Why electrification of Great Britain’s truck fleet can happen faster than many expect

An ERM perspective

The business of sustainability

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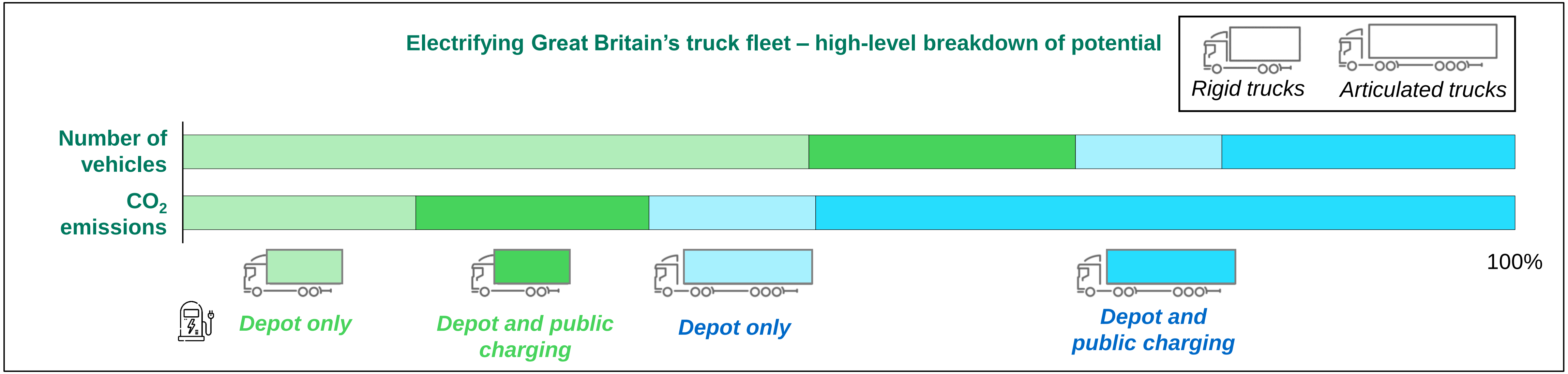
Around half of the Great Britain's truck fleet could switch to battery electric today without needing to wait for a public charging network

For many operators of rigid trucks, there is no need to wait for a public charging network before electrifying the fleet

- **Rigid trucks**, ranging from 7.5 tonnes to 32 tonnes max weight, comprise the majority of Great Britain's trucks and are primarily used for urban and regional last-mile deliveries (with some exceptions). They are generally used either because their smaller size allows them to fit into space-constrained urban locations, or for multi-drop operations where delivery volumes are constrained by time rather than vehicle capacity. Rigid trucks generally spend the night at their home depot and our research shows that around **two-thirds of Great Britain's rigid trucks can electrify in 2023 without any need for charging away from their home depot**, **using off-the-shelf products from OEMs**.
- **Articulated trucks**, primarily 44 tonnes max weight, are used for a wide range of long-distance operations. Most articulated trucks will need some public charging for their longest trips.



Many of the most common use cases for rigid trucks are already cost effective to electrify

Battery electric rigid trucks are already at total cost of ownership parity with diesel equivalents for many urban and regional last-mile delivery operations

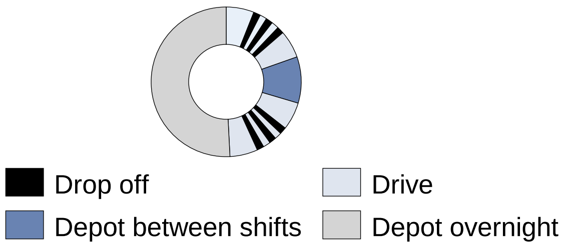
Infrastructure costs are low – the relatively low energy use and large amount of time spent overnight in depot means that low power chargers can be used

