Future Travel Scenarios

Future Transport Measures and Solutions Annex

December 2020

TRANSPORT FOR THE NORTH

Document history

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1.0	15/12/20	

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1 Introduction

1. There are a number of travel-related developments, policies and measures which could aid delivery of the North's vision and our Investment Programme. This annex to our Future Travel Scenarios adds further depth by mapping the uptake or success of these across our scenarios, creating a plausible picture of which solutions are supported within each scenario.

2. Future Transport solutions and measures offer opportunities to make significant progress in our shared ambitions for a net zero transport system (no later than 2050), as well as delivering an inclusive transport network which provides opportunities for all. This may be possible through a combination of behavioural change; increased public transport use; new technology; on-demand, flexible or shared mobility; active travel; electrification (or other low carbon energy options). It should be supported by a whole systems approach, with much more integration of transport, energy, housing infrastructure and associated land use planning.

3. Delivering the right outcomes will take a combination of transport measures and policies, and will include both demand and supply side measures. Taking our road network as an example, TfN analysis shows that shifts to active travel alone would reduce car-kms by 1-6%, due to short trip lengths for walk and cycle modes. The reduction in car-km could be improved to 4-18% with increased uptake of public transport, showing that it is critical to helping reduce longer distance car trips (responsible for the majority of emissions). In addition, promoting an ongoing culture of remote working could lead to more significant reductions in car km in the range 12-22%. Whilst a large reduction in car-kms, this means a substantial amount of demand will remain on the road networks, which will require supply side measures to support delivery of our vision.

4. The measures outlined in this document will likely change over time and new options will appear. Therefore transport planners and services will need to be flexible and use methods such as scenario planning to tackle uncertainty in order to ensure suitable results for the user. It is our intention that this foresight work helps to inform TfN's strategies and programmes, and that of our stakeholders. Identifying the national and local conditions under which different transport solutions thrive, and in which places. Developing our own regional evidence base and embedding that within our own decision-making processes, via TfN's Future Travel Scenarios, is a key first step to achieving this.

2 Our Future Travel Scenarios

Section Overview

Scenario planning is used to explore uncertainty about the future, providing enhanced information and testing to improve the resilience of long-term plans. TfN has adopted this approach to help future-proof decision-making on the investment needed to deliver the vision set out in the STP.

Our Future Travel Scenarios represent a shared understanding across TfN and Northern Local Transport Authorities (LTAs) of plausible future states for society and travel demand in the North of England through to 2050. The Future Travel Scenarios are intended to stimulate collaboration, discussion and challenge towards building a consensus on factors of future uncertainty and their effects.

Figure 1: TfN's Future Travel Scenarios

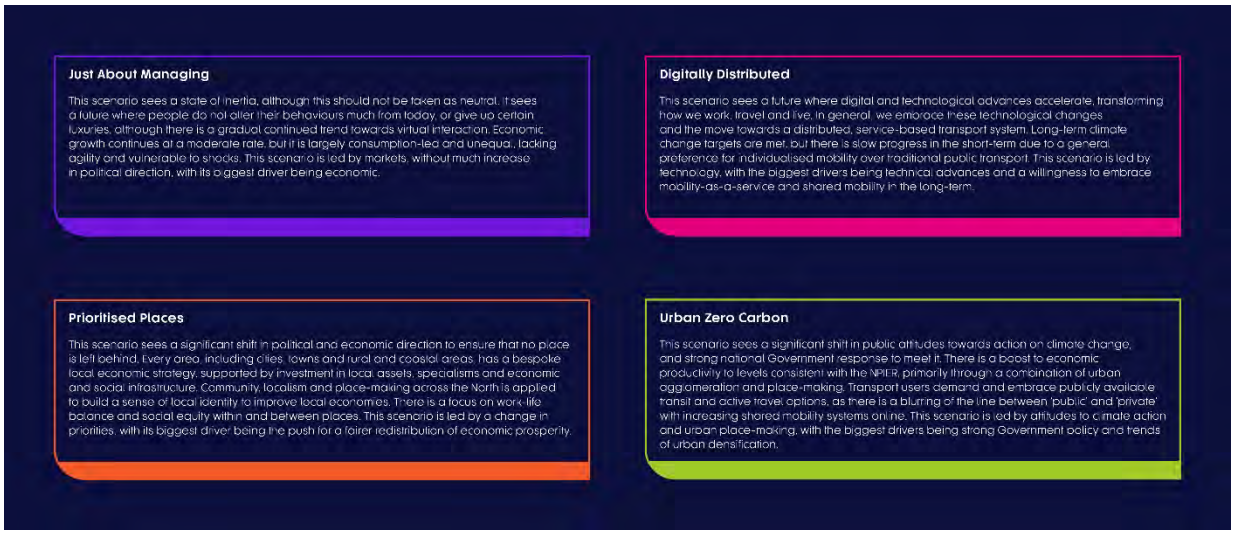

Figure 2: What changes our scenarios imply for key transport related developments, policies and measures?

This figure provides a summary of how the transport developments, policies and measures outlined in this document play out within our 4 Future Travel Scenarios.

