Written evidence submitted by Vivacity Labs (EVP0088)

Vivacity was founded in December 2015 with an objective to use technology to empower Cities and Transport Authorities to create sustainable, citizen-centric transport networks [1]. Our core product is a vision-based traffic sensor that provides transport authorities real time, anonymous data on how their road networks are being used by different classes of vehicles and pedestrians alike. We are currently developing (part funded by Innovate UK) an AI optimisation algorithm to improve the flow of pedestrians, cyclists and traffic through traffic signalled junctions. Our company therefore delivers on three of the four Government Grand Challenges [2], namely using Artificial Intelligence to deliver the future of mobility in a way that enables clean growth.

Reason for submitting evidence: I received a request from the Transport Committee's Operations Manager to submit evidence to this call following "Vivacity's innovative approach to supporting transport authorities". Furthermore, this call for evidence could directly impact Vivacity's mission improve sustainability in transport networks in a way that puts citizens first.

Summary: In this response, I address three of the matters listed in the call under the topic of Road Pricing, as these topics are most relevant to my processional experience.

- The case for road pricing
  - Petrol and diesel vehicles currently contribute to the Treasury through fuel duty. These revenues will decrease and ultimately stop as Petrol and diesel vehicles are phased out.
  - Road pricing is one obvious solution to this problem, although others are discussed.
  - Technology requires operational funding to deliver solutions for transport networks. Road pricing offers an alternative to the current model of central government focusing on capital funding grants for road building.
- Public support for road pricing
  - The public are very sensitive to how their personal data is used by government. Any road pricing scheme will meet significant opposition if it could plausibly also be used by the government to know where or when an individual travelled.
  - Road pricing should therefore be designed such that wherever possible it is technologically impossible for any private or government body to reverse engineer the journeys taken by a vehicle from the implemented system.
  - Studies have shown that road pricing is more likely to be tolerated by the population if the funding gathered from it is re-invested into transport networks directly, and not passed into the generally taxation pot.
- How to deliver road pricing
  - Pricing based on mileage and charged annually (e.g. at MOT) would be the simplest solution.
  - Flat mileage-based charging could be supplemented by local congestion charges without adding too significant a privacy invasion.

> ○ If variable pricing based on road and time of day is a government objective, a technical solution should be found whereby the car calculates its cumulative dues without needing to report its location back to the government.

I have also added a short summary on the Zero Emission Vehicle policy in my capacity as a private individual.

- A cost-effective way to encourage Zero Emission Vehicle adoption and increase charging capacity would be to ensure all local authorities allow on-street charging from cables from the home.

The case for introducing some form of road pricing

Petrol and diesel vehicles currently contribute to the Treasury through fuel duty. These revenues will decrease and ultimately stop as Petrol and diesel vehicles are phased out. In order to encourage the transition to Zero Emission vehicles, it is appropriate that there is currently a difference in the tax rate paid by these vehicles compared to their fossil fuel counterparts. As this transition becomes more successful, however, it will significantly impact this form of revenue generation [3].

Replacing fuel duty with a direct replica on electric car charging is not practical, as while car charging points could be targeted in this way, home charging means that electric vehicle owners will be able to circumvent this tax easily on all but long journeys. Short of taxing all electricity or introducing smart meters into every home which know if the electricity is being used to power the car (as opposed to heating or cooking), this approach simply will not work. The other alternative would be to replace fuel duty revenue through a rise in general taxation. For the remainder of this answer, I will assume that road pricing is the chosen form of taxation; however, this should be a political decision and is not for me to recommend.

Road pricing offers an opportunity to fix the current funding model for roads funding, if the revenue the road pricing generates is directed towards the operating cost of the roads based on usage.

Central government currently focuses its support of local road networks by offering capital grants, rather than annual payments towards operation and maintenance. This leads to sub-optimal design decisions being made, as the local authority is not heavily incentivised to manage the capital cost, but instead is overly incentivised to remove operational cost. This can lead to sub-optimal design decisions being made with a higher full life cost, if this cost is shifted from operation to capital. This type of funding model is also inherently higher risk, as costs are sunk up-front into a system, making it harder to change course later if demand or technology supply change.

If tax revenue (for example from Road Pricing) were assigned to roads based on their usership, this would instead incentivise roads to be efficient, safe and pleasant to use.

Modern technology systems in the private sector are typically priced using recurring revenue business models (for example Software as a Service – SaaS). This approach supports the technology business to continuously invest in iterating and improving their technology, with a need to always maintain a competitive edge. The pace of technological development requires this approach, as ever-reducing computing costs/increasing computing power (Moore's Law), improving algorithmic approaches from academia, and emerging security

threats mean that a software-based solution will be out of date within a year of being "finished" unless a subscription fee based funding model ensures its continued iteration and improvement.

The current capital-heavy approach towards road infrastructure therefore guarantees that road technology will always be out of date. Only by switching to an operational funding model will this structural problem be fixed. Road pricing, where the revenue is dedicated to the operation and maintenance of the road, offers the solution to this problem.

A revenue-based funding model will also support the development of technological solutions that can make roads more efficient – which in turn will save the Government significant expenditure that would otherwise be required to build new roads. The goal of using technology to increase existing road capacity rather than building new roads is the premise behind Vivacity's Smart Junctions research [4], where we have shown that the use of AI to control traffic signals can improve junction throughput by between 10% - 40% (further benchmarking still underway) compared to the current state of the art adaptive control algorithms. The deployment and maintenance of such an AI powered algorithm does not require significant capital to deploy but does require ongoing revenue. If a portion of road pricing revenue is returned to invest into the roads most heavily used, a commercial model which incentivises the technology to maximise throughput would become viable, helping to create the market incentives required to drive this type of technology innovation and development.

