



2017 WOLFSON ECONOMICS PRIZE

2017 Primary Submission
Catriona Brown

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?

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T-Forward, A Stepped Approach

Catriona is a busy mum with two young children, and expecting her third child next week. 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.

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.

Prize Team



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What Happens Next

Shortlisted entrants will be offered the chance to submit a revised and expanded submission. Shortlisted entrants are free at this stage to join up with others to help develop their proposals, including entrants whose submissions were not shortlisted.

These finalists will be given until June 2017 to expand their submissions before the Judges consider the winner. All shortlisted entrants who provide expanded submissions will receive £10,000. The winning entry, designated by the judges, will receive £250,000 in total. The Judges expect to announce the winner in July 2017.

The Judges also have the discretion to award further smaller prizes to recognise entrants whose submissions address aspects of the Prize Question in innovative, creative or otherwise outstanding ways, in particular giving weight to the use of technology. The winners of any such awards may not comprise a full entry for the £250,000 prize.

[The Judges' decision is final.](#)

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Summary

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.

Future road ambitions can equal rail's grand projects. Giving people dramatically improved roads, in return for today's road taxes and tomorrow's alternative funding, is politically deliverable.

How can we drive our roads and economy into the future? There is no silver bullet for diffuse challenges, but many ideas and initiatives together can draw an inspiring new road map.

Road Charging: "Tforward" Stepped Approach

If road charging is introduced, a stepped approach is appropriate, with re-evaluation of policy at each step, and without any pre-assumption road charging should be fully rolled-out:

Step 1: create the "TForward" platform, providing back-end payment mechanics and customer accounting, that existing and future telematics-based road charging schemes can link into.

Step 2: potentially convert the existing London Congestion Charge platform and customer database into the national TForward platform. Modernise

the Congestion Charge with variable telematics-based tariffs linked to congestion, and enable expansion of road charging where most needed in London (e.g. Silvertown and Blackwall Tunnels as already announced).

Step 3: integrate existing road charging and parking schemes into TForward (e.g. Dart Charge, M6 toll, Low Emission Zone), and enable them to upgrade to variable telematics-based tariffs.

Step 4: upgrade the HGV Road User Levy to TForward telematics.

Step 5: potentially integrate public transport "smart" ticketing into TForward.

Step 6: enable cost-effective installation of electric vehicle ("EV") recharging points by linking into TForward.

Step 7: enable future autonomous vehicles ("AV"), car clubs, ride-sharing and innovative apps, to use TForward for their back-end payment system.

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

Step 9: with the Local Government Deal, local authorities can choose to introduce telematics charging at local hotspots, in return for keeping the revenue for local road improvements.

Step 10: with the Highways England Deal, potentially introduce road-charging at hotspots on the Strategic Road Network ("SRN").

Many players can be taking different steps forward in parallel, which cumulatively will build a critical mass of people registered with TForward.

TForward is a platform for integrating and developing recent exciting technological advances into an optimal customer-facing transport solution.

Political Deliverability

Steps 1-7 are not especially controversial politically. While they are being introduced, the government needs to show some tangible benefits from road charging initiatives to mitigate opposition to more extended road charging. See section 2 for road-user benefits the government could be starting to deliver related to road investment, financial incentive, better procurement, exciting new technology, road safety and the economy.

Rather than building an intellectual case for road charging, given scepticism of political promises, these actions will be more persuasive with road-users than words. The answer to political deliverability is starting to deliver.

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.

Value Capture

Value capture initiatives for the increase in land values surrounding new or improved roads include land development tax or selling planning permission, so those who benefit pay for the infrastructure.

Transport arteries connecting, and orbiting, towns and cities, with development clustered along could re-shape urbanisation. Giving existing local residents improved transport infrastructure could build local support.

Better Procurement

People need to feel their money is well spent, and better procurement is an opportunity to build public support.

Establishing the Wolfson Select Committee, comprising Members of Parliament who can scrutinise infrastructure procurement, and fight for the interests of the public paying for and using the roads, could save billions and address cost over-runs and delays.

It is time to move beyond PFI to improved capital structures which optimally package risk.

More should be expected from the government's professional advisers, and alternative engagement options are considered.

Freeing the UK from the EU's mandatory procurement rules is a valuable objective to achieve in Brexit negotiations.

Technology Revolution

The worlds of traditional car manufacturers and the tech industry are colliding, as we witness a "land grab" for an emerging new automotive industry.

AV, car clubs and ride-sharing "apps", along with mode-neutral mobility service contracts, offer a new capital model where people do not pay the upfront capital cost of a car. That could lead to a higher proportion of journeys being made on public transport. Road charging could encourage this shift.

Uk Strategic Funding

Even if more money is made available for improving UK roads, there remains the challenge of how to increase capacity where there is no space in congested urban centres.

Global research funding focuses more on vehicle technology, than road infrastructure. New technologies are delivering some congestion improvements (e.g. better vehicle utilisation, less parking need and platooning), but UK urban centres are different to California, and vehicle technologies alone are unlikely to solve the UK's congestion problems.

The opportunity is for UK government research funding to be targeted onto road infrastructure solutions for tightly-packed urban centres, and to make the UK a world-leader in these solutions.

Appendix: Av On Rails

An innovative solution is explored in the context of the current South Wales Metro procurement.

Rail lines are arteries into the heart of congested urban centres. The gap between trains is an horrendous waste of major transport arteries, when there is no space to expand the surrounding congested roads. Henry Ford did not design the factory assembly line to only send one widget along every half hour.

AV travelling along rail lines, on existing or specially designed tracks, would resolve AVs mixing with human drivers and pedestrians, and better utilise rail line capacity. Electrified rail lines supply power resolving battery limitations, enabling high-speed and inter-city travel.

In preparing the Primary Submission, to meet the 10,000 word limit, sections from the full report have been redacted, leaving the structure headings.

Summary = 991 words

Primary Submission = 9,769 words

Appendix = 1,291 words

1. Stepped Introduction Of Road Charging

Stepped Approach

An over-arching policy to introduce road charging nationally 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 ensure new charges support economic activity. 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.

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, operating from the same TForward platform.

Step 1: Establish "Tforward" Integrated Payment System

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

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

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.

TForward would be cheaper overall for road-users with economies of scale, and back-end 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.

Additional benefits include enabling:

- i. a stepped introduction of future telematics road charging
- ii. existing road charging and parking schemes to upgrade to variable telematics-based tariffs
- iii. cost-effective roll-out of EV recharging infrastructure
- iv. payment schemes to be cost-effective for smaller projects
- v. new technological innovation which can take advantage of the back-end payment system (e.g. AV, ride-sharing and other apps)
- vi. sophisticated pricing structures to be trialled (to better allocate road usage and link it with economic activity)
- vii. money raised to be ring-fenced (if politically desirable) for road improvements in the area where the money is raised, by passing the money

to the relevant central, devolved or local administration

- viii. integrated website travel and EV chargepoint information

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.

TForward is a platform allowing us to bring together numerous exciting technological advances that have recently emerged, and develop them into an optimal customer-facing transport solution.

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

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

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 payment and accounting mechanics for other UK 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 a younger population. It 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, and has

- developed the successful Oyster card
- it would allow London to develop a more sophisticated telematics road charging platform, at lower cost if shared with central government

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 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 at the most congested and polluted areas. It would provide a user-friendly platform to implement the already promised tolling at the Blackwall Tunnel, alongside the new Silvertown Tunnel.

