Future fuels mix

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

August 2018

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

40,000 lives cut short annually across the UK as a result of air pollution, with the elderly, children and medically ill highest risk

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

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

1 European Environmental Agency.
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**... due to high up take of Mobility as a Service and reduction in personal ownership.
  - Up to 30%

- **Cost per mile could go down**... due to removing the driver cost, longer vehicle life, new technologies and mobility scaling.
  - Up to 40%

- **UK vehicle parc will constitute**... more highly utilised commercial fleets by 2030.
  - Up to 10%

- **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’.

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

<table>
<thead>
<tr>
<th>2030</th>
<th>Passenger cars</th>
<th>LCV</th>
<th>Bus &amp; coach</th>
<th>MCVs</th>
<th>HGVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total parc</td>
<td>32m</td>
<td>4m</td>
<td>75k</td>
<td>180k</td>
<td>375k</td>
</tr>
<tr>
<td>ULEV or low carbon % of parc</td>
<td>20%</td>
<td>25%</td>
<td>10%</td>
<td>14%</td>
<td>6%</td>
</tr>
</tbody>
</table>

**Market share – UK sales % by drivetrain type**

- **H2 fuel cell**
  - <1%
  - <1%
  - 2%
  - 2%
  - 2%

- **EV**
  - 69%
  - 66%
  - 23%
  - 30%
  - 23%

- **ICE**
  - 4%
  - 10%
  - 30%
  - 30%
  - 40%

- **CNG**
  - 5%
  - 10%
  - 30%
  - 10%
  - 20%

- **LNG**
  - 20%

- **Hybrid**
  - 26%
  - 23%
  - 40%
  - 28%
  - 30%

- **Biofuels**
  - 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 petrolfuels 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

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

Key: Based on current state in the UK, addressing each solution will be:
- **Achieved**
- Likely to be achievable (6-10Y)
- Highly Achievable (2-5Y)
- Unlikely to be achieved
- May be achievable (12Y+)

Sources:
1. UK Department of Transport
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

<table>
<thead>
<tr>
<th>Passenger Cars</th>
<th>LCV</th>
<th>Bus &amp; Coach</th>
<th>Trucks (MCVs and HGVs)</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EV</strong></td>
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<tr>
<td>■ Nissan</td>
<td>■ Renault</td>
<td>■ Solaris</td>
<td>■ Daimler</td>
<td>■ BP</td>
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<td>■ Tesla</td>
<td>■ Ford</td>
<td>■ BYD</td>
<td>■ VW</td>
<td>■ Vattenfall</td>
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<td>■ BMW</td>
<td>■ Nissan</td>
<td>■ Volvo</td>
<td>■ E-Force</td>
<td>■ Shell</td>
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<td>■ Daimler</td>
<td>■ Peugeot</td>
<td>■ Chariot</td>
<td>■ Nikola</td>
<td>■ Innogy</td>
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<td>■ Toyota</td>
<td>■ Daimler</td>
<td>■ VDL</td>
<td>■ Wrightspeed</td>
<td>■ Tesla</td>
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<td>■ Jaguar</td>
<td>■</td>
<td>■ Skoda</td>
<td>■ Thor</td>
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<td><strong>LNG/CNG</strong></td>
<td>■ Ford</td>
<td>■ Ivec</td>
<td>■ Scania</td>
<td>■ BP</td>
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<tr>
<td>■ Honda</td>
<td>■ Ivec</td>
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<td>■ Volvo</td>
<td>■ GasRec</td>
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<td><strong>Hybrid</strong></td>
<td>■ Toyota</td>
<td>■ Ford</td>
<td>■ Toyota</td>
<td>■ Shell</td>
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<td>■ VW</td>
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<td>■ Solaris</td>
<td>■ Scania</td>
<td>■ ENN</td>
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<td>■ BMW</td>
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<td>■ Hyundai</td>
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<td>■ Mercedes</td>
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<td>■ Mitsubishi</td>
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<tr>
<td><strong>Hydrogen Fuel Cell</strong></td>
<td>■ Toyota</td>
<td>■ Honda</td>
<td>■ Toyota</td>
<td>■ Shell</td>
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<td>■ VW</td>
<td>■ Toyota</td>
<td>■ Hyundai</td>
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<td>■ Ford</td>
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<td>■ Ford</td>
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<td>■ Van Hool</td>
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<td>■ Citroën</td>
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<td>■ Wrightbus</td>
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<tr>
<td><strong>Biofuels (B10, E10)</strong></td>
<td>■ Toyota</td>
<td>■ Toyota</td>
<td>■ Scania</td>
<td>■ Shell</td>
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<td>■ Ford</td>
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<td>■ Citroën</td>
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<tr>
<td>■ Mercedes</td>
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</tbody>
</table>