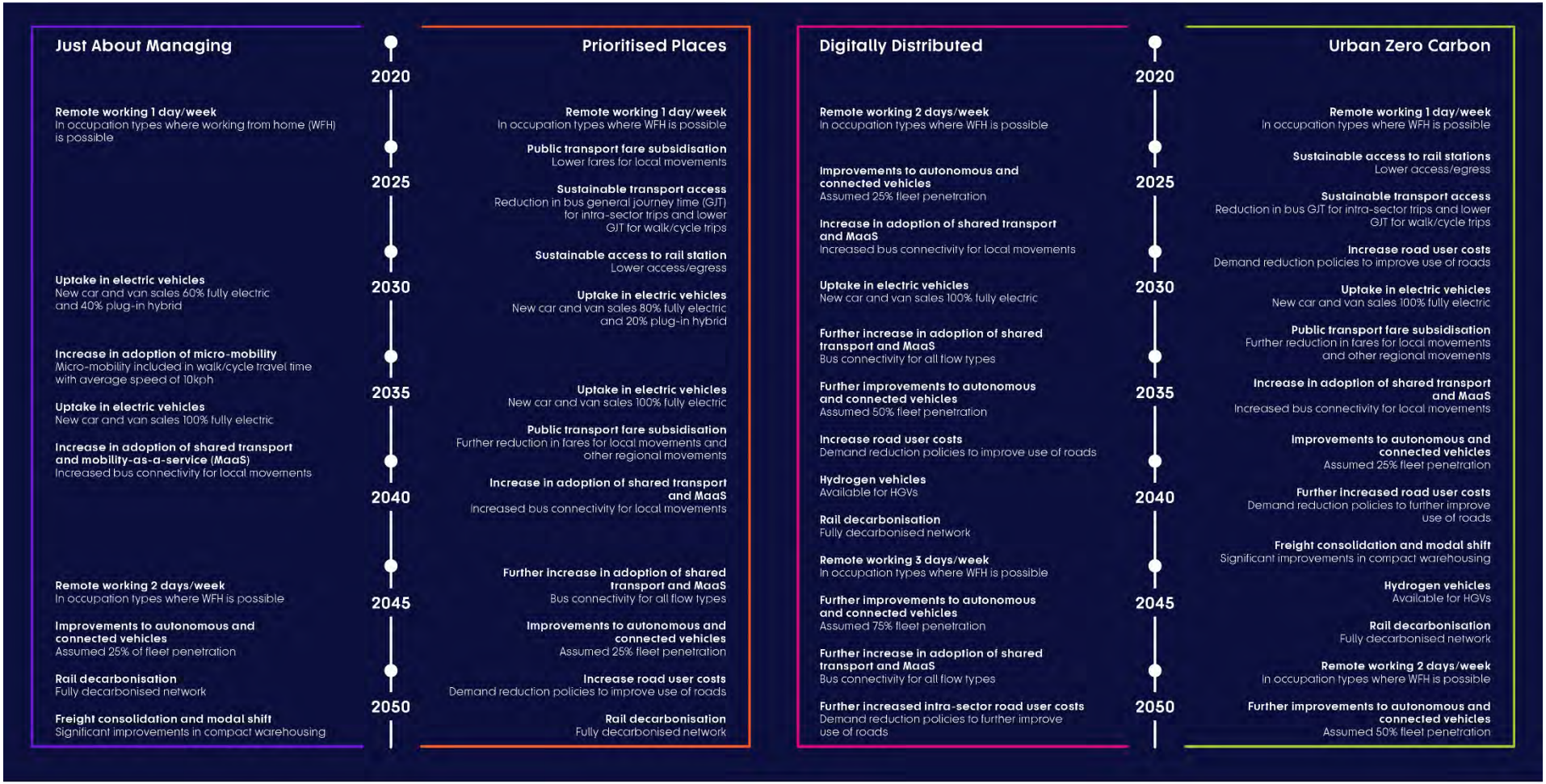

Figure 3: How future travel related developments, policies and measures are input into our Future Travel Scenario modelling framework.1

The travel related developments, policies and measures mapped by our Future Travel Scenarios are summarised here.

Policy or exogenous change	Notes	Just About Managing			Prioritised Places			Digitally Distributed			Urban Zero Carbon		
		2030	2040	2050	2030	2040	2050	2030	2040	2050	2030	2040	2050
Economic growth	Uses updated post-COVID NPIER scenarios	BAU			BAU			NPIER			NPIER		
City and town densification		Most growth in urban and suburban areas			Growth more evenly shared, with shift towards rural areas from 2025 onwards			Growth highest in suburban areas, but also some growth in urban and rural areas			Growth mainly weighted towards urban areas with very little growth in rural areas		
Increased home working	In occupation types where WFH is possible	WFH 1 day/ week	WFH 1 day/ week	WFH 2 days/ week	WFH 1 day/ week	WFH 1 day/ week	WFH 1 day/ week	WFH 2 days/week	WFH 2 days/ week	WFH 3 days/ week	WFH 1 day/ week	WFH 1 day/ week	WFH 2 days/ week
Electric car and van sales		60% BEV, 40% PHEV	100% BEV	100% BEV	80% BEV, 20% PHEV	100% BEV	100% BEV	100% BEV	100% BEV	100% BEV	100% BEV	100% BEV	100% BEV
Electric small HGV sales		15%	60%	80%	15%	60%	80%	20%	100%	100%	20%	100%	100%
Hydrogen large HGV sales		0%	0%	0%	0%	0%	0%	0%	70%	90%	0%	70%	90%
Rail electrification	Measured as impact on 2018 emissions	-25%	-50%	-50%	-25%	-50%	-50%	-50%	-100%	-100%	-50%	-100%	-100%
Sustainable access to rail stations		No change			10% lower perceived costs for access/egress			No change			20% lower perceived costs for access/egress		
Sustainable transport access	GJT = Generalised Journey Time	No change			15% lower bus GJT for intra-sector trips 10% lower GJT for walk/cycle trips			No change			10% lower bus GJT for intra-sector trips 10% lower GJT for walk/cycle trips		
Micro-mobility	Active travel in modelling used to represent both traditional and new micro-modes	No change	Include micro-mobility in walk/cycle travel time with average speed of 10kph		Include micro-mobility in walk/cycle travel time with average speed of 10kph		Increase speed to 20kph	No change	Include micro-mobility in walk/cycle travel time with average speed of 10kph		Include micro-mobility in walk/cycle travel time with average speed of 20kph		
Shared transport / MaaS	Bus travel in modelling used to represent both traditional and new shared transport solutions	No change	Bus connectivity for all intra-sector pairs		Bus connectivity for all intra-sector pairs		Bus connectivity for all flow types	Bus connectivity for all intra-sector pairs	Bus connectivity for all flow types		Bus connectivity for all flow types		
Public transport fare subsidisation		No change			10% lower fares for intra-sector trips	20% lower fares for intra-sector trips, 10% lower for other flow types		No change			20% lower fares for intra-sector trips 10% lower fares for other flow types		
Connected vehicles (public and private connected)	GJT = Generalised Journey Time	3% car GJT reduction	4% car GJT reduction	5% car GJT reduction	3% car GJT reduction	4% car GJT reduction	5% car GJT reduction	5% car GJT reduction	7% car GJT reduction	10% car GJT reduction	4% car GJT reduction	5% car GJT reduction	5% car GJT reduction
Autonomous vehicles (shared publicly) and privately owned	Represented as a change in effective capacity of highway links	0% fleet penetration		25% fleet penetration	0% fleet penetration		25% fleet penetration	25% fleet penetration	50% fleet penetration	75% fleet penetration	0% fleet penetration	25% fleet penetration	50% fleet penetration
Demand reduction policies and measures to improve use of roads	RUC = Road user cost	No change	No change	No change	No change		5% RUC increases applied intra sector	No change	5% RUC increases applied intra sector	10% RUC increases applied intra sector	10% RUC increases applied to all zone pairs	15% RUC increases applied to all zone pairs	20% RUC increases applied to all zone pairs
Logistics improvements, consolidation centres and freight modal shift	km reduction relative to initial forecast	0%	0%	0%	-5%	-5%	-5%	0%	0%	0%	-5%	-10%	-10%

[1] The Future Travel Scenario modelling inputs for Economic Growth (including population, employment and productivity), and City and Town densification are explained in the Future Travel Scenario Technical Annex found here: https://transportforthenorth.com/future-travel-scenarios/

3 Transport related developments, measures and policies

Section Overview

Many of the transport solutions summarised here are currently delivered through national or local means (i.e. external to TfN leadership and powers). Our local authority partners undertake important work to make the case for, and implement, improvements on their local transport networks in line with local growth and place-based strategies. Action has been taken to increase the delivery of some of these transport solutions during 2020, with the COVID-19 pandemic acting as a stimulus for acceleration of Government intervention in areas such as Active Travel and transport sustainability policy. The UK Government is also pushing ahead with its Future of Transport programme which aims to support transport innovations (https://www.gov.uk/government/collections/future-of-transport-programme).

This annex is provided to add further depth and rationale behind our Future Travel Scenarios, and to act as reference point to the collective future transport aspects important to how people, businesses and goods may travel in the future. As with the Future Travel Scenarios, this takes a plausible view of future aspects (based on intelligence during 2020) and will be re-visited periodically as new evidence arises.

Further information on the modelling application of these transport inputs to the TfN Future Travel Scenarios can be found in the Future Travel Scenarios Technical Annex here: https://transportforthenorth.com/future-travel-scenarios/.

3.1 Remote and flexible working

Summary:

Flexible working policies, business practices and digital communications technologies that enable remote working. A demand-side shift resulting from the ability for organisations to support their employees in working virtually and flexibly, either from home or remotely; rather than being office based and confined to historic 9 – 5 working patterns.