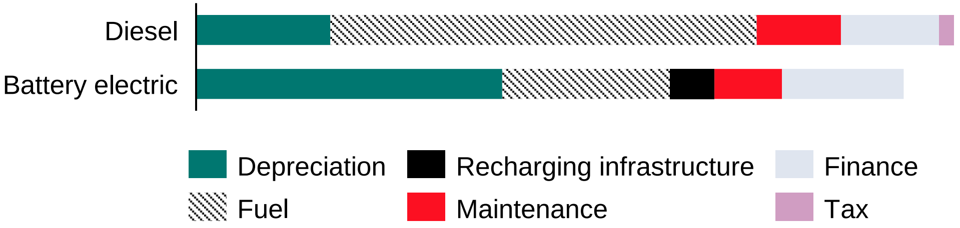
Battery sizes are small – local deliveries only require modest battery capacity which has a comparatively small impact on overall vehicle cost – fleets can realise cost savings by right-sizing the batteries for their operation to avoid overspending on larger batteries than needed.

Fuel cost savings are large – the fuel cost advantage of battery electric vehicles is particularly large for urban driving styles since they can recover energy in “stop-start” driving using regenerative braking. Fleets can improve these benefits by training drivers to maximise use of regenerative braking.

The vehicle can be depreciated over a long period – long battery life and low maintenance costs for battery electric vehicles on these operations can give a longer depreciation period than diesel equivalents, reducing the impact of the higher capital cost.

Example 24-hour activity profile (left) and 2023 annualised total cost of ownership, £ (right) for an 18-tonne rigid vehicle used for urban refrigerated deliveries (c. 35,000 km/year)





Battery electric technology has reached a tipping point for long-distance heavy-duty trucks

Range and recharge time barriers will be tackled with technology arriving in 2024. 2024 OEM models will be able to drive 4.5 hours fully loaded and recharge with a 1 MW charger during a 45-minute driver rest break. However, over 90% of articulated truck driver shifts in Great Britain (GB) do not involve two consecutive periods of 4.5 hours of non-stop motorway driving separated by just 45 minutes of downtime, and the vehicle will often spend part of the day less than fully loaded, meaning these model capabilities are more than enough to meet the needs of GB 44 tonne trucks. Instead of a complete recharge, most vehicles will only need a small top-up at a public charge during the middle of their shift - we estimate that around 80% of Great Britain's 44 tonne trucks will be able to source at least 70% of their energy from either depot charging or slow overnight charging at a truck stop.

Battery packaging constraints can be overcome. Most of Great Britain's articulated trucks are 44-tonne vehicles, with three axle tractor units that leave little space for batteries. This means that to run a 44-tonne battery electric vehicle, a longer tractor unit is needed in order to leave space for three axles and the battery packs. With most common trailer types, this would result in the whole vehicle exceeding current vehicle length limits. However:

- Around half the fleet could switch to two axle vehicles without loss of payload – gaining space for batteries. An example is shown in the picture on the right, which shows a three-axle vehicle running with one axle raised.
- By coincidence the vehicles in the most payload-critical applications that most need three axle tractor units (such as milk tankers and tippers) already operate unusually short trailers, so, unlike the rest of the fleet, could use a longer three axle tractor unit with plenty of space for batteries – without falling foul of vehicle length limits.
- Finally, for those vehicles (well under half the fleet), who run most common trailer types but need three axle tractor units because they run the occasional weight-constrained trip, a one-metre increase in vehicle length limits for these vehicles would allow for a longer tractor unit with plenty of space for batteries. The success of the longer semi-trailer trial – in which longer vehicles were allowed provided they had rear wheel steering to maintain maneuverability – provides a clear real-world analogy for how this issue can be overcome for battery electric vehicles.

Source: ERM analysis based on DfT data, considering around 2000 44-tonne truck duty cycles

We expect many long-distance, heavy-duty operations to be cost competitive with battery electric by 2030

Additional downtime, even if it does occur, will have only a tiny impact on costs. As mentioned previously most driver shifts will only need a small top-up rather than a complete recharge mid-shift. With MW charging this means disruption from any misalignment between driver breaks and an early-stage charging network would typically only be around 10-15 minutes. Three factors help further: software for planning routes and charging, the ability to split a 45-minute driver break into two slots, and in many cases additional downtime while the trailer is loaded or unloaded, during which time the tractor unit can decouple and charge. Even for the worst case of vehicles that do back-to-back driver shifts, the total cost of additional downtime is only 1-2% of vehicle TCO – very small compared to the fuel cost savings from battery electric vehicles.