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 road charging and emissions charging schemes can integrate into TForward, such as London’s Low Emission Zone, the Dartford Crossing, the M6 toll road etc...²

Initially run TForward in parallel with the existing charging platform, iron out any teething problems, and encourage voluntary customer uptake of TForward, with a discount if needed, until there is sufficient acceptance to make TForward the only mode of payment.

This would enable existing road charging schemes to upgrade to flexible telematics based charging tariffs, if they wanted to take that additional step.

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, when the overhead costs of running a car park would not make that viable.

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 apps) which might emerge in the UK to take advantage of the TForward back-end payment system.

User-friendly: Road charging cannot be made intrinsically popular, but the problem does not need to 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 Dartford Crossing ... 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, given only some schemes require advance payment. The customer helpline experience can be dismal. TForward aims to make the mechanics of payment customer-friendly.

² Question why the new Dart Charge payment scheme (for the Dartford Crossing) created its own system, presumably at significant expense, and did not simply license an extension of the existing London Congestion Charge payment system?

Step 4: Replace Hgv Road User Levy

Replace the HGV Road User Levy³ with TForward telematics, including for vehicles from overseas. Charging could be extended to lorries smaller than the 12 tonne categorisation.

Step 5: Integrate Public Transport “Smart” Ticketing

Public transport ticketing could in theory 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 (see “Mobility Service Contracts”).

This funding might 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.

An additional benefit would be people not having to register for separate road charging and public ticketing schemes, and building a critical mass of people registered with TForward.

Step 6: Integrate Ev Chargepoints

The government’s approach⁴ is to prescribe technical, interoperability and user information requirements, and potentially require motorway services and fuel retailers to install EV chargepoints. The Autumn Statement 2016, announced £80 million for business chargepoints, and

£40 million for the Plug-In-Car Grant. Perhaps this funding could be more effectively used establishing TForward.⁵

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 an existing customer base, that all chargepoints can link into, removing this expensive up-front capital cost and barrier to market entry⁶

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 See the Vehicle Technology and Aviation Bill 2017 published on 22 February 2017

⁵ Since introduction of the Plug-In-Car grant in January 2011 there have been 60,755 EVs registered, increasing by 10,000 in 2016 (up 3.3% on 2015). There are already 11,000 EV chargepoints in the UK. Refer to www.gov.uk/government/publications/enhanced-capital-allowance-scheme-for-energy-saving-technologies, and www.gov.uk/government/publications/plug-in-car-grant

⁶ “Smart” off-peak charging incentivised by preferential tariffs can balance electricity demands on the grid. Much recharging can be done overnight, enabling EVs to act as a mass national battery storing generated off-peak electricity, reducing additional generation capacity needing to be built to support mass-EV ownership.

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

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

- TForward enables installation costs to be recovered over time. The user pays to recharge, TForward takes a small administration fee, and passes the balance 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
- chargepoints can be rolled out in small numbers, making it cost-effective for small businesses. We have over 26,000 electricians in the UK, and TForward would enable them to do the installations (supported by and training apprentices), avoiding the inflated rates of large corporations⁷
- 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, could help roll-out chargepoints.

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. These back-end costs are a significant barrier for small businesses and it will help roll-out of AV, alternative capital models and innovation.

Step 8: vIntegrate New Road Infrastructure

Consider applying TForward road charging to new road infrastructure which is built.

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

⁷ NICEIC roll of registered contractors

Step 9: The Local Government Deal

Local authorities that choose to participate in the “Local Government Deal”, would identify congested or polluted local areas to introduce TForward charging, with the incentive that in return they would keep the revenue generated to fund their own local road improvements.

Charging could be introduced, perhaps initially on a trial basis, at peak times, in those specific geographic areas affected by higher levels of congestion, such as a city centre, bridge, or major traffic junction, or alternatively a scheme might be based on emissions (like London’s Low Emission Zone).

Local authorities have the benefit of in-depth local road knowledge, congestion and pollution hot-spots, maintenance priorities, and how to link charging to improvements attractive to local people.

Funding to maintain local roads is crucial, considering people typically do more day-to-day travelling on their local roads than on the SRN, and local roads are needed for that “last mile” delivery. A number of UK cities have considered introducing road charging, but met with adverse public reaction. It would be easier for a local authority to introduce limited peak time charging at a particular road, bridge or junction, than to roll-out a wider city-centre scheme, and TForward would enable that limited introduction to be practical and cost-effective.

Local authorities are facing severe budget pressures, with significant maintenance back-logs on local roads, which could make this attractive for many local authorities.⁸ The Local Government Deal may also have advantages over the major road network concept.⁹

If revenue generated reaches the level of exceeding the amount the local authority wants to spend on its roads, a policy decision can be taken at that future time on the extent of hypothecation, and whether money raised can fund other local authority services or reduce council tax.

A statutory power already exists for local authorities to introduce road charging.¹⁰ However, what is needed is

- i. a clear central government policy supporting local authorities taking it forward,
- ii. TForward up and running, reducing risk and costs, and
- iii. replace prior Secretary of State approval with a backstop call-in power.

⁸ The 2016 Asphalt Industry Alliance’s ALARM survey estimated it would cost almost £12 billion to bring the local road network back to a reasonable standard.

⁹ 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 of major roads.

If local authorities could fund their roads directly via the Local Government Deal, there would be less need to introduce the major road network concept, as local authorities 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.

¹⁰ Sections 163 - 177 of the Transport Act 2000.

Step 10: The Highways England Deal

With the “Highways England Deal”, Highways England could similarly identify hotspots on the SRN suitable for road charging, and use the revenue generated to improve the SRN. Again, charging might only be introduced on a trial basis, at peak times, in those specific geographic areas affected by higher levels of congestion or pollution, or where there is a specific requirement (such as reducing pollution levels around Heathrow to enable a third runway).

Successful TForward telematics could then be extended over time to gradually replace road taxation.

If telematics revenue generation progresses to the stage where it raises more than the government wishes to spend on the roads, the balance could be passed to the Treasury, subject to other road taxes being correspondingly reduced.

Cost Of Introducing “Tforward” Telematics

It is public opinion, rather than cost or deliverability, that has held back road charging.

The technical challenge in establishing TForward should not be underestimated. TForward will require levels of financial and information processing and security almost equivalent to a bank. The UK has the technical expertise, being a world-leader in Fintec (financial technology) emanating from the City, and the UK can deliver TForward with government backing.

Companies developing TForward may become market leaders exporting to other countries looking for similar solutions. This should enable them to develop at a lower up-front cost, or the government could retain a share in intellectual property. Telematics system costs are falling, being spread globally across private sector insurance, fleet management and other applications.

Establishment costs are not disproportionate given potential revenues, notwithstanding potential tax incentives for installing telematics boxes in vehicles (if needed instead of smartphone apps)¹¹, or discounts incentivising switching from existing tolling schemes.

The TForward platform should become self-funding, by taking a small administration fee from each payment processed. Revenue might also be raised from insurers (with driver consent), or private sector fleet management and other road services.