It should be recognised that this is not an option available to all. The North's sectoral composition is one that may not lend itself well to remote working when compared to the rest of the UK. The North has a higher proportion of employees working from their normal place of work, rather than working remotely.

There are many different remote and flexible working models (i.e. full day, half day, work from home, work from anywhere) and it should be noted that our Future Travel Scenarios take an average approach which will not take full account this diversity at this stage.

Table 1: Challenges and Opportunities of Flexible and Remote working

Challenges	Opportunities
Digital infrastructure	Reduced travel demand
Does not provide an option for all workers or sectors. Some areas, such as services and logistics will remain largely physical in delivery.	More efficient demand management to reduce congestion and peak travel
Social preferences to adopt digital and remote working. Digital working is not for everyone, and may be best served as an option rather than requirement as a whole.	Increased opportunity for skills and development across a wider area (i.e. job catchment areas may increase if the need or frequency to travel to a physical location is reduced.
Organisational will and ability to support remote working effectively.	More investment in workers local areas as they spend more time working from home rather than travelling to the office.
Potential for increased working from home to increase our carbon output, due to use of low efficiency homes compared to offices.	Reduced carbon footprint of those workers previously commuting.
Potential for an increase in local trips, mainly by car, due to new options available to workers (i.e. to undertake tasks and responsibilities during the working day). There may be increased need for other local travel options further to car.	More time for workers to undertake social or other responsibilities outside of work. Expanding work / life balance and wellbeing if managed correctly.
Increased demand on the energy network to support increased working from home.	

Figure 4: What working from home might mean for our scenarios:

Just About Managing	Minimal travel behavioural change with high levels of congestion and peak hour traffic demand. Presenteeism remains with 1 day per week average during the 2020s; raising slowly to 2 days per week during the 2040s. Human interactions are valued and some sectors do not change working practices.

Prioritised Places	A modest increase (1 day per week) in home working is seen is this scenario due to people continuing to prioritise meeting face-to-face engagement, rather than via technology. In this scenario, working patterns see more leisure time available to the people of the North, due to shorter commutes and policies to promote and value a better work-life balance, such as shorter working weeks.
Digitally Distributed	Significant increase in home working due to excellent digital connectivity, extending to rural areas. 2 days a week average is common during the 2020s in a growing number of sectors, supported by reliable, immersive technology. By the 2040s, this raises to 3 days per week. An increase in working from home provides some individuals with more free time or the ability to adapt their working day with other responsibilities. In some cases, this leads to more short local trips. For those sectors that can work remotely, staggered start times become common place as travellers look to avoid congestion and peak traffic by using remote and flexible working options. There is a significant reduction in the social need for physical presenteeism and new sectors digitise to embrace new working practices.
Urban Zero Carbon	Home working is encouraged wherever possible. However this is mixed due to increased population living closer to urban employment and shared workspaces. Technological solutions are available and adopted where appropriate, but urban living and working makes face-to-face interaction with friends and co-workers easy. Average 1 day a week during the 2020s, with a slow increase to 2 days per week during the late 2040s. For those sectors that can work remotely, staggered start times become common place as travellers look to avoid congestion and peak traffic by using remote working options. Some new sectors digitise to embrace new working practices.

3.2 Electric Vehicle (road and rail)

Summary:

Cars and light-duty vehicles that run with an electric motor supported by a rechargeable battery. There are multiple variations of EVs such as hybrid electric (HEV) vehicles, plug-in hybrid electric (PHEV), battery electric (BEV). With the latter being an example of a Zero Emission Vehicle.

EVs require separate charging infrastructure to combustion engine vehicles, which are available at a range of power ratings and speeds. These chargers can be places in car parks, on-street or off-street parking.

Shortly before publication, the Government published its ten point plan for a green industrial revolution[2], which included a new policy to ban the sale of new petrol and diesel cars and vans by 2030 and the sale of new plug-in hybrids by 2035. TfN scenario assumptions have been updated to reflect this new policy, with the main variation between scenarios now being the rate of increase in EV sales before 2030 and the status of hybrids after 2030. Scenarios for the electrification of small HGVs are also drawn from CCC Net Zero scenario analysis (CCC, 2019b).

Electric Vehicles as we know them today are not the endpoint of this technology or other related zero-carbon traction methods. Understanding the benefits of hydrogen (see section 3.3) or any other emerging technologies as they develop will ensure a broader coverage of options for more sustainable outcomes.

Table 2: Challenges and Opportunities of Electric Vehicles (road and rail)

Challenges	Opportunities
Ensuring low carbon emissions from electricity generation and from manufacturing which tend to be higher than for a conventional car. Also embedded carbon and battery disposal.	Substantial reduction in carbon emissions and meaningful reduction in NOx, SOx and particulate emissions, to protect public health and reduce impacts on global climate.
High upfront costs	Lower operating costs for user with government grants available. Once a second market is established, overall costs should go down.
Risk that increased ownership will encourage car dependency and congestion, without demand reduction measures to supplement this.	Financial incentives for businesses

[2] https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution

Ensuring that new technologies and policies do not carry negative social impacts such as Transport Related Social Exclusion (TRSE).	Infrastructure availability has seen an increase since electric grids are in close proximity to most parking areas.
Current local authority funding mechanisms / bidding for funds from national government pots means roll out of EV is currently piecemeal.	The development of new technology will drive subsequent innovations and opportunities, as well as trade and investment benefits.
Supply of Electric Vehicles to support uptake.	Reduced noise pollution
Supporting electricity infrastructure which provides coverage across the whole of the North. This includes the need for interoperability to ensure charging payment processes are simple, with understandable tariffs and effective data sharing between companies who own, run, maintain and supply the electricity.	Opportunities to better understand general driving behaviours through monitoring of plugged-in vehicle data (if done in a suitably privacy-preserving way).
Potential for trade barriers for import / export of battery technology (which may drive high purchase prices).	
User range anxiety; speed of charging; and variety of charging power ratings.	

Figure 5: What electric vehicles might mean for our scenarios

Just About Managing	Zero Emission Vehicles are reasonably widespread by 2050 (76% of road fleet), but not ubiquitous, with uptake slow through the 2020s. Most people continue to purchase cheaper Internal Combustion Engine (ICE) driven cars for longer; there is a mix of battery and hybrid electric vehicles during the 2030s; and the use of shared EVs is not widely adopted. Electrification and other alternative traction methods for train are slow, either due to cost or feasibility. This sees 25% carbon reduction during the 2030s and 50% reduction during the 2040s, compared to our Future Travel Scenarios base year (2018).

Prioritised Places	Similar outcomes to 'Just About Managing', uptake of EVs is widespread by 2050, but slow to gain momentum. 76% the road fleet is Zero Emission Vehicle by 2050. Electrification and other alternative traction methods for train are slow, either due to cost or feasibility. This sees 25% carbon reduction during the 2030s and 50% reduction during the 2040s, compared to our Future Travel Scenarios base year (2018).
Digitally Distributed	By 2030, 100% vehicles are battery powered electric or other Zero Emission Vehicle, however the uptake in the 2020s is slower than 'Urban Zero Carbon'. EVs, at least in the short term, are not accessible by all. But the conditions set out in this scenario bring about increased vehicle km travelled and road demand, which brings the risk of network congestion due to good availability of new transport solutions. However, the adoption of shared mobility and MaaS means that more people can afford to use electric vehicles earlier, while their outright purchase price is still higher than ICE cars. All trains are bi-mode, battery electric or hydrogen powered (or other alternative traction method), as the UK Government target to decarbonise the rail network by 2040 is met. This sees 100% carbon reduction from our Future Travel Scenarios base year (2018).
Urban Zero Carbon	100% of vehicles are battery powered electric or other Zero Emission Vehicle by 2030, driven by strong public demand and government action in the 2020s. This is facilitated by early and widespread charging infrastructure. This rapid increase in EV capacity demand for road travel is offset by a significant increase in use of rail, shared mobility and active travel. All trains are bi-mode, battery electric or hydrogen powered (or other alternative traction method), as the UK Government target to decarbonise the rail network by 2040 is met. This sees 100% carbon reduction from our Future Travel Scenarios base year (2018).