Payload losses will only impact a small proportion of the fleet. Battery energy density improvements mean that payload loss from 44-tonne long haul battery electric vehicles available in 2024 will only be around 2 tonnes. This will have no effect on amount of payload carried for most 44-tonne vehicle trips since usually the payload carried is limited by volume, not weight. Just 10% of 44-tonne vehicles are routinely weight constrained – and around two-thirds are entirely volume constrained, so would not suffer any payload loss at all. As battery energy densities continue to improve, payload losses will become even less important.

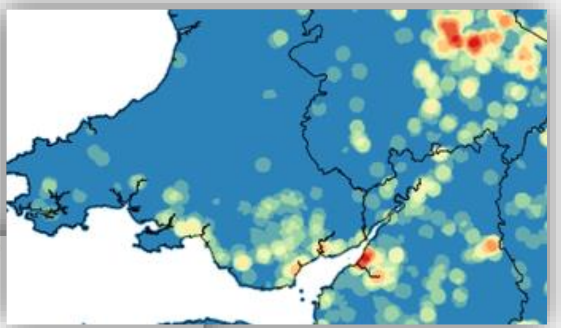
Battery electric vehicles will become cheaper on a total cost of ownership basis than diesel vehicles around 2030 for most long-distance, heavy-duty operations. The exact parity date will depend on use case – but with battery electric vehicles offering the chance to halve the largest cost to operators (fuel), economic advantage over diesel is a question of when, not if.

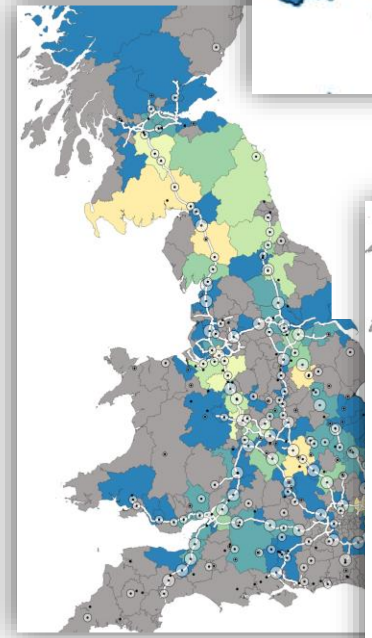
Example 2030 annualised total ownership for a cost of specific 44-tonne truck use case

Great Britain's geography means trucks will mostly only need a partial recharge in the middle of their trips, not a full recharge