¹¹ Current telematics car insurance policies provide (i) devices the size of a pack of cards professionally installed into vehicles, (ii) smaller devices plugging into a charger port, or (iii) a smartphone “app”. If physical devices are needed to be installed in vehicles, roll-out could be incentivised by various tax reductions - on VED, vehicle sales VAT, company car tax, VAT on compatible satnavs, or insurance premium tax on compatible telematics policies. The Autumn Statement 2016 announced insurance premium tax is to increase to 12% from June 2017, doubling insurance premium tax from 6% in just 18 months.



2. Political Deliverability

Addressing Public Concerns

In 2005, 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.

The Starting Steps

Many of the steps set out 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 (such as new Heathrow roads, Lower Thames Crossing and Silvertown Tunnel)
- enabling legislation for the Local Government Deal and Highways England Deal

Many players - central, devolved and local government, TfL, Highways England, 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 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 or 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:

- the Mayor of London and London Assembly can decide whether or not to geographically extend road charging in London, and set the tariffs
- under the Local Government Deal, some local authorities may introduce congestion or emissions charging to deal with a specific problem or fund a particular local road improvement, in a way that is acceptable to local people

Political Deliverability And Delivery

It will take a few years (ideally less than ten) 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 that might be desirable at a later date, such as Highways England extending charging on the SRN, or more extensive local road charging under the Local Government Deal. There is potential for greater political controversy, not least because these steps could 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 since people remain sceptical of political promises.

However good an intellectual case is

made for road charging and its benefits, it can still be met with scepticism and adverse public reaction to paying a new tax.

The answer to political deliverability is political delivery. Actions not words.

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

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 and 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, and delivered local road improvements, providing a model to other local authorities
- telematics charging is guiding HGVs away from congestion hotspots, with increasing night-time use of the 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 (see “Pot Holes and Asphalt”)
- people can see money raised from VED and limited road charging actually being invested back into the roads

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 the first reduction in VED or fuel duty, so that road-users can see the road charging is revenue neutral.

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, but progress on some would help create an inspiring forward-looking UK roads environment more receptive to road charging:

Financial

- the total financial burden on road-users is 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 (see “Value Capture”)
- telematics insurance policies that reward good drivers with lower premiums are available
- people can choose to avoid the capital cost of buying a car because ride-sharing apps, along with car clubs, and better integration with public transport, have given them a realistic alternative (reduced car ownership amongst young people may reduce opposition to road charging compared to 2005)

Procurement

- the Wolfson Select Committee has been established and is prominent in the media reining in excessive procurement costs and fighting for the public interest (see “Better Procurement”)
- the government has given up PFI, used a flag-ship project to challenge government advisers to negotiate better terms, and freed the UK from EU procurement rules so more spending goes on creating 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 (see Appendix), 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 is appearing from government funding into infrastructure

research, availability of the TForward platform for emerging technologies, and telematics technology (see “UK Investment Perspective”)

Information Security

- TForward has demonstrated robust financial and information security
- a balanced civil rights debate around telematics data collection, communicates privacy concerns have been overtaken by widespread mobile phone uptake, while insurance based on a person’s driving habits rather than demographic group is more affordable for most 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 by alerting emergency services to incidents, identifying bad driving, or immediately recognising a motorway pile-up and transmitting warnings to vehicles heading into the danger zone
- child pedestrians wear LED safety lights in the dark making them safer (see “Child Safety”)

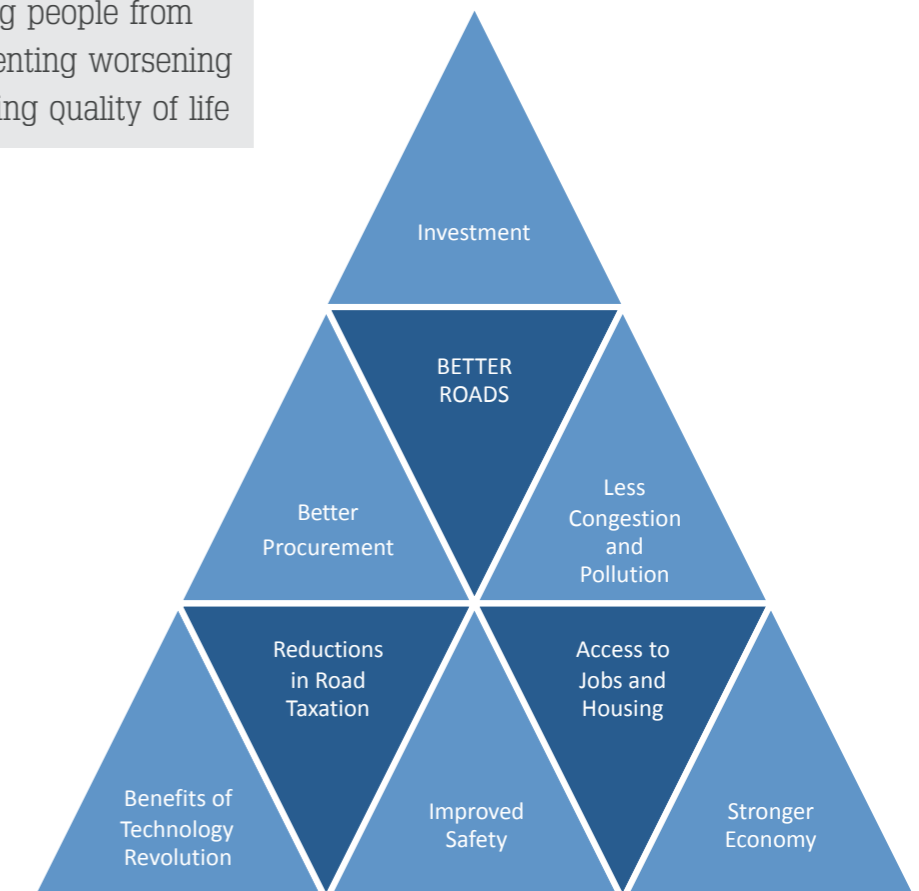
Quality Of Life

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

Economy

- the UK stands as a world- leader in new automotive technologies, batteries research, infrastructure solutions, and telematics road charging, and exploits 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 make wider road charging, beyond the Starting Steps, more deliverable politically.



3. Economics Of Road Charging

The Current Taxation Model

Under the current UK system roads are paid for out of taxes. The road-related taxes, primarily fuel duty and VED, raise far more than is spent on the roads.¹²

Transition to EV, or other fuels, could undermine fuel duty in its current form. Fuel duty is an unsophisticated form of road charging, increasing with mileage but only tangentially linked to congestion and the cost of infrastructure used. Rather than taxing future car fuels more (or accepting the revenue loss), road charging taking advantage of advances in technology could be better targeted and fairer.

To preserve VED revenue, given improved environmental vehicle performance and transition to EV, VED is already changing for new vehicles to no longer be calculated on CO2 emissions (see "Evolution of Vehicle Excise Duty"). In that way, VED could continue to raise equivalent amounts in the future.

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)

Linking Demand And

Investment

Road charging can be fairer and result in better economic resource allocation, with those using the road infrastructure paying for it. Road charging creates the crucial link so that demand generates revenue, and capital investment can be repaid from that future revenue. That link is missing with the current taxation model.

