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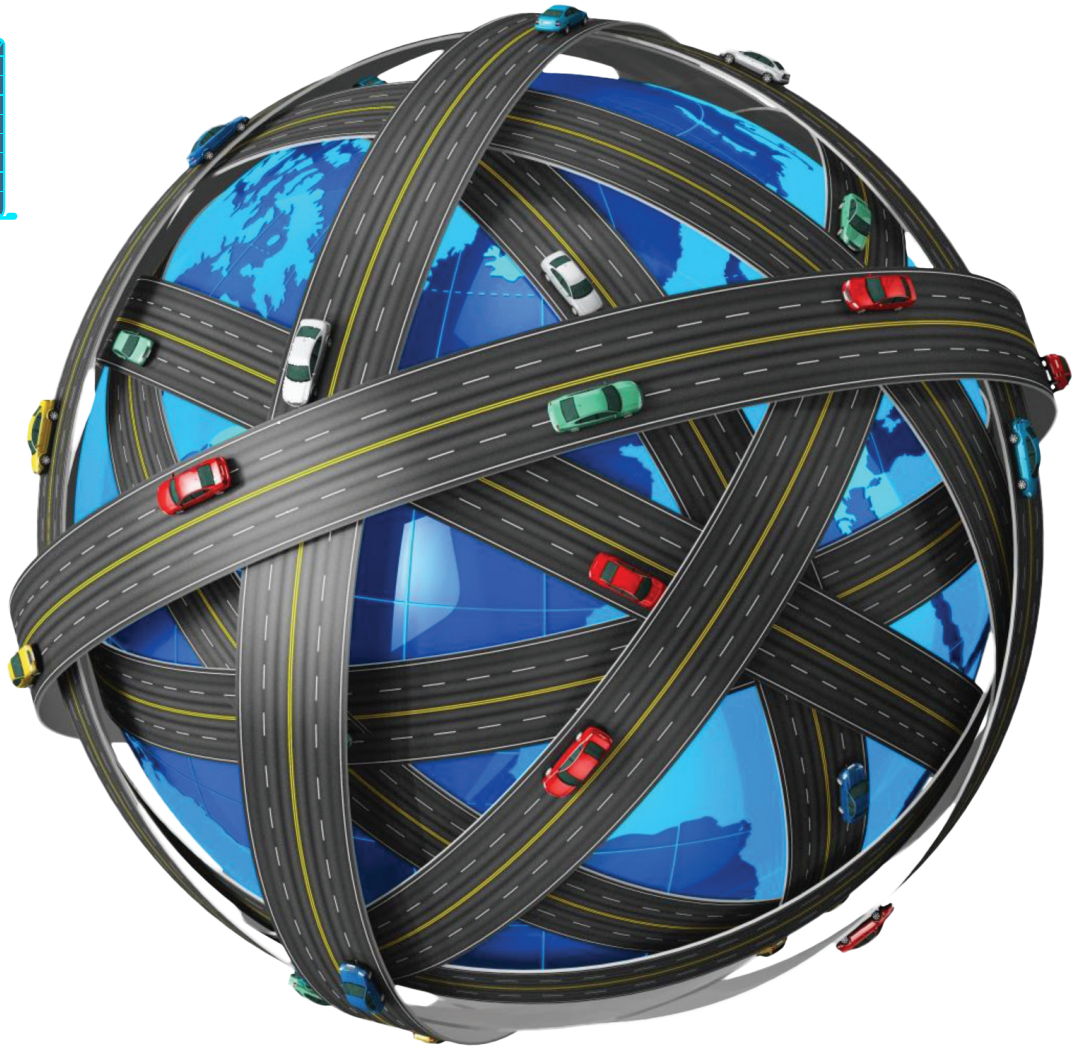
TForward Delivering Better Roads

Catriona Brown



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TForward, A Stepped Approach

Catriona is a busy mum with three young children. Catriona does not have a professional background in transport, but her everyday frustrations with road congestion have motivated her to draw on her background as a lawyer to find solutions.

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The Wolfson Economic Prize invites entrants from around the world and all sorts of backgrounds to propose original, well-argued and informed solutions to big national challenges. The aim is to bring forward fresh thinking to help people, governments and businesses develop practical policies.

This year the prize addresses an issue at the heart of every country's economic future: road infrastructure, and

how can we pay for better, safer, more reliable roads in a way that is fair to road users and good for the economy and the environment?

The way cars are powered, driven and owned is being revolutionised. Soon a world of cleaner, automated vehicles will arrive and old annual charges and petrol taxes will no longer work. A new kind of driving will take a new kind of road and a new kind of funding – ideas needed not just in Britain but around the world.

The five shortlisted submissions – of which this is one – show that it is possible to come up with potential answers that can help road users, improve safety, protect the environment, and support our economy.

CONTENTS

1. Summary

TForward Technology Platform

TForward enables road charging to be introduced in many small steps, without political "cliff-edges", by central, devolved and local government.

TForward is a technology platform that provides a customer interface, vehicle satellite tracking (telematics), and a payment and accounting system that all road charging schemes can link into. TForward creates economies of scale, and enables new road charging schemes to be started quickly, reliably and cost-effectively.

Technology advances can continually be harnessed by the platform and developed into optimal transport solutions

TForward Stepped Approach

An over-arching policy to introduce road charging across the UK is not appropriate.

A stepped approach allows re-evaluation of policy at each step, without any presumption that road charging should be fully rolled-out:

Step 1: build the "TForward" platform

Step 2: modernise the London Congestion Charge to TForward variable telematics-based tariffs linked to congestion and pollution, and enable expansion of road charging where most needed in London, e.g. Blackwall and Silvertown tunnels as already announced (potentially convert the London Congestion Charge and customer database into the TForward platform)

Step 3: integrate existing and planned road charging and parking schemes into TForward (e.g. Dart Charge, Mersey tunnel, Low and Ultra Low Emission Zones), and enable them to upgrade to telematics-based tariffs

Step 4: update the HGV Road User Levy to TForward telematics, and meet Draft UK Air Quality Plan objectives

Step 5: potentially enable public transport "smart" ticketing via TForward

Step 6: enable cost-effective installation of EV recharging points by linking into TForward

Step 7: enable future AV, car clubs, ride-sharing and innovative apps, to use TForward

Step 8: integrate charging for new road infrastructure into TForward (e.g. Lower Thames Crossing, potentially around Heathrow)

Step 9: with the Local Government Deal, local and combined authorities can introduce road charging and keep the revenue for local road improvements, and local authorities can establish clean air zones proposed by the Draft UK Air Quality Plan

Step 10: with the Highways England Deal, roll-out road-charging on the Strategic Road Network ("SRN").

Many players can take different steps forward in parallel, which cumulatively builds a critical mass of people registered with TForward.

Political Deliverability

Steps 1-8 are not especially controversial politically. While they are being introduced, the government needs to show tangible benefits from road charging initiatives to mitigate opposition to more extended road charging. See Section 3 for road-user benefits the government could be starting to deliver related to road investment, financial incentive, better procurement, new technology, road safety and the economy.

Given scepticism of political promises, these actions will be more persuasive with road-users than any intellectual case for road charging. The answer on political deliverability is starting to deliver.

Off-setting reductions in fuel duty are also crucial to winning public support when more extensive road charging is introduced.

Much decision making about more controversial extension of road-charging (such as extending road charging in London, or under the Local Government Deal) can be taken in the future at a devolved or local level where there is a good understanding of the area's road network and what local people may accept.

TForward International

The UK can "export" TForward by making the platform available for road charging schemes in other countries facing the same challenges as the UK with ever-increasing traffic, congestion and pollution, and financing their roads infrastructure. Road charging schemes are slow, expensive and risky to set up (around £160 million for the London Congestion Charge). That combined with political resistance to road charging, means only limited charging has been introduced around the world for roads beyond bridges and tunnels.

Economies of scale with the TForward International platform would make many road charging schemes around the world economic, even on a trial or rush-hour only basis. TForward makes it financially viable for other countries to follow the UK's stepped approach to introducing road charging, and therefore politically deliverable for them too.

Governments looking at road charging schemes have focussed on making a particular scheme pay its costs, rather than realising the problem of paying to administer one scheme can be turned into a business opportunity across all schemes.

The TForward International business plan can extend beyond road charging to provide:

- parking payment systems
- smart-ticketing for public transport
- integrated travel information and ticketing enabling Mobility as a Service, internationally, across multiple modes of transport, from different transport providers, for passengers and freight
- payment infrastructure for cost-effective roll-out of electric vehicle ("EV") recharging points, autonomous vehicles ("AV"), apps, and other future innovation

TForward International has potential for significant profit generation, taking a small administration fee from each payment processed, given the size of the international transport market. Equity ownership can be shared between the UK government and the private sector consortium that will be needed to build and operate the platform. Substantial profits could go to funding the UK's roads.

The UK has competitive advantages for becoming the world-leader for an international transport platform; the UK's FinTech expertise, stable and trusted political and legal systems, and leading with the London Congestion Charge.

Developing and running TForward will create skilled UK jobs and the basis for a new industry. The UK should aim to build critical mass before competitors appear.

Value Capture

Value capture initiatives, combined with modernised compulsory purchase legislation, could re- shape urbanisation with those who benefit paying for infrastructure.

Wolfson Select Committee

A Wolfson Select Committee would be a practical way of ensuring actual benefit as road charging is rolled-out in the real world, with its remit including:

- ensuring any road charging introduced is fair to road-users, and good for the economy and environment
- overseeing creation and running of the TForward International platform in the best interests of UK road-users and taxpayers
- overseeing transition to EV and improved air quality
- keeping the UK at the forefront of AV and innovation
- overseeing better infrastructure procurement practices
- developing value capture
- championing infrastructure funding innovation

That would increase the long-term impact of this Wolfson Economic Prize.

2. Stepped Introduction Of Road Charging

2.1 Stepped Approach

An over-arching policy to introduce road charging across the UK is not appropriate.

Instead, a stepped approach should be taken, where before each step the views of the public are listened to, policy adjusted in light of people's views, and a balanced decision taken (by central, devolved or local government as appropriate) as to whether or not to move forward with road charging.

This is a gradual approach allowing road charging policy to evolve, giving people time to express their views and adjust, and ensuring new road charges support economic activity, are good for the environment, and give road-users a fair deal.

There should not be any presumption that road charging will necessarily be rolled-out nationally; the case for each extension of road charging should be freshly evaluated.

The steps need not happen sequentially, and some steps may run in parallel, or the order reviewed.

2.2 The Name "TForward"

A road charging scheme would benefit from a customer-friendly name suitable for branding. The name might be indicative of what the road charging scheme delivers, such as better roads or reduced congestion and pollution (e.g. London's "Low Emission Zone").

For the purposes of this report, the name "TForward" has been chosen, although a creative marketing team may come up with an alternative.

The name is short for "transport forward", and deliberately not limited to roads, as road charging could integrate with public transport ticketing, as part of a future integrated mode-neutral mobility service, delivering Mobility as a Service, operating from the same TForward platform.

Step 1: Establish The "TForward" Platform

The proposal is to establish TForward, a national integrated system providing the front-end customer interface, telematics, and back-end IT, payment and accounting mechanics, that current and future road charging schemes link into.

TForward is a platform enabling numerous exciting technological advances to be harnessed, and developed into an optimal customer-facing transport solution. Future technology is about more than driverless vehicles, and the UK needs to embrace the benefits that can be unleashed from a spectrum of innovation ranging from smartphones, to advanced satellite technology and digital management of vehicles. TForward would take advantage of the technology inflexion point we are at, and apply the best in recent innovation to our roads sector, while continually incorporating and driving new technological development (discussed further at "TForward Technology and Development Cost").

TForward would integrate payment mechanics for existing road tolling, congestion and emissions charging, parking schemes, future road charging, HGV levies, lorry parks, EV recharging, car clubs, future AV hire, and future ride-sharing and other innovative apps, park and ride, and potentially telematics vehicle insurance, and public transport ticketing.

TForward would establish standardised technology protocols to support both telematics and EV recharging points, enabling mass roll-out.

TForward removes significant cost and risk from new road charging projects, by providing an existing proven reliable back-end payment system, and registered customer base, making projects easier to finance and get started, and speeding up delivery of new road charging schemes.

It would be cheaper overall for road-users with economies of scale, and technology solutions, payment mechanics and customer service not being re-created for separate schemes.

Customers would only need one UK payment account (charging automatically to a debit card or chosen payment method), making payment for using road infrastructure a straightforward user-friendly experience. TForward would take a small administration fee from each payment.

Additional benefits include enabling:

i. a stepped introduction of road charging
ii. existing road charging and parking schemes to upgrade to variable telematics-based tariffs
iii. cost-effective roll-out of EV chargepoints
iv. cost-effective smaller road charging schemes
v. new technological innovation which can take advantage of the back-end payment system (e.g. AV, and ride-sharing and other apps)
vi. digital management of vehicles, including flexibility to manage change, with AV and conventional vehicles mixing together in as yet unknown ways
vii. Mobility as a Service across different modes of transport
viii. trials of sophisticated pricing structures to better allocate road usage and link it with economic activity
ix. different levels of government to generate revenue for road improvements in their areas
x. integrated website and smartphone travel and EV chargepoint information

Whilst new vehicles are generally telematics-enabled, accelerating telematics roll-out to existing road-users and vehicles, to lay the foundation for later telematics-based road charging, could be taken forward by insurers with government support (see Section 5 “Insurance and Telematics”).

A centralised national system would have the critical mass to invest in robust cyber-security, to safeguard people's confidential information about where they travel, and protect against payment fraud. It would have the capacity to invest in, and evolve with, future technological innovation that will change how we use our roads and how we pay for them.

Step 2: Modernise London's Congestion Charge

The London Assembly Transport Committee has called for replacement of the existing London Congestion Charge with road charging. The Committee considers the Congestion Charge to be "no longer fit for purpose - a blunt instrument of old technology that covers a tiny part of London" and that "fundamentally, vehicles should be charged according to their impact on congestion".[1]

This is an opportunity. As an alternative to creating the TForward platform from scratch, it is recommended that central government collaborates with Transport for London ("TfL") (under the Mayor of London and London Assembly), with an appropriate sharing of costs, to convert the existing London Congestion Charge platform and customer database into a new national TForward platform, capable of providing the back-end for other charging schemes.

Politically this step is deliverable - it is simply modernising the existing Congestion Charge which people are already used to paying, into a more sophisticated telematics system, with variable tariffs to better address congestion.

The benefits of converting the London Congestion Charge platform and database, rather than building a new platform, include:

- most London drivers are already registered for the Congestion Charge, providing an existing customer base, and avoiding the upheaval of all those people re-registering with a new scheme
- London is a natural pioneer of road charging, given the extent of road congestion, the availability of public transport, and younger population. London has successfully introduced the Congestion Charge and Low Emission Zone charge, and drivers are used to paying for central London roads
- London already leads on public transport integration with transport devolved to one body (TfL), the successful Oyster card, and contactless bank card payment
- it would allow London to develop a more sophisticated telematics road charging platform, at lower cost, if shared with central government

[1] "London Stalling" report dated 19th January 2017.

It would be a separate matter to be democratically determined in the future by the Mayor of London and London Assembly, whether or not to extend TForward road charging geographically to cover more of London, or to roll Low Emission Zone and planned Ultra Low Emission Zone charging into TForward, and set the variable tariffs to be charged.

An advantage of TForward, is that TForward would enable gradual geographical roll-out of road charging across more of London, enabling prioritisation of the most congested and polluted areas. It would provide a user-friendly platform to implement the already promised tolling of the Blackwall Tunnel, alongside the new Silvertown Tunnel.

If, for any reason, the London Congestion Charge could not initially be converted into the TForward platform, either the Blackwall and Silvertown Tunnels, or the 2019 Ultra Low Emission Zone applying to the north and south circular roads, would be good alternative anchor schemes for TForward.

Step 3: Integrate Existing Road Charging And Parking Schemes

Once the TForward charging platform is established (either by converting London's existing Congestion Charge platform, or creating a new platform), next steps can be considered.

Road Charging: Existing and planned road and emissions charging schemes can integrate into TForward, such as London's Low and Ultra Low Emission Zones, the Dart Charge, the Mersey tunnel etc.

Initially run TForward in parallel with the existing charging platform to iron out teething problems, and encourage voluntary customer uptake of TForward, with a discount if needed. Only then, when there is sufficient acceptance of TForward, should it become the only mode of payment.

This would enable existing road charging schemes to upgrade to more flexible telematics-based charging tariffs.

Parking Schemes: Enable parking schemes to link into TForward, including private car parks, and parking operated by local authorities.

The telematics TForward platform would support variable parking tariffs related for example, to time of day, or events (such as a football game) affecting demand.

TForward could also make it economical for those with only a few parking spaces, or spaces only available at certain times, to make those spaces available to the public, since the overhead costs of running a car park would not otherwise make that viable.[2]

In Sydney, the "Divvy" app lets offices and hotels rent out unused parking spaces, a classic example of supply innovation for unmet demand, and the kind of innovation (along with parking guidance systems) which might emerge in the UK to take advantage of the TForward back-end payment system and its established customer base.

[2] It has been reported that 30% of traffic in a city centre can come from people driving around looking for a parking space, by the International Parking Institute, 2012 Emerging Trends. Emerging technology parking guidance systems aim to reduce this by efficiently guiding drivers to available parking spaces.

User-friendly: Road charging may not be intrinsically popular, but the problem should not be exacerbated by user-unfriendliness experienced with current charging systems. Each charging scheme is run independently requiring registration for the London Congestion Charge, and separately for the Dart Charge etc ... and hunting for change for parking or setting up multiple parking accounts. That can lead to people forgetting to register and pay, frustration registering on yet another web-site, confusion visiting a new part of the country with different tolling, and anger at penalty demands when only some schemes take payment automatically. The customer helpline experience can be dismal. TForward aims to make payment mechanics customer-friendly.

Step 4: Update HGV Road User Levy

Update the HGV Road User Levy[3] to TForward telematics, and to meet Draft UK Air Quality Plan objectives. Charging would apply to vehicles from overseas, and could be extended to more lorries (rather than only applying to lorries over 12 tonnes).

Telematics tariffs can guide HGVs away from congestion and pollution hotspots, and encourage HGVs to make greater night-time use of motorways.

Lorry parks (to avoid another Operation Stack) could be set up, with lorries paying via TForward to use them and the surrounding roads, thereby contributing to local road improvements so local residents receive some benefit.

Step 5: Potentially Integrate Public Transport Ticketing

Public transport ticketing could potentially be integrated into TForward. This would facilitate integrated mode-neutral mobility services extending across public and private transport, and future AV.

There are current initiatives to integrate public transport ticketing, including £30 million for Oyster- style ticketing in the North, £80 million for "smart" ticketing in major cities, and the "Pick & Mix Project" pilot in Scotland.[4]

Rather than funding separate schemes, money could be better spent establishing TForward in a way that is workable for public transport "smart" ticketing, with public transport ticketing being integrated into TForward over time.

People would not need to register for separate road charging and public ticketing schemes, and TForward would quickly reach critical mass.

Step 6: Integrate EV Recharging Points

Enable EV chargepoints to use TForward for their back-end payment and accounting system, to enable cost-effective national roll-out of EV chargepoints (see Section 7 "Environment").

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[3] The HGV Road User Levy was introduced in April 2014 to even the playing field between domestic and overseas HGVs, with the effect that HGVs from overseas are now also required to pay a levy to contribute to the cost of wear and tear on the roads.

4 Innovate UK is currently funding a two year pilot in Scotland of the "Pick & Mix Project" to provide young people with a mode-neutral end-to-end transport service, with the aim of developing a working model that can be rolled out across the UK.

Step 7: Enable Future AV To Integrate

Enable future AV, car clubs and carpooling, apps for hailing and ride-sharing, and future innovation, to use TForward for back-end payment and accounting mechanics, and to benefit from TForward's established customer base.

These back-end costs, and processing initial customers, are significant barriers for start-up businesses and it will help roll-out of AV, alternative capital models and innovation. How AV will come, and over what time-frame, is unknown. Having payment infrastructure and a customer base in place, will make the UK attractive and help place it at the forefront of AV innovation. The introduction of new technology can also create opportunities to roll-out road charging in parallel.[5]

Step 8: Integrate New Road Infrastructure

Consider applying TForward road charging to specified new road infrastructure once built.

Initial candidates include the new or upgraded roads supporting Heathrow expansion, the Lower Thames Crossing, and the Silvertown Tunnel. Being around London, they would benefit from the existing London Congestion Charge customer base, if TForward is developed from that platform.

TForward could make new road infrastructure viable, such as the previously proposed Gallions Reach and Belvedere River Crossings in east London.

Step 9: The Local Government Deal

Local and combined authorities participating in the "Local Government Deal", would identify particularly congested or polluted local areas to introduce TForward charging, with the incentive of keeping the revenue to fund their own local road improvements.

Combined authorities, which generally have transport powers over a metro-region, are possible early adopters (e.g. Greater Manchester and the West Midlands with their newly elected metro-mayors). The TForward platform would enable them to start major city schemes in Manchester or Birmingham, but TForward's economies of scale would also make a low-tariff rush-hour only scheme in a small town viable.

Funding for local roads is crucial, considering people do more day-to-day travelling on their local roads than the SRN, and local roads are needed for that "last mile" delivery.

Congestion Charging could be introduced, perhaps initially on a trial basis, at rush-hour, in target areas affected by higher levels of congestion, such as a city centre, bridge or major traffic junction, and if successful expanded over time.

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[5] See Professor Edward Glaeser's Lightbulb Award winning entry

Emissions The Draft UK Air Quality Plan published in May 2017 includes proposals for mandating local authorities to establish clean air zones. TForward could facilitate this with charging schemes based on emissions, like London's Low Emission Zone.