3.3 Hydrogen (road and rail)

Summary:

Hydrogen-fuelled vehicles run on low or zero carbon emissions fuel burned with oxygen. Currently, hydrogen fuel has potential use for both road and rail vehicles or fleets, to provide increased multi-modal options. At the time of our Future Travel Scenarios 2020 development, hydrogen is an emerging transport option and our assumptions are based on findings by the UK Committee on Climate Change (CCC). This points to hydrogen most likely being used from Heavy Goods Vehicles (HGVs), or buses and trains on local transport networks.
Examples include double decker buses were introduced in London in 2019; projects underway within Liverpool City Region and Tess Valley Combined Authority; and the HydroFLEX train trail in Warwickshire will see the first-ever hydrogen-powered train will run on the UK mainline.

Table 3: Challenges and Opportunities of Hydrogen

Challenges	Opportunities
Environmental concerns associated with hydrogen fuel remain, as combining high-temperature steam with natural gas to extract hydrogen releases a small amount of carbon dioxide.	Low-carbon emission fuel which would improve air quality.
Production of 'green hydrogen' is expensive and will need significant investment in production plants. Plausible estimates suggest a mix of green and blue hydrogen, as well as biomethane, by 2050.	Strength of Energy capabilities and capacity in the North of England lends itself to trials and implementation of innovative new solutions using this and other transportation energy sources.
Hydrogen vehicles' running costs are more expensive than pure battery electric vehicles (BEVS) and conventional vehicles, which would discourage people to adopt a hydrogen vehicle. Costs and capacity risks could further spike when use of hydrogen becomes more widespread and not just for transportation.	UK Government 10 point plan aims to deliver effective Carbon Capture and Storage, and also pursue options to support green hydrogen production.
Hydrogens energy to volume content is low, therefore the fuel requires high pressure, lower temperatures. This is a barrier for use in light-duty or smaller vehicles.	Hydrogen has a rapid refuelling time and higher efficiency density which makes it more efficient than batteries or generating renewable electricity to charge batteries.

It is expensive to build hydrogen fuel stations for vehicles compared to petrol stations due to safety regulations. Current suppliers also have difficulty storing hydrogen fuel.	Potential to develop wider scale as a feasible solution for HGV fleets.
Design of hydrogen trains for long distance journeys can be challenging, particularly in terms of gauge clearance.	Potential for UK economic benefits from adopting hydrogen fuel early and diversifying into the industry to provide significant savings and strong trading point.
Public perceptions of hydrogen fuel is often negative as it combustible. It is, therefore, difficult to encourage users to adopt hydrogen fuel.	Potential for opportunities for jobs requiring high level skills and trained workers.
Hydrogen refuelling stations need to be built outside congested cities as they require a large amount of land. How will regular hydrogen-fuel vehicle car users be able to refuel for regular trips within the city?	Current Hydrogen strengths and capabilities across the North of England and wider UK; as well as the ability the use existing gas pipe distribution network.
HGVs would pass by rural areas or distribution Centres. Furthermore, Hydrogen is also a difficult energy to store. Hence refuelling stations will need to be strategically located.	Hydrogen-fuelled cars can now travel up to 380 miles, therefore they may be suitable for some interurban journeys.

Figure 6: What hydrogen might mean for our scenarios

Just About Managing	Relatively low uptake of hydrogen fuelled vehicles and trains due to the lack of widespread strategic refuelling points and distribution networks.
Prioritised Places	Similar uptake to 'Just About Managing', however with an increased emphasis on public transport, buses in some areas use hydrogen fuel where investment has allowed for it.

Digitally Distributed	Widespread uptake of hydrogen fleet vehicles, particularly handling freight by road between the increasingly dispersed distribution centre, local rail networks and bus transport.
Urban Zero Carbon	Most vehicles are powered by electric drivetrains. Readily available hydrogen is an easy and attractive solution for HGVs, buses, vans and some cars and trains. There are no remaining internal combustion engine cars on the road.

3.4 Active Travel and sustainable travel access

Summary:

Capacity of active travel infrastructure and frequency of use; as well as the quality of active travel infrastructure as an access mode to rail.

1. Active Modes (walking, running, cycle, e-bike and electric cargo bikes)

2. Public Bike Share - Public Bike Share (PBS) is a service in which bicycles are made available for shared use to individuals on a short term basis for a price or for free. There are two main types in docked bikes and dockless bikes. Docks are essentially bike racks that lock the bike and release it by computer control when the user enters their payment information. Dockless systems often use smartphone mapping apps to show nearby available bikes. Both of these can use electric bikes that reduce the amount of effort the rider needs to give.

3. Micro-mobility and e-scooter – Different forms of micro-mobility are popular in cities providing first and last mile mobility. They are often managed by private companies and users can locate and pay for them through applications.

Table 4: Challenges and Opportunities of Active Travel and sustainable travel access

Challenges	Opportunities
Inconsistency in active travel infrastructure standards across the North (and nationally), and in particular urban / rural differences.	Carbon emission reduction / air quality increase from increased active travel and reduction of other journey modes. Increased integration with rail stations also supports mode shift and effective multi-modal journeys, reduced journey time, and a further benefit towards greenhouse gas emission reduction.
Appropriate road infrastructure as traffic on roads increase, it may affect the number of users that adopt cycling or other modes. First-time cyclists cannot be encouraged and therefore difficult to incentivise users to shift modes of travel.	Increased health and wellbeing (physical and mental).
Valuation of benefits for active travel schemes – health, wellbeing and quality of life metrics need to be captured in economic appraisal.	Noise reduction benefits.

Funding is given in short bidding cycles which does not allow long term programmes and schemes; rather a piecemeal approach which leads to inconsistent standards.	Economic and town space benefits (cycle storage can take up less space than car parking; walking or running requires no storage).
Whilst the majority of active travel journeys are short, integration with the SRN, MRN and rail is key to enable multi modal journeys.	Less space taken up on roads (in comparison to cars and bigger vehicles), therefore space for more cyclists than if they used cars.
Impact of road traffic on perception of risk is a major barrier to encouraging more active travel.	Relatively low infrastructure and maintenance costs, if planned and delivered effectively, than other modal options.
Supporting infrastructure (i.e. company shower, changing and storage facilities; secure bike storage). i.e. Dockless bike sharing can result in vandalism and people using bikes as if they own them, although can be mitigated this risk by using geofencing technology.	Increase placemaking and attractiveness of living, working and visiting a location.
Most bike share schemes target urban centres due to high demand for last-mile travel and suitable existing cycling infrastructure. Likewise, the infrastructure required for docked bikes makes them typically unsuitable for areas with sparse demand, although they could be installed at key hubs (e.g. between rail stations and villages / business centres).	Bike share availability provides inclusivity benefits for those who can't afford a bike / or more likely have nowhere to store a bike.
Topographical challenges, particularly in rural areas of the North of England. Although electric bikes may provide some mitigation.	Bike share systems can help collect data to understand cycle travel, which can help understand passenger flow or improve popular routes by making them cycle friendly.