Road charging incentivises innovation, enables investment to flow to where it is most productive, and road users avoiding uneconomic road usage:

- a range of tariffs from rush-hour to off-peak can lead to better journey spread, encouraging more flexible working hours, and incentivising haulage at night;
- variable parking charges could encourage ride-sharing, and investment into AVs that are hailed like taxis when needed;

¹² 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.

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

- charging for road space could encourage investment into platooning, and allocate road space for mobility services where people do not own a car in the traditional sense; and
- it can mean public transport competes more fairly on price; currently it is often cheaper to drive than pay for a bus or train ticket. Similarly, rail freight would compete more fairly on price with road haulage (see "New Capital Models").

Demand Management

[To comply with the 10,000 word limit, sections from the full report have been redacted, leaving the structure headings.]

Transition To Road Charging

Telematics

Offsetting Road Tax Cut

If the government wants to successfully introduce road charging it should accept that if money is raised from road charging, there should be a corresponding reduction in road taxation to compensate.

With past failed attempts to introduce road charging, the debate has failed to incorporate corresponding road tax reduction. Gaining public trust that road

taxes will be reduced and road users will not be paying twice is key to public support, and necessary to give people a sense road charging gives them a better deal, or at least not a worse one.

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, recognising public and political sensitivity to road charges.

Communicating The Positive Case For Our Roads

Better engagement with the public is key for a road industry needing additional investment and new infrastructure, changing rapidly with emerging technology, and transitioning to new forms of funding.

[Redacted]

4. Value Capture

Generating Economic Growth

New and improved transport links are expected to generate economic growth by bringing in residential, commercial and industrial occupants to the newly accessible areas.

Government shares directly in some of this economic growth through taxation, such as receiving additional business rates, and income tax, corporation tax and VAT on new economic activity, which can be set against the infrastructure costs.

The value of that additional economic growth and its benefits to society more widely, should be greater than the government expenditure of taxpayers' money in building the infrastructure, and cost/ benefit analysis creates the economic justification for the government's original investment. Crossrail has been successful in communicating that its construction cost of around £15.8 billion, is estimated to have generated around £42 billion for the wider economy.

Realising Land Value Increases

How can the value generated by new and improved transport links be better captured, so those who benefit from the infrastructure pay for it?

New or improved transport links will generally increase the value of the surrounding land. Value can be captured to fund the infrastructure by making land surrounding the new or improved transport routes available for development.

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.

HS1&2 fail to capture for government the potential increase in the value of the surrounding land. The government has not sought to introduce specific value capture initiatives. Because with railways people are only able to embark and disembark at 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.¹³

¹³ There is discussion of potentially building a new city on the HS2 line at Toton (between Nottingham and Derby). This 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.

Land Development Tax

A Land Development Tax could be introduced, paid by property developers for planning permission, based on the hecterage of land permitted to be developed.

Selling Planning Permission

An alternative mechanism to a Land Development Tax, would be to sell planning permission for particular building projects. This could give control over the development standard for specific projects. This could raise more money per hectare than the Land Development Tax because more of the variable surplus for 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 because this may reduce uncertainty for private bidders as to what they will be allowed to build. Different auction models would allow the form of planning permission auctioned to be developed either privately or publicly and allow for different options. Mix or environmental restrictions could still be required by government, but there would likely be a trade- off between how prescriptive these were and the revenue raised for the public sector.

The Cambridge - Milton Keynes - Oxford corridor proposes East-West Rail and the Cambridge-Oxford Expressway road improvements, and is an opportunity immediately before the government for value capture of the increasing surrounding land values with appropriate new building. Emphasising the crucial link between transport arteries and housing, the NIC reported a shortage of housing

represents a fundamental risk to the success of this area and investment in transport links must be "properly aligned with a strategy for new homes and communities, not developed in isolation".¹⁴

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, and to develop an optimal model that can be rolled out nationally on future infrastructure projects. The NIC may be an appropriate body to take this forward.

Reshaping Our Cities

Our towns and cities typically form in a roughly circular shape around a centre. In the UK most of our town and city centres were built in a previous age before modern population and transport levels, with roads that are now too narrow for the volume of traffic, with new-build continually being squashed in around the edges and into any urban sites that become available. There can be no surprise that such an approach leads to acute traffic congestion.

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

¹⁴ 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.

- 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 one of clusters along a line.

Transport arteries might be today's conventional motorways, or entirely new kinds of artery designed for future AVs. 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. developing the surrounding land could fund building the transport arteries;
- iii. it could open up large amounts of land for development, with access between housing and jobs, and thereby help resolve the housing crisis;
- iv. a motorway, or new kind of AV artery, with regular slip roads or embarkation and disembarkation points along the line, could make all the surrounding land accessible (in contrast to a railway where access is limited to stations);
- v. the new developments 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 the work of 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 emerging transport technologies could enable the distance between new and existing settlements to increase without losing connectivity benefits.

New transport arteries have the potential to connect people far more effectively over greater distances than ever before. Just as the railways brought communities within reach of each other, investing in the arteries between and around towns and cities to realise the potential of emerging transport technologies can make a new model of urbanisation possible. Transport innovation has the potential to change where the geographic balance lies between economies and diseconomies of agglomeration.

There is an opportunity to utilise planning regulations to ensure the best lay outs, with buildings set back and shielded from the main transport artery by trees and greenery, with buildings representing the best in architecture, build quality and sustainable design, and utilising the garden city concept.¹⁵ Development must not be uncontrolled unsightly US-style strip development.

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

¹⁵ 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.

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

Resolving The Greenbelt Debate

There is pressing debate between those wanting to uphold greenbelt protections preventing urban sprawl, and those maintaining the only way to have sufficient land to resolve the housing shortfall is to build on greenbelt.

In its recent housing White Paper, the government maintained its protection for the greenbelt, which is only to be built on in "exceptional circumstances".¹⁶

In contrast, Professor Cheshire¹⁷ has contended the UK's planning regulations have failed us by preventing greenbelt becoming available for house-building, leading to the current housing crisis, as well as causing excessive commute distances for many 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 the creation of new technology fast, high-capacity, efficient transport arteries between, and orbiting around, towns and cities with new development sited in clusters along the lines:

- a. we need and have transport arteries in any event between towns and cities, which inevitably route through greenbelt, and by containing development along these arteries it would avoid a more general sprawl and encroachment into the greenbelt;
- b. orbital arteries around towns and cities could be built around the edge of greenbelt.

In return, existing residents would benefit from reduced congestion and pollution, shorter journey times and greater connectivity and economic opportunity, which may transform some local resident opposition into support. Debate to date on building on the greenbelt has meant more congestion and disadvantages for local residents, rather than offering them a new infrastructure model where they can share its benefits.

If new transport technology allows existing and future traffic to move more efficiently, quietly, with less pollution, then well-designed building on the lowest amenity greenbelt along designated routes avoiding sprawl, could potentially enhance the greenbelt environment.

¹⁶ "Fixing Our Broken Housing Market" White Paper dated 7th February 2017

¹⁷ 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".

5. Better Procurement

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.

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.

This is a problem that can be turned into an opportunity. Improving procurement practices so people have confidence their money is wisely spent, and perceive the price paid for the underlying infrastructure as fair, are key to building public support and political will for future road infrastructure.

The sums called for in the multiple billions to pay for large infrastructure projects are too high for most people to compute. Instead, people too often hear a tale of spiralling costs, delayed delivery, and poor quality end service, to the point where there is almost a collective resignation and acceptance. It is not acceptable.