The level of public support for road pricing and how the views of the public need to be considered in the development of any road pricing scheme

The public are very sensitive to how their personal data is used by government. Vivacity experienced this sensitivity first hand recently. Despite our commitment to only ever producing anonymous data [5], and not to provide any enforcement solutions, our product to measure Social Distancing from video-based sensors during Covid-19 to measure behavioural change and support government decision making received significant negative media attention on the mere assumption that the system might be related to (or a slippery slope towards) "Big Brother" surveillance. This experience has taught us that even if a system is designed so that it is not possible to gather any personal data from it, the public's lack of trust in government to use their data appropriately drives conspiracy theorists to assume the worst.

In order to maintain public support for any technological solution, it is therefore imperative to not just engineer a solution that cannot be used to track individuals, but also to educate the public specifically on why it cannot be mis-used, and how introducing the system will specifically benefit them as citizens.

Road pricing should therefore be designed such that wherever possible it is technologically impossible for any private or government body to reverse engineer the position of a vehicle form the implemented system. Furthermore, if possible, the reasons it is technologically impossible for the data to be mis-used should be obvious to the public. Options are presented in the next section.

Studies have shown that road pricing is more likely to be tolerated by the population if the funding gathered from it is re-invested into transport networks directly, and not passed into the general taxation pot [6]. This reinforces the message in the section above that road pricing

should be used to fund the operation and maintenance of transport networks. If the money is invested in technological solutions that deliver a measurable reduction in journey times, this can be used as part of the sell to the public that the new road pricing system is in their personal benefit.

Which particular road pricing or pay-as-you-drive schemes would be most appropriate for the UK context and the practicalities of implementing such schemes

If a mileage-based road pricing scheme is adopted, where every mile, whether driven in central London, on a Motorway or on a rural lane is "worth" the same, by far in a way the simplest, and least privacy invasive method of collecting this revenue would be to add it onto annual MOT bills based on the change in mileage since the previous MOT. This solution guarantees that the data gathered simply cannot be used to track an individual. It is also obvious to the population that this method could not be used to track them, removing any risk over misunderstanding of the technology.

If the road pricing revenue is then to be distributed to roads based on their usage level, road side sensors can easily be deployed that measure demand by vehicle type, without needing to measure which specific vehicle is passing.

If pricing is to be varied based on road type or time of day, this presents a greater technical challenge.

One approach would be to supplement annual mileage-based charges with localised charges such as TfL's Congestion Charge, which use ANPR to detect vehicles entering the zone. While this system is privacy invasive to some degree (the system knows which cameras a car has passed within the central London zone), it has generally been accepted by the public as it does not track the vehicle all the way from origin to destination, and it is broadly possible to avoid driving in the congestion charge zone for most purposes.

Such congestion charging systems could be designed to further protect citizen data – for example if an encrypted list of every number plate that had either already been seen that day, or which had pre-paid for entry were sent to each camera, the camera could then be instructed at the edge to ignore that plate for the remainder of the day, thereby ensuring that only one data point on each vehicle ever exists, and removing the possibility of tracking. Such innovations could be explored, however whether the less trusting in society would believe the strategy had been implemented remains to be seen.

If the goal is to provide variable pricing on every road, and not just in key areas, the most cost-effective approach would switch from deploying road side technology (e.g. ANPR) to relying on a black-box style recorder. For this approach to be protective of the personal data of the driver, it would need to calculate its fee on the car, and only transmit the sum due, rather than taking the approach of broadcasting each trip taken and relying on a central server to calculate the sum due.

To enforce the use of such devices, they could broadcast a cryptographic signal which confirmed authenticity of the fee-measurement system at check points, without needing to broadcast who the vehicle was. Any vehicle that was not broadcasting the right signal could then have its numberplate read at the checkpoints to issue a fine. This way the system does

not know where law abiding citizens are traveling (and indeed would only pick up the illegal vehicles at checkpoints).

I would strongly recommend against any system which recorded or shared the exact trip that a vehicle takes, as this will not be tolerated by the public.

The actions required by Government and private operators to encourage greater uptake of electric vehicles and the infrastructure required to support them

This final answer is written in a personal capacity, rather than as a recommendation from Vivacity Labs. I have made this observation as an electric car driver myself.

A big barrier to a large portion of the population to adopting electric vehicles is the inability to charge at home if your home only has on-street parking. Not being able to charge at home means that you cannot benefit from low-cost electricity overnight, and cannot benefit from having a full charge on your vehicle every morning.

Lamp-post charging solutions, where the user gets billed at their home electricity rate are a possible solution, however there are simply not sufficient lamp columns on residential streets for this to be the final solution.

I would recommend that Local Authorities are given guidance on how to safely encourage running cables from homes to the street.

There is different guidance on this from different authorities, adding to buyer confusion. A very clear set of advice is offered by Hampshire County Council [7], which could be used as a template for others, although I would suggest updating the recommendation on cable guards to something more wheelchair friendly [8]. Such advice proves that this can be done safely.

In a different authority area, when I sought the equivalent local advice, I was told that we could not run a cable from our house to the car under any circumstance, no mater how safe the solution proposed was. The latter here should not be tolerated by central government. Quick action by government to ensure every authority to allow on-street charging will help accelerate the adoption of zero emission vehicles at virtually no cost.

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References

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