There is a difficult political balance between people's concerns with exposure to dangerous emissions, compared with diesel drivers' views they were encouraged by past tax policy to buy diesel to help the environment, but are now being punished by a policy about-turn.

Charging diesel vehicles to drive along a congested and polluted high street would be easier to justify than some other local approaches, e.g. charging diesel cars hundreds of pounds more for parking permits as currently proposed by Merton Borough Council in London.

Localism Local government has the benefit of in-depth knowledge of local roads, the congestion and pollution hot-spots, maintenance priorities, environmental concerns, and how to link charging to road improvements attractive to local people. Local government will know the priorities people want addressing, from pot holes, to an additional river crossing, or increasing capacity at a key junction. Different authorities will come up with tailored approaches, with variation between urban and rural areas, and take into account access to public transport.

Rather than road-users suffering an endless wait for pressing local improvements (unlikely to become a central government priority), local government can start road improvements straightaway, potentially paid for with borrowing to be repaid out of future road charging revenues.

Mayors and local councillors will be sensitive to whether road charging is fair to their different constituents, and good for the local economy and environment, and alter or reverse the scheme if not.

TForward Efficiencies A number of UK cities have considered introducing road charging, but met with adverse public reaction.

It would be easier, for example, for local government to introduce (at least initially) limited rush-hour charging at a particular road, bridge or junction, or emissions charging around local schools, than to roll-out a wider city-centre charging scheme. Small scale local charging projects are made practical and economically viable by TForward, when otherwise the overhead cost, and inconvenience for road-users starting payment accounts, would prevent them getting started.

TForward shortens the time-scale for introducing a scheme, and removes risk, making it easier for local government to raise borrowing against future road charging revenues.

The Local Government Deal may also have advantages over the "major road network" concept.[6]

[6] The Rees Jeffreys Road Fund has supported an outstanding report (by David Quarmby and Phil Carey published in October 2016, entitled "A Major Road Network for England" at www.reesjeffreys.co.uk/transport-reports) making the case for combining strategic local authority-controlled "A" roads with the 4,200 mile SRN, to make an 8,000 mile major road network, to ensure investment is spread more widely on the whole network

Funding Central government might give a financial incentive to the first authorities to pilot the Local Government Deal to get things started, and create examples for other authorities to follow.

Local authorities are facing severe budget pressures, with significant maintenance back-log on local roads, which could make TForward attractive for many.[7]

Roads have always been thought of as an expense for local government, rather than as revenue generating assets with the potential to fundamentally augment how local government funds not only its roads, but other key priorities, such as housing.

Central government might encourage a shift to local governments increasingly funding themselves with road charging, by reducing central government contribution to local government budgets, while supporting TForward.

If clean air zones become mandatory for some local authorities, they might constitute the initial small-scale road charging scheme in an area, but also provide the basis for later expansion into a more extensive road charging scheme addressing congestion too.

A statutory power already exists for local authorities to introduce road charging.[8] Having TForward operational would make it practical for local government to move forward and raise more of their own revenue.

Step 10: The Highways England Deal

The "Highways England Deal" provides for full roll-out of road charging across the SRN, with some of the money raised being used to fund improvements to the SRN:

a. first, Highways England would introduce road charging on all major new SRN road infrastructure built, and where there is a specific requirement (e.g. reducing pollution levels around Heathrow to enable a third runway). These will act as pilots for wider road charging.
b. next, Highways England will identify parts of the SRN with the strongest basis for road charging, e.g. by measuring traffic speeds to identify higher levels of congestion, or particularly polluted areas.

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of major roads.

If local government could fund its roads directly via the Local Government Deal, there would be less need to introduce the major road network concept, as they would have a means of raising funding, and would have longer-term certainty of funding, for maintaining the strategic local authority controlled "A" roads themselves. The Local Government Deal is administratively more workable than the major road network concept, as Highways England would not be needing to co-ordinate projects with over 100 local authorities.

[7] The 2016 Asphalt Industry Alliance's ALARM survey estimated that it would cost almost £12 billion to bring the local road network back to a reasonable standard.

[8] Sections 163 - 177 of the Transport Act 2000.

At a carefully planned point in time, Highways England will roll-out TForward road charging to critical mass, in these particularly congested areas in a way where clear benefits are demonstrable:

- as a form of demand management the number of vehicles should reduce at the most congested times and places
- some of the road charging revenue raised should be used to improve these parts of the SRN and key alternative routes, increasing road capacity, so people can see a link between their payments and investment

At this point, when substantial revenue is first raised from road charging, to be politically deliverable, an off-setting reduction in fuel duty is essential, so road-users are not simply gouged for extra revenue. With past failed attempts to introduce road charging, the debate has failed to include off-setting road tax reduction. A reduction in fuel duty, combined with a demonstrated cut in congestion, alongside road improvements, are crucial to winning public support at this key time.[9]

c. road charging introduced on one part of the road system, can lead to surrounding "free" roads becoming overloaded with traffic. Highways England can then move to a strategy of "smoothing" out road charging (and balancing it with any local road charging introduced under the "Local Government Deal"), so roads over a wider geographical area are charged for, but likely at lower tariffs so people do not pay significantly more overall.

d. Highways England can then continue to extend road charging over time until full road charging is rolled-out across the SRN.

The next section "Political Deliverability" sets out substantive areas where the government needs to be delivering to make extended road charging on the SRN and local authority roads politically workable. TForward is not a proposal for road charging by stealth, or based on gimmicky incentives for road-users. It is a long-term, evolutionary and sustainable programme.

Later, the section "Good for Road-Users, Economy and Environment" sets out the economic theory and rationale for road charging, and assesses in what circumstances road charging is fair to road users, and good for the economy and environment.

Transition to AV, and how and when it might have impact, is an unknown quantity. It may be the government will be able to receive additional uplift by introducing road charging alongside introduction of AV using the roads differently, avoiding adverse reaction from road users. Again, the flexibility in the TForward platform puts the government in the optimum position for being at the forefront, and taking advantage, of unknown technological change that will come.

[9] In 2000, petrol and diesel prices were driven rapidly to a level by the fuel duty escalator which generated enormous public discontent. Governments since have felt they needed to freeze or limit fuel duty increases, which are highly visible, and this illustrates the public and political sensitivity to road charges.

STEPPED INTRODUCTION OF TELEMATICS ROAD CHARGING

Step 1	• establish "TForward" providing back-end payment and accounting mechanics that existing and future charging schemes can link into • potentially convert existing London Congestion Charge platform into TForward
Step 2	• modernise London Congestion Charge to telematics-based variable tariffs • potentially expand London road charging beyond current congestion zone
Step 3	• integrate existing road charging and parking schemes into TForward • enable customers to have only one user-friendly payment account
Step 4	• upgrade the HGV Road User Levy to TForward telematics to meet Air Quality Plan objectives and increase night-time motorway use
Step 5	• potentially integrate public transport "smart" ticketing into TForward
Step 6	• enable EV chargepoints to use TForward for back-end payment and accounting, for cost-effective roll-out of EV recharging infrastructure
Step 7	• enable future AV, car clubs, ride-sharing and other innovative apps, to use TForward for their back-end payment system
Step 8	• potentially apply TForward road charging to new road infrastructure that is built such as new and upgraded roads around Heathrow and the Lower Thames Crossing
Step 9	• Local Government Deal enables local authorities to introduce TForward telematics at congested local hotspots and establish clean air zones • in return the local authority keeps the money for local road improvements
Step 10	• Highways England Deal enables TForward telematics to be rolled-out on the Strategic Road Network, starting with congestion hotspots

3. Political Deliverability

3.1 Addressing Public Concerns

In 2005, government plans were announced to introduce road charging likely to be based on telematics. There were objections to more charges on motorists, civil rights objections that it would amount to mass surveillance, and an online petition in protest gained over 1.8 million signatures.

This experience is at the heart of the question - how can payment models needed for future road infrastructure be politically acceptable? Concerns raised by 1.8 million people should be addressed to develop better policy.

3.2 The Starting Steps

Many of the steps set out above in "Stepped Introduction of Road Charging" are not especially controversial to introduce from a political perspective. Let us call these the "Starting Steps":

- establishing the TForward platform
- modernising the existing London Congestion Charge from its flat-rate, to variable telematics tariffs linked to congestion
- integrating existing road charging and parking schemes into TForward, upgraded to enable variable telematics tariffs
- upgrading the HGV Road User Levy to TForward variable tariffs
- potentially integrating public transport ticketing into TForward
- TForward providing back-end payment and accounting mechanics for EV chargepoints, car clubs, future AV, ride-sharing apps and other technological innovation
- potentially charging for new road infrastructure (e.g. around Heathrow, Lower Thames Crossing)

Many players - central, devolved and local government, TfL, Highways England, insurers, parking providers, EV and AV pioneers, and app developers - can move forward concurrently in their areas.

Time and political capital does not need to be spent upfront developing and defending detailed policy for more extensive road charging.

Nonetheless, the Starting Steps, together with insurers promoting telematics, will cumulatively have significant impact, and build a critical mass of people and vehicles registered with TForward and linked into the telematics system. The Starting Steps may not be big revenue generators, but they can contribute towards replacing decline in fuel duty receipts.

Next, decision making can advance democratically at the devolved and local level, where there is good understanding of the local road network, congestion hotspots, pollution levels, maintenance and improvement priorities, as well as sensitivity to what local people will accept.

3.3 Political Deliverability And Delivery

It will take a number of years to introduce the Starting Steps and deal with teething problems.

That time needs to be used purposively to lay the groundwork for more extensive road charging, such as Highways England extending charging on the SRN, and substantial local road charging under the Local Government Deal. There is potential for greater political controversy, not least because these steps can raise substantial revenue.

Focussing on building a case, or putting together a "deal" with the public, that makes road charging politically deliverable may be a flawed approach given scepticism of political promises. However good an intellectual case is made for road charging and its benefits, it can still just be met by adverse public reaction to paying a new tax.

The answer to political deliverability is political delivery.

Actions not words.

The politicians will be much better placed to extend road charging if they can point to actions, and a track record of improvements already delivered.

They need to show the system is being changed, and in return for a new way of paying for the roads, people are getting a better system which clearly benefits them.

In parallel with introducing the Starting Steps, the government needs to be delivering some tangible benefits from road charging related initiatives.

It is a two-way street, and if the government wants a politically deliverable policy, it needs to deliver politically in real time in some of the following areas. If the rights steps are taken now, in a few years time, this is how the UK roads environment could look from a road-user perspective, and resistance to further extending road charging may consequently be less:

- new roads are being constructed, additional roads are planned, and road improvements are being made, funded by the VED ring-fenced Roads Fund
- new road infrastructure is being built under the Highways England Deal, funded by pilot telematics road charging schemes (perhaps on new improved roads supporting Heathrow expansion, the Lower Thames Crossing and Silvertown Tunnel)
- a modernised London Congestion Charge with variable telematics tariffs has cut congestion and pollution in previously blighted areas of London
- pioneering schemes under the Local Government Deal have reduced local congestion and pollution, delivered local road improvements, and created clean air zones, and are providing a model to other local authorities
- TForward telematics charging is guiding HGVs away from congestion and pollution hotspots, with increasing night-time use of motorways
- existing road charging and parking schemes have been integrated into TForward, so customers only have one user-friendly payment account to manage

- new parking providers have entered the market advertising more and cheaper parking because they have been able to link into TForward
- pot holes are being filled, and road maintenance innovations have been introduced, from warm-mix asphalt, to getting a fleet of cold repave machines operating
- people can see money raised from VED and limited road charging actually being invested back into road improvements they can identify with[10]
- a roads communications strategy is better engaging with the public to raise awareness of actual progress and improvements being made, and the exciting future offered by technology[11]
- the Wolfson Select Committee has been established and is prominent in the media fighting for the public interest

This is the point at which the government (via Highways England) may be able to extend road charging on the SRN. This must be in parallel with a significant reduction in fuel duty, so that road-users can see the road charging is not just to raise more tax.

The government should also be working towards other target ambitions. To achieve them all would set an unrealistically high bar, and a number are outside the government's control. However, progress on some would help create an inspiring forward-looking UK roads environment more receptive to extending road charging:

Financial

- the financial burden on road-users is reduced by TForward International generating profits from overseas transport
- the financial burden on road-users is further reduced with value capture, so those benefiting from new road infrastructure (including property developers) contribute to the cost, with projects like the Cambridge - Milton Keynes - Oxford corridor having successfully piloted value capture initiatives
- telematics insurance policies that reward good drivers with lower premiums are widely available
- people can choose to avoid the capital cost of buying a car because ride-sharing apps, along with car clubs and carpooling, and better integration with public transport, have given them a realistic alternative (lower car ownership amongst young people may reduce opposition to road charging compared to 2005)

[10] In November 2016 in Los Angeles, 71% of people voted to pass Measure M, a sales tax increase to improve transport. Most people could identify with at least one of the improvements in the Measure M package, crucial to winning voter support.

[11] Lessons about engaging with the public can be learned from Crossrail, with its positive messaging about engineering achievement, training and employing people, delivering on time, and adding greater value to the economy than its cost, recently showcased in a BBC series

Procurement

- the government has moved on from PFI, and freed the UK from EU procurement rules cutting bureaucracy and supporting more UK jobs
- mode-neutral procurement is used to find the best transport solutions, with fairer apportionment of spend between road and rail

Exciting New Technology

- it has become as cost-effective and practical to own an EV as a traditional petrol or diesel car, and sufficient EV chargepoints have been rolled out, so EVs comprise the majority of new car sales, and air quality is improving as a result
- AVs are starting to penetrate so more people are thinking about their potential
- a prototype AV rail test line has been built, maintaining the UK at the forefront of AV development, and heralding potential solutions to urban congestion and inter-city travel
- they are as yet unknown, but exciting innovation and collateral unplanned benefits are appearing from government funding into infrastructure research, availability of the TForward platform for emerging technologies, and telematics technology
- people can see that technology is rapidly bringing benefits, and it will take new ways of funding to fully realise that potential

Information Security

- TForward has demonstrated robust financial and information security
- a balanced debate develops around telematics data collection, with privacy concerns set in the context of widespread mobile phone and social media uptake, and telematics insurance based on a person's driving habits making insurance more affordable for many young people
- Parliament is determining the extent to which telematics information, with appropriate judicial oversight, is used to combat crime and terrorism

Safety

- telematics is demonstrably making our roads safer, for example with telematics insurance policies identifying dangerous drivers, by alerting emergency services to incidents, or immediately recognising a motorway pile-up and transmitting warnings to connected vehicles heading into the danger zone and onto overhead gantries

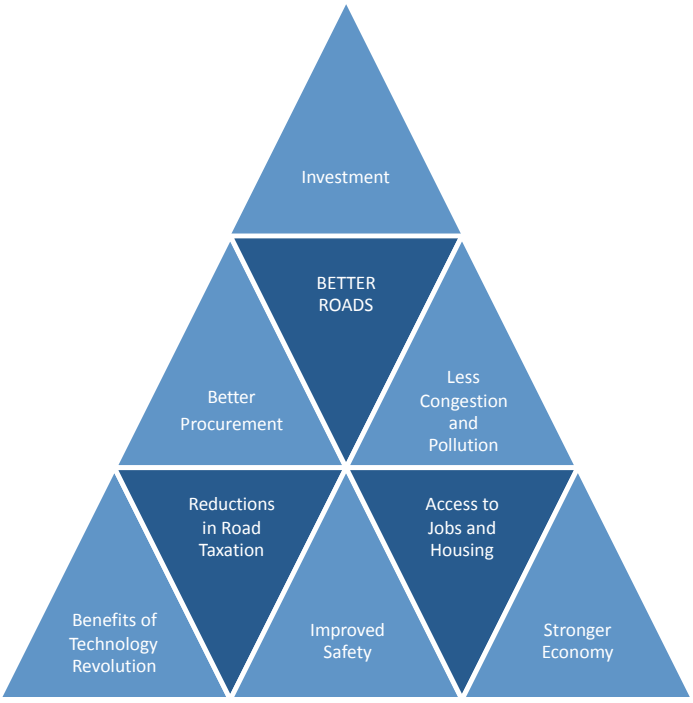
Quality Of Life

- better roads are opening up land for less-costly housing, saving people from hours in traffic, preventing worsening gridlock, and improving people's quality of life

Economy

- better roads are making jobs accessible, including for people in depressed areas
- the UK stands as a world-leader in new automotive technologies, batteries research, infrastructure solutions, and telematics road charging, and the UK economy is exploiting the export potential
- roads are helping drive the economy rather than holding back economic growth

Demonstrable progress in at least some of these areas will help make wider road charging, beyond the Starting Steps, more deliverable politically.



3.4 Additional Roll-Out Approaches

The Wolfson Economics Prize drives innovative ideas and debate, recognising the best solutions combine ideas from multiple sources. The TForward platform creates a mechanism for implementing good ideas put forward by other entrants for rolling-out road charging:

1. Gaming Approaches: making road charging fun, such as "road miles" with lotteries and auctions, or other promotions and discounts, could be made available on TForward's customer web-site, and administered by TForward's back-end payment system
2. Trusted Brands: persuading retail brands to partner with a road charging scheme, and market with companion products, may be easier if a trusted TForward platform is established, so brand-owners have confidence there will not be teething problems and customer and account services will be properly managed
3. New Technology: can provide opportunities to implement road charging. A core objective of the TForward platform is to encourage roll-out of new technology by providing the customer base and payment mechanics (which would otherwise be a barrier to entry) for EV chargepoints, AV, apps and other innovation to come, and TForward is the practical solution for implementing road charging alongside introducing these new technologies

This entry has not relied on voluntary roll-out of road charging as, even if the financial cost of adverse selection is addressed (where only drivers financially better-off with road charging opt-in, e.g. off-peak drivers), this approach does not reduce pollution, or manage peak-time demand and reduce congestion. Oregon state's voluntary scheme (OReGO) launched in July 2015 charging 1.5 cents per mile in return for a fuel duty rebate, but only 1,300 drivers had signed up by April 2017.[12] Full roll-out will only happen if the road charging scheme is made compulsory for the remaining majority of drivers, which is unlikely to be politically deliverable when that will include rush-hour and van drivers.

This entry proposes telematics road charging, with its sophisticated differential tariffs, rather than a simple road charging formula which does not address congestion (even fuel duty has a weak link to congestion, increasing with fuel consumption in slow-moving traffic).

The TForward platform will take customer payment on a pay-as-you-go basis, or by regular direct debits, to avoid a situation where customers drive cheaply all year without paying fuel duty, but then struggle to find the money for an unexpected lump sum road charge.

The TForward platform could provide the data and technology capacity to compute tailored individual journey prices and bill the driver, although in comparison to a universal advertised road tariff people might perceive their route as over-priced and unfair. Road charging would become highly visible (opacity of fuel duty at the pump means people think less about it), and drivers might be irritated having to book journeys before setting-off.

The TForward platform's sophisticated data collection might help find some practical solutions for compensating drivers for slow journeys, given people make unplanned stops on-route (e.g. at shops or service stations), and compensation could encourage adverse behaviour such as people deliberately slowing-down. However, such compensation may run counter to marginal cost pricing, which implies charging more if a route is congested, rather than compensating for delay.

TForward is not a quick cheap solution, but it is a realistic solution to collecting around £27 billion a year (if fuel duty is to be replaced), from millions of drivers, in a politically acceptable way that so far has eluded policy-makers.

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[12] Oregon's Road Usage Charge, The OReGO Program Final Report, Oregon Department of Transportation, April 2017

4. TForward International

4.1 Business Plan

TForward creates an enormous international business opportunity for the UK to build a new industry. The UK's challenges with road charging, upgrading public transport ticketing to "smart-ticketing", and rolling-out EV recharging infrastructure cost-effectively, are experienced by other countries around the world, also looking for practical solutions.

When governments have looked at road charging schemes previously, they have done so with an isolated approach of making a particular scheme pay for its costs, rather than stepping back and realising the problem of paying for overhead cost on one scheme, can be turned into a business opportunity across all schemes.

The proposal is for the government to support building a TForward platform that would work internationally. It could be used by other road charging and transport ticketing schemes for both passengers and freight, and for EV chargepoints, around the world to facilitate customer interface and back-end payment and accounting.

The TForward platform would take a small administration fee from each payment processed. Economies of scale, given network effects, would enable the TForward platform to be run cost-effectively. TForward's IT systems would be up-to-date, and hence both flexible and scalable.

Mobility as a Service ("MaaS") is a new concept for a traveller being able to seamlessly make a journey combining multiple modes of transport, operated by different transport providers, with integrated travel information and one combined ticket, to get from A to B. TForward International is the business plan for turning that concept into a product.

Given the phenomenal amount spent internationally on transport, even with only a small fraction of the international market, the TForward platform could generate very substantial profits amounting to billions of pounds each year. The long-term profit-making potential of TForward International, if it continued to grow and take larger market share, is outstanding.

Those profits, if the platform were to prove a commercial success internationally, could go towards replacing fuel duty and VED, and funding the UK's roads.

4.2 Establishing TForward International

TForward should be established for the UK road charging market, but in a way that could both work internationally, and support all transport ticketing.

A corporate vehicle would own the TForward International platform. Equity ownership would be shared between government and the private sector consortium that will be needed to build and operate the platform, including forward-thinking financial institutions and IT providers. The government should hold a "golden" share to prevent an unwanted take-over, which the government might later choose to release to maximise value on selling all or part of its shareholding.

The financial incentive of operating the international platform, would encourage the private consortium to drive creation of a market-leading platform for the UK in real-time, to create a demonstrably successful platform ready for international roll-out. The predictable long-term nature of aggregated road charging revenues would be particularly attractive to pension funds and insurers.