Figure 7: What the Active Travel and sustainable travel access might mean for our scenarios:

Just About Managing	Car trips increase in the long term, whilst modal share of public transport and active travel see some increase in places. Towns and cities continue to have bike services. There isn't a growth nor a decline of these services. However, increasing extreme weather events disrupt business as usual. There is a modest uptake in micro-mobility (such as e-scooters) towards 2050.
Prioritised Places	Step change in localisation of travel, uptake of active travel replacing other modes within local communities and integration to support this. As there is an increase in active and sustainable transport, access to bike sharing services grow and are supported across all communities. Individuals choose active sustainable modes, as they are supported by a shift towards integrated transport modes through hubs offering increased sustainable travel choices. Micro-mobility and e-scooters see an increase in popularity as there is a focus on localised activity. However this is somewhat limited to as technology isn't sufficiently embraced (i.e. uptake is limited to those who embrace apps and digital payments for e-scooters). A large majority of individuals also still choose private car ownership is their primary mode of travel.
Digitally Distributed	Increase prevalence in technology solutions leads to less active travel. Micro-mobility and e-bikes still used for some longer local journeys. Reduction in overall trips and increase in shared mobility trips. Distanced travelled increases. As working from home grows and is further supported by the digital development, bike and micro-mobility sharing schemes become less vital for commutes, though some will use them for shorter trips. Individuals who cannot work from home are now increasingly travelling out of town (outside the ideal range or distance for these modes), there is a greater focus on shared vehicle services.
Urban Zero Carbon	Individuals and government attitudes and actions shift towards appreciation of the environmental, and understand this can help the net zero target. Individuals choose active sustainable modes, as they are supported by a shift towards integrated transport modes through hubs offering increased sustainable travel choices. Significant increase in active travel journeys and distances; increased use of e-bikes, and increase in uptake of e-scooter use Greater integration and interoperability between modes, i.e. within urban, well-connected areas, bike share schemes are well used and optimised. Increase in multi-modal journeys. Regions work collaboratively to create a wider integrated network, with well-regulated urban mobility systems.

3.5 Increased publicly shared transport and Mobility as a Service (MaaS)

In 2017 it was estimated there were around 600 billion empty vehicle seats moving around the UK across the year. Evidence suggests that shared transport can play a significant role in delivering an inclusive and sustainable transport network.

Shared Mobility can broadly be defined as transportation services and resources that are shared among users, either concurrently or one after another. This includes public transit; micromobility, bikesharing, scooter sharing (see Active Travel section above); automobile-based modes (carsharing, rides on demand, and microtransit); and commute-based modes or ridesharing (carpooling and vanpooling).

Shared mobility options have actively been tested and implemented in urban areas around the world, with different types of mobility option suiting the place type and embedded local networks. There remain opportunities for further application within an urban setting, and a significant challenge is understanding its role in rural settings. These are being actively explored by the UK Government's Future of Transport programme[3].

Mobility as a Service

Summary:

"The integration of various modes of transport along with information and payment functions into a single mobility service. Recent services that allow customers to purchase monthly subscription packages giving them access to public transport and private taxi and bike hire schemes are an example", DfT's Future of Mobility: Urban Strategy.

MaaS can be described as a novel approach to mobility, that can change the overall understanding of access to transportation and reduce the necessity of car ownership. It aims to provide mobility services as a package using a digital interface that:

- Offers tailor made mobility solutions based on individual needs and preferences
- Integrates transport solutions to provide seamless mobility from A to B.
- Changes habitual behaviour and opens up mobility options beyond car.
- Provides cities or regions with significant data insights to better manage the network and influence and nudge travel choices.

In future iterations of our Future Travel Scenarios, consideration should be given to MaaS as a broader category which includes other transport measures in this annex (such as Active Travel, Sustainable Travel Access and Connected Autonomous Vehicles). We recognise that the value of scenario analysis is the ability to make multiple parallel assessments of a how a policy or programme will perform in different futures to help decide relatively quickly whether it is the right course of action. Capturing full impacts of MaaS

[3] https://www.gov.uk/government/collections/future-of-transport-programme

within TfN's Future Scenarios is not an achievable or desirable objective due to the intentionally high-level and strategic nature of our modelling. Achieving this would require a new, complex, dynamic and integrated model of all the transport modes, including public and private modes, its demand and supply, as well as their interactions through integrated network. For this reason, we have separated the assessments of these potential MaaS aspects in order to draw out the various conclusions clearly.

The transport sector should prioritise the building blocks to support MaaS integration and innovation, this would include an open data strategy and regulation that will minimise the concerns many private sector companies have around commercial sensitivities when sharing data.

Table 5: Challenges and Opportunities of Mobility as a Service (Maas)

Challenges	Opportunities
Depends heavily on whether the required transport are available in a specific area to make a viable MaaS offer.	Potential for better travel option, choice and efficiency for the customer.
Adequate digital infrastructure in place to support innovation is key.	Potential to provide single point of payment for access to multiple modes of travel, providing best value for the customer if delivered effectively.
Data is commercially valuable and private companies are reluctant to open it to competition, regardless of the public benefits.	Could provide affordable transport solutions, connecting people to opportunities.
Lack of a single centralised authority / service operator to make a decision for all services. One of the biggest barriers to rollout of integrated ticketing remains the co-operation and transparency required from commercial operators.	Decreased spending on new transport infrastructure through integration of existing network.
Lack of data standardisation between operators and authorities.	Historic and real time transport demand data can lead to better network, more insights and service improvements which unlock opportunities. i.e. Real time information on network usage, bottlenecks, peak points and disruptions.
Where personal data is used, lack of public understanding or trust in where and how their data is sent could limit uptake	A MaaS platform could introduce and manage future mobility solutions such as bikeshare and other active modes, carshare, car club, EV infrastructure.

Legal and regulatory challenges. MaaS has not developed as quickly as it could have and can be complicated by piecemeal approaches and complex regulations.	Tool to shift travel behaviour from individual trips to shared trips.
Provision of effective parking spaces for inactive service vehicles, i.e. bikes or scooters	End users benefit from 3rd party services (for example wayfinding apps) with trusted, reliable up-to-the-minute data. The organisation which originally generates or holds this data is often not best suited to make the data useful to the public.
Reliance on customer responsibility when using and storing MaaS services, and finding the right incentives and measures to encourage the positive user behaviour.	
Questions of user safety	
Questions of user equity. MaaS must be accessible to all demographic groups in the population, but existing regulations mean that it is likely to present accessibility and inclusivity concerns.	

Figure 8: What Mobility as a Service might mean for our scenarios

Just About Managing	Low uptake of public transport with a fragmented transport network. Car travel remains most popular and seen as cheaper and more efficient mode of travel for many. Distance travelled increases and high levels of urban employment. Minimal regulation means MaaS platforms are developed with limited collaboration with private tech companies and the market. Focus on profits means investment is more geared towards densely populated areas, high-income areas, and areas which currently have good public transport connectivity. Those whose transport routes will not generate as much income for these companies may miss out.