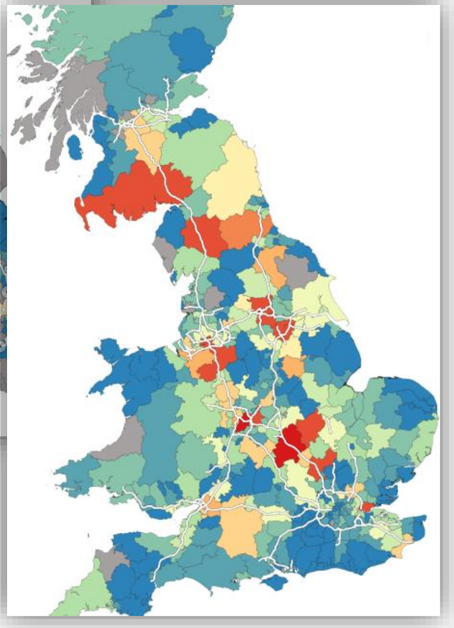
- **Around 75% of the public charging demand from domestic vehicles will arise from less than 20% of the trucks**. Public charging demand is dominated by the portion of the highest truck weight class (44-tonne articulated trucks) that do long journeys, alongside international trucks.
- **Public charging is a critical enabler of long distance truck operations but the number of public chargers needed is smaller than might be expected**. This is because GB's geography means that most trucks will not need to fully recharge mid-shift and instead will only need a small top-up. This means that 350 kW chargers will be sufficient for much of the charging that will occur during driver breaks but also allows a small number of 1 MW chargers to make a very large impact. For example, an extra 100 km of range needed to get back to depot can be added in just 10 minutes at 1 MW, meaning that 1 MW chargers can be operationally useful even if, with an early stage network, they are not always aligned with every driver rest location.
- **A mixture of charger powers will be needed for daytime public charging.** The most energy-demanding vehicles, with the least downtime (particularly those with drop off locations unsuitable for charging) will require 1 MW public chargers, alongside a public network of 350 kW chargers for operations use on days when vehicles travel less far and/or have more downtime. Charging demand for both types will be present at warehousing areas and Motorway Service Areas, but relatively speaking, the lower power 350 kW charging will be biased towards warehousing areas, and the more powerful 1 MW charging more biased towards MSAs.
- **Most charging will occur at depot or when parked at a truck stop overnight** – even for most long distance, heavy duty 44-tonne vehicles.
- **Geographical dislocation may occur with snowball effects on specific routes**. Routes that achieve good infrastructure coverage and utilisation first will be most attractive to fleets both operationally and financially, stimulating further demand on these routes and further investment in infrastructure and charging price reductions.
- **International trucks account for a significant share of public charging demand despite only constituting a tiny proportion of vehicles** – this is because international trucks are virtually the only vehicles in the country doing the true long-haul operations that require a complete recharge in the middle of the shift.

Deep dive on warehouse charging demand hot-spots around the Severn Estuary ▶





▲ Skeleton 1 MW public charging demand distribution, c. 2030

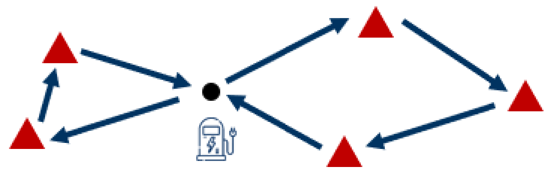


Skeleton 350 kW public charging demand distribution, c. 2030 ▶

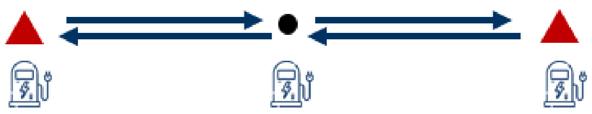
There is a phased, investable pathway to solve the chicken-and-egg problem for public truck charging infrastructure

There is a natural progression from use cases requiring only depot charging up to a nationwide public charging network. Investment risk starts low and each phase de-risks the subsequent one. Operational need, total cost of ownership (TCO) and investment risk follow the same pattern - the ordering of the infrastructure phases mirrors both the order in which the respective use cases reach TCO parity, and OEM product maturity.

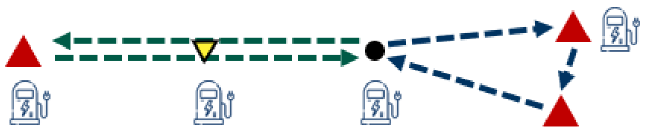
Phase I – use cases that can **complete their operations while charging entirely at their home depots** (around half the fleet – mostly urban and regional distribution) **electrify first**. These use cases also have the most competitive TCO and broadest OEM product range so naturally move first.



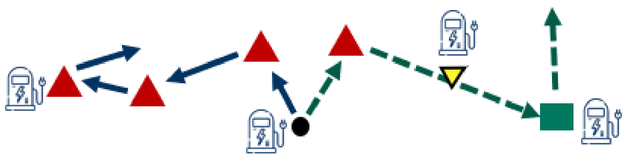
Phase II – **semi-private charging networks** with **some guaranteed utilisation** emerge from vehicles **shuttling between depots** owned by the same operator and from **bilateral arrangements for operators to charge at customer warehouses**. **Opening up these chargers to 3rd parties** allows more operators to electrify and creates demand pools for public charging as these operators look to electrify more of their operations. These use cases have the second lowest TCO and so naturally follow at this point.