The Wolfson Select Committee (below) should be given a specific additional remit to oversee establishment and operation of the TForward International platform, to ensure good and fair value is obtained for government, taxpayers and road-users.

Establishing, operating and growing the TForward International platform would create many skilled and professional UK jobs, and cultivate world leading UK sectors in FinTech (financial technology) and innovative automotive investment, underpinning the government's industrial strategy.[13]

4.3 The UK's Competitive Advantage

An international transport platform for road charging has not arisen before because the technology has not been good enough, most road charging schemes to date (e.g. Singapore and Stockholm) have been fairly small-scale, and no-one has yet grasped the opportunity.

The UK has some unique selling points for becoming the world-leader for an international transport platform. The FinTech sector linked with the City of London means the UK has the expertise to build and run the technology platform. The UK has established stable and trusted political and legal systems. The London Congestion Charge is a large and world-leading road charging system.

- First Mover Advantage: this business plan for TForward International should be taken forward, with government support, quickly - or other players will seize the opportunity. The UK should aim to build critical mass before competitors appear. The UK may be able to gain additional competitive advantage as first mover, leading in developing the standards for (i) telematics-enablement of vehicles and people, and (ii) EV "smart" terminals that recharge when it is off-peak for the grid (see Section 7 "Environment").

[13] Building our Industrial Strategy", HM Government Green Paper January 2017

- Critical Infrastructure Risk: there will be inherent caution by other governments outsourcing something as important as their road and transport systems. A company that is part-owned by UK government, with a track-record of reliable delivery through an innovative but well-regulated system in the UK, could best address such concerns.

- Network Effects: achieving critical mass across international transport would generate extraordinary advantage, but given the size of the international transport market, that is a longer-term proposition. However, the UK may be able to benefit from network effects by first focussing on geographically close countries (e.g. France and Ireland) where there is already substantial cross-border transport with the UK."

4.4 The TForward International Service

TForward International would have many features making it attractive to transport providers, passengers, and freight transporters:

- transition to new capital models, with MaaS across multiple modes of transport, could be enabled internationally, rather than only nationally. The TForward website would provide clear customer travel and ticketing information, and be able to put together combined travel tickets working across various modes of transport (from air travel, to boats, buses, trains trams, and taxis) from different transport providers for one journey, national or international, from start to end point
- transport providers would be attracted by (i) a substantial international base of customers using transport services, and (ii) it being easier to operate a single transport network across different jurisdictions
- TForward International would be an established reliable payment and ticketing system, reducing the risk of teething problems and set-up risk and delays, and cost-effective due to economies of scale
- access to the TForward Platform would enable other governments facing similar resistance to road charging, to cost-effectively and reliably introduce road charging with a shorter lead time. It would give the additional flexibility to introduce road charging in small steps on limited or trial basis, such as at rush-hour only, without that being uneconomic due to overhead costs. Road charging could be viable with low tariffs, which may be particularly relevant for the US given its low fuel duty
- by piggy-backing on the already developed UK regulatory approach (e.g. for privacy and data protection), overseas governments could also save on time and fixed costs needed to develop appropriate regulation from scratch, even if they chose to adapt the UK approach

- the TForward platform would generate extensive travel data, enabling sophisticated pricing structures that manage peak demand so transport infrastructure is used optimally and congestion reduced

4.5 Additional Opportunities

Other potential opportunities for the TForward International platform are more speculative and require critical mass.

The TForward International platform could be well-placed to provide additional profit making services, starting with foreign exchange services to support international payments, and ancillary travel services such as hotel bookings.

Given the extensive road transport data the TForward platform would be accumulating, it could develop competitive advantage (and provide a pathway for UK focussed insurers to expand globally) in providing transport insurance internationally, including for a changing insurance market where AV and conventional vehicles operate alongside each on the on the world's roads over a transition period of decades.

The City of London might (with effective regulation) create a new financial market based around the TForward International platform, creating and trading new derivatives based on transportation risk.

4.6 Political Messaging

To return to the beginning, Step 1 is establishing the TForward platform. From the perspective of the transport minister on day one, their job is not to sell an overall blueprint for road charging, but to announce government investment in an exciting new public/private technology platform. The following reasons for, and benefits of, the platform can be explained:

- access to private sector funding and expertise for public benefit
- earning overseas revenue from TForward International, for the UK taxpayer, including to spend on roads
- helping make the UK an investment hub for AV, new apps, and other innovation
- cost-effective roll-out of EV recharging infrastructure
- user-friendly integrated payment system for existing parking and charging schemes
- enabling "smart" public transport ticketing, and customer-friendly integration of all modes of transport (MaaS)
- modernising the London Congestion Charge to better address congestion and pollution
- targeted HGV and lorry charging to take their routes away from where people live, and encourage night-time motorway use
- enabling emissions charging against the worst offenders (such as lorries and large diesel vehicles) to improve air quality
- making the UK the world-leader for transport platform technology

The case for creating the TForward International platform stands on these arguments alone, irrespective of whether the platform goes on to raise substantial sums through UK road charging. In any event, decisions on UK road charging would be a long time in the future to be made by a future government. That enables the minister to limit any push-back on road charging at the outset.

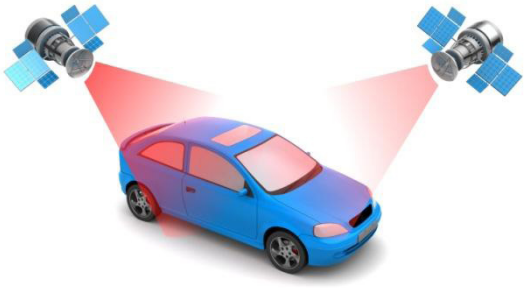
To the extent the minister is drawn into discussion of road charging, it can be made clear that road charging would only ever be introduced if it (i) was offset by fuel duty reductions, and (ii) produced a demonstrably fairer deal for road-users, with road charging linked to emissions and congestion, and proceeds funding much better roads.

If TForward International succeeds, earnings from overseas would offset the fixed costs of developing the platform, and could potentially generate substantial profits for the benefit of road-users and taxpayers.

5. Insurance And Telematics

5.1 Advantages Of Telematics

The government can explore rolling-out telematics via vehicle insurance. The government needs to consult with the vehicle insurance industry, and adapt or not proceed with any aspects which are not workable from the insurers' perspective. Collaboration and mutual benefit is needed.



Telematics can be described as satellite vehicle tracking, and the technology brings numerous benefits including:

a. Sophisticated Road Charging: telematics offers the optimal model for road charging as it can offer sophisticated tariffs calculated on a range of metrics such as vehicle model, emissions levels, vehicle weight, and which roads, tunnels, bridges or parking spaces are used, at which times.
   By way of example, the lowest or zero tariff might be for a small EV driving on a rural or suburban road at the weekend, whilst a diesel HGV travelling on a congested route at rush-hour might pay the highest tariff. Delivery vans servicing the growing home-delivery market could pay a tariff reflecting their size and weight and impact on road maintenance Telematics tariff differentials can be used to reduce congestion and pollution, flexibly adjusted in real time according to traffic flows, or for predicted events such as road works, festivals or sports events, or for unexpected events such as taking traffic away from an accident.
b. Cost-Effective Road Charging: telematics avoids the need for physical road-side cameras to recognise number plates, enabling fast cost-effective roll-out of road charging schemes. Until all road-users are telematics enabled, road charging schemes will still need physical cameras, either to provide a parallel non-telematics payment system, or to enforce fines for non-compliance if telematics are required for use of particular section of road infrastructure.
c. Safety: telematics insurance financially incentivises safe driving, with those driving dangerously having to pay higher premiums, or in extremis being denied insurance cover (such higher-risk drivers might be early users of AV). Telematics insurance policies are already being taken up by young and other high-risk drivers.

Telematics has the potential to alert emergency services to accidents, and immediately transmit warnings to connected vehicles heading into a motorway pile-up, or onto overhead gantries.

Most importantly this brings humanitarian safety benefits, and secondarily avoids the financial costs of road accidents, hospital treatment, and long-term care for the seriously injured. Telematics can also help identify vehicles being driven without insurance cover.

d. AV insurance: there are open questions about how the insurance industry will manage changing risk with AVs (of differing levels of automation), mixing on the roads with conventional vehicles over a lengthy transition period. The government's approach is for anyone affected by an accident caused by driverless technology to claim from insurers, and insurers to then reclaim from AV manufacturers.[14]

   Telematics can provide the data that will enable insurers to calculate and price new and changing risk. It will enable people to pay a one-off insurance charge when they "hire" an AV.

e. Vehicle Management: telematics enables digital management of traffic by public sector authorities. The number of private-sector companies managing fleets of lorries and cars with telematics has recently taken-off.

[14] Vehicle Technology and Aviation Bill

5.2 Roll-Out Telematics Via Insurance

Accelerating the roll-out of telematics will enable the government to get on with more extensive road charging under the Local Government Deal and the Highways England Deal.

The government could establish a common telematics technology protocol that works for the vehicle insurance industry and with the TForward platform. The GPS locator might be an app on a smartphone kept in the vehicle, or a dongle plugged into a vehicle data port. Whether it is workable for the telematics to be linked to people, rather than vehicles, can be explored so as well as enabling vehicle insurance and road charging, it also enables a person to use the same GPS locator and TForward account for integrated public transport and MaaS via TForward.

Combining roll-out via vehicle insurance (there are over 26 million UK car insurance policies), with payment for existing road charging and parking, would help telematics reach critical mass more quickly, and would each reinforce each other.

Optically, it will be better if insurers rather than government, take the lead on rolling-out telematics. This should allay opposition to "government" collecting data on people's movements, given few people object to Google or mobile phone providers collecting such information. It will also facilitate a stepped approach to roll-out and avoid any political "cliff-edge" where the government would need to announce a national road charging scheme.

The government could take the view that the benefits of accelerated telematics roll-out are so great, it would subsidise insurers' costs to administer transitioning people to telematics, e.g. by supporting distributing dongles, and not initially charge insurers an administration fee for operating telematics insurance through the TForward platform. That would lower insurers' costs, which could be passed on to customers in lower telematics premiums, increasing telematics insurance uptake.

Telematics insurance could be made compulsory for new drivers, given many young drivers already use telematics policies, young people are amenable to new technology, and it could be justified on safety grounds. Compulsory telematics insurance could then potentially be extended to cover others, such as those making an insurance claim following a collision, so that over time a greater proportion of drivers are covered by compulsory telematics.

When traditional vehicle insurance policies come up for their annual renewal, insurers might offer the policyholder, and the other drivers named on the policy, their own free telematics dongles or apps linking into the TForward platform with the benefits of:

- greater safety, with the telematics able to notify emergency services and speed up response time if they are in a road accident
- assessing whether they could save money switching to a telematics policy
- flexible vehicle insurance options, e.g. pay-as-you-go, or limited mileage or restricted hours policies
- user-friendly payment system for paying existing road tolls and for some parking schemes
- combined user-friendly payment system for public transport smart ticketing (when available)

The government might support this by funding accompanying advertising campaigns highlighting the benefits. A pilot project with a forward-thinking insurer is recommended.

5.3 Introducing Road Charging Via Insurance

An alternative way to introduce road charging might be via vehicle insurance, and acknowledgment and credit is given to Gergely Raccuja's primary prize submission considering a mileage-based road tax with collection outsourced to insurance companies.

More sophisticated telematics-based road charging through TForward could also be introduced with vehicle insurance, perhaps via implementation stages as follows:

Stage A: create the TForward platform

Stage B: increase customer uptake of telematics vehicle insurance with the consensual approaches outlined above. Payment for a telematics policy would be on a regular or pay-as-you-go basis

Stage C: make telematics vehicle insurance compulsory for new drivers (above)

Stage D: make telematics vehicle insurance compulsory for others, justified on improved road safety grounds

Stage E: have all telematics vehicle insurance policies administered via TForward, creating TForward customer accounts, with TForward providing the back-end accounting, and passing premiums onto insurers, and insurance premium tax ("IPT") to the Treasury

Stage F: TForward (collaborating with Highways England) introduces limited road charging at the worst congestion or pollution hotspots

Stage G: road charging is increased gradually over time to full roll-out of road charging. Alongside increases in road charging, there is an offsetting reduction in fuel duty (or potentially also IPT for vehicles), along with demonstrable road improvements

On balance, this is not considered a better approach to introducing road charging, with compulsory telematics insurance likely at some point to become a political cliff-edge. However, there may be room for overlap in approach between the TForward stepped approach and introducing some road charging via insurance. Flexibility in thinking is important given the pace of technological change, and an insurance industry considering how to insure a transition to AV, and insurers views would need to be listened to.

6. Raising Tax From EVs

6.1 "Free-Loading" By EVs

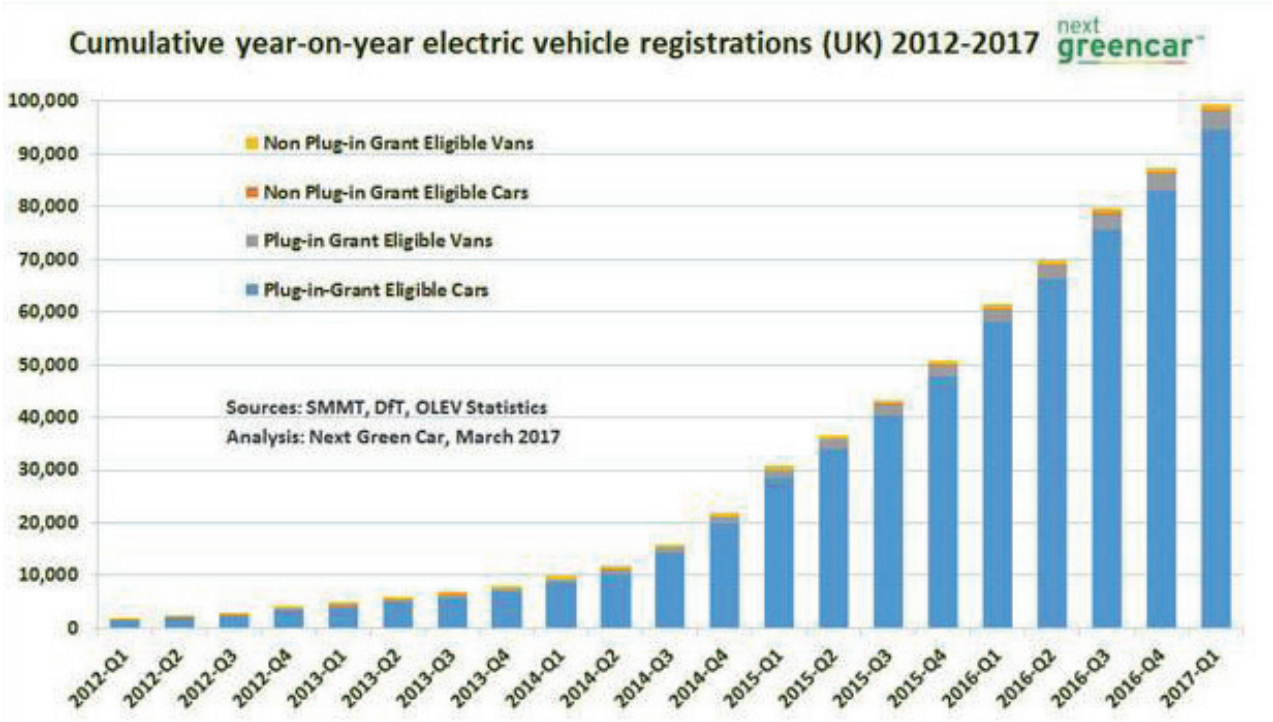
EVs are "free-loading" without contributing VED and fuel duty. The fuel duty tax base may now be undermined sooner than previously predicted given:

i. significant political and legal pressures to address emissions and increase EV uptake
ii. technology innovation potentially driving sudden uptake of AVs (likely to be EVs)
iii. resistance at the pumps preventing fuel duty rates being maintained in real terms[15]

Telematics road charging is the optimal model to replace fuel duty, as it can address congestion, and link revenue with investment. Taxing fuel (whether petrol, diesel or electricity) is a comparatively blunt instrument.

However, road charging will take time to reach its potential, and there may be ways to protect the tax base during the transition period.

The focus to date has been on tax incentives to accelerate take-up of EVs. In the near future, EV take-up is likely to reach a tipping point when critical mass ensures continued roll-out. EVs need to start paying more in tax, and soon.



[15] The OBR has forecast fuel duty receipts may halve within 20 years.

6.2 The Sooner The Better

The sooner any additional EV taxation is introduced the politically easier it will be:

- EVs are not yet widely-owned so there are fewer people to object
- given the purchase-price for EVs, the first-wave owners are generally affluent, often using the EV as a second vehicle, and less sensitive to a tax increase
- more affluent drivers can be more concerned with the practicalities of recharging and access to chargepoints, which can be supported by EV taxation
- many EV owners are concerned about the environment, and EV taxation could help support renewable electricity generation for EVs
- it can be explained new EV taxation is the same as (or less than) fuel duty on petrol and diesel, and justified as fair
- if EVs are not taxed more heavily soon, EV owners could resist road charging, since they will not be paying any tax which could be cut to offset widespread road charging (as is proposed for fuel duty to make extending road charging under the Highways England Deal politically deliverable)

Any additional taxes can also be applied to AVs (which may well be EVs), which is politically easy now when people are not yet using AVs.

6.3 New EV Taxes

The Treasury has to date understandably resisted pressure to reduce or remove VAT on EV purchases.

The Treasury might like to raise as much tax from EVs, as fuel duty currently raises from petrol and diesel vehicles, so transition to EVs does not undermine the tax base. Since fuel duty is such an effective, and difficult to evade tax, this is a challenge.

TForward can improve the EV taxing options available to the Treasury, and three are considered:

6.3.1 VED for EVs

EVs could start paying VED. The key to making this politically deliverable is to use some of the initial revenue to roll-out EV chargepoints. The government policy could be establishing TForward and its strategy for rolling-out chargepoints (see Section 7 “Environment”).

Making EV recharging more widely available is a better way to encourage relatively well-off people to purchase EVs than an excessive tilting of tax treatment towards EVs. That in turn will help make EVs accessible to less well-off people, since reaching critical mass of EVs on the road is the key to bringing down their price.

That argument turns a tax-raising policy from potentially being perceived as anti-EV, into a policy which can be presented as pro-EV and environmentally positive.

In addition:

- VED need only be levied on new EVs (avoiding backlash from existing EV owners) as it is the potential rapid future increase in the number of EVs that threatens the tax base
- VED on EVs might rise over a few years to the £140 standard rate (and initially without the additional £310 premium if the EV list price is over £40,000). Pre-announcing such an increase might also bring forward EV sales
- to help sell the April 2017 VED increases, VED raised in England from 2020/21 is hypothecated to a new ring-fenced Roads Fund to provide certainty of funding for Highways England and the SRN.[16] With VED going into the Roads Fund, if some of that fund is used to install chargepoints, it will make VED easier politically to introduce for EVs.[17]

The government could also consider protecting the overall tax base by raising VED relative to fuel duty, as VED will no longer be threatened by transition to EVs.

Chancellor William Gladstone:

"But, after all, what use is (electricity)?"

Michael Faraday:

"Why, Sir, there is every probability that you will soon be able to tax it!"

(WEH Lecky, Democracy and Liberty, 1889)

6.3.2 Higher EV Recharging Tax

The TForward platform creates a separate metering and payment mechanism for chargepoints linked into it. TForward would invoice and collect payment from the customer, and pay any tax to the Treasury. If public chargepoints are required to operate from the TForward platform, that enables an alternative tax rate to be applied to the electricity. That could be a powerful tool for the Treasury, and make at least some contribution to recouping fuel duty.

Public chargepoints are currently subject to 20% VAT on the electricity. TForward could apply:

- a VAT rate higher than 20% (if EU VAT rules no longer apply post-Brexit), or
- a specific new tax (potentially with 20% VAT then levied on it, as with fuel duty)

[16] Ring-fencing VED is not a new idea, and hence Chancellor Osborne's statement that he "will return this tax to the use for which it was originally intended". In 1909, then Chancellor Lloyd George dedicated VED to roads so they could be self-financing. Between 1920 and 1937, VED was paid into a separate road fund, although in reality the money was not properly ring-fenced from other government spending (a practice advocated by Winston Churchill as Chancellor).

[17] Given the government spends around £9 billion annually on the roads, and VED currently raises only around £6 billion annually, hypothecating additional VED into the Roads Fund does not mean the government is making more money available for the roads

However, too high a tax on public EV charging would incentivise EV users to charge vehicles only at home paying just 5% domestic-rate VAT, and impede roll-out of chargepoints.[18]

There have been various customer complaints of over-charging at public chargepoints. If public chargepoints operated from the TForward platform, as well as lowering installation costs, TForward could ensure government-approved standards on pricing and consumer transparency, creating room for both price reductions for customers and a tax increase.

Such a higher recharging tax could be introduced more easily soon, when there is scope for prices to fall, and before many people are charging EVs on the public network, and, as with fuel duty, could be relatively invisible. Only a basic TForward platform will need to be operational, so implementation would not be delayed.

[18] Domestic electricity is subject to 5% VAT, but because people could evade TForward metering and a higher tax rate by connecting (even if it was illegally) directly to their own domestic supply, in practice it may not be workable to apply a higher tax rate to domestic recharging. There are other theoretical approaches, such as giving each household a fixed number of electricity units at 5% VAT, but applying 20% VAT to units used above this (broadly catching the additional electricity that will be used domestically to charge EVs on-mass), but politically difficult given people's sensitivity to utility bills.

6.3.3 Earlier Road Charging for EVs

TForward is rolled out on a step by step basis to avoid political "cliff-edges". One such step might be to apply early road charging to EVs before other vehicles.