Prioritised Places	Private tech companies will continue to develop MaaS platforms in urban areas. However, more localised place making may provide support for MaaS platforms for some non-city areas. With a limited public appetite for digital transformation and expected high level of car dependency, action would need to be taken to provide this as a workable solution across the North of England (and UK) in this scenario (i.e to provide suitable alternative transport options to make MaaS a viable option for the traveller).
Digitally Distributed	Continued and increased appetite for digitally connected solutions would ease the challenges involved in data sharing, and the public would be more willing to introduce a digital element into their travel planning. This means MaaS would be easier to roll out than in the other scenarios. It could happen faster and with more coverage. This sees higher levels of car dependency, due to the increased role out of Connected and Automated vehicles, with journeys organised using MaaS systems and platforms. MaaS in more rural and remote settings may struggle without intervention and support.
Urban Zero Carbon	The environmental focus in this scenario means that people would be more willing to change their travel habits. With lower car ownership and increased public transport usage, an ideal scenario for MaaS uptake. With a large amount of public transport available in urban centres and some towns, as well as an increase in housing density, there will be many opportunities for integrated MaaS infrastructure to be in place. The reduced appetite towards digital transformation and data sharing compared to Digitally Distributed may however make it difficult for all public and private operators to work together on an integrated platform. MaaS in more rural and remote settings may struggle without intervention and support.

Contactless smart ticketing and enhanced customer information

Summary:

Smart ticketing is an electronic or digital travel ticket which may be applied across multiple modes or operators, so that passengers experience 'seamless payments' (subject to operator buy-in). Smartphone penetration plays a big role in the purchase and use of smart tickets. As more people have access to smartphones, the use of smart tickets is growing. Smart ticketing could become hand-free, utilising smartphones with Bluetooth or similar technology to detect passage through an open gate.

Further integration of smart ticketing mechanisms is a must if we want to ensure interoperability of data across modes and support MaaS.

Our Strategic Transport Plan includes plans for the road and rail networks to be integrated with our plans for smart ticketing to transform the way people travel in the North. As MaaS apps and platforms continue to develop, travel should be easier and more accessible. For local journeys, users should be able to Pay as you Go, with the reassurance that they will be charged the best fare and not be penalised for multi-mode journeys. MaaS ticketing and data platforms are key to delivering this. As of 2020, the Integrated Smart Ticketing programme contains four phases:

- Phase 1: Implementing smartcards for rail travel in the North, including seasons and flexi tickets.
- Phase 2: Providing better quality information to customers using open source data.
- Phase 3: Developing an account-based travel solution to deliver contactless pay-as-you-go travel on rail.
- Phase 4: Supporting our transport authority partners to deliver localised smart travel schemes across bus, trams and ferry.

Table 6: Challenges and Opportunities of Contactless and smart ticketing and enhanced customer information

Challenges	Opportunities
People aren't well informed of new technologies and are therefore reluctant to evolve with the system. Users may require incentives to increase uptake.	Opportunity for personalisation, incentivisation and fair-price fare promises for users.
This can only happen if all the stakeholders involved collaborate to make it a user-friendly system.	Smart ticketing provides increased customer journey data, allowing more effective analysis and scheduling and user-personalised journeys.

Smart ticketing options could become confusing in areas with multiple competing ticketing schemes. Consistency and interoperability must be considered	Tickets can be traced back to individuals and are therefore more resilient to fraud.
Supporting infrastructure needs to be in place, i.e. many rural rail stations do not have electronic gates currently.	Reduced operating costs by replacing paper tickets which are difficult and expensive to maintain (i.e. printing machine, replacement if lost) and track.
	Reduced station congestion and real-estate as more customer needs can be addressed online.
	Journeys for passengers with reduced mobility are made more streamlined and potentially hands free in the future. Reduced need for navigating around busy and inaccessible stations to buy tickets.
	The development of open data portals and shared back offices for rail, enables the operator to share information and gain a greater understanding of the users and travel.
	Through gaining additional information and data about users, this can assist transport operators and planners to continually build on their understanding and act on this information in a more.

Figure 9: What contactless ticketing might mean for our scenarios

Just About Managing	Uptake of smart ticketing continues at current rate, however low levels of regulation mean that ticketing isn't standardised or in many cases multimodal. The user benefits are mostly un-realised and the potential to work with user's data for continuous improvement is lower. Rural areas lacking commercial incentive lag behind in getting ST infrastructure without investment.

Prioritised Places	Account based ticketing with personal incentives and discounts helps communities achieve the equity and quality of life that they now prioritise. Schemes are multi-model and price capped so as not to disadvantage those with fewer public transport options who need to make changes. Regions must be sure not to work in silos so that people living near and traveling across borders can use the same ST schemes as others.
Digitally Distributed	In many cases, smart ticketing has been superseded accounts with MaaS providers which are widely embedded in society, replacing the function of traditional car ownership. There may be a place for innovations in smart ticketing catering to particular societal needs – i.e. people with low digital literacy (who are particularly left behind in this scenario), visually impaired people, children who can't own a full MaaS account, occasional visitors & tourists.
Urban Zero Carbon	With increasing urban densification and uptake of zero-carbon travel, there is a greater emphasis on multimodal ticketing for short journeys using micro-mobility modes. Opportunities open for dynamic ticket pricing based on the carbon impact of the modes you travel using. Integration of shared mobility systems may lead to wider scope of ticketing (e.g. Uber rides included in daily charge capping).

Demand Responsive Transit

Summary:

Passengers are demanding personalised mobility to adapt their needs, which is going to increase in the future. People also look for quick, easy, flexible and affordable ways to commute or travel for leisure. DRT is a flexible mode of transport that provides an on-demand service to users. It is a form of private transport where vehicles travel on calculated routes based on demand rather than a fixed schedule. Local authorities in the North are already trialling DRT services as part of their Future Mobility strategies, such as ArrivaClick in Liverpool City Region.

Data and funding for Major Roads could be used to bolster the North's MaaS offering through Demand Responsive Transport (DRT) services, behavioural nudges, and improved active travel spaces.

Table 7: Challenges and Opportunities of Demand Responsive Transit

Challenges	Opportunities
Single or low occupancy ride hailing vehicles cause increased congestion and can be more polluting per passenger mile than a private car. Therefore extensive thought and planning needs to go into devising the system.	Personalised public transport to decrease travel times and increased accessibility – door-to-door, corner-to-corner journeys, or to specific points – i.e. train stations
Difficult to implement a user-friendly DRT platform/system – would have to educate people but that might put them off using the new service.	Support people with limited mobility or special requirements.
Complex routing decision that have to made may not be favourable to all the passengers signed up to the service.	Improve transport flows in cities and reduces carbon emissions by increasing efficiency
	Can help people get between towns in rural areas without having to own a cars, reducing dependency on private car or limited public transport options.
	Plays a vital role in the MaaS ecosystem, can help improve connectivity without adding additional vehicles on the road.
	Can transport more people per vehicle than most other shared mobility modes.

Figure 10: What Demand Responsive Transit might mean for our scenarios

Just About Managing	DRT will continue to modestly grow in some large conurbations and commuter locations as people become more accepting of shared mobility. Rural areas are not serviced by DRT services.
Prioritised Places	DRT services grow as they are tailored to local needs and complexities. People are more accepting of sharing for the social benefit it provides. DRT service the whole community, with clear growth in areas with airports, ports and enterprise zones.
Digitally Distributed	DRT provides services to those who cannot work from home, especially connecting residential areas to out-of-town business parks. Increase in this scenario is slightly lower than Prioritised Places and Urban Zero Carbon due to the range of other transport modes available and the level of remote working. Peoples willingness to book services through app based systems supports these services.
Urban Zero Carbon	DRT services become increasingly integrated with traditional public transport. These shared services are also consolidated with freight or small delivery services to minimise the impact of deliveries.