Phase III – an initial **small skeleton public charging network** at **regional hubs** and on **a few key trunking corridors** complements the warehouse charging network and extends the operational range of the existing BEV fleet. The **infrastructure barrier begins to topple** and, combined with an increasingly competitive TCO, **uptake of BEVs for regional operations and core trunking routes begins to hockey-stick** as increased vehicle numbers drives demand for more infrastructure and drive down costs.



Phase IV – operators on **national, long distance routes find that they can hop between most regions and along core corridors using the charging in place in each region** built in phases I to III. Public charging **demand is now high** and public charging hubs **fill in remaining gaps** in the network with greatly **reduced investment risk** – the most unpredictable general haulage and tramping operations can now transition.

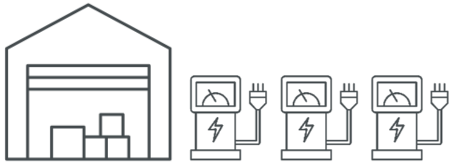


Key ● *Depot* ▲ *Pick-up / drop-off (e.g., warehouse)* ▽ *Public MW charge (e.g., Motorway Service Area)* ■ *Overnight truck stop*

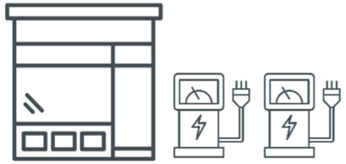
Despite rapid progress, some short-term barriers still need to be overcome

Current limited availability and high capital cost of battery electric vehicles for the most demanding operations. Careful planning will be needed so that "low hanging fruit" operations are tackled in the short term using off-the-shelf products. With truck battery prices falling, battery lifetimes increasing and vehicle capabilities improving, the type of operations that can switch to battery electric both operationally and cost-effectively should increase year-on-year.

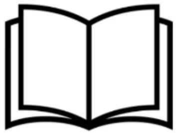
Electricity price variations. These can be mitigated using sophisticated approaches to procuring electricity. Falling wholesale prices can add tailwinds. Energy as a Service models combining scale, renewables, PPAs and smart tariffs to bring down prices can open up routes for fleets to access predictably priced, low cost electricity.



Depot infrastructure costs and timeframes. Right-sizing of chargers to be no larger than required by the energy needs of the operation is key to minimising these costs in the first place. A range of turnkey solutions from infrastructure providers is entering the market, easing the path to financing and installing depot infrastructure.



Lack of public infrastructure. At a fleet level, identifying which parts of the fleet can electrify without public infrastructure, and evaluating options for out-of-depot charging through engagement with customers and infrastructure providers, provide routes forward. In the medium term, an investable pathway exists to solving the problem through a phased roll-out of infrastructure, requiring close co-ordination between actors.



Supportive policy. The pace of electrification of Great Britain's truck fleet could be increased with small changes to vehicle length and weight limits – these are most needed by certain portions of GB's 44 tonne vehicle fleet. "Bonus-malus" schemes, deployed successfully around the world, provide a means of removing the short-term cost barriers to zero emission vehicle deployment in a way that is revenue-neutral to the treasury. Removing barriers to electricity network operators investing proactively in grid capacity ahead of demand would help prevent delays caused by "red tape" around grid reinforcement.