To make early implementation workable the road charging could be:

- priced at a low initial level (and if low relative to fuel duty it should have little impact on EV take-up)
- applied only to new EVs (to avoid backlash from existing EV owners)
- calculated on a simple per mile basis. New vehicles can transmit mileage data remotely. The vehicle's GPS timeline (needed for more sophisticated telematics-based tariffs) would not be needed, so avoiding early-stage privacy objections particularly as mileage data is already collected at MOTs
- given a name linking to environmental benefit, such as the "Clean Air Fund" or "Renewable Energy Fund" (without strict hypothecation)
- allow the registered owner to select a billing and payment option through TForward, such as direct debit

Although not required for the stepped approach to rolling-out TForward, applying road charging early to EVs, would help TForward reach critical mass earlier. This would benefit the economy and environment earlier, as well as ensuring fairer tax treatment between EVs and other vehicles.

7. Environment

7.1 Transition To EVs

Introducing taxes on EVs, so they do not threaten the tax base so seriously, is key to enabling the government to drive an environmental agenda of increased EV uptake. Increased EV uptake reflects more than preferential EV tax treatment. For a relatively affluent initial EV ownership base, funding chargepoint roll-out is a more effective way to increase EV ownership to critical mass (see Section 6 "Raising Tax From EVs").

Increasing taxes on EVs, so they are similar to petrol and diesel vehicles, and using some of that initial revenue to fund chargepoint roll-out, can be presented as an environmentally positive policy.

7.2 Pollution

Transition from petrol and diesel vehicles, to EV or perhaps hydrogen, taking emissions (and noise) away from roads where people live, is one of the most environmentally beneficial roads policies to take forward, and addresses air quality concerns, specifically complying with legal NO2 limits.[19]

Diesel emissions harmful to human health, such as nitrogen oxides and particulate matter, are now recognised as a significant public health issue, and a political priority, in the UK and globally.[20]

The recent emissions scandal revealed under-reporting of diesel emissions. Partly because of such under-reporting, UK VED policy had incentivised diesel over petrol, to lower carbon dioxide emissions that contribute to climate change.[21]

Unfortunately, the time and cost to shift vehicle stock back away from diesel, now its negative impact is fully appreciated, leaves a difficult long-term legacy (although sales of diesel cars have been on a declining trend since May 2016).

Diesel emissions from vehicles are only part of the air pollution problem, with substantial pollution also coming from other sources such as machinery and gas boilers, and vehicle braking particulates. However, the government's focus is now clearly on roadside NO2 emissions from diesel, since it is roadside NO2 levels which are breaching legal limits.

[19] The government has previously stated an ambition to have all cars and vans effectively zero emission by 2050.

[20] The Royal College of Physicians estimates air pollution across the UK is linked to around 40,000 premature deaths every year. Research recently published in the Lancet, that followed nearly two million people in Ontario over 11 years, suggests an increased risk of dementia for people living near major roads.

[21] Greenhouse gas emissions from road traffic decreased every year from 121 million tonnes in 2007, to 108 million tonnes in 2014; DfT Road Use Statistics Great Britain 2016.

7.3 UK Air Quality Plan

In response to a court order the government published its updated "Draft UK Air Quality Plan for tackling nitrogen dioxide" in May 2017. The plan concludes that:

> "road transport is still by far the largest contributor to NO2 pollution in the local areas where the UK is exceeding limit values. Addressing road transport emissions therefore presents the most significant opportunity to tackle the specific exceedance problem ... The solution involves effective and appropriately targeted actions to:
>
> a. reduce emissions of NO2 from the current road vehicle fleet in problem locations now; and
> b. accelerate road vehicle fleet turnover to cleaner vehicles"

Proposals include mandating local authorities to establish clean air zones, reconsidering tax treatment of diesel vehicles, regulatory changes to encourage alternatively fuelled vans, updating the HGV Road User Levy, potential scrappage schemes, and retrofitting more heavily polluting vehicles.

Chancellor Osborne began to address diesel emissions (and falling tax receipts from CO2-efficient vehicles), by removing the CO2-based VED incentive for diesel cars registered from April 2017.

TForward would enable local authorities to establish the clean air zones, extending beyond just buses (see "The Local Government Deal"), and update the HGV Road User Levy to address emissions.

The Mayor of London now proposes to launch an Ultra Low Emission Zone in April 2019 across the whole of London for heavy vehicles, but also for cars and vans using London's north and south circular roads. Since that charging scheme will apply to most pre-2015 diesel cars, London's north and south circular roads may provide a suitable anchor scheme for TForward, if the current London Congestion Charge were not suitable.

Amidst a heat wave in June 2017, the Mayor of London triggered an emergency air quality alert, with warnings displayed on the underground, road signs and at bus stops, alongside City Hall advice to commuters to avoid London's most polluted areas. TForward tariff flexibility would enable temporary road charging to be applied when weather or another event caused a spike in pollution levels, to encourage people to alter their routes away from the worst affected areas.

7.4 EV Recharging Points

Commentators (and potential providers!) often describe the need for EV recharging infrastructure. Using the word "infrastructure" almost implies a need for a grandiose solution involving paying billions to large companies to install the chargepoints. There are already over 11,000 chargepoints in the UK.

Keep it simple. Keep costs low. Do not over-engineer.

A chargepoint is simply three things:

1. a back-end payment and accounting system
2. installation by an electrician
3. a terminal taking user account details, with a plug socket and electricity meter

Sometimes the best economics is not grandiose erudite theories, but basic thrift and common-sense. How would the typical person spending their own money go about installing a chargepoint?

[22] NICEIC roll of registered contractors

7.5 TForward Cost-Effective Recharging Points

The government approach to EV chargepoint roll-out considered in the Vehicle Technology and Aviation Bill ("VTAB") before the 2017 election included potentially requiring motorway services and large fuel retailers to install chargepoints.

TForward offers a better approach, encouraging cost-effective chargepoint roll-out by many players. TForward creates the back-end payment and accounting system, an information website, and customer base, that all chargepoints can link into, removing this expensive up-front capital cost and barrier to market entry.

- we have over 26,000 electricians in the UK.[22] TForward could enable independent electricians to do the installations, avoiding the inflated rates of large corporations. It creates an opportunity for electricians to set up competitive local installation businesses, perhaps in teams with other tradespeople like plasterers and asphalt layers to make good installation channelling, supported by and training apprentices
- TForward enables installation costs to be recovered over time. The user pays to recharge, the money is accounted for by TForward, taking a small administration fee, and paying tax directly to the Treasury, and the balance is passed onto the chargepoint operator, which can apply the margin (over electricity cost) against their original capital spend

- the capital cost can be spread amongst a large number of players including private car park owners, motorway services, petrol stations, retailers and EV manufacturers
- recharging points can be rolled out in small numbers, making it cost-effective for small businesses
- TForward could facilitate shared chargepoints being installed outside blocks of flats
- allowing private householders to install chargepoints accessible from public roads outside their houses, and make some money via TForward from charging third parties, might be a way to efficiently roll-out recharging infrastructure
- TForward provides a solution for the various existing networks which have different payment and access systems

The Autumn Statement 2016, announced £80 million for business chargepoints, and £40 million for the Plug-In-Car Grant. This funding may be more effectively used establishing TForward.

7.6 Customer Fairness

VTAB included provisions for chargepoint interoperability and mandatory available user information, in part to ensure customer fairness, against a background of customer complaints about being overcharged for public recharging.

If chargepoints were required to operate via the TForward platform, TForward would be able to apply government-approved standards to the market, including clear website and smartphone information about location and pricing of chargepoints, with real-time updates about which chargepoints are vacant and in working order, and appropriate pricing levels.

7.7 Electricity Generation

A transition to EVs will require additional electricity generation; from non-carbon sources if climate change emissions are to be avoided. The government target is to cut carbon emissions by 80% by 2050.[23] Roads of the future which generate their own energy from solar, wind, ground-pumps and other energy sources might be part of the solution.[24]

Credit is due to the UK for being at the fore-front of impressive research into improved batteries, to increase EV range, and also to store excess off-peak energy, including that generated by intermittent renewables such as wind, tidal, wave and solar. Electricity generation has inherent inefficiency with grid capacity built to supply peak demand, but inability to efficiently store much of the excess off-peak energy generated.

EV recharging has a significant role to play, as EVs charge mainly over-night when it is off-peak for the grid. EVs can then function as a mass national battery storing the additional off-peak energy

[23] Climate Change Act 2008

[24] Dr. David Williams has received a Lightbulb Award from the 2017 Wolfson Economics Prize for developing these ideas.

generated, and limiting any additional generation capacity needing built to support mass-EV ownership. Higher taxation of public recharging, used more at peak-time, along with variable electricity tariffs, can also play a role here (see Section 6 "Raising Tax from EVs").

Government should take the lead on establishing a common technology protocol for chargepoints so they can link into TForward and communicate with the grid. This will enable smart metering that helps balance supply and demand on the electricity grid, with chargepoints that can be mass-manufactured and sold cheaply.

TForward provides a single solution both to facilitate road charging and roll-out EV.

8. Good For Road-Users, Economy And Environment

8.1 A Better Deal

In the UK:

- each year the government raises around £33 billion in road taxes, but only spends around £9 billion of that on the roads; a difference of around £24 billion each year[25]
- our roads are hugely successful with a staggering 36 million vehicles travelling 320 billion miles, carrying nine out of ten passenger journeys, and transporting over two-thirds of our freight each year[26]
- that success has led to congestion, which can be considered a problem, or alternatively as representing unsatisfied customer demand, which if linked with the right infrastructure investment, can unlock the economic potential in our roads
- road investment is an opportunity to create access to jobs and less-costly housing
- vehicle pollution is now recognised as one of our biggest health challenges, increasing the relevance of alternative fuels, EV, improved batteries and power generation

It is only fair to give road-users a better deal, and save people from wasting endless hours in traffic, given how much more road-users pay in road taxes than is spent on roads.[27]

8.2 The Wolfson Select Committee

There is a role for a dedicated House of Commons select committee. Given the unwieldy official names of some of the select committees, for ease it shall be referred to as the "Wolfson Select Committee".

Whatever the theories and rationales behind road charging being fair to road-users, and good for the economy and environment, the Wolfson Select Committee would be a practical way of ensuring people actually benefit as road charging is developed and rolled-out in the real world.

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[25] In 2015/16 fuel duty raised around £27 billion, VED raised around £6 billion, and spending on the roads was around £9.3 billion, Transport Statistics Great Britain 2016 and DfT Tables TSGB 1310 and 1303. OBR predicts fuel duty receipts rising to £27.9 billion for 2016/17.
That does not include the additional VAT (£12.2 billion in 2012) raised on fuel, vehicle purchases, and other motoring goods and services.

[26] DfT Road Use Statistics 2016, and Provisional Road Traffic Estimates Jan - Dec 2016

[27] A CEBR report dated 22nd February, 2017 ranked Britain's road network 27th in the world.

The Wolfson Select Committee would have remit to:

- ensure any road charging introduced is fair to road-users, and good for the economy and environment
- oversee the creation, and scrutinise the running, of the TForward International platform, in the best interests of UK road-users and taxpayers
- oversee transition to EV, including roll-out of EV recharging points, demands on electricity generation, and improvements to air quality
- help keep the UK at the forefront of AV and other vehicle and infrastructure innovation, and encourage roll-out of new technology
- develop value capture
- oversee better infrastructure procurement practices, and scrutinise delivery of infrastructure projects
- continue to develop infrastructure funding innovation, increasing the long-term impact of this Wolfson Economics Prize

The Members of Parliament sitting on the Wolfson Select Committee would be able to fight for the interests of road-users paying for the road charging, and fairness for the losers from change.

The Wolfson Select Committee could provide cross-party oversight of the Conservative 2017 manifesto commitment "to deliver a better deal for customers and sharper incentives for investment efficiency" through a new approach to transport infrastructure.

Being called before a select committee for questioning before the media about delays, cost overruns, or profiteering at the expense of the taxpayer or infrastructure users, is a daunting prospect for many corporate managers and professional advisers.

An effective Wolfson Select Committee could save billions, particularly with a proactive focus on projects as they develop rather than afterwards.

Parliamentary select committees have become much more effective since 2010, when the appointment of MPs by party whips, was changed to election by a secret ballot of MPs. That has empowered the MPs sitting on select committees to challenge and hold government, the civil service and big business to account. Consider recent high-profile select committee scrutiny of matters such as phone-hacking and multinational tax avoidance.

8.3 The Current Taxation Model

Under the existing UK system, roads are primarily paid for out of the taxes VED and fuel duty. Transition to EV, or other fuels, could undermine fuel duty in its current form and there is a need for government to plan for replacing declining fuel duty receipts (see Section 6 "Raising Tax From EVs"). Many countries around the world are in a similar position and also need solutions.

Fuel duty is an unsophisticated form of road charging, increasing with mileage, and to a limited degree congestion (and therefore better than a flat charge per mile). Fuel duty does not reflect the cost of infrastructure used. Rather than taxing future vehicle fuels more (or accepting the revenue loss), road charging using telematics and improved technology, could be better targeted and fairer.

VED previously incentivised vehicles with lower CO2 emissions, but to preserve VED revenue now that most new vehicles have lower CO2 emissions, VED changed from April 2017 so it will no longer be based on CO2 emissions. Similarly, while low or zero VED rates now incentivise accelerated EV take-up, in future VED receipts can be preserved by increasing the VED rate for EVs. Therefore, in contrast to fuel duty, the VED tax base does not need to be threatened. However, replacing VED with road charging would give drivers a marginal rather than fixed cost, which could prompt behavioural change to less congested routes and cleaner vehicles.

8.4 Fair For Road-Users, Good For The Economy And Environment?

How can we pay for better, safer, more reliable roads in a way that is fair to road-users and good for the economy and the environment?

Understanding how different rationales affect different groups of people, and impact on the economy and environment, is crucial to rolling out road charging in a way that is politically acceptable and attractive to people.

Any new road charging scheme needs to be designed for the future, not just today, and consider technological change and future rationales for road charging.

The over-arching rationale for road charging must be to improve people's quality of life, including by generating economic growth. Investment in the UK's roads will generate economic growth. The UK's roads are congested to the point they frustrate people getting to work, distribution of goods, and business logistics, and that holds back the economy.

Some commentators note that when new roads are built they induce more traffic and quickly become congested, and that when vehicles get faster people travel further, and conclude it is pointless to keep building new roads. That is mistaken. Those additional journeys, and people travelling further, are products of a growing healthy economy.

How Road Charging Can Improve Quality of Life				
	Current Rationales for Road Charging	Fair to Road-users	Good for Economy	Good for Environment
1	Raising money for building, improving and maintaining roads	✓	✓	✗
2	Demand management to cut congestion, and spread peak demand so infrastructure is used optimally	✓	✓	✓
3	Emissions reduction to improve air quality	?	?	✓
	Future Rationales for Road Charging			
4	Enabling roll-out of AV and future technology	✓	✓	✓
5	Enabling new capital models	✓	✓	?
6	Consumer Choice	✓	✓	✗
	Government Revenue Rationales			
7	Raising money to improve public transport	?	?	✓
8	Raising money for other government spending	✗	?	?

Those improved journeys also benefit people's quality of life. People spend too much time stuck in traffic.[28] Investing in roads so people's time is not wasted and they have more choice about where is practical to live and work, and can easily travel to see family, along with all the other aspects of life facilitated by road travel, improves people's quality of life.

Using TForward to introduce road charging in many small steps allows the actual effect on road- users, the economy and environment of each step to be assessed. If a particular road charging scheme is not beneficial, it can be reversed or altered, without the problem being rolled-out further.

8.4.1 Rationale: Building, Improving and Maintaining Roads

Road charging creates the crucial link between demand and investment, so that road-user demand generates revenue, capital investment can be repaid from that revenue stream, and road-users can benefit from improvements made with the investment. That linkage is missing with the current taxation model.

Telematics enables sophisticated tariff structures, establishing an even stronger link between demand and investment (and in that respect telematics is preferable to a simple charging formula per mile).

Road charging can be fairer and result in better economic resource allocation, with those using the road infrastructure paying for it.

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[28] The average UK driver spends an estimated 235 hours each year behind the wheel.

Road charging enables investment to flow to where it is most productive, and market forces to select between competing and potentially innovative approaches.

If a business has customers queuing, it will seek to increase supply, by employing more staff, opening longer hours, or opening another outlet. A permanently congested road demands a similar increase in supply. Building a new road will not always be an option, e.g. into a tightly-packed urban centre, but where it is, charging to use the road can fund its construction, and bring forward new supply to meet unsatisfied demand.

Road-users will want to see road charging revenue well-spent. There have been too many examples of public procurement costs spiralling out of control amid project delays. Improving procurement practices is an opportunity to build public support for road charging to support the economy with new roads, while being fair to road-users (see Section 13 "Better Procurement").

8.4.2 Rationale: Demand Management

Without changing how we pay for our roads, demand (with congestion and pollution) for using our roads is expected to increase with:

- population growth increasing the total number of journeys
- growth in the size of the economy increasing demands on road infrastructure
- growth in the home delivery market
- demand for driverless AVs from people currently unable to drive themselves, including some disabled and elderly people and adolescents
- demand for driverless AVs from people preferring the comfort and convenience of private driverless travel so they can work or rest
- new mobility services as some people will make private car journeys from which they were previously dissuaded by the capital cost of buying a car

Road charging facilitates demand management and economically efficient allocation of road space. Without road charging, demand is by default managed through queuing/ congestion. The less value people place on their time, the more willing they will be to make a journey, ignoring the time value of others they delay. Road charging brings marginal cost to the road-user closer to the societal cost, including congestion and pollution, stopping journeys being made where the benefit is less than that higher cost.

Without charging for using road infrastructure, traffic levels are likely to grow faster than new road infrastructure can be financed by government.

Another aspect of demand management is that variable road charging tariffs can spread peak demand across a greater time-span, e.g. by incentivising flexible working, or night-time haulage. Therefore less road infrastructure needs to be built to meet peak demand, and road infrastructure is used more efficiently.

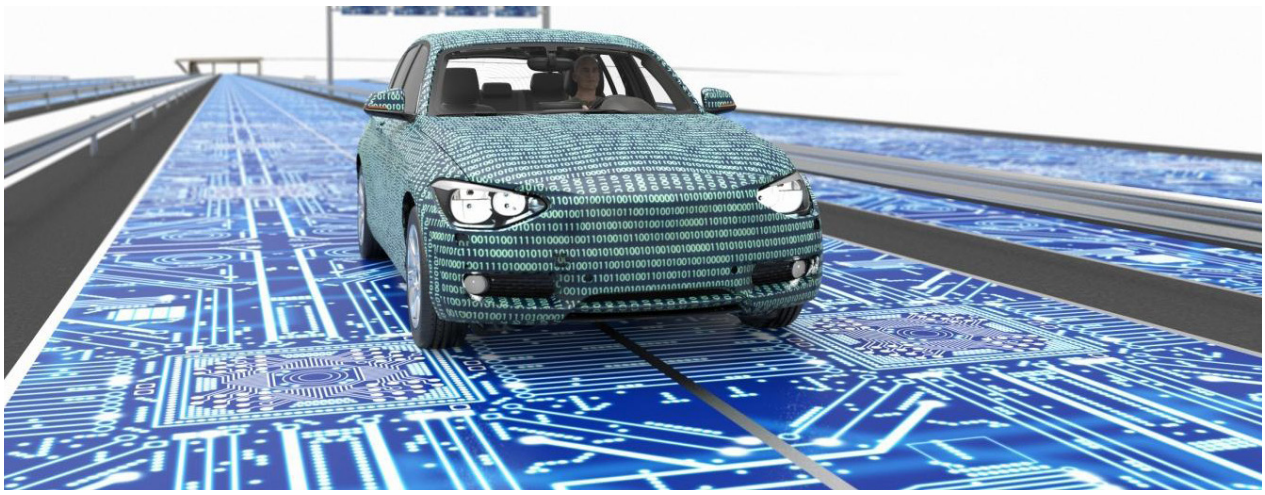
8.4.3 Rationale: Emissions Reductions

Road charging can be linked to reducing vehicle emissions, encourage EV uptake, and establish clean air zones under the Draft UK Air Quality Plan (see Section 7 "Environment").

8.4.4 Rationale: Enabling Roll-Out of AV and Future Technology

We know AV and other technology innovations are bringing incredible change, which can benefit road-users, the economy and environment, but we do not know when or how. The proposed TForward road charging system has the necessary flexibility to enable, and take full advantage of, AV and future technology innovation.

We do not yet know if AV and conventional vehicles will drive alongside each other on the same roads? We do not know if AV will lead to some roads, or perhaps lanes on roads, becoming dedicated entirely to AV? Might AVs share bus lanes, with bus drivers (and potentially eligible taxi drivers) trained in how to interact with AVs? Will AVs platoon and use road space more efficiently? Will AVs travel on rail lines (see Appendix)? Will young people lose interest in learning to drive a car? In the early transition stages, with only a small number of AVs, will they reduce or increase congestion?



The flexible TForward platform would:

a. provide the back-end payment mechanics for people paying to "hire" an AV (and pay for associated insurance), enabling embryonic AV schemes to get started in the UK and help keep the UK at the forefront of this global transition
b. allocate and charge for road space so that AVs and conventional vehicles pay fairly for the road and parking space they take up - encouraging efficiency innovation such as AV platooning and less parking

Human driver error is the biggest cause of road accidents. If AVs transpire to be safer, will that mean higher insurance premiums for people choosing to drive compared to AV? TForward could provide the telematics data for calculating insurance risk and tailored premiums, and the back-end payment system for customers to pay for that insurance where customers temporarily "hire" a vehicle.