Car clubs

Summary:

Individuals gain the benefits of private vehicle use without the costs and responsibilities of ownership. The individual uses the vehicle when they want and usually pays for only what they use. The company looks after fuel, maintenance and repair tasks and insurance.

- **Station-based Carsharing (Round Trip):** The trip must end in the same place it started One-way Carsharing: The vehicle can be picked up at one station and returned at another
- **Home Area:** A virtual fence where individuals have the freedom to park their vehicle anywhere on permitted side streets or company-marked parking locations.
- **Free-Floating:** Pick up a vehicle and end the trip anywhere in the home area.

Table 8: Challenges and Opportunities of car clubs

Challenges	Opportunities
Getting car clubs to convert to EVs and getting to locate their vehicles in residential areas where they may perceive a high % of private car ownership.	Use assets more effectively (vehicles and land-use). In 2016, each carsharing vehicle replaced 10 personal cars and freed up 9 parking places.
Social inequality - people with less disposable income and requiring mobility assistance are unintentionally excluded. Options should be provided for those that cannot drive.	Can be a solution for the first/last mile problem
Wider adoption – car sharing primarily services highly populated, dense cities with a more affluent demographic.	Opportunity to extend car clubs outside of city centre/business locations and into residential areas. This was done in London extremely effectively by ZipCar. The knock on is an opportunity to tackle Transport related social exclusion to some extent as initially focus could be put on car club spaces near flats and on terraced streets.
Reduces vehicle ownership, but doesn't actively manage single occupant vehicle use.	Car clubs may be used to help with range anxiety of EVs – providing vehicles with larger battery sizes for long range alternatives for the odd longer trip (e.g. through a car club vehicle on their street).
	EV car clubs may help EV purchase prices to drop more quickly

Figure 11: What car clubs might mean for our scenarios

Just About Managing	Private car use and ownership is still preferred. Car clubs experience challenges to implementation in the early years (Covid-19 pandemic) and will continue at the current rate.
Prioritised Places	People continue to be connected through traditional transport modes, but private mobility ownership continues. Car club uptake and use continues at current rate.
Digitally Distributed	Car clubs and sharing see a growth for those who are commuting to out of town business parks. Those who no longer need to commute, reduce purchasing new cars once existing cars reach the end of their lifespan; and carsharing usership models increase to replace ownership for one off journeys.
Urban Zero Carbon	Electric car-clubs and car sharing will continue as those who still need to travel via car will do so in a more environmentally considered manner. Private car ownership will lower as people will choose to pay only when need to. These services will be integrated into the wider network.

Ride hailing and share

Summary:

On-demand service where someone picks you up and drives you to desired location. I.e. Uber. These services are often booked through an app, and all payment occurs with the app. There are a range of options targeted at different groups and price profiles. Including sharing or pool options and premium or executive options.

Table 9: Challenges and Opportunities of ride share and hailing

Challenges	Opportunities
Areas of low or inconsistent demand are not commercially attractive for operating ride hailing schemes.	Personalised, flexible and direct journeys which can be faster than public transport for some routes.
Ride hailing business models in which drivers use their personal car are unlikely to cater widely to accessibility needs leaving a proportion of the population to be excluded.	Can fill public transport gaps, allowing individuals to travel to, and gain access to, areas which are otherwise out of reach without a private car.
Ride hailing journeys (without further mitigation) are considered to have a greater emission contribution than the journeys they are replacing. This is as the journeys they are replacing are often shorter trips which individuals would walk or use public transport.	Larger ride hailing fleets are supporting their driver to transition and change to electric or hybrid vehicles.

Figure 12: What ride-hailing and sharing might mean for our scenarios

Just About Managing	Private car ownership remains high, and so ride-hailing provides a similar function as it does now, complementing other transport options rather than replacing any. Ride Sharing would be primarily from poorly regulated, profit-driven private operators prioritise locations which provide largest commercial value. Services would be highest in dense urban areas and lower in less densely populated areas. However, in places that do not have a suitable public transport system currently, ride sharing would perform better than MaaS as this system does not rely on pre-existing public transport systems.

Prioritised Places	With a focus on localising communities, the short occasional journeys provided by road hailing continues to be demanded. To ensure that the benefits extend to vulnerable population groups, accessibility guidelines and standards for private hires are tightened. The migration of people to low density semi-urban and rural areas would make it hard to provide the effective public transport system required for some MaaS, however the density would be sufficient for ride sharing. Some commute models, led by employers in out of town business parks, are used to connect workers and the local community. However, with people living in such low density, individual car ownership and usage would remain high.
Digitally Distributed	By 2050, ride sharing and hailing become popular choices through shared mobility and MaaS platforms for local journeys and connecting first/last mile trips. Increased use of shared mobility and CAVs means that ride sharing and hailing can operate successfully outside of urban areas too, which addresses travel solution gaps in the network. Commute models, led by employers in out of town business parks, are widely used to connect workers and the local community.
Urban Zero Carbon	Ride sharing and hailing is commonly used through shared mobility and MaaS platforms, supplemented by a large investment in public transport and a focus on low carbon solutions.

3.6 Connected and Autonomous Vehicles

Summary:

Connected Vehicles – Vehicles which use a series of technologies which enable them to communicate with other vehicles, infrastructure and operations / control centres. This allows drivers to receive more in-vehicle information and therefore facilities safer and more efficient decision making.

Autonomous Vehicles - Vehicles of any type with automated driving functions, or capable to drive themselves with little or no human interaction, drawing on a suite of all-round cameras and other sensors, analysis of the Gigabits of data they produce, and supporting information from wider infrastructure. The commonly used SAE model describes 5 levels of increasing automation, from Automated Driver Assistance Systems (ADAS) at Level 1 to Full Automation at Level 5.

Further development will depend upon:

- Availability and costs of Autonomous Vehicles through sharing-based services that can be easily accessed by members of the public
- Availability and costs of Autonomous Vehicles to be purchased and used privately by households and businesses
- Technology and infrastructure required to connect vehicles to each other and to wider infrastructure.

Significant research has been developed around Autonomous Vehicles with many roadmaps identified. In order to progress these roadmaps there is a desire and need for standards and policy in both a public and private context. The autonomy measure should include freight and platooning as this is one area where autonomous technology can bring significant benefit.

Challenges and Opportunities:

Table 10: Challenges and Opportunities of Connected and Autonomous Vehicles

Challenges	Opportunities
Competing connectivity standards	Ability to provide personalised information to road users and digital assistant technologies integrated into infotainments systems
Implementing safety and cyber-security best practice across the industry; issues during testing or roll-out, could erode public trust that AVs are safe.	Safety benefits can be realised through in vehicle alerts and the sharing of information upstream to road users (e.g. advanced ice/ aquaplaning warnings; speed reduction warnings)
CAVs may increase road use by making road travel more convenient: according to	Potential to enable for more sustainable road traffic flow patterns, (e.g. through

a survey by Arthur D. Little, while 50% of users believe that an AV would replace their own car (across long and short distances), 30% believe that it would replace their use of public transport.	traffic flow optimisation (GLOSA), re-routing around congestion/disruption), helping save time and reduce carbon emissions by up to 10% (Compass4D, Final Results, 2016).
Technology still not fully tested and suited for widespread use. Safety concerns and lack of widespread user confidence remain key challenges.	Potential for improved safety and reducing lives lost on the road: 85% of road accidents are attributable to human error, and evidence shows that ADAS functions currently in use (e.g. Automated Emergency Braking) reduce accidents by an estimated 15%.
Implementing and running suitable infrastructure for CAVs to run on all roads and motorways; licensing and insurance models will need to adapt to cope with new ways of attributing accidents. Challenge of integrating autonomous vehicles with user operated vehicles on the same network.	Could lead to reduced impact on congestion and increased road capacity. A change in vehicle ownership can lead to more sharing of vehicles. Estimates of the amount of 'road throughput' enabled by AVs range from 80-270% increase (Comparative study by Arthur D. Little, Future of Urban Mobility 3.0, 2018).
Resistance from valuable services whose jobs compete with CAV services.	Use of AVs has the potential to save each driver up to 225 hours per year, allowing more productive time (DfT 2018).
The current prevalence of car ownership may not work in a CAV-heavy society, if the cost of purchasing a CAV remains high.	