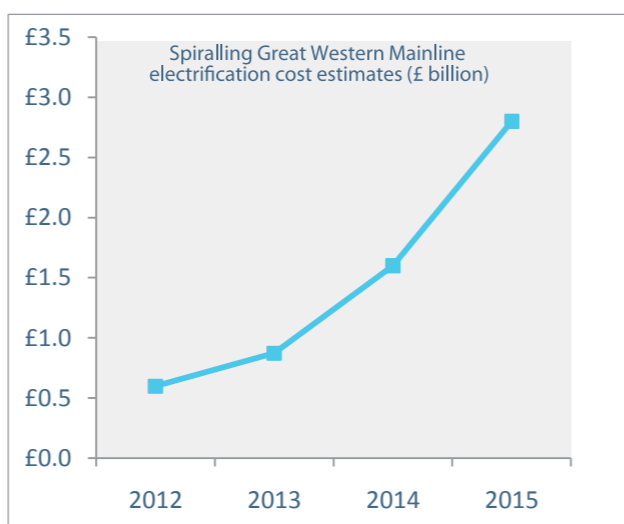
This applies to all aspects of government procurement, from health through to defence. The sums involved are staggering, and even a small improvement in procurement practice would deliver tremendous returns, and take pressure off the ever-larger national debt.

The Wolfson Select Committee

There is a role for a dedicated House of Commons select committee focussed on the scrutiny of infrastructure projects before and after procurement. Given the unwieldy official names of some of the select committees, for ease it shall be referred to as the “Wolfson Select Committee”.

An effective Wolfson Select Committee could save billions. The Members of Parliament sitting on the Wolfson Select Committee would be able to fight for the interests of the public paying for and using the infrastructure.

The Wolfson Select Committee should have a continuing remit to oversee infrastructure funding innovation and development, increasing the long-term impact of this Wolfson Economics Prize.



To enable the Wolfson Select Committee to be effective, all proposed infrastructure contracts over a specified threshold value, together with government advisers' contracts, should be published and available 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.

Infrastructure projects need planning decisions, and the Wolfson Select Committee could oversee these in the context of the cost and contractual trade-offs involved.

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.

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.

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.

Parliamentary select committees have become much more effective since 2010, when the appointment of MPs by party whips to a select committee, 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.

Beyond Pfi

A Critical Look at PFI

Off-Balance Sheet Incentive

Optimal Packaging of Risk

Some PFI investors have made returns that have been widely seen as excessive, particularly on some of the 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 on-sell 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 that they can 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.

Different private sector infrastructure players bring different attributes. A common failure to date, and what is needing 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 to:

- a. construction funding
- b. planning and regulatory risk
- c. maintenance risk
- d. revenue management
- e. revenue stream risk

Construction

- ① **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.
- ② **Planning and regulatory risk:** the government is the best placed party to carry these risks and should retain them, as the government itself influences them.

Post- construction

- ③ **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 (ideally 30 year) view of the investment needs of the infrastructure, and negotiate 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. "Adviser Fee Structures" considers incentivisation of the government's advisers for best management of flexible long-term maintenance contracts.

- ④ **Revenue management:** outsourcing companies, such as Capita or G4S, could be best placed to manage revenue collection, perhaps through TForward.

- ⑤ **Revenue stream risk:** the government has the option of retaining the revenue stream (or charging less for using the road infrastructure).

Alternatively, the government can choose to sell the revenue stream (as with HS1). Post- completion, construction and planning risk is removed, and the actual usage level and revenue being generated is known, and when those substantial uncertainties are removed, the valuation of the future revenue stream increases. For this reason, there is a benefit if the government waits to sell the revenue stream until the infrastructure is operational.

The value of the revenue stream is affected by interest rates, and the government will receive 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.

The Political Balance

With low interest rates, and quantitative easing pumping money into the economy, now is a good time for the government to be investing in infrastructure.

Given how unpopular PFI has become, we already see PFI being used less frequently. Moving away from PFI and reverting to more straightforward capital structures, where the government funds infrastructure construction with public borrowing, has comparatively little political back-lash.

The government can repay that public borrowing by selling the revenue stream. Packaged optimally, the long-term overall cost to the government and taxpayer, and impact on the national debt, should be reduced.

It will be easier for the government to move away from PFI while interest rates are low because:

- i. the government pays lower interest on public borrowing, compounding less on the national debt, and markets are less sensitive to greater levels of government borrowing
- ii. the value of the revenue stream increases, and it can be sold for more once the infrastructure is in operation.

Adviser Fee Structures

Intelligent Client

Wolfson Select Committee

Professionals To Make Business Decisions

An Opportunity for Advisers

Fee Structures

The government needs to have negotiating for it a team of professional advisers including a lawyer, financial adviser and a civil road engineer. The customary fee structures need to change. Advisers should not charge by the hour. Agreed overall deal fees, paid at the negotiation stage irrespective of how good a deal is delivered, are sub-optimal.

Alternative corporate finance fee models could incentivise advisers, paying them a larger amount, the lower the overall cost of the project, and the better the timing and quality of delivery of the project.

With the value of public infrastructure projects and associated professional fees, the government can and should dictate advisers' terms, and not accept terms dictated to them. The professional advisory industry needs a shake-up. There is intense competition amongst professional advisers to win mandates, and they will reform their business models if that is what they are required to do to win business.

Competitive but flexible tendering and beauty parades between the advisers competing for the mandate can develop the more sophisticated engagement contracts needed.

Long-Term Engagements

The professional engagement contracts should be long-term contracts running in parallel with the construction and subsequent maintenance period.

The fees should not be front-loaded so the bulk of the money is received by the advisers at the negotiation stage, but paid out over the course of the construction and maintenance period, incentivising the professional advisory firm to take a long term view of value delivery to the government, and to treat the contract and client relationship as a long term asset of their business, and to monitor delivery of the project and subsequent maintenance.