8.4.5 Rationale: Enabling New Capital Models

A flexible road charging system like TForward can enable new capital models, bringing road-user and economic benefits, by allocating and charging for road and parking space used. This would enable (i) MaaS pricing structures to be created, (ii) public transport to compete more fairly on price (currently it is often cheaper to drive, ignoring capital cost, than pay for a bus or train ticket), and (iii) rail freight to compete more fairly on price with road haulage.

Capital and Marginal Costs: Currently with private vehicle ownership, people commit upfront to paying the capital cost of a vehicle, and an advance annual VED charge. The capital is used inefficiently given a car typically spends over 90% of its time parked (and taking up valuable space).[29]

When people make a choice between different modes of transport for a journey, such as private car, bus, train or other public transport, this financial model fundamentally affects that choice. If a person is already committed to paying the capital cost of a vehicle, the marginal cost of using that vehicle for any one journey (principally the cost of fuel including fuel duty), may then be significantly less than buying a ticket to use the competing modes of transport.

This is compounded because the fuel duty paid for any particular journey is not linked to the cost of the road infrastructure used.

It is a market distortion that financially pre-determines, preferring to use a private vehicle on the road for a journey, rather than another mode of transport.

Nine out of ten journeys in the UK are made by road.[30] Would it be such a high proportion with a different financial model that spread vehicle capital cost equally across each road journey? Would it be this proportion if a road charging scheme charged specifically for road infrastructure used, rather than such costs being met (many times over) by fuel duty and VED?

[29] A 2012 UK study by the Royal Automobile Club reports on average a car is only driving around 3-4% of the time. Typically 80% of the time a car is parked at home, and another 16% of the time parked elsewhere.

[30] It is noted that includes bus journeys.

In the future the cost of "hiring" a conventional vehicle or AV (via MaaS, a hailing app or car club) for a journey might principally comprise:

i. a contribution towards the capital cost of the vehicle
ii. any road charging (which might vary with peak times and congestion)
iii. fuel costs (which might be electricity, and any tax on that electricity)
iv. insurance (currently a substantial cost for car clubs, but telematics could effectively monitor use or abuse of "hire" vehicles giving users direct responsibility for tailored insurance premiums)
v. the vehicle provider's profit margin

A behavioural shift to MaaS (rather than private vehicle ownership), and a policy shift to road charging, could give rise to a more even playing field between the cost of private road travel, and the cost of using public transport.

This new funding model could potentially have a revolutionary impact on vehicle ownership and road usage, and transport more generally. A substantial proportion of journeys currently made by private vehicles on the road could in future become journeys made on public transport. That has profound implications for planning future transport capacity.

MaaS: Mobility as a Service is an extension of today's apps, car clubs and car-pooling[31], combining with public transport, into a full mode-neutral transport service. This would be "intelligent mobility" using data to combine multiple forms of transport to provide optimal customer-centric transport options for getting from A to B.

In the US, using mobility service providers to replace traditional provision of public services and infrastructure has started with innovative trialling of mobility services by Uber:

Parking permit holders given free Uber journeys from home to the station, to save building a new car park

(New Jersey)

Local government subsidising Uber rides, instead of supporting bus services, in low population density areas

(Florida)

Uber cars being considered instead of ambulances for non-emergencies

(Washington DC)

Some new appartment blocks giving residents Uber credits instead of parking spaces

(LA)

[31] French car pooling company, BlaBlaCar, has 35 million members in 22 countries and was valued at €1.4 billion in its last round of funding. Car-sharing company ZipCar's global fleet reached 15,000 vehicles.

MaaS offers the potential of a new capital model where people do not conventionally own a car, but have the flexibility to pay to access a vehicle when and where it suits them, or to share the cost of a journey with other travellers, with a few taps on an app. Customers need not be tied to a specific vehicle, but could select the appropriate size and type of vehicle for each journey.

MaaS enables a new generation of road-users to question if car mobility requires traditional car ownership. It offers an ageing generation new opportunities to stay mobile. Commercial users might in the future call AV vans and lorries on demand.

8.4.6 Consumer Choice

Today's roads only offer one customer service at one price (via general taxation). That is very different to other modes of transport. From airlines to Uber, people expect to pay more to travel at peak times or to congested places. Equally, they expect to pay less for less popular options, e.g. flying at 3 a.m. using airports distant from city centres.

In the future, road charging, along with AV and new capital models, could lead to price differentials for alternative road services, creating consumer choice, and allowing people to pay according to the value they put on their time. Premium service, ensuring a faster and more reliable journey time would come at a cost. However, such premium revenues can cross-subsidise journeys at less popular times or on uncongested routes, benefiting those on a tighter budget. Road charging can be win-win as it allocates road space better than queuing.

8.4.7 Rationale: Improving Public Transport

Whether road charging to raise money for public transport is fair to road-users, or good or bad for the economy, largely depends on where and how it is done. Road charging to improve public transport has been a key rationale for the London Congestion Charge, and Londoners have seen the benefits in public transport investment.

Critical Mass: Where the public transport system has enough critical mass to give road-users a genuine alternative, then increased investment in public transport can be fair to road-users. Where the bulk of commuters cannot reach work by car (as in London and many major European cities) investment in better public transport can be good for the economy and environment.

Where a higher proportion of travellers depend on roads, and public transport does not provide an effective alternative, it is not clear that road charging to invest in public transport is fair to road-users, or benefits the economy.[32] Many UK towns and cities are too small to be able to make rail or trams financially viable, although buses can be effective.

[32] In Los Angeles 83% of people drive to work, compared to 7% using public transport. Despite investment in public transport and population growth, the actual number of people travelling on public transport has declined since the 1985 peak.

AV and MaaS: There could in the future be a clearly beneficial rationale for spending on public transport with road charging revenues, if AV and other MaaS services can "plug" the gaps around limited public transport (e.g. getting people from a train or bus station to their home or workplace).

That would create a genuine public transport/ AV/ MaaS alternative for road-users. AV and MaaS could make small-scale public transport infrastructure financially viable for smaller towns. Then there could be benefits for road-users, the economy and environment if additional investment is made into improving public transport from road charging revenues.

Actual UK Spending: In the UK in recent years investment for major transport projects has largely gone to rail rather than the roads, generating some sense of unfairness for road-users paying for that investment through VED and fuel duty.[33] Whilst the theoretical case for using road charging revenue to pay for public transport can be made, that needs to be understood against the context of actual spending in the UK. The successful London model with revenue reinvested locally, could potentially be applied to some other major UK cities, but charging generally for road use in order to fund rail investment nationally (e.g. HS2) is unlikely to benefit the economy or be seen as fair by road-users.

[33] A CEBR report dated 22nd February, 2017 found UK rail investment in 2015 to be almost nine times that for roads investment, with £186,000 spent on rail infrastructure for every million passenger miles, but only £21,000 for roads.

8.4.8 Rationale: General Government Revenue

Road charging could be used to replace declining fuel duty revenues, and to continue to raise around £24 billion more each year than is spent on the roads. If road charging is used to raise money for (non-transport) government spending, that is not obviously fair for road-users. There could theoretically be benefit to the economy or the environment if the revenue were spent to benefit them, but such arguments are unlikely to be politically persuasive.

It can at least be argued road charging revenues going to general government spending would be no more unfair to road-users than current VED and fuel duty (provided any road charging introduced is revenue neutral).

A more persuasive argument is that the rate per mile charge on the less congested and polluted roads could be set lower than the current fuel duty cost for most vehicles, so being fairer to road-users who would pay less than they do now.

The government could still protect its tax base, since the higher road charges necessary to improve traffic flow on more congested roads and at busy times are likely to raise more money than fuel duty for driving on them does now. The revenue gain to government on such roads can also be fair for road-users, since they should enjoy faster journeys (due to demand management), which can benefit the economy and environment. This in turn can finance lower costs to road-users on uncongested roads and at quieter times, ensuring that overall road charging is fair to road users generally, as well as good for the economy and the environment.

8.5 Diverting Parking Revenues To Public Funds

Currently road-users pay substantial amounts for parking. Where road charging is introduced (such as in a city centre), that means less vehicles travelling into that area, which means lower demand for parking, and less revenue for parking providers.

Where that is private (rather than local government) parking provision, the effect of introducing road charging is to divert private sector parking revenues, to public sector road charging revenues. The exact substitution will depend on elasticities of demand and supply.

That means not all road charging is a new cost to be borne by road-users. That will improve the arguments for some road charging schemes being fair to road-users, and good for the general economy.

Overall reduced parking demand due to road charging (which might be exacerbated by a shift to AV) could mean some parking areas, particularly on valuable urban centre land, are re-developed. Alternatively, some parking areas might transition into service centres for maintaining and recharging AVs.

8.6 Losers From Change

Any road charging scheme will have winners and losers. Depending on tariff structures, a scheme might disproportionately adversely affect a particular group, from rural drivers making longer journeys, to van drivers making urban deliveries, or those travelling to work at rush-hour. It is inevitable as road charging changes the economics of where people live and work.

Less well-off peak-time drivers in congested areas will be particularly affected, although may find some compensating benefits:

- everyone benefits from economic growth generated by investment in the roads. Road charging is not a zero sum game; for every pound paid in road charging, particularly with the right investment, a greater amount of wealth is generated for the wider economy
- altering travel patterns to avoid road charges, and therefore travelling more cheaply, since road charges paid by others can fund offsetting fuel duty cuts
- enjoying less congestion on existing routes when road charging funds new capacity, e.g. drivers staying on the M6 benefit at the margin when better-off drivers pay to use the M6 Toll instead
- using more public transport, potentially improved with increased investment from road charging revenues
- using bus, and park and ride, with increased services now viable, and shorter bus journey times from less congestion

The proposed approach of introducing road charging in many small steps, allows the actual effect on people of each step to be measured, and if a particular road charging scheme is not overall fairer and giving most people a better deal, it can be reversed or altered, and the problem not rolled-out further.

The gradual stepped introduction over many years, also enables people and businesses to adjust over time, so fewer people lose out, as they take into account implications for travel costs when they move house or job, choose a school for children, or locate a business.

With the Local Government Deal, local councillors will be highly sensitive to the impact of any scheme they introduce, and attuned to the effect any road charging scheme is having on their constituents, and ready to amend or reverse a scheme where it is not right. Local councillors are best placed to take into account the interests of all constituents, including those who will benefit from less pollution and faster travel times, rather than only those most concerned about paying.

There is a similar obligation on Highways England to monitor and understand the fairness for road-users of any road charging it introduces on the SRN, with oversight from the Wolfson Select Committee.

Any road charging introduced should generate more benefits for more people, than it does costs for those disadvantaged.

9. TForward Technology And Development Cost

9.1 The TForward Technology Solution

The TForward technology platform would be an integrated IT system providing the front-end customer interface, and back-end payment and accounting mechanics, that current and future road charging schemes link into. The platform would use telematics-based road charging, matching timelines of GPS positioning data for vehicles within active charging schemes. It would be built as a scalable system able to grow from its first UK road charging scheme, into the TForward International platform providing:

- vehicle GPS timelines to trigger matching billing against location and time-related tariffs for all participating charging schemes
- mobility as a service (MaaS) across all modes of transport, including AV, for passengers and freight
- a centralised information cloud collating real-time information about road networks, other transport systems, and geo-social data from the travelling public, enabling the digital management of vehicles, and MaaS
- integrated travel information, pricing and smart ticketing options on a web-site and app
- customer on-line access to their travel accounts similar to on-line banking, with customer options for travel and accounting text and email updates
- further potential revenue streams from charging insurers for driver data for calculating telematics insurance premiums (with driver consent perhaps incentivised with a road charging discount), and private sector fleet management and others for data

9.2 Managing Procurement

Developing the TForward platform is best broken down into different stages, with each part of the platform scalable and able to inter-link, so only a basic platform is needed initially to get up and running, and the full TForward International platform can be built-out over time once success and profitability has been demonstrated:

a. first, identify an anchor road charging scheme as a base for developing the TForward platform (e.g. converting the London Congestion Charge or Dart Charge, or start with a new scheme such as the Silvertown Tunnel)
b. establish telematics protocols and EV recharging standards, so telematics insurance and EV chargepoints that link into TForward can be rolled-out
c. develop the TForward platform to allow processing of other payments supported by vehicle GPS timelines, e.g. parking charges, HGV Road-User Levy
d. scale-up the TForward platform to cover more road charging schemes and support widespread Local Government Deals and SRN charging
e. later, exploit network effects from TForward's customer base to add functionality for public transport ticketing, so TForward can develop as a full international mobility as a service (MaaS) platform

Procuring a large IT platform needs to be well managed. Perhaps the most notorious example of poor public procurement was Connecting for Health. This NHS IT project saw costs rise from an initial estimate of £2.3 billion to around £20 billion and was described by the Public Accounts Select Committee as one of "the worst and most expensive contracting fiascos".

To avoid such a scenario, TForward as a public/ private joint partnership, must incentivise private sector companies to keep procurement costs down, and delivery on-time. TForward is likely to be profitable, in contrast to the not-for-profit NHS, so key IT providers can be compensated as equity holders, making it in their interests to develop an optimal platform to market, rather than drive-up fees.

Establishing one platform to manage payments from multiple road charging schemes, rather than administering each scheme separately, while using the same platform for other payments based on vehicle GPS timelines, can create significant value. Government is needed to facilitate this, and can thus capture much of the value. However, to develop a suitable and adaptable technology platform cost-effectively, government needs to co-invest with private sector partners and share value created with them.

9.3 TForward Development Costs

The technical challenge in establishing TForward International should not be underestimated. It will require levels of financial security almost equivalent to a bank, and information storage and processing capabilities similar to a mobile phone company.

Crucially, the whole technology platform can be cloud based and is unencumbered with legacy systems. This facilitates development of flexible, secure and customer focused technology solutions. The primary front-end user interface can be designed for mobile phone or iPad use, with a variant for PC use, rather than vice versa.

The closest analogy for developing TForward is probably an internet challenger bank, e.g. Atom or Starling. Atom Bank launched in April 2016 after raising £100 million of finance. It is reported that "Atom hasn't built its core IT systems from scratch, instead building on commoditised banking software ... and building a unique front-end (the mobile app) on top". Atom Bank's Chief Innovations Officer justifies the approach on the basis that "the core engine needs to be bulletproof, located in a bullet proof environment. It doesn't need to be too fancy" (Edward Twiddy interview with Techworld 22/317).

Starling Bank, which has raised £70 million but has yet to fully launch, has taken a different approach and describes itself as "a tech business with a banking licence". It states "By building our bank ourselves, we can ruthlessly pare down our scope and focus on what our customers need".

It also identifies a key requirement being "advanced data encryption and sharing technologies that ensure that your personal information and transactions are sent and stored securely".[34]

There is a similar choice in developing TForward's technology platform:

- like Starling Bank, TForward can develop its full technology platform in-house, including back-end data processing and potentially bespoke security encryption programming
- alternatively, as with the Atom Bank analogy, TForward could facilitate road charging by integrating a third party database programme with bought-in GPS positioning technology, and focus its IT development on the front-end user interface

The first option is ideally more attractive with greater flexibility to support later development. However, if only limited customisation is needed of third party database and GPS software (as customisation can hinder later vendor upgrades), the second option could work and facilitate a faster launch.

Some road charging schemes implemented around the world have had high collection costs. With gradual roll-out, initially TForward development costs, potentially by analogy with challenger banks in the £70 - £100 million range, will not be spread across a large number of vehicles and will be high relative to revenue raised.

[34] Greg Hawkins, Starling Bank website article dated 18th October 2016

However, the telematics scheme could quickly come to apply to many vehicles and cost-effectively raise substantial revenue. Certainly, TForward will be more cost-effective than numerous independent schemes.

That £70 - £100 million estimate for establishing TForward, compares favourably with £162 million for the London Congestion Charge, although this is subject to TForward using an anchor scheme's existing ANPR cameras for enforcement.

Were the anchor scheme for TForward to be the London Congestion Charge or Dart charge, initial dual running of telematics and ANPR camera enforcement would allow a smooth and gradual transition to telematics, and telematics uptake could be encouraged by a small discount. This would allow TForward's IT processing and storage capacity to be built up gradually. When telematics for that road charging scheme later became mandatory, road-users could be given the option in the early years to share only GPS timeline data within the perimeter area of participating charging schemes.

In the November 2016 Autumn Statement, Chancellor Hammond announced £450 million of funding for digital rail signalling technology (long-used on France's TGV and across Europe) which enables trains to run closer together creating additional rail line capacity. Similarly, the TForward International platform enables a future with digital management of vehicles to create additional road capacity, and if the political arguments stand for rail, they are stronger for roads.

10. Financial Analysis

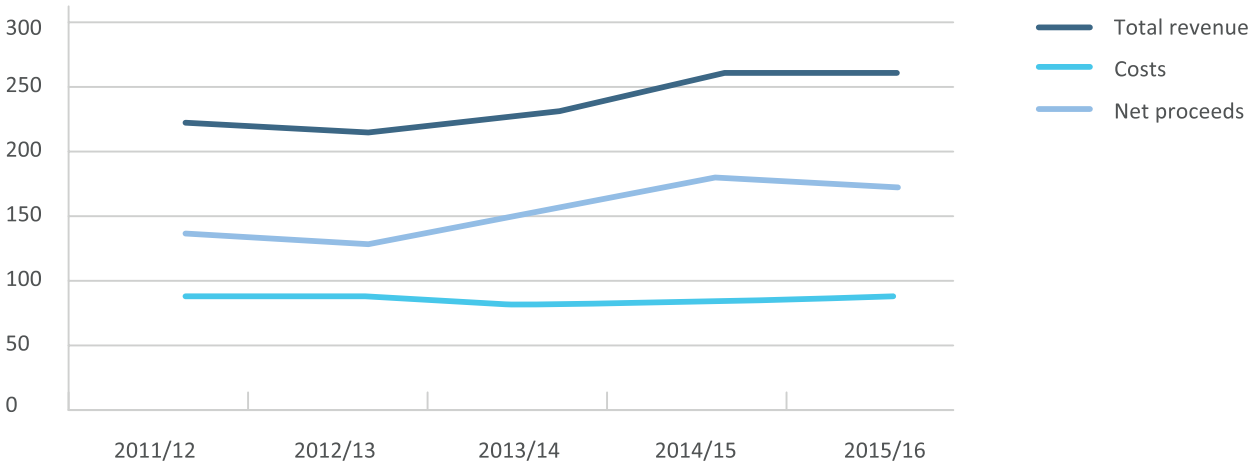
10.1 Economies Of Scale

TForward creates substantial economies of scale. Road charging schemes are expensive to set-up, and expensive to run. The London Congestion Charge cost £162 million to set-up, and around £80-90 million annually to run.[35]

As shown by the graph below, London Congestion Charge revenue increased from £222 million in 2012/13, to £257 million in 2014/15, partly reflecting an increase in the standard daily charge to £11.50, but collection costs were little changed:

London Congestion Charge £m

Source: Transport for London



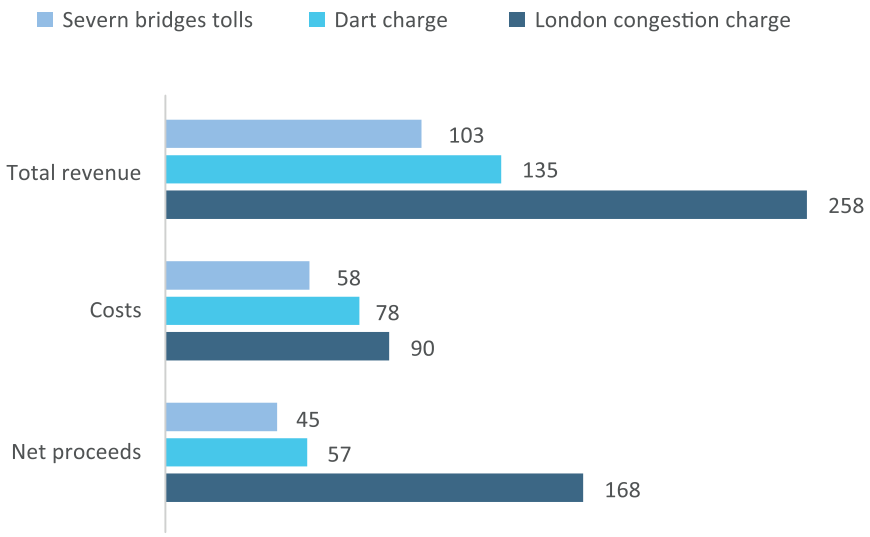
Road charging schemes generally have substantial fixed costs, which do not vary significantly with changes in the amount of revenue collected, implying clear economies of scale. Financial data for the Dart Charge and Severn bridges tolls also show greater variation in revenue than costs:[36]

[35] "Where has the money gone?", BBC London 26th May 2017. The London Congestion Charge set-up costs included installing a large network of cameras, the need for which is reduced by telematics technology.

[36] There are differences in the accounting treatment of capital costs. The £77 million which Severn Crossings plc reports as cash flow from operations for 2016 may better reflect net proceeds than the £45 million officially cited, since that is reduced by a depreciation charge set to reach a net zero book value for the Severn bridges when they return to the public sector. Meanwhile, Highways England accounts for Dart Charge classify £26.4 million 'impairment to income' for non-collection of fines as expenditure. For consistency this is categorised in the bar chart as lower total revenue rather than within costs. It should also be noted that up to £32.4 million of £38.9 million expenditure still within costs is 'for the implementation of Dart Charge and renewal of road, structures and technology schemes' might properly be considered capital.