How ERM can help

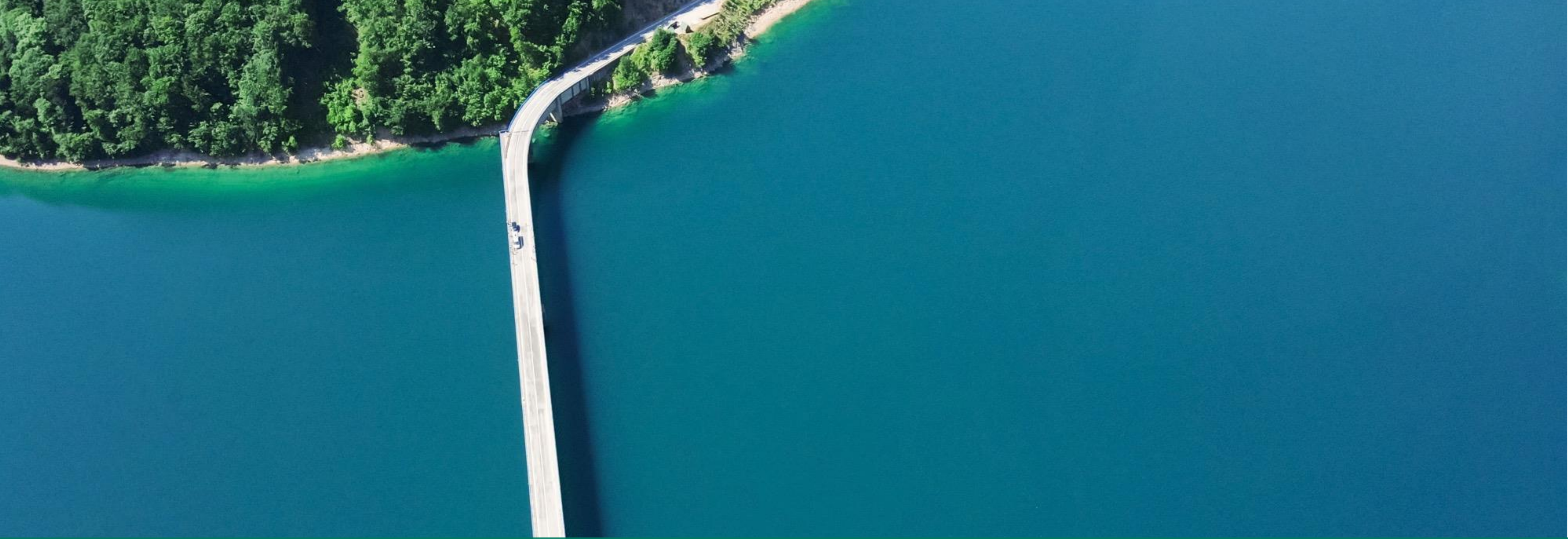
Fleet operators. ERM can assist fleets in identifying “no-regrets” opportunities in parts of the fleet best suited to electrification, as well as designing an initial customer offer (vehicles, infrastructure, customer buy-in) that allows fleets to take the first step to electrification. ERM can also assist fleets in developing a strategy for out-of-depot charging, and developing a fleet transition plan that maximises the commercial opportunities provided by the decarbonisation of transport, and optimises choices around powertrain (e.g., Battery EV vs Fuel Cell EV) and infrastructure.

Charging infrastructure providers. ERM can use expertise in electrification of the heavy-duty road transport sector to assist charge point operators in roll-out planning and customer targeting. This can include helping understand how different types of customers will use the infrastructure and how both the locations and specification of the charging sites can be tailored to best meet customer requirements. ERM can also provide vehicle uptake forecasts under a range of scenarios to help charge point operators understand likely future utilisation profiles. ERM’s in-house models have also been used to optimise PV / Battery Storage systems at charging sites to minimise grid connection and energy costs.

Electricity network owners. ERM can assist electricity network owners in modelling the temporal and geographical distribution of expected future network demands. For independent network providers, ERM can assist in identifying the early opportunities provided by the electrification of heavy duty transport and the broad range of locations where infrastructure will be required to support this.

Investors. The electrification of heavy-duty transport presents a range of financing and investment opportunities as the industry moves from an opex-intensive to capex-intensive *modus operandi*, while also presenting challenges as existing practices are disrupted. The transition will bring opportunities for logistics firms whose operational profiles allow early offering of green solutions, while the dependence of battery electric vehicle TCO on operational type will spread operators further apart in terms of costs than they are currently. ERM can help investors navigate the risks and capitalise on the opportunities provided by this transition, and assist in developing portfolio decarbonisation strategies that maximise commercial opportunity.

Policymakers and agencies. ERM’s blend of technical and strategic capabilities provides insight into the effectiveness of different policies and incentives for achieving nation-wide decarbonisation targets.



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