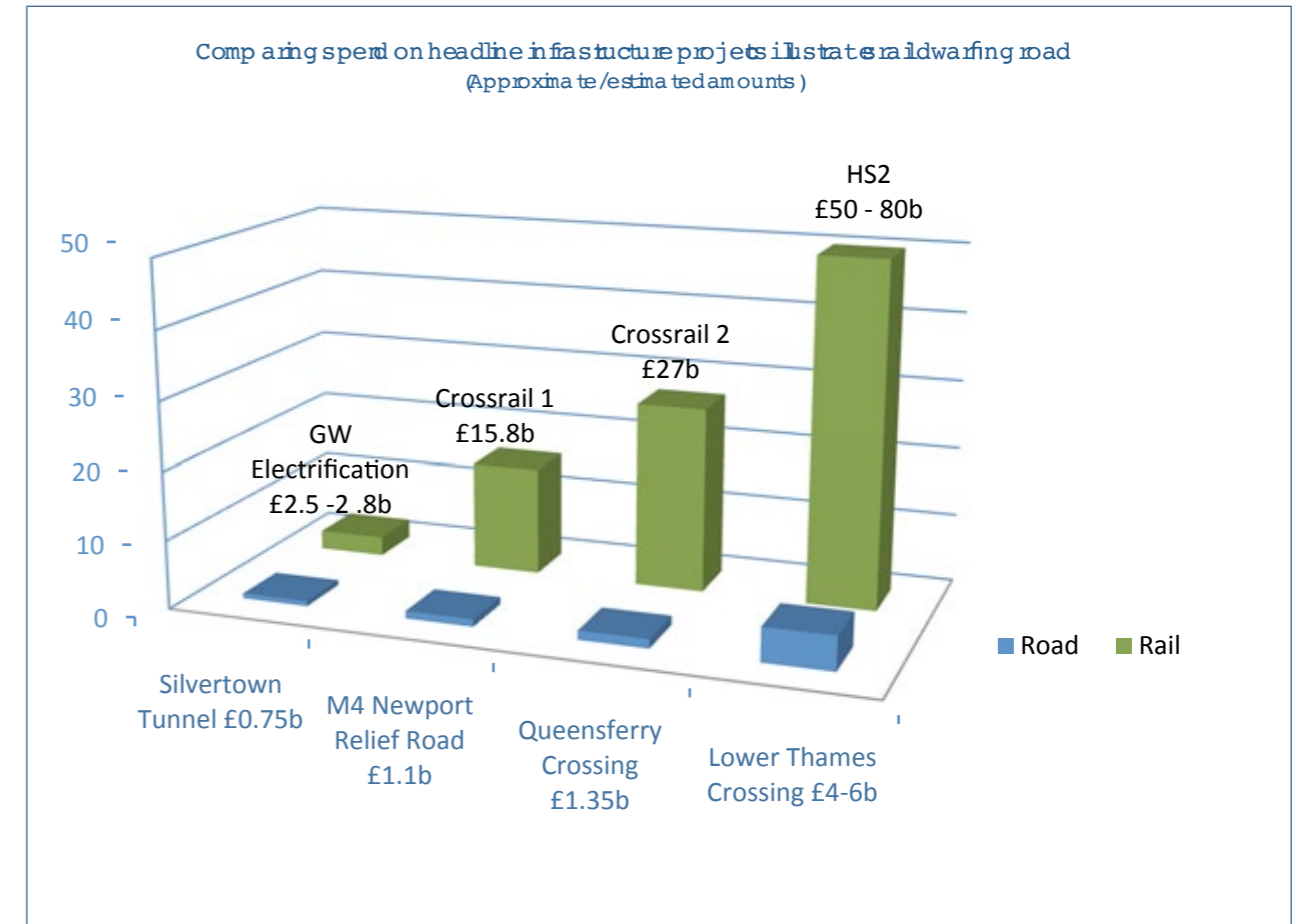
Long-term maintenance contracts (see "Beyond PFI") need in-built flexibility to allow adjustment for change, and the professional advisers need to be incentivised to optimally re-negotiate the flexible elements of the contract.

The engagement contract should permit the government to terminate, and put the engagement out for re-tender, without financial penalty and without reason, so the advisers have ongoing pressure to deliver value.

Eu Procurement Rules

Mode-Neutral Commissioning

Road Vs. Rail



6. Vehicle Excise Duty

Evolution Of Vehicle Excise Duty

Ringfenced Roads Fund

Pollution

7. The Labour Force

Investing In The Labour Force

Supply Chain Continuity

Learning From Rail

8. Improving Roads Today

Straightforward Solutions

Pot Holes And Asphalt

Information Cloud

Move Vehicles On Trains

The School Run: Mobilise Our Teachers

Child Safety

9. Technology Revolution

10. New Capital Model

“Apps” And Car Clubs

Hailing and ride-sharing “apps”, along with car clubs and carpooling, offer the potential of a new capital model. People would not conventionally own a car, but have the flexibility to pay to access a vehicle of their choice, when and where it suits them, or to share the cost of a journey with other travellers, with a few taps on an app.¹⁸

This 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

utilise AV vans and lorries on demand. In the US, using mobility service companies to replace traditional provision of public services and infrastructure has started.

Mobility Service Contracts

New Infrastructure And Services Model

Rather than investment in infrastructure and public services, in the US there is innovative trialling of mobility service providers

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 apartment blocks giving residents Uber credits instead of parking spaces

(LA)

Rather than investment in infrastructure and public services, in the US there is innovative trialling of mobility service providers (most prominently market-dominant Uber). [Redacted]

¹⁸ 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.

Public Transport Shift

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.¹⁹

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 only weakly linked to the cost of the road infrastructure used.

It is a market distortion that pre-determines in financial cost terms, 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 may be made by road.²⁰ 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 such a high proportion if a road charging scheme charged specifically for road infrastructure used, rather than road costs being met (many times over) by fuel duty and VED?

In the future the cost of “hiring” a conventional vehicle or AV (via 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)
- iii. insurance (currently a substantial cost for car clubs, and telematics could effectively monitor use or abuse of “hire” vehicles giving users direct responsibility for tailored insurance premiums)
- iv. the vehicle provider’s profit margin.

A behavioural shift to apps, car clubs and mobility service contracts, 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.

That 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

¹⁹ 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.

²⁰ It is noted that includes bus journeys.

private vehicles on the road could in future become journeys made on public transport. That has profound implications for planning sufficient future transport capacity.

More Road Journeys

A shift from private road journeys to public transport should not be confused with an assumption of less overall road journeys, and congestion and pollution problems will be magically solved. There are factors indicating, even with this shift in capital model and introduction of road charging, that in the future more road journeys will be made:

- growth in population and the economy increasing demand
- more home delivery
- demand for AVs from people currently unable to drive themselves, including certain disabled people, elderly people and adolescents
- demand for AVs from people choosing to pay more for the comfort and convenience of private driverless travel
- some people will make private car journeys from which they were previously dissuaded by the capital cost of buying a car

11. Uk Investment Perspective

Current Uk Government Support

Silicon Valley Dreaming

Much AV technology emanates from around Silicon Valley, but Californian and UK road infrastructure needs are not the same.²¹ California was designed around the car, with wide multi-lane roads, without roundabouts, and limited pedestrian access. US-centric funding focuses on US-style freeways, and is unlikely to have optimal application in the UK's tightly packed urban centres.

Consider the plausibility of fully driverless level 5 AVs²² travelling without human assistance on the UK's congested urban roads, without adding to congestion, alongside human drivers, from delivery vehicles unloading, to emergency vehicles, cars parking, cyclists, and crowded narrow pavements with unpredictable pedestrians (including children) stepping into and crossing roads.²³

Even removing human-driven vehicles and cyclists from some roads, dedicating them to AVs, would leave the pedestrian safety problem.

Technology has amazing ability to prove pundits wrong. Nonetheless, it is hard to imagine fully driverless level 5 AVs mixing with conventional vehicles on the majority of the UK's congested urban

roads in the foreseeable future. Surveys show people have reservations about driverless cars.²⁴ Leading players in AV technology say they expect AVs to run first on UK motorways, but do not give further insight into how the UK urban congestion and pedestrian problem might later be addressed. Safety, insurance costs and consumer acceptance remain to be resolved.

²¹ The Obama administration announced \$4 billion AV investment over ten years. Consider the prevalence of automotive innovation at the CES 2017 technology event in Las Vegas. Many companies spending billions have a US base (e.g. Ford, General Motors, Chrysler, Alphabet (owner of Google and Waymo), Apple, Microsoft, Elon Musk's Tesla, Uber, Lyft, nuTonomy and numerous Silicon Valley innovators). Much AV testing has taken place in the US, or been funded by US companies.