Key road charging schemes 2015/16

Source: Severn Crossing plc Annual Report and Accounts 2016, Highways England Dartford-Thurrock river crossing charging scheme Accounts 2015/16, TfL Annual Report and Statement of Accounts 2015



The amount by which the £1.029 billion (at 1989 prices) which Severn Crossing plc is allowed to toll on the Severn bridges, exceeds the £387 million value of the construction contract for the second Severn bridge, indicates the inefficiency of self-standing tolling schemes. It is also notable that two-thirds of the 184 people employed by Severn Crossing plc are engaged in tolling or administration, rather than maintenance.[37]

Crucially, TForward can reap economies of scale by (a) integrating current tolling schemes, (b) acting as a flexible platform for future road charging schemes, and (c) supporting other charging (e.g. parking, EV and AV). A far higher proportion of revenue would represent net proceeds to the public purse. If TForward expands internationally, and into public transport, the economies of scale savings would be very substantial.

10.2 M6 Toll: Funding Road Construction

Another important road charging scheme to consider is the M6 Toll, the only substantial stretch of standard UK motorway run by the private sector.

However, its financial results are not disclosed although quarterly traffic data is published. Matching that against published toll charges gives a revenue estimation for 2017 of £96.6 million (see table: "M6 Toll Revenue Calculation" at the end of this section).

On its face this is a substantial amount of revenue, given the M6 Toll operational

[37] Severn Crossing plc annual report and accounts 2016

concession runs for 40 years. Nonetheless, debt funding for the scheme needed to be restructured in 2013. The M6 Toll owner described traffic levels, which are less than a quarter of the un-tolled M6, as 'disappointing' in June 2005 after 18 months of operation. HGVs and commercial traffic predominately use the un-tolled M6. Highways England assessed impact on M6 congestion as 'small'.

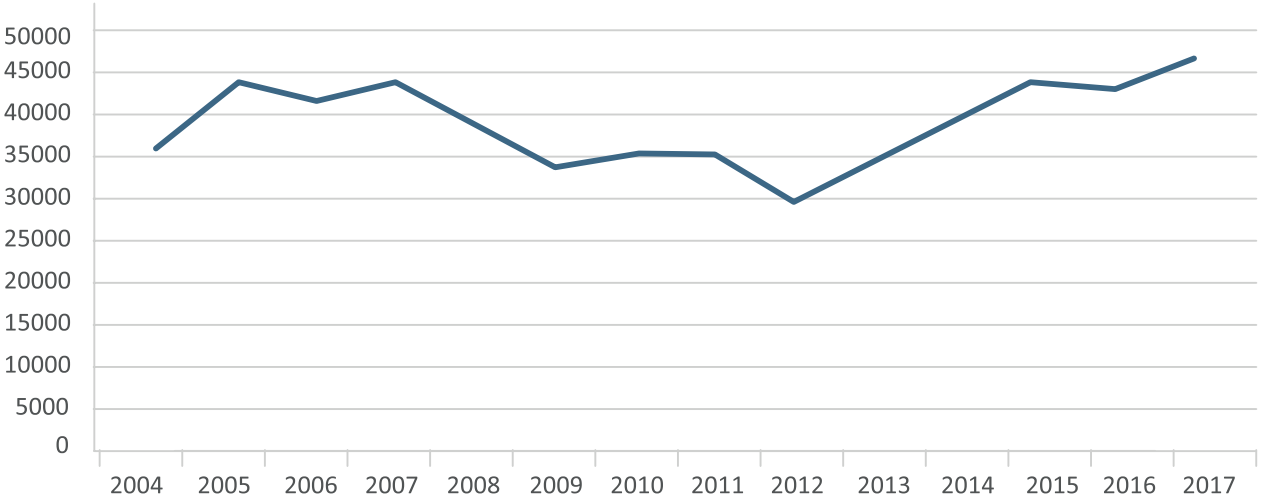
Worse, M6 Toll income declined substantially between 2007 and 2012 as traffic fell 28%, reflecting the precarious market position of toll roads for which there is a free alternative. The economic downturn after 2007 not only made road users keener to economise on tolls, it also reduced traffic flow on the competing M6, thus undermining the congestion reducing benefit of the M6 Toll.

Key implications are:

1. relief roads are likely to require underwriting by the public sector
2. setting tolls at a level to repay construction costs of a particular road is not the best way to deal with congestion generally on the road network
3. where there is a relief road, or competing road, Highways England should have a role in pricing the toll for both roads, so congestion is properly managed (e.g. when the Lower Thames Crossing is completed and competing with the Dartford Crossing)

TForward's economies of scale mean a larger part of revenue raised goes towards road funding. These implications are assessed in the South Wales Case Study regarding the planned M4 relief road.

M6 Toll Traffic Volumes (Q1 vehicles/ day)



Source: M6 Toll website www.m6toll.co.uk

2017 Q1 vehicles/day data published by M6 Toll				
		Average	Work day	Weekend
Total		44942	50849	30399
HGV		5848		
Assuming non-HGVs are cars and that same % travel at weekend implies:				
		Average	Work day	Weekend
HGV		5848	6617	3956
Cars		39094	44232	26443
Tolls vary day to night. Assume 90% day and 10% night similar to Dartford:				
Day-time vehicles			Work day	Weekend
HGV			5955	3560
Cars			39809	23799
Day-time charge			Work day	Weekend
HGVs (£)			11.00	9.60
Cars (£)			5.50	4.80
Multiply day-time vehicles by day-time charge:				
Day time HGV revenue (£)			65505	34177
Day time car revenue (£)			218950	114235
Night-time vehicle			Work day	Weekend
HGV			662	396
Cars			4423	2644
Night-time charge			Work day	Weekend
HGVs (£)			8.60	8.60
Cars (£)			3.80	3.80
Multiply night-time vehicles by night-time charge:				
Night time HGV revenue (£)			5690	3402
Night time car revenue (£)			16808	10048
Add day-time and night-time:			Work day	Weekend
HGV revenue (£)			71195	37578
Car revenue (£)			235758	124284
Multiply night-time vehicles by night-time charge:				
Night time HGV revenue (£)			5690	3402
Night time car revenue (£)			16808	10048
Add day-time and night-time:			Work day	Weekend
HGV revenue (£)			71195	37578
Car revenue (£)			235758	124284
Add five work days and two weekend days				
HGV revenue/week (£)			431132	
Car revenue/week (£)			1427360	
Total weekly revenue (£)			1858492	
Multiply total weekly revenue by 52				
Total annual revenue (£ million)			96.6	

Source: M6 Toll website www.m6toll.co.uk and author's assumptions and calculations

Severn Bridge

11. Case Study: South Wales

11.1 Abolition Of Severn Bridges Tolls

The Severn bridges tolls are expected to be abolished in 2018, given the May 2017 Conservative manifesto commitment to this, with the Welsh government and Assembly supporting abolishing the tolls.

The current toll on the two Severn bridges is west-bound only at £6.70 for cars, and £20 for HGVs, paid at a tolling plaza, rather than using free-flow technology. Tolls raised £98 million in 2015. Following abolition, the £7 million annual bridge maintenance costs will instead be met from general UK taxation.[38]

The current tolling arrangements end after the capital cost of building the southern bridge has been recouped. That sum of £1.029 billion at 1989 prices is expected to be reached around the end of 2017, at which point the Severn bridges return to the public sector and management by Highways England. The UK government can continue tolling until further costs (mainly relating to latent defects in the older northern bridge) are recouped later in 2018.[39]

With the Severn bridges tolls the politicians are actually doing what they previously promised, and ending tolls once they had repaid the cost of constructing the new bridge (in contrast to Dartford). Conceivably, this could make the public less cynical about commitments given if any future road charging were to be introduced in South Wales.

There are winners and losers from any change in government policy:

a. most people who regularly use the Severn bridges will want the tolls abolished
b. there will be negative implications for others, notably people who travel on the M4 around Newport (without using the Severn bridges), since the abolition of the Severn bridges tolls is expected to increase traffic flowing onto that part of the M4 by 10% worsening congestion.[40]

[38] Severn Bridge Crossing plc annual report and accounts 2015/16. Welsh government response to UK government consultation The Severn Crossings: reducing toll prices and other issues.

[39] Severn Bridges Act 1992

[40] Professor Stuart Cole, quoted by BBC Wales 16th May 2017

11.2 M4 Relief Road

Roads are crucial in South Wales for linking people's employment in Cardiff, Bristol and around Newport, to their homes there and in the valleys to the north, and west towards Swansea.

The M4 (the "Original M4") is chronically congested around Newport, particularly at the Bryn Glas tunnels, which constitute a pinch point north of Newport. There are two main competing proposals for an M4 relief road:

i. the "Black M4 Relief Road": the black route comprising 14 miles of new motorway to the south of Newport at an estimated cost of £1.1 billion, optimistically intended to open in 2022, but with a public inquiry only now underway[41]

ii. the "Blue M4 Relief Road": the less expensive blue route based on dualling and grade separation of the existing A48 and use of Newport's "Steelworks Road", at an estimated cost of around £600 million and potentially capable of completion more quickly.[42]

Development of proposals for the M4 relief road started long before the 2007/8 financial crisis, since when actual M4 traffic in South Wales has been lower than originally projected. However, the need for an M4 relief road is now made more pressing by abolition of the Severn tolls and the 10% additional traffic this is expected to generate on the M4 around Newport, and which the public inquiry must now consider.

Source: based on Professor Stuart Cole's route map and "blue" route proposal

[41] By routing traffic away from residential area close to the Original M4, the black route is estimated to bring beneficial cuts in NO2 concentrations for 12,475 properties to the north of Newport, while only having an adverse NO2 impact on 117 properties, DEFRA/DfT "Draft UK Air Quality Plan for tackling nitrogen dioxide", May 2017

[42] See Professor Stuart Cole "A Cost Effective Solution to Relieving M4 Congestion Around Newport"

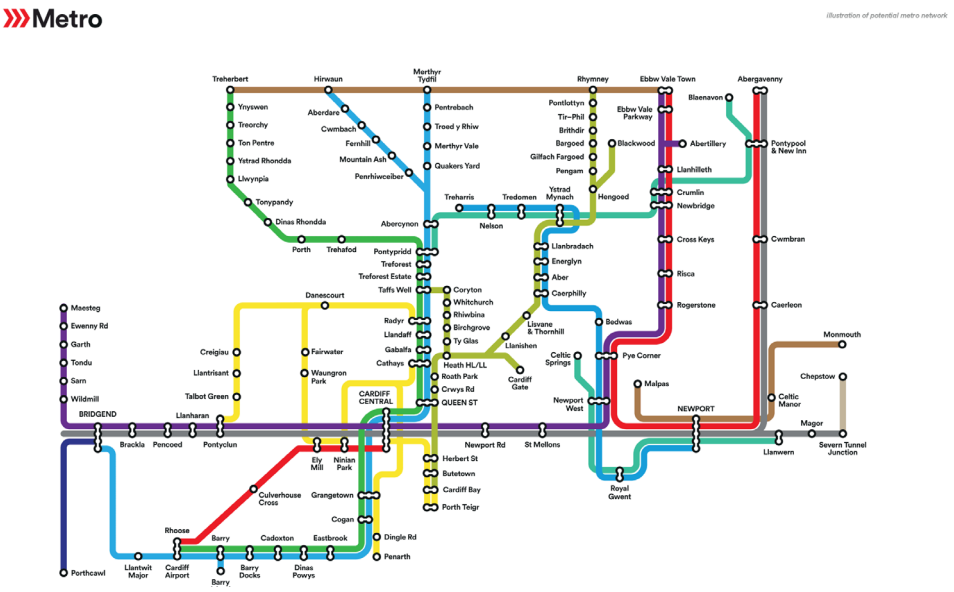
Traffic projections frequently prove inaccurate for new roads, often significantly underestimating actual traffic growth.[43] Analysis by the CPRE shows enormous variation of between 0.1% and 109% in the uplift in traffic relative to background levels across thirteen road schemes studied.[44] Different schemes vary in how much extra traffic they induce as oppose to re-direct from other routes, with implications for setting road charging tariffs if the rationale for a new road is to relieve congestion elsewhere.

Traffic predictions are never certain, plus AV could arrive and add to the unpredictability by increasing or decreasing road demand. The TForward flexible charging system would allow tolls to be increased or reduced in future years, so as to address actual rather than projected traffic and congestion and pollution levels, as shown for South Wales in this case study.

11.3 South Wales Metro

A South Wales Metro[45] is proposed, at a cost of around £600 - £750 million[46] but final funding arrangements are still not confirmed. Project funding had been expected to include around £200 million of EU funding which is now uncertain with Brexit.

The Metro is a concept for improved public transport links around the "Cardiff Capital Region" (encompassing Bridgend, Cardiff, Newport, Monmouthshire to the Severn, and valleys to the north) by building new transport infrastructure, and improving and better integrating existing infrastructure.



Source: Welsh Government (proposed Metro for South Wales)

[43] See Highways England Post-Opening Project EVolutions for all road projects costing over £10 million

[44] The End of the Road? Challenging the road-building consensus, Campaign to Protect Rural England

[45] Refer to http://gov.wales/docs/det/publications/160224-metro-information-brochure-en.pdf

[46] The capital cost is estimated at £600 - £750m. In addition to the capital cost, the Metro is expected to be subsidised by the taxpayer by around an additional £180m each year - over the first 15 year franchise period that adds around another £2.7 billion in funding costs.

The Metro is intended to increase accessibility of deprived valleys communities across the South Wales coalfield, to make them more attractive for inward investment, as well as help people commute from them to Cardiff, the region's main employment centre.

Importantly, procurement for the Metro is on a mode-neutral basis. Four preferred bidders are currently developing alternative proposals bases on a combination of traditional rail, light rail and express bus services. Different options have varying implications for use and potential electrification of some, if not all, of the Valleys rail lines into Cardiff. The innovative option of using one of these rail lines to trial AV on rails as part of developing the South Wales Metro concept is considered later (see Appendix).

11.4 TForward Solution

By using South Wales as a case study for the rationales for road charging, and evaluating fairness for road-users, and benefit for the economy and environment, it is clear a key advantage of TForward is its flexibility for low, peak or temporary tolling, so road charging can meet specific objectives reflecting the different rationales for road charging.

11.4.1 Demand Management Before the M4 Relief Road is Built

An early use of the TForward platform could be to manage congestion at the Bryn Glas tunnels on the M4 north of Newport. Queues at this pinch point are likely to lengthen substantially, and continue for a longer part of the day, after the Severn tolls are abolished and traffic levels rise by around 10%.

There is currently no satisfactory alternative to the M4 through the Bryn Glas tunnels for many road-users, so road charging alone cannot offer a full congestion solution. However, charging road-users a small sum for using the Bryn Glas tunnels in the morning and evening peaks would spread that rush-hour traffic more evenly, with some road-users foregoing or re-timing their journeys.

It would not be worthwhile investing in road charging infrastructure just to apply a small charge at the Bryn Glas tunnels at morning and evening peaks, particularly if this would only be necessary until an M4 relief road opened. Linking into the TForward platform would make this viable.

11.4.2 Demand Management on the Blue M4 Relief Road

Were the less expensive "Blue M4 Relief Road" chosen, TForward flexibility would create other innovative options, such as using variable peak-time charging on the more congested of the Original M4 or the Blue M4 Relief Road to balance demand between them. Real-time tolling and travel time information would be displayed on roadside signs, and on smartphones and satnavs, encouraging road-user behavioural change to alter their route according to their time/cost trade-off.

A small price signal would be sufficient to balance traffic between the two routes, given they will be similar in capacity and specification.

A small charge would not make a significant contribution to the cost of building the Blue M4 Relief Road, but it costs around £500 million less than the Black M4 Relief Road.

11.4.3 Financing the Black M4 Relief Road

The Welsh government is currently proposing to finance construction of an M4 relief road partly from its existing capital roads budget, and partly from additional borrowing, including new powers devolved under the Wales Act 2017 to borrow a further £500 million.

There is opposition to the Welsh government's preferred Black M4 Relief Road, some environmental, but also against the estimated cost of at least £1.1 billion. This single investment in South-East Wales would take much of the roads capital budget for the whole of Wales, and there are concerns construction risks may increase the budget and delay completion.

The Black M4 Relief Road would be built to higher specification than the Blue M4 Relief Road and the Original M4. This means some road-users would likely be prepared to pay a toll to use the Black M4 Relief Road, and road-users benefiting from the better faster Black M4 Relief Road would be contributing to its cost.

However, there is a lesson from the private M6 Toll road. Only a relatively small proportion of road-users, and rarely HGVs and commercial traffic, opt to pay a relatively high M6 Toll (currently £5.50 for cars, and £11 for HGVs), even when the alternative ("free") M6 is congested. Setting a toll for the Black M4 Relief Road at a price point that would fully fund its construction would lead to relatively few road-users using the route, given the alternative competing Original M4, and thus fail to alleviate congestion at the Bryn Glas tunnels. The toll would need to be set at a lower level to significantly relieve congestion on the Original M4.

Using the TForward platform would allow the toll to vary according to congestion conditions, both on the Black M4 Relief Road and Original M4. In its early years, with the relief road having ample capacity, including sufficient capacity at peak times, that would likely imply a lower toll at peak times, to increase the relief road's diversionary impact and ability to alleviate the Bryn Glas tunnels pinch point on the Original M4. In future decades, were traffic levels and congestion to continue to increase (we do not know if they will), a higher charge might be required at peak times on the relief road to ensure at least that route remained free flowing. TForward gives the needed flexibility to respond to uncertain future developments.

11.4.4 Cardiff City Centre Road Charging

Once the M4 relief road is complete, flow of traffic to Cardiff is likely to increase, exacerbated by plans to build twenty thousand new homes on the outskirts of Cardiff. This in turn may underpin the following rationales for modest road charging in Cardiff:

- funding extension of the A4232 to complete a ring-road around Cardiff. Space restrictions within Cardiff limit opportunities for further new road building
- demand management to reduce and spread peak rush-hour demand on the roads in and out of Cardiff
- using the flexible TForward tariffs to keep traffic flowing for the many major sporting events now hosted in the centre of Cardiff

- reducing emissions and pollution in Cardiff. From the political perspective, there are those who want vehicle emissions cut, but also those diesel car drivers who feel they were encouraged to buy a diesel car by past VED policy, and fear being punished by an about-turn in tax policy. Whatever balance is struck between those interests, the ability to use TForward to disincentivise harmful emissions as well as congestion, will increase the number of times when it is attractive to deploy TForward to manage city centre traffic
- raising funding for the South Wales Metro (which the Welsh government may otherwise struggle to pay for). Using road charging to fund public transport improvements could be justified as the Metro with large numbers of stations across South East Wales would be giving commuters a genuine alternative to the road. It is important the Metro is affordable for people on low incomes who can least afford road charging, given the Metro's purpose of increasing the accessibility of deprived valley communities, and revenue from road charging could help deliver this
- making "park and ride" schemes (and increased bus services generally) economically viable with sufficient critical mass to run enough buses to make them convenient and attractive for people. Park and ride may suffer from a humble image, but it is a low-infrastructure inexpensive approach, and effective, and deserves a renaissance. Cardiff, unlike London, has sites on its outskirts suitable for inexpensive (i.e. not multi-storey) parking

This case study focuses only on Cardiff for simplicity, but similar considerations will apply for traffic management into Bristol and Newport, and to a lesser extent Swansea. However, smaller city and population size can make the economics unviable for sufficiently deep public transport connections to offer a real alternative to car transport. This is particularly true for rail, although funding buses can still be cost-effective for smaller centres, and design of the South Wales Metro will need to reflect this.

This case study does not consider the rationale for road charging to replace declining fuel duty revenues. This is because road charging, along with decisions about how to spend the proceeds, are devolved to Wales, Scotland and Northern Ireland, while VED and fuel duty are not devolved.

11.5 Political Deliverability

Whether any new tolling arrangements in South Wales were fair to road-users, and good for the economy and environment, can be monitored, and if they were not working, flexibility with TForward would allow tariffs to be changed or schemes suspended.

There are many combinations of how tolling might work in South East Wales from the TForward platform in the future. The focus is on raising revenue to fund transport improvements, given the need for these, and that the Welsh government lacks the power to give money back by cutting fuel duty. This example does illustrate how there might be gradual transition from tolling the Severn bridges to flexible, variable or peak tolling of some other key roads and access points in South Wales. That is not something people are currently used to, but offers:

- gradual transition
- better congestion management
- addressing vehicle emissions
- raising money to pay for the M4 relief road, Cardiff ring-road, and South Wales Metro (which are transport improvements most road-users in South East Wales can identify with)
- potentially a fairness promise that total road charging would not raise more than the Severn Bridges tolls did (£98 million at 2015)

Whether this is seen as potentially desirable may depend on whether the Welsh government can deliver its transport goals without this additional revenue stream. TForward would facilitate this option for giving people a better deal.

12. Value Capture

12.1 Value Capture Concept

With value capture, the value added to land by making it accessible for development with new transport links, is captured to help fund the transport infrastructure, so those who benefit from the infrastructure pay for it.

Unfortunately, in the UK, this rarely happens in practice with much land either already built on or protected from development (e.g. green-belt). This suggests a need to re-evaluate the UK's compulsory purchase, green-belt and planning regulations in light of the wider social and economic benefits of value capture:

- funding new transport infrastructure
- regenerating depressed areas
- replacing run-down legacy building stock with modern, safe and energy-efficient buildings
- creating accessible land to help resolve the housing crisis with high quality development[47]

Realising land value increases to fund transport infrastructure has excellent precedent: (i) parts of London's Underground were paid for by land made accessible for new suburban housing, and (ii) increasing land values funded much late nineteenth century United States railway building from East to West coast.

12.2 Capturing Value

12.2.1 Economic Growth and Taxation

New and improved transport links generate economic growth by facilitating residential, commercial and industrial use of the newly accessible areas. Government shares in the economic growth through taxation, e.g. additional business rates, income tax, corporation tax and VAT on new economic activity.

