel/energy development market
- Opportunity to **partner with incumbents** to trial energy sectors
- Opportunity to **apply for funding** from growing number of green funds/grants

Source: KPMG UK Mobility 2030 analysis

Our Mobility 2030 Leadership Team are enriching strategic conversations with clients across the ecosystem

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