**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.
UK government 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

Selection of current policy levers

<table>
<thead>
<tr>
<th>Fuel/Drivetrain</th>
<th>Drivetrain adoption incentives</th>
<th>Infrastructure development incentives</th>
<th>Standards</th>
<th>International case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EV</strong></td>
<td>Plug-in EV grant 35% of price(^3)</td>
<td>Charging infrastructure investment fund £400m, home/ workplace charging</td>
<td>ULEV classification Applicable for grant if under 75gCO(_2)(^2) Interoperability standard under EV/AV bill European vehicle standards</td>
<td><strong>Norway</strong></td>
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<td></td>
<td>London congestion fee exemption for ULEVs</td>
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<td>- EV purchase incentives active since 1990; generous subsidies pushed down price of EVs to compete with ICE vehicles</td>
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<tr>
<td></td>
<td>Research/development grant £100m for ULEVs</td>
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<td>- 2017 new sales market share for EVs is 40%</td>
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<tr>
<td><strong>LNG/CNG</strong></td>
<td>Fuel duty differential Natural gas is currently priced 33.25p cheaper than ICE per 1 kg/litre(^1)</td>
<td>OLEV funds for gas infrastructure £4m</td>
<td>UK standards include multiple CNG dispensing pressures 200 bar (buses) and 250 bar (HGV), which are not cross-compatible(^6) No UK specific LNG standard</td>
<td><strong>Japan</strong></td>
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<td>- World’s largest NG importer due to lack of domestic energy resources; currently has 95,000 trucks running on CNG</td>
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<td>- Gov’t to offer $10bn to service LNG infrastructure in Asia region; LNG HGVs have launched domestically by OEMs</td>
</tr>
<tr>
<td><strong>Hydrogen</strong></td>
<td>H2 Fuel Cell Bus pilots 20 buses to be trialled in Birmingham from March 2019(^9)</td>
<td>H2 Fuel Cell Refuelling Station Infrastructure Grant 12 stations</td>
<td>Hydrogen safety standard compliance mandate £10,000 fine for each point not meeting the ISO standard(^7)</td>
<td><strong>China</strong></td>
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<td>- 2nd largest fuel-cell importer after Japan, likely to overtake soon by pure volume</td>
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<td>- Comprehensive plan and targets for hydrogen by 2030, including:</td>
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<tr>
<td><strong>Biofuels</strong></td>
<td>Incentives exist for biofuel producers that meet RTFO sustainability standards, but not for industrial application</td>
<td>RTFO £22m of funding to develop waste-based biofuels</td>
<td>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</td>
<td><strong>Brazil</strong></td>
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<tr>
<td>(E10, B10)</td>
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<td></td>
<td>- 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</td>
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<td></td>
<td>- Introduced certification system in 2018 to mandate fuel distributors to increase their biofuel mix; target for 2030 is 18% of energy mix</td>
</tr>
</tbody>
</table>

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
5. DfT Vehicle Certification Agency
6. Gas Refuelling Infrastructure in the UK, Element Energy
7. Alternative Fuel Infrastructure Regulations 2017, legislation.gov.uk

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

<table>
<thead>
<tr>
<th>Impact on UK’s energy sector</th>
<th>EV</th>
<th>LNG/CNG</th>
<th>Hydrogen</th>
<th>Biofuels (E10, B10)</th>
<th>Hybrid</th>
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<tr>
<td>Oil and gas</td>
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<td>Fuel and lubricants</td>
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<td>consumption reduction</td>
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<td>Power generation</td>
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<tr>
<td>Additional energy demand</td>
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<td>of ~18TWh²</td>
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<td>Distribution network</td>
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<td>Increase in peak time</td>
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<td>consumption of up to</td>
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<td>18GW²</td>
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<td>Energy retail</td>
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<td>Integration needed</td>
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<td>with other smart energy</td>
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<td>applications</td>
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</tbody>
</table>

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 (e.g., 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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