The value of additional economic growth and its benefits to society, will often exceed government expenditure building the infrastructure. Such cost/benefit analysis creates the economic justification for the investment. Crossrail has successfully communicated that its construction cost of around £15.8 billion is estimated to generate around £42 billion for the wider economy.

[47] Refer to "Fixing Our Broken Housing Market" White Paper dated 7th February 2017. The government has described the housing market as "broken", stated at least 250,000 new homes are needed each year, aims to build a million new houses by 2020, and has identified the need for competition to break the control a small number of large commercial house-builders have in restricting new housing supply.

12.2.2 Land Development Tax

Planning legislation could be amended, to permit development around new transport arteries, subject to a Land Development Tax being paid by property developers for planning permission based on hectarage of land (unlike the current Community Infrastructure Levy). This could capture for the public much of the uplift in land values generated by new transport arteries and permission to develop land around them.

12.2.3 Selling Planning Permission

An alternative mechanism to a Land Development Tax, would be to sell planning permission for particular projects. This could give control over the development standard, and raise more money per hectare than the Land Development Tax because more of the variable surplus value of each development could be captured.

If planning permission were sold by auction this could prove an effective way of maximising revenue for government, not least by reducing uncertainty for private bidders as to what they will be allowed to build. Different auction models would allow the form of planning permission to be developed privately or publicly and allow for different options. Mix or environmental restrictions could still be required by government, with a trade-off faced between how prescriptive these were and revenue raised for the public sector.

12.2.4 Financing Timing Constraints

There is a timing challenge, with development costs needing to be paid up-front as infrastructure is built, but value not being realised until after transport is operational, and buildings have been built and sold. Borrowing to fund development adds to the cost, and is a greater barrier to smaller developers. To help, the government might accept deferred payment for Land Development Tax or planning permission, until buildings are built and being sold.

12.2.5 Pilot Value Capture

East-West Rail and Cambridge-Oxford Expressway road improvements are proposed for the Cambridge - Milton Keynes - Oxford corridor. This is an opportunity immediately before the government for value capture of the increasing land values with new building. Emphasising the crucial link between transport arteries and housing, the National Infrastructure Commission (NIC) reported that a shortage of housing represents a fundamental risk to the success of this area, and consequently, investment in transport links must be "properly aligned with a strategy for new homes and communities, not developed in isolation".[48]

It is recommended the government uses the Cambridge - Milton Keynes - Oxford corridor to pilot alternative Land Development Tax, and sale of planning permission, models to raise funding for this corridor. This could help develop an optimal value capture model to roll out nationally on future infrastructure projects, overseen by the NIC.

[48] The National Infrastructure Commission ("NIC") became an executive agency operationally independent of government in January 2017, and reference is to its interim report of November 2016.

12.3 Reshaping Our Cities

In the UK our towns and cities typically form in a roughly circular shape around a centre, and were built in a previous age before modern population and transport levels. Roads are now too narrow for the volume of traffic, and new-build is then squashed on top. Chronic traffic congestion results.

The world is urbanising and needs solutions that do not result in endemic congestion. Consider an alternative model which:

a. provides fast, high-capacity, efficient transport arteries (i) between towns and cities, and (ii) orbiting around town and cities; and
b. sites new developments along these transport arteries, so that the shape of urban development becomes clusters along a line.

Transport arteries might be today's motorways, or entirely new kinds of futuristic AV arteries. They might be sited on new routes, run alongside, or be built above, existing road and rail lines (see Appendix).

Potential benefits include:

i. with this change in geometry much structural urban congestion could be avoided
ii. value capture could fund the transport arteries
iii. land could be made accessible to help resolve the housing crisis
iv. an expressway with regular slip roads, or AV artery with regular embarkation and disembarkation points, could make all the surrounding land accessible (in contrast to a railway where access is limited to stations)[49]
v. existing urban residents and businesses might locate along these transport arteries, reducing pressure on crowded urban centres
vi. new development would connect via the transport artery to existing towns and cities, with the benefit of being able to share their established social and economic base. This draws on David Rudlin's winning Wolfson Economics Prize entry promoting garden cities connected by trams to existing settlements. A step forward from today's trams to the potential offered by AVs, could enable the distance between new and existing settlements to increase without losing connectivity benefits

[49] HS1&2 fail to effectively capture for the government the potential increase in the value of the surrounding land. The government has not sought to introduce specific value capture initiatives. Because they are railways with people only able to embark and disembark at designated train stations, they do not make all the land surrounding the new rail lines easily accessible, in contrast to a road which could have access slip-roads continually along the route. Discussion of potentially building a new city on the HS2 line at Toton (between Nottingham and Derby) highlights (i) land surrounding the rail line needs a train station to benefit from increased accessibility, (ii) more train stations slow rail journeys overall, (iii) there are only limited candidates along a rail line in the UK for large development.

New AV transport arteries have the potential to connect people over greater distances, and change where the geographic balance lies between economies and diseconomies of agglomeration. Just as railways brought communities together, investing in arteries between and around towns and cities with emerging transport technologies could make a new model of urbanisation possible.

There is an opportunity to utilise planning regulations to ensure the best lay-outs, with buildings set-back and shielded by trees from the transport artery, emphasising high-quality architecture and sustainable design, and utilising the garden city concept.[50] Development must not be uncontrolled unsightly US-style strip development.

The new developments could be purpose-built AV zones (walking and cycling friendly), saving valuable land from parking and garages, with buy-in from people living there from the start.

There is an opportunity to regenerate depressed areas and brownfield sites made accessible by the new transport arteries, and bring wider employment opportunities for people in these areas.

12.4 Compulsory Purchase

The UK's compulsory purchase regulations are too slow, expensive and cumbersome, and would benefit from an overhaul to better balance protections for property owners, against wider public interest in re-development investment.

It is not in the best interests of residential occupants to live (and bring up children) in run-down houses and flats by noisy polluted roads without green space. With a more pro-active approach residential tenants could be helped to find somewhere better to rent, while residential owners could be fairly compensated so they could re-buy somewhere better.

Commercial operations can re-locate with appropriate support. Perhaps the main complaint from SMEs potentially subject to a compulsory purchase order (CPO) is business uncertainty and the length of the process. Public inquiries do not consider compensation, but promoters helping affected businesses to relocate would be better than giving standard "negotiations are ongoing" inquiry responses, while relying on eventual CPOs.[51]

The 2017 Conservative manifesto stated "We will reform Compulsory Purchase Orders to make them easier and less expensive for councils to use and make it easier to determine the true market value of sites". Media briefing suggests this is aimed at helping councils and housing associations build more social housing.[52] A promising initiative, but it could be taken further so Highways England and developers also benefit from reformed CPO rules when developing transport schemes and housing.

[50] The government has announced the creation of 10 new garden towns and cities, and 14 new garden villages, since the Wolfson Economics Prize 2014 relating to garden cities.

[51] Compulsory Purchase Reform by Richard Guyatt and Colin Smith May/June 2016 at www.compulsorypurchaseassociation.org

[52] Theresa May pledges council house revolution, Sunday Times, 14th May 2017

12.5 Resolving The Greenbelt Debate

There is continuing debate between those wanting to uphold greenbelt protections preventing urban sprawl, and those maintaining it is necessary to build on the greenbelt to resolve the housing shortfall.

In its recent housing White Paper, the government maintained its protection for the greenbelt, stating it is only to be built on in "exceptional circumstances".

In contrast, Professor Cheshire[53] has contended the UK's planning regulations have failed by preventing greenbelt becoming available for house-building, leading to the housing crisis, and excessive commute distances from beyond the greenbelts adding to congestion. Some question the amenity value and accessibility of parts of the greenbelt, and propose selective building on the least attractive and lowest amenity parts, offset by new protections for more valuable landscapes. Travelling around the UK reveals vast areas of countryside which are not built on, in stark contrast to cramped areas of housing.

A potential resolution to this debate would be AV fast, high-capacity, efficient transport arteries between, and orbiting, towns and cities with new development sited in clusters along the arteries:

a) we need and have transport arteries between towns and cities, which inevitably route through greenbelt, and by containing development along these AV arteries it would avoid a more general sprawl into greenbelt;

b) orbital arteries around towns and cities could be built around the edge of greenbelt.

The potentially attractive deal for existing local residents would be that in return for development, they would benefit from AV transport routes, reduced congestion and pollution, shorter journey times and greater connectivity and economic opportunity.

The combination of better arrangements for value capture, and bespoke charging through TForward for people travelling on the new transport arteries, would generate revenue sufficient to finance higher quality, and therefore more welcome, development than previously, alongside an improved public realm.

[53] See publications by Professor Paul Cheshire, Emeritus Professor of economic geography at the LSE, including "Turning houses into gold: the failure of British planning" and "Greenbelt myth is the driving force behind the housing crisis".

13. Better Procurement

13.1 An Opportunity To Build Public Support

Reducing the financial cost of procuring and maintaining road infrastructure, will go a long way to helping answer the question of how we fund our roads. TForward is part of the answer, providing for efficient and cost-effective road charging. The Wolfson Select Committee is another part of the answer, but procurement practices must also change.

Without improvements to procurement practices, there is a danger any new funding raised, will dissipate in ever escalating project prices. Public support for new infrastructure can be undermined if people perceive (i) their money is badly spent, or (ii) projects are delayed without good reason, particularly when the sums involved are very large.

Whilst costs have been well controlled on some transport projects (e.g. Crossrail) on others, such as electrifying the Great Western Mainline, procurement costs have soared.

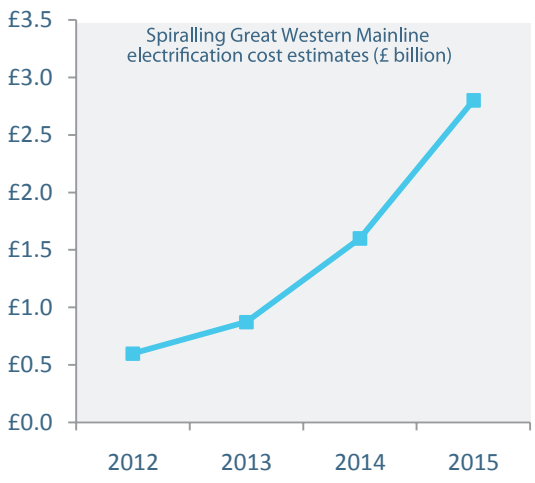
This applies to all aspects of government procurement, from health through to defence. The sums involved are staggering, such that even small improvements in procurement practice would deliver tremendous returns, and take pressure off the ever-larger national debt.

This problem can be turned into an opportunity. Improving procurement practices so people perceive the price paid for infrastructure as fair, is crucial if the public are to support paying for future road infrastructure through a platform such as TForward.

13.2 The Wolfson Select Committee And Procurement

To enable the Wolfson Select Committee to be effective, all proposed infrastructure contracts over a specified threshold value should be published for 60 days for scrutiny by the public and the Wolfson Select Committee, before the contract commencing. The Wolfson Select Committee should be able to extend the initial 60 day period where it considers further scrutiny is necessary.

The Wolfson Select Committee could scrutinise delivery of infrastructure projects post-procurement, and investigate the amounts paid to contractors, financiers, and the government's professional advisers. When it is necessary or desirable to vary a contract, as is often the case, the Wolfson Select Committee could provide political and parliamentary oversight to ensure that such variation is genuinely in the public interest, and seen to be so.



The Public Accounts Select Committee scrutinises public spending, but it is after-the-event, and cannot prevent mis-spending before it happens. Other select committees have been frustrated when the government will not disclose contracts as "commercially sensitive". Instead, government contracts should be disclosable as there is a public interest, and the government should not agree to contractual confidentiality restrictions.

13.3 Beyond PFI

We have the experience of 25 years of private finance initiative ("PFI") projects with a capital value around £55 billion, committing current and future generations of taxpayers to payments of over £300 billion over the life-time of the projects.[54] There are PFI success stories, such as the southern Severn Bridge where tolling will shortly repay its construction costs, and both Severn bridges return to public ownership with the tolls then abolished. Notwithstanding, some PFI deals have given poor value for money.

We already see PFI being used less frequently, and now is the time for government to move away from PFI while interest rates are low.

13.3.1 Off-Balance Sheet Incentive

PFI's off-balance sheet treatment enables politicians to fund infrastructure with private sector capital, without adding to government borrowing and the national debt at the outset. The financial problems typically do not emerge for several years, and can be left for the next political administration.

In 2011, the Parliamentary Treasury Select Committee reported on PFI and concluded, in the words of its Chairman, Andrew Tyrie MP, that "PFI should be brought on balance sheet. The Treasury should remove any perverse incentives unrelated to value for money by ensuring that PFI is not used to circumvent departmental budget limits. It should also ask the OBR to include PFI liabilities in future assessments of the fiscal rules.".

13.3.2 Optimal Packaging of Risk

Some PFI investors made returns seen as excessive, particularly on some early PFI deals. They were paid a substantial premium for taking construction funding, planning and regulatory risk, which often did not materialise. When interest rates fell dramatically after they had been awarded the deals, that drove up the value of the revenue stream, which investors were able to sell on at significant profit. The government could have avoided much of this, and the political back-lash, if it had packaged the risk differently.

There is an established infrastructure industry actively looking for projects to invest billions of private money into now, if provided with an investment model which generates a revenue stream (such as a toll road) to repay capital investment.

[54] Guardian, 5th July 2012 (the absence of comprehensive easily available current numbers tells its own story).

Different private sector infrastructure players bring different attributes. A common failure to date, accentuated by PFI, and what now needs to be done, is a better breaking down of the risks and roles in a way that matches the different players, so the risks and obligations can be optimally allocated:

a. Construction funding: the government should finance construction with government borrowing. The government is able to borrow at far lower rates of interest, particularly given quantitative easing, than a private company can borrow to fund infrastructure construction risk, and it is uneconomic for the government to pay a premium to a private company for this.
b. Planning and regulatory risk: the government is best placed to carry these risks and should retain them, as the government itself influences them.
c. Maintenance risk: the principal contractor that constructed the asset can be best placed to carry maintenance risk. Using the same principal contractor for construction and ongoing maintenance, with that contractor's branding attached to the asset over its life-time, removes incentive to cut corners during construction.
   If the government intends to keep the revenue stream, the government should take a long-term view of the investment needs of the infrastructure and negotiate, say, a 30 year maintenance contract alongside the construction contract, at the procurement stage, notwithstanding timing pressures to skip this step. This is particularly important when interest rates are low, and the net present value of such later costs is therefore higher.
d. Revenue management: outsourcing companies, e.g. Capita or G4S, have generally been considered best placed to manage revenue collection, such as a road toll. However, there have been substantial fixed costs charged for each separate project, and this could be more cost-effectively delivered through TForward.
e. Revenue stream risk: the government should generally wait to sell the revenue stream (e.g. as with HS1) until the infrastructure is operational, with construction and planning risk removed, and the actual usage level and revenue generated is known. Removing those uncertainties increases the valuation of the future revenue stream.

The value of the revenue stream is affected by interest rates, with the government receiving a higher price for the revenue stream when interest rates are low. Pension funds and insurance companies are the natural buyers of the revenue stream, given they are prepared to pay a premium for long-term predictable income. Revenue streams that are very sensitive to the economic cycle, e.g. the M6 Toll competing with a free alternative (above), are less valuable to them.

13.4 EU Procurement Rules

Leaving the EU may free the UK from mandatory rules requiring public procurement to be advertised across the EU, and awarded according to the EU's definition of best value:

- this incurs procedural cost and delay
- awarding contracts can be less commercially astute
- the bureaucratic pre-qualification process before companies are eligible to bid, limits competition, and can prevent smaller companies from participating
- long-term supply contracts may need to change flexibly, which can be best managed with good collaborative relationships with preferred suppliers, but this is restricted by EU procurement rules
- a significant proportion of business awarded by the UK government under EU procurement rules goes to other countries, while some question whether UK businesses receive equivalent opportunity

While protectionism would drive up costs, removing restrictions on buying domestically when the price difference is marginal, allows greater commercial flexibility, and may increase public support for new infrastructure.

To illustrate, the Queensferry Crossing (a road bridge over the River Forth near Edinburgh) is opening in summer 2017, at a cost of around £1.35 billion. The mandatory EU procurement process was followed for the 37,000 tonnes of steel required, awarding contracts to China (24,500 tonnes), Spain (8,500 tonnes) and Poland (4,200 tonnes), notwithstanding the environmental costs of transporting the steel. Subsequently, the UK steel industry was in crisis at Redcar, Port Talbot and other plants, causing unemployment and wider economic damage. There were allegations of China dumping steel at below production cost, and the UK government has been restricted is assisting the UK steel industry by EU state aid rules.[55]

Queensferry Crossing

[55] The UK steel industry has had limited reprieve with the fall in the sterling exchange rate since the EU Referendum in June 2016, and management changes have been made at the top of TATA.

13.5 Competition For Investment

Roads have lost out to rail in the competition for government funding, despite the majority of journeys being made on the roads. Road taxes generate around £24 billion more each year than is spent on the roads, and much of this is spent on rail and other public transport without the underlying investment rationale being understood by the public, creating a sense road users are not getting a fair deal.

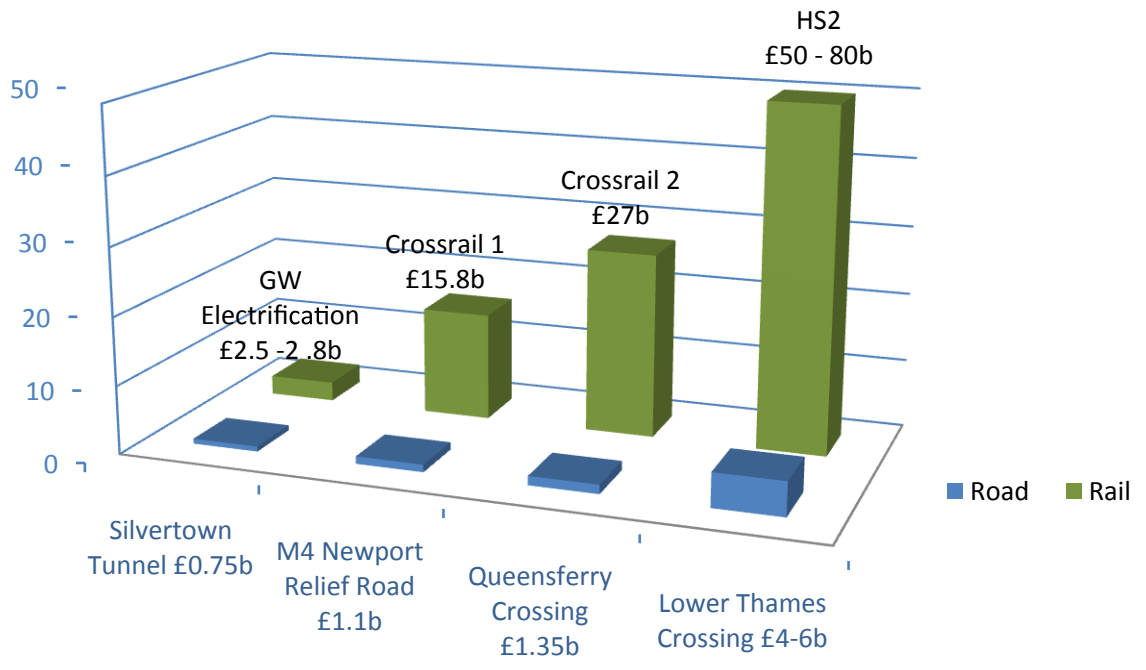
It remains to be seen whether the ONS acting in 2014 to bring Network Rail's debts belatedly onto the government's balance sheet will help level the playing field.

The small size of many road projects means it is difficult to justify costs to promote them to the public. Road spending further suffers because of "nimbyism" from those adversely affected by the specific geography of works but not compensated. The path of least resistance has been to give in to green protestors since the early 1990s, with Swampy and the Twyford Down protest against the M3. There can be easier political gain for the government if money goes to uncontroversial areas like health or education, and investment in the roads has suffered as a result.

Road charging through TForward will generate revenue linked to specific road infrastructure and help make the case for re-investing that revenue into road improvements, which can in turn benefit the economy and road-users.

Comparing spend on headline infrastructure projects illustrates rail dwarfing road

(Approximate / estimated amounts)



13.6 Mode-Neutral Commissioning

Procuring bodies should use "mode-neutral" commissioning whenever possible. That means competing transport proposals can be put forward for road, heavy or light rail, tram, bus etc. without pre-determining which is the best form of transport. This is the basis of tendering for the South Wales Metro.

It creates competition for Network Rail for rail infrastructure spending, and allows AV and new technology to compete.

HS2 is not due to be completed until at least 2033. There is a danger it will become a white elephant, eclipsed by new technology, a risk accentuated by delay. Real consideration was not given at the commissioning stage as to whether the staggering £50-80 billion taxpayer spend[56] would have been better spent on new motorways, or new transport solutions utilising innovative AV technology.

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[56] When HS2 was first approved the estimated cost was £43 billion. That did not include the trains, which increased the estimate to around £50 billion, which has since been revised higher. Separately, the IEA has independently estimated the cost may be around £80 billion.

14. Next Steps

The Wolfson Economics Prize should lead to practical policies that government can take forward. This entry is not intended to be just an intellectual exercise that sits on the shelf.