²² SAE International has devised AV classification levels categorised from level 0 which has no vehicle control but may issue warnings, to level 5 where no human assistance is required and the vehicle can drive to any location where it is legal to drive.

²³ Recent DfT research predicts one in four cars being driverless would increase congestion because early models act cautiously leading to "potential decrease in effective capacity" and a "decline in network performance", but that greater uptake with 50-75% of cars being driverless would reduce congestion.

²⁴ A Uswitch survey in the UK found 48% would be unwilling to be driven as a passenger in a driverless car, and 16% said they were "horrified" by the idea. A Goodyear survey of young drivers found only 11% would have full confidence in a driverless car. A survey in the US by the American Automobile Association found 75% would be "afraid" to ride in a driverless car.

Infrastructure Solutions Are Needed

The UK needs near term congestion solutions for its urban centres where there is no space to expand conventional roads, and where vehicles need to operate in tightly-packed spaces alongside human-driven vehicles, cyclists, pedestrians and other hazards.

AV technology can be a partial solution to the congestion problem, with innovations such as ride-sharing, AVs reducing the need for parking, platooning vehicles to use road space efficiently, parking guidance apps, and increased automation on motorways.

However, with overall journey demand forecast to increase, AV adoption itself driving demand, and the questionable plausibility of fully driverless AVs replacing conventional cars in tightly-packed urban centres in the foreseeable future, it is unlikely anticipated AV technology alone will resolve the congestion problems facing UK urban centres anytime soon.

There are important points for the UK to consider when targeting future UK government funding:

- most current global funding is into
 - (i) vehicle connectivity,
 - (ii) hailing and ride-sharing apps, and
 - (iii) EV and AV. That can deliver extraordinary vehicle improvements, but the focus is on the vehicles, rather than road infrastructure
- whilst EV and AV are exciting, there is a danger the hype is crowding-out research into expanding the capacity of the road infrastructure, and into

"mundane old-world" maintenance and improvements

- it is not good economics to spend UK taxpayers money 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

Focus On Urban Infrastructure Solutions

There is an opportunity for the UK economy not currently prioritised by the California tech-industry. The UK could focus investment onto road infrastructure solutions for tightly-packed congested urban centres, for the benefit of the UK, and export to the many other countries with similar urban centres.

Future objectives for CCAV²⁵, Innovation UK, and in due course UKRI²⁶, could extend to include:

²⁵ 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.

²⁶ A new body to be known as UK Research and Innovation (UKRI) is being established by the government to integrate research and Innovate UK functions, and maximise value from the government's investment of over £6 billion each year in research and innovation.

- i. targeting UK government research funding onto crucial but neglected problems such as infrastructure solutions for UK-style tightly packed congested urban centres (rather than vehicle technology)
- ii. funding competitions could support development of a telematics road charging system, creation of the TForward platform, resolution of any practical implementation challenges, and lateral application of the technology for collateral benefits and cost-savings
- iii. funding competitions should encourage an open approach to infrastructure solutions beyond the traditional automotive area. The exclusion by automotive funding competitions to date of research into rail or other modes of transport may be misguided. Open and lateral thinking is needed. 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 modes of transport for an optimal mobility

solution (see Appendix)

iv. more powerful than any particular idea, is to empower innovators to find optimal and effective urban infrastructure solutions. Transformative innovations are often sudden and completely unforeseeable, but might encompass anything from:

- ① traditional approaches to improving infrastructure such as developments in construction techniques for road-widening, bridges and tunnelling, pre-fabrication, materials innovation, improved traffic signalling, laying asphalt, and locating and filling pot-holes
- ② better application of AV innovation to resolve urban infrastructure capacity restrictions
- ③ innovative value capture or road charging technology addressing funding and congestion challenges
- ④ development of legal and regulatory regimes (such as compulsory purchase) to enable low-quality legacy building stock, that blocks transport routes, to be transformed into new transport arteries with modern well-designed buildings
- ⑤ other innovations, from AV utilising unused capacity on rail lines, cable car systems with little ground footprint, airport-style travelators, hybrid airships landing on rivers in cities, to drones making commercial deliveries

- v. the UK has made itself a world-leader in Fintec, and could aim to do the same for urban road infrastructure solutions, where there is less direct US competition than in developing AVs

In addition to government research funding,

- (i) Highways England is expected to promote innovation through its supply chain with RIS2²⁷, and
- (ii) the large infrastructure projects have a crucial role to play in developing and targeting innovation onto problems needing to be solved.²⁸

Long-Term Infrastructure Planning

Grow Uk Start-Ups

²⁷ Road Investment Strategy 2

²⁸ 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.

Appendix: Av On Rails

In the UK rail lines are arteries going straight into the heart of our congested urban centres.

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.²⁹ The surrounding roads are filled to the gunnels 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.

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

If under-used urban rail lines were converted to dedicated AV use, that could help address urban congestion by maximising capacity throughput down those crucial arteries. 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 life limitations on high-speed and long-distance travel - the electricity infrastructure is already present on electrified rail lines.

Perhaps over time the UK's rail network could be converted to dedicated AV transport - with AV's 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 "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 line capacity.

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.

²⁹ 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, 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.

Research

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 everyone congesting at main stations) and making more of the land surrounding the line accessible and 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
 - having small commercial depots along the line where AVs could deposit deliveries for onward distribution by conventional vehicle, and where people could collect deliveries, enabling commercial distribution and the burgeoning home delivery market to utilise the AV line, but with a diffused network of smaller depots closer to end delivery points
 - perhaps converting conventional inter-city rail lines to maglev, which AVs could travel along at very high speeds

An M4 relief road is currently proposed around Newport to alleviate severe congestion. There are two main proposals:

- i. the “black” route comprising 14 miles of new motorway to the south of Newport at an estimated cost of £1.1 billion, optimistically aiming to be completed by around 2022, but with a public inquiry only now commencing
- ii. alternatively, the less expensive “blue” route based around dualling and grade separation of the existing A48 and use of Newport’s “Steelworks Road”, at an estimated cost of £600 million and potentially capable of completion more quickly.³⁰