The first practical steps to take by the end of this year to move forward with creating the TForward International platform are:

- seek high-level support from the Treasury, DfT and Highways England for the TForward International platform
- identify the right private sector joint venture partners
- identify the building blocks with IT providers for an optimal TForward International platform
- assess existing road charging schemes for technical suitability for conversion into the TForward International platform
- identify the first anchor road charging scheme for the TForward International platform. This should include discussion with the London Assembly and Transport for London, as the London Congestion Charge, Blackwall and Silvertown Tunnels, and Ultra Low Emission Zone, are potential candidates
- work with the DfT to identify a pilot local authority clean air zone to deliver under the Draft UK Air Quality Plan
- work with the DfT and insurers to develop a common telematics standard, and appropriate steps for accelerating telematics vehicle insurance roll-out
- work with the DfT on supporting EV recharging points through the TForward International platform by developing technical and interoperability standards

There is a compelling political case for better roads connecting people and employment, opening up new areas for housing, saving people from endless hours in traffic, reducing pollution, enabling business and distribution, and driving our economy.

The UK can create the TForward International technology platform, empower its world-leading research and development community, embrace AV and innovation, and realise international opportunities for the TForward platform. That will put in place a solid financial base for funding roads, so road-users, the economy and environment reap the benefits.

Giving people dramatically improved roads through TForward and a step by step approach without any political “cliff-edge”, in return for today’s road taxes and tomorrow’s alternative funding, is practically and politically deliverable.

Appendix: Technology Revolution

A.1 Two Worlds Colliding

Two worlds are colliding. The world of traditional car manufacturers that, until now, have essentially followed the same business model since Henry Ford started mass producing the Model T in 1908. Disruption is coming from the tech world comprising giants like Google and Apple, along with many new kids on the block, such as Uber, Cruise and Lyft.

We are in the midst of witnessing a "land grab" for a whole new intelligent automotive industry with driverless vehicles and extraordinary new vehicle technologies. Billions are being laid on the table, as the giants and start-ups intensely compete, and increasingly partner with each other, in a rush to generate competitive advantage. There will be winners and losers, and some market consolidation is inevitable.

A.2 Today's Policy Initiatives

In a fast changing world, the UK needs to identify the best government policy, R&D spending, and investment strategies to implement now. These should not presume to predict the future, but have the greatest likelihood of delivering better roads in a way that is fair to road-users and good for the economy and environment, with focus on:

a. finding congestion, pollution and infrastructure solutions for the UK's roads in the near term, where there is no space to expand conventional roads. As well as financing our roads, engineering solutions need to be found to enable expansion of roads capacity
b. managing a (potentially lengthy) transition period where conventional vehicles and AV may need to operate in tightly-packed spaces alongside each other, cyclists, pedestrians and other hazards
c. enabling the UK to benefit from (often unforseen) technological change
d. putting the UK economy at the heart of a new multi-billion pound automotive industry

The UK government deserves credit for the steps it has been taking including £690 million for tackling congestion,[57] bringing forward the Vehicle Technology and Aviation Bill, establishing CCAV,[58] creating a £100 million Intelligent Mobility Fund, publishing a code of practice for testing AV on UK roads, and extensive funding support including AV trials at Greenwich (GATEway[59]), Bristol (Venturer), and Milton Keynes and Coventry (UK Autodrive).

The UK is punching above its weight attracting AV development, with Volvo and Nissan choosing to test AV in London in 2017, and Oxbotica to trial a fleet of AVs travelling from Oxford to London in 2019.[60]

[57] Announced by Chancellor Hammond in the 2017 Spring Budget

[58] The Centre for Connected and Autonomous Vehicles ("CCAV") is a joint policy unit set up by the Department for Business, Energy & Industrial Strategy and the DfT.

[59] GATEway develops the Ultra PODS that have operated along tracks at Heathrow's Terminal 5 for around five years, which have carried over 1.5 million passengers eliminating the need for 700,000 bus journeys.

[60] The trial assesses how AVs interact with each other in a fleet. The AVs are to make the journey without human intervention, and an insurance company will be assessing risks at each stage of the journey.

[61] Highways England is expected to promote innovation through its supply chain with Road Investment Strategy 2. Crossrail developed the "Innovate 18" strategy for capturing and exploring pioneering and innovative ideas throughout its supply chain, with over 800 ideas submitted, leading to over 300 innovations and over 100 shared ideas being adopted.

[62] The Obama administration announced $4 billion AV investment over 10 years. Consider the prevalence of automotive innovation unveiled at the CES 2017 technology event in Las Vegas. Ford, General Motors, Tesla, Uber, Apple, Google's Waymo, Shanghai Automotive - to name but a few - are investing billions.

A.3 Differentiate UK Investment

Most current global funding is into (i) EV and AV, (ii) vehicle connectivity, and (iii) hailing and ride sharing apps. That can deliver extraordinary vehicle improvements, but the focus is on the vehicles, rather than road infrastructure.

The UK could differentiate its approach and aim to make itself a world-leader in road infrastructure solutions, both for itself and export to other countries with tightly-packed urban centres.[61] There would be less direct US competition[62] than in developing AVs:

- whilst AV technology can help resolve congestion, with innovations such as ride-sharing, reduced parking need, platooning, parking guidance apps, and increased automation on motorways - much development emanates from California with its wide multi-lane roads, without roundabouts, and limited pedestrian access - and may not apply optimally to UK urban centres
- it is not good economics to spend UK taxpayers money on developing technology likely to be primarily used on US roads, unlikely to end up being built in the UK for export, and where the intellectual property ends up being exploited outside the UK. Whilst the UK road user will benefit from AV innovation, these innovations will be paid for and developed in any event for the dominant US market

A.4 Funding Infrastructure Solutions

How best to empower innovators to find road infrastructure solutions? Open and lateral thinking is needed:

- whilst EV and AV are exciting, there is a danger the hype is crowding-out "mundane" innovations, such as developments in construction techniques for road-widening, bridges and tunnelling, pre-fabrication, materials innovation, improved traffic signalling, warm-mix asphalt, cold repave machinery, and locating and filling pot holes
- funding competitions could support development of the TForward International platform and associated technologies, resolution of any practical implementation challenges, and lateral application of the technology for collateral benefits and cost-savings
- encourage an open approach to infrastructure mobility solutions beyond the traditional automotive area. The exclusion by AV funding competitions to date of research into rail (such as "AV on Rails") or other modes of transport may be misguided

AV can be thought of as potentially combining the best attributes of private cars and public transport, with new capital models meaning an increasingly blurred distinction between private and public transport. The domination of road over rail in the US may mean US-centric AV development has focussed on roads, overlooking the potential in other modes of transport. AV might inter-link road and rail transport systems, constitute a light rail solution, or more fundamentally re-invent both modes of transport for an optimal mobility solution.

Road infrastructure is inter-related with other infrastructure sectors. Consider the impact of AV on public transport, or on the energy sector if most vehicles become powered by electricity, or the implications of drones making commercial deliveries.

Technological innovation is a key driver of future infrastructure demand, but the agents of change are unknown, making long-term infrastructure decisions difficult. The more closely involved the UK is in developing innovation, the better the likelihood of anticipating change, and improved long-term investment decisions, supported by flexible charging through the TForward platform.

A.5 AV On Rails

In the UK rail lines are transport arteries going straight into the heart of our congested urban centres. AVs could develop for use on rail, as well as on road, to take advantage of this.

Stand back and look at these arteries at rush-hour. There can be a large gap - from a few minutes to half an hour - between trains travelling along the line.[63] The surrounding roads are filled to the gunwales with traffic.

That is an horrendous waste of a major transport artery, in a congested urban centre where there is no space to expand conventional roads. The under-utilised rail line capacity between trains needs to be used.

If under-used urban rail lines were converted to dedicated AV use, that could help address urban congestion by maximising capacity through-put down those crucial arteries with vehicles continually travelling along them. AVs might travel along existing rail lines, or alternatively on specially designed tracks. It is plausible with foreseeable level 5 AV technology, from a safety perspective, by not having to contend with human drivers, cyclists or pedestrians on the tracks.

It could be extended to moving AVs at high-speed on inter-city rail lines. Electric trains receive power from overhead lines or a third rail. AVs could do the same, overcoming battery limitations on high-speed and long-distance travel - the electricity infrastructure is already present on electrified rail lines.

Perhaps over time further rail lines could be converted to dedicated AV transport - with AVs travelling continually along the tracks - rather than trains travelling intermittently. The value capture initiatives for realising increases in land values could provide funding, given regular embarkation points would make more of the surrounding land accessible, compared to trains with long distances between stations (see Section 12 "Value Capture").

In the UK, rail lines and stations moth-balled with the 1960's Beeching cuts, which have not since been built over, might potentially be resurrected as new AV arteries.

There are export opportunities to many cities around the world with unused rail capacity between trains.

A.5.1 Assembly Line Economics

Henry Ford gave us a truly great innovation; mass production of the Model T and its combustion engine along assembly lines, to enable mass car ownership (and the foundation for mass production underpinning today's standards of living). After reigning for more than a century, the combustion engine might be about to give way to EV, and mass car ownership might transition to car-sharing and mobility service arrangements.

Henry Ford did not design the factory assembly line to only send one widget along every half an hour.

[63] It is acknowledged main train stations in London and certain other major cities have trains going in and out on their lines every 3-4 minutes, although that is still unused potential capacity between trains.

Nonetheless, Henry Ford's assembly line economics may still be the future of transport, but instead of applying assembly line economics to factory widgets only, we should think of our rail lines as the assembly lines that need to efficiently and continually transport vehicles along them.

If the accountants and management consultants analysed rail line efficiency, in the same way as they quantify factory assembly line efficiency, their spreadsheets would demand vehicles continually moving along the rail lines.

A.5.2 Research AV on the Rails

Much research is into AVs travelling on roads, rather than AVs travelling along rail lines, possibly because US-centric funding focuses on solutions for US-style roads, or due to lack of easy accessibility to rail lines for testing.

The current GATEway trials at Greenwich, based around the Heathrow Ultra pods which run along tracks, might provide AV technology suitable for taking forward on the rails.

Imagine the potential if desirable features could be developed, such as:

- junctions enabling an AV to change from one line to another
- regular passenger embarking and disembarking points along the line to get people closer to their destination (rather than concentrating congestion at main stations) making more of the land surrounding the line valuable for development
- designing AVs which could travel along tracks, and switch to a conventional road (perhaps then driven by a responsible human), allowing "mix and match" of road and rail
- the ability to drive a conventional vehicle into an AV pod that travels along the line, but allows the conventional vehicle to continue the journey beyond the reach of the line
- platooning AVs together to maximise capacity
- building double-tier tracks along priority lines for greater capacity
- AVs which are comfortably big enough, and designed for wheeling in prams, double-buggies, wheely-bags, bicycles, wheelchairs, and possibly even mobility scooters
- placing small commercial depots along the line, where AVs could deposit deliveries for onward distribution by conventional vehicle, and where people could collect a delivery waiting for them, enabling commercial distribution and home delivery through AV
- perhaps converting one or more conventional inter-city rail lines to maglev, which AVs could travel along at very high speeds

A.6 Extension Of South Wales Case Study

The South Wales Metro procurement is on a mode-neutral basis, and anticipates integrating a combination of different modes of transport. There are four approved bidders currently engaging in competitive dialogue with the Welsh government, actively weighing-up the trade-offs between heavy rail, light-rail and rapid bus transit for different parts of the Metro.[64]

Mode-neutral procurement allows the possibility of part of the Metro comprising AVs travelling along rail lines. There are existing rail lines running through the heart of Cardiff, and linking Cardiff with Newport, the Valleys and beyond. The roads alongside these arteries are already severely congested. The South Wales Metro aims to deliver modernisation and some increased capacity on these train lines.

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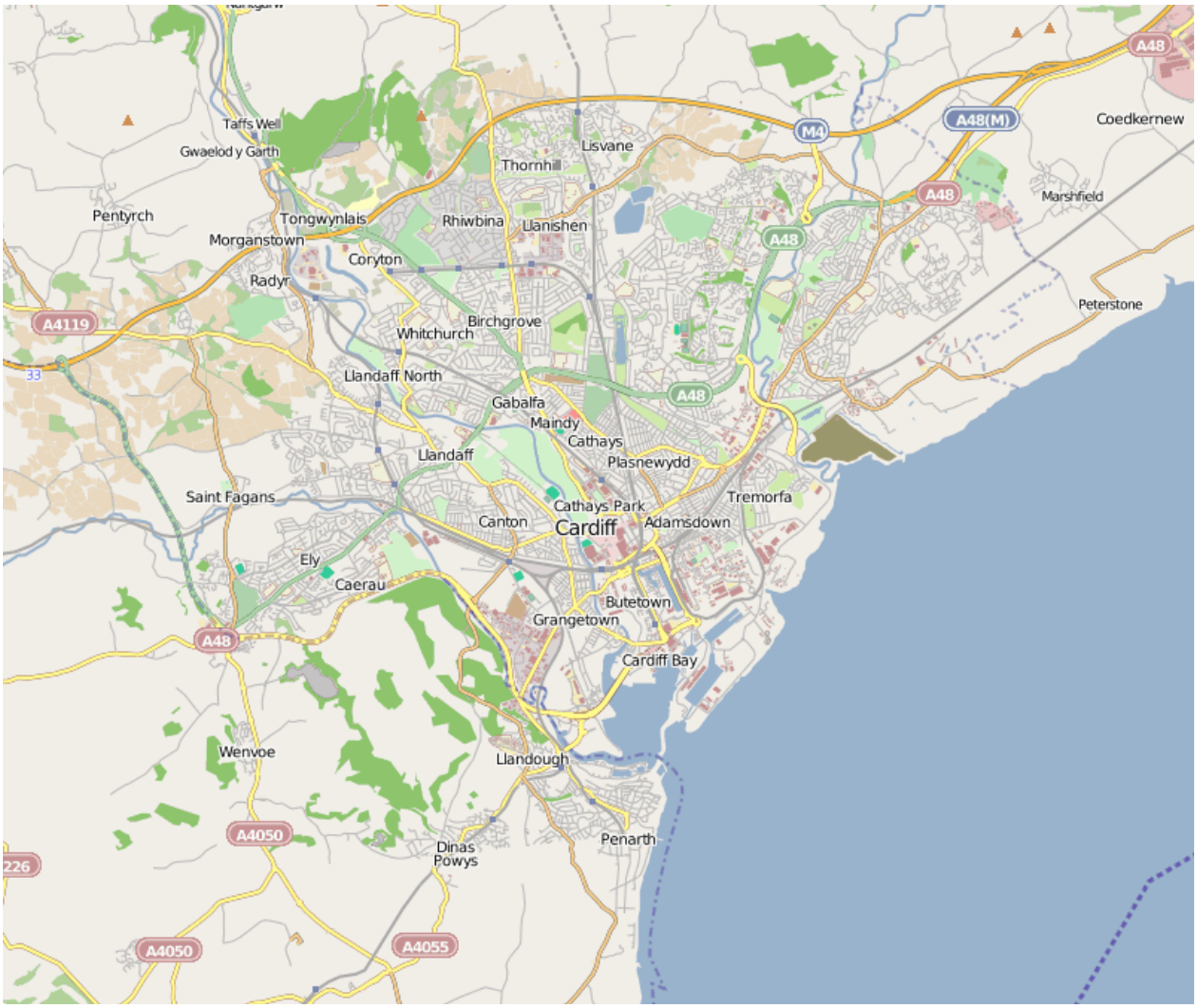
[64] Phase 1, an extension to Ebbw Vale and capacity improvements on that line, are already under construction or complete. Phase 2, intended to run to 2023, is not finally determined but is expected to include a focus on electrification of core Valley rail lines and other improvements to the wider South Wales rail network. Further phases beyond 2023 are still to be determined, although construction of new light rail is under serious consideration.



Source: Google Maps

A map of Cardiff shows the benefits of high-capacity usage of existing rail arteries. What if rail lines were converted to dedicated AV use, with AVs travelling continuously (rather than intermittently as trains do) maximising capacity. Customers could benefit from:

- many embarkation and disembarkation points close to destinations
- not stopping at other people's stations
- the comfort of private travel and reduced pollution
- operation and ticketing integrated through TForward

Commercial distribution could benefit from AVs transporting goods along the line to a diffused network of small local depots.

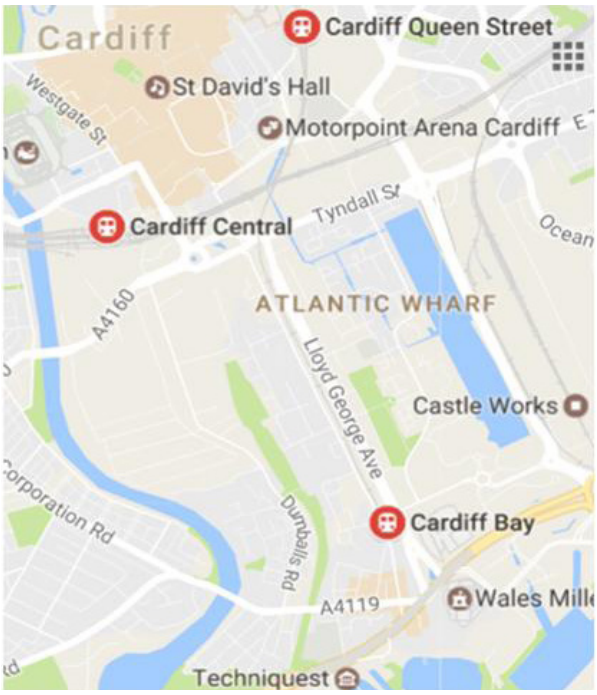
The combined estimated cost of the proposed black route M4 relief road and South Wales Metro is at least £1.7 - £1.85 billion. It would not be disproportionate to deploy some of that money on testing a new AV rail line solution that could transform transport infrastructure.

There is a good candidate for a test site: the spur rail line linking Cardiff Bay station to the city centre. This is a short distance of only 1.2 miles with a single carriage train shuttling slowly back and forth about three times an hour. There was a proposal around fifteen years ago to run ULTra pods between Cardiff Bay and the city centre, and although it was not taken forward at that time in Cardiff, those pods are now used at Heathrow and are being further developed with the current GATEway trials at Greenwich.

The South Wales Metro project has already stated an ambition of improving the link and adding connectivity with Cardiff Central mainline station. Cardiff Bay has successfully regenerated and an innovative AV pilot would add to its appeal.[65]

If successful, the AV artery could extend to other rail lines emanating from Cardiff Central station. This gets right to the heart of a solution for transport in Cardiff, and potentially many other congested urban centres, as well as inter-city transport between those urban centres. Constructing new tracks for AV may need steel, providing an opportunity to support local steel production and cement political buy-in.[66]

In South Wales, the Port Talbot steel works are only 30 miles west of Cardiff with a train line running directly from the steel plant into Cardiff city centre. Further specialist steel production is located 12 miles east of Cardiff along the same line in Newport.

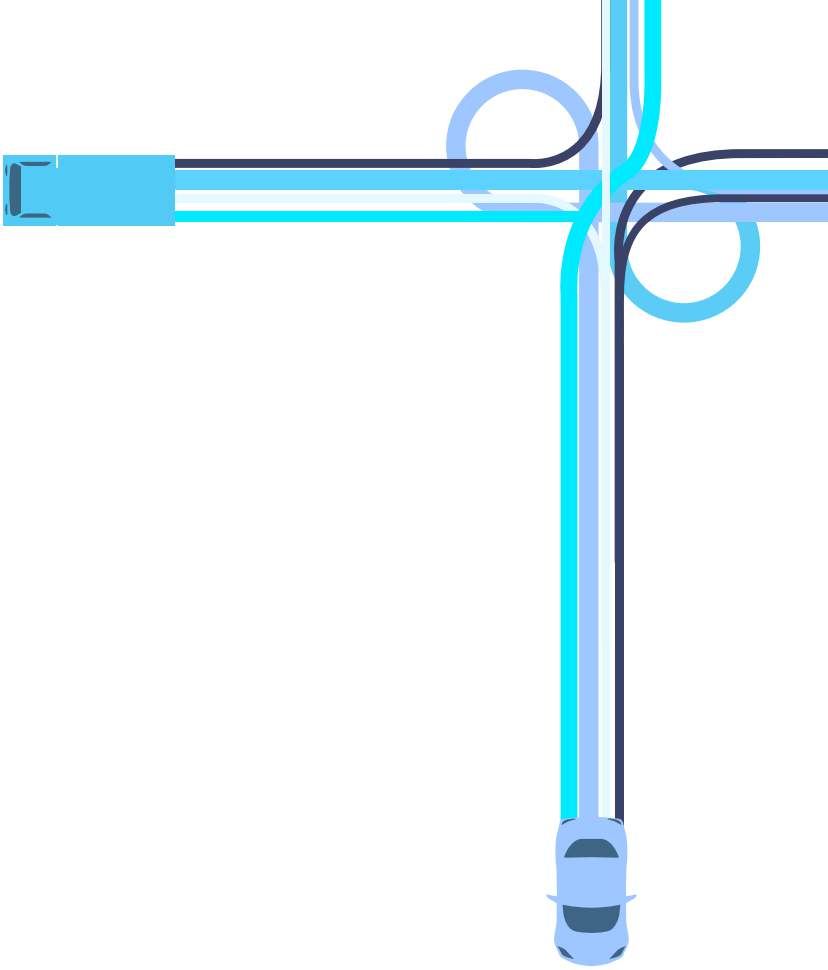


Train line between Cardiff Queen Street Station and Cardiff Bay Station

Source: Google Maps

[65] A replacement bus service on Lloyd George Avenue would prevent disruption whilst converting and testing the new AV artery. There is excess road capacity for the replacement bus service with the four-lane Lloyd George Avenue and Bute Street running parallel to the train line (historically it was a dock since filled in) with the narrow roads at each end prevent these roads being used to full capacity.

[66] Refer to "EU Procurement Rules" below regarding steel supply from overseas for the Queensferry Crossing.



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