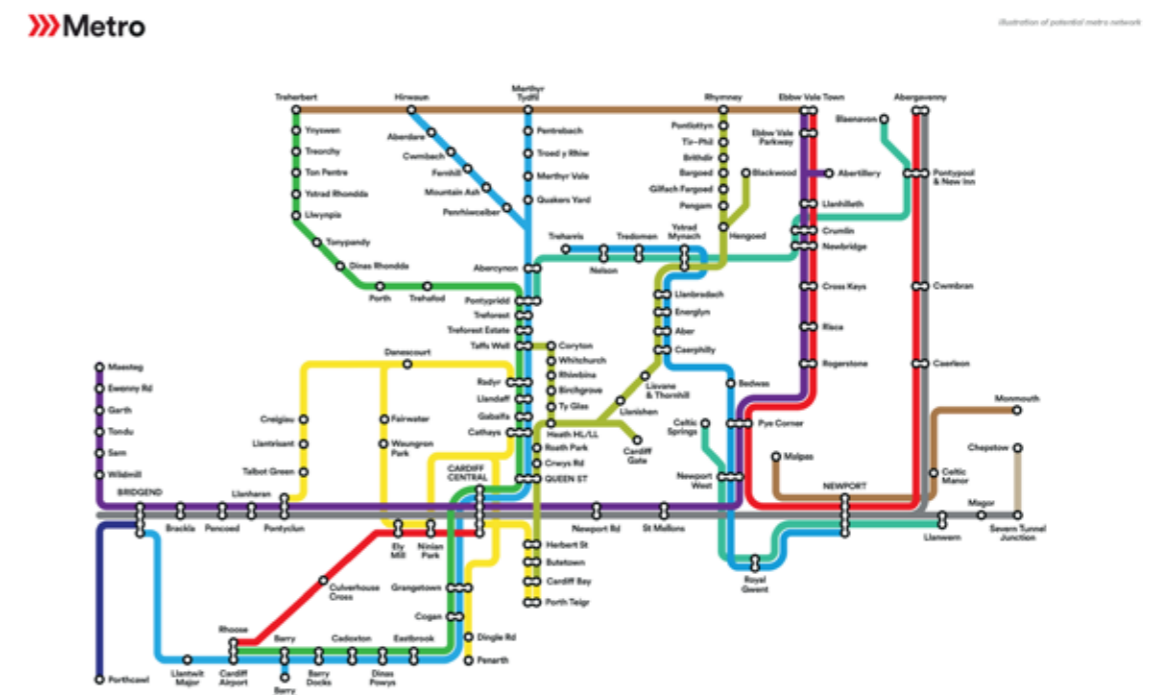


³⁰ See Professor Stuart Cole’s report “A Cost Effective Solution to Relieving M4 Congestion Around Newport”.

Separately, a South Wales Metro³¹ is proposed, at a cost of around £600 - £750 million³², although final funding arrangements are still not confirmed.³³

The Metro is a concept for improved public transport links around the “Cardiff Capital Region” (encompassing Brigend, Cardiff, Newport, up to the Severn Tunnel, and Valleys to the north) by building new transport infrastructure, and improving and better integrating existing infrastructure.³⁴

The 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



Proposed Metro for South Wales

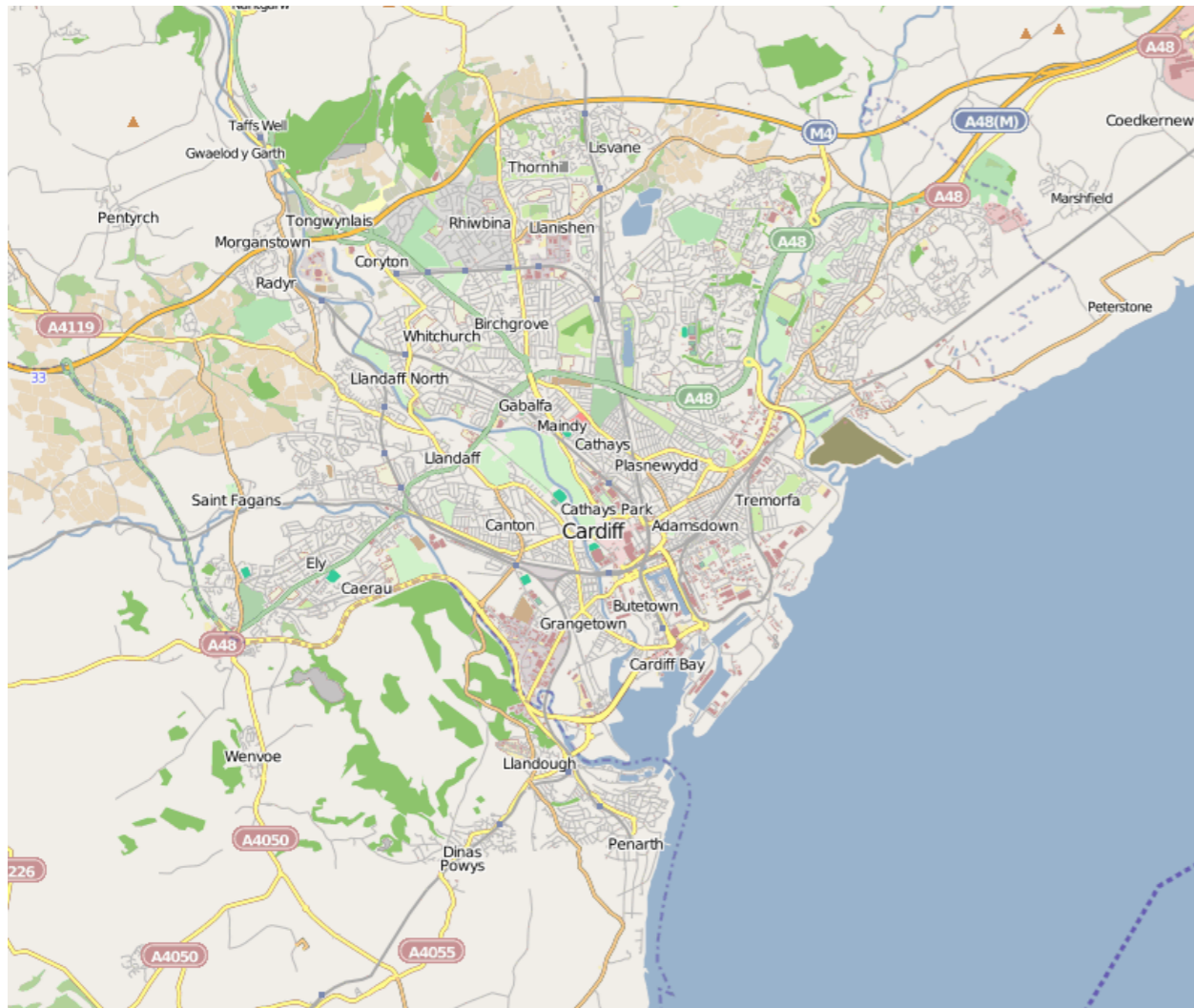
³¹ Refer to <http://gov.wales/docs/det/publications/160224-metro-information-brochure-en.pdf>

³² 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.

³³ Availability of around £200 million of proposed EU funding towards the capital cost is now uncertain.

³⁴ 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.

Mode-neutral procurement allows the possibility of part of the Metro comprising AVs travelling along rail lines. A map of Cardiff shows the benefits of high-capacity usage of existing rail arteries:



Source Google Maps

There are 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 Metro aims to deliver modernisation and some increased capacity on these train lines.

What if instead, rail lines were converted to dedicated AV use, with AVs travelling continuously (rather than intermittently) maximising capacity. Customers could benefit from many embarkation points close to destinations, not stopping at other people's stations, the comfort of private travel, and reduced pollution. Commercial distribution could benefit from AVs transporting goods along the line to a diffused network of 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 is not disproportionate to redeploy some of that money to test an AV rail line solution.

There is a good candidate for a test site: the spur rail line linking Cardiff Bay station to the city centre, a short distance of 1.2 miles taking a few minutes on a single carriage shuttle train. The South Wales Metro project has already stated an ambition of improving the link and adding connectivity with Cardiff Central mainline station, given Cardiff Bay has regenerated and is expanding.³⁵



Source Google Maps

Map showing train line between Cardiff City station and Cardiff Bay station

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.

³⁵ 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.



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