Figure 13: What CAVs might mean for our scenarios

Just About Managing	Connected vehicles see 25% penetration of the vehicle fleet, however systems are not fully activated (i.e. Level 5 autonomy) and perceived benefits fully realised. Connectivity standards have not been agreed and the use of connected infrastructure is reserved mainly for the Strategic Road Network. The majority of the public are reluctant to give up private ownership. Some of the benefits of autonomous vehicles are realised for the individuals who own them, but not for wider society or the general transport network.

Prioritised Places	Similar to Just About Managing for the most part, with 25% vehicle fleet penetration (although again Level 5 autonomy not activated). Alhough there may be more emphasis on realising the benefits of AVs for vulnerable groups, people with disabilities and extending AV networks to more isolated areas.
Digitally Distributed	By 2040, 50% of the vehicle fleet is CAV. Nearly all new vehicles are fully autonomous and individual ownership is low, leading to high vehicle utilisation. By 2050, the penetration increases to 75% of the fleet. Full autonomy is reached (Level 5). As a key enabler of autonomy, connected cars are ubiquitous, and follow mandated connectivity standards. Real time traffic data is continuously shared allowing the road networks to be optimised. This enables the dynamic mobility as a service and road pricing models seen in this scenario. All vehicles form a wider shared public mobility network which people can interact with through other smart devices and get highly personalised travel advice and pointers. Trips are often shared. While there are still legacy vehicles on the road, there is a preference towards AVs and widespread autonomy means that vehicles became more space efficient on the road, increasing capacity without infrastructure investment.
Urban Zero Carbon	Connected vehicles are integrated into the wider shared multi-modal mobility environment for the purpose of energy saving. People only use cars where other transport means are unavailable, and then the in-vehicle information provision links with smart-parking and micro mobility schemes to enable last-miles to be more carbon friendly. All new vehicles have a high level of autonomy, but aren't fully autonomous by 2050. 25% of the fleet is CAV in 2040 and 50% by 2050. Shared AVs are well integrated into urban transport systems to complement public transport, but doesn't extend to rural areas or small towns.

3.7 Demand reduction policies to improve use of roads

Summary:

Demand reduction policies centre around encouraging and incentivising people to move quicker, away from highly polluting vehicles to cleaner vehicles or even potentially outside vehicles at all. Demand reduction policy measures may develop differently across our scenarios.

Examples include - Clean Air Charging, Road User Charging (Time of day, distance based congestion charging), Mobility Credits, Carbon credits, Vehicle Excise Duty, Maintenance charge, Local parking policies.

This is likely implemented through economic incentives for the use of road space. This is motivated by the desire to 'internalise' one or more aspects of the cost of driving not currently incurred by the driver, such as air pollution, delays due to congestion, roadworks and improvements. Charging has traditionally been for access to a defined stretch of road according to a published 'rate card'. Increasingly, wireless communications integrated with e-payments would allow for free-flow at charging points, and similar technologies are now enabling 'per-mile' charging proportionate to the length of the trip.

Table 11: Challenges and Opportunities of Demand reduction policies to encouage sustainable use of roads

Challenges	Opportunities
Political and social appetite towards lifestyle restrictions and people's ability to travel.	Options available to devise road charging strategies to work towards sustainability ambitions to meet the 2050 Net Zero target.
Demand reduction must be used in conjunction with improving accessibility by sustainable modes as the other significant challenge is that in many places, a suitable alternative transportation offer is not available. Developing increased accessibility to public transport is vital before any charging policies are implemented in all regions (depending on place type).	Policies have the potential to enable better management of road user demand, supporting improved traffic flow and efficiency of the road network. Charging may encourage users to use public transport if perceived as a cheaper and quicker way to travel within and between cities.
Dynamic pricing needs to be considered. Demand reduction polices should take account of geographical location, the	Charging may encourage users to use public transport if perceived as a cheaper

access to public transport connections, and the level of congestion in an area. If a car is registered, and used regularly, from a rural address, should it be cheaper to use in rural areas, than if travelling into an urban area for example.	and quicker way to travel within and between cities.
RUC is not widespread across the UK, so development and implementation of a broad scheme would take considerable effort.	Demand management of congestion should improve the environment for pedestrians, cyclists and other active modes.
New fiscal measures required to ensure deliverability – revenue generating options (such as Vehicle excise duty and fuel duty) will change, as in the future road tax on vehicle emissions decreases due to the increase in net-carbon or electric vehicles (e.g. charged as per distance or time of day).	Opportunity to generate ring fenced revenue towards use for active travel schemes and improved public transport.
Individuals or family's dependent on the private car, particularly for their employment, are impacted by charging, especially those living in rural areas where cars may still be the dominant mode of transport and are unable to afford RUC on routes they regularly take.	Demand reduction policies and measures can form part of a mobility ecosystem which would help integrate transport networks and payment system for transport. Could also present opportunities to raise revenue and directly impact travel behaviour.
	New technologies can include GPS-enabled and in-vehicle technology to create a more dynamic charging and distance-based system.

Figure 14: What Demand Reduction Policies might mean for our scenarios

Just About Managing	ULEZs continue to grow in urban areas but there is no significant use of charging on the SRN or MRN to manage the increasing congestion, even though the opportunity exists. Integrated networks between areas with charging regimes, and those without, do not exist. The government has not led a campaign for road user standardisation and interoperability, and public opposition to road charging has prevailed.

Prioritised Places	By 2050, there is an increase in demand reduction policies and measures, but progress towards this point was slow. Economic incentives for road use, combined with more localised styles of living has reduced long distance travel and congestion of major road networks.
Digitally Distributed	Demand reduction policies and measures are widespread, but not introduced as quickly as Urban Zero Carbon. User costs and perceived impacts are offset by other mobility options, such as CAVs and the increased efficiency of highways. The user will often indirectly pay through their MaaS or vehicle sharing account. All cars are electric by 2050, so low emissions zones are superseded by low congestion zones. Most schemes are dynamically priced based on demand to smooth congestion between peak and off-peak times.
Urban Zero Carbon	Demand reduction policies and measures are introduced early and extensively in the scenario. This contributes to the reduction in road traffic and uptake of public and shared transport overall. However, other transit options are not extensively available across all place types in the North to offset this user cost, particularly in rural places. Similar to Digitally Distributed, payment is often indirect and through dynamic pricing.

3.8 Platooning

Summary:

Platooning is a connected and automated vehicle system for motorway traffic, in which at least two trucks (or other vehicles in future) travel in close proximity with the help of driver assistance and sensor systems. Participating vehicles will be synchronised in a 'Vehicle Ad-Hoc Network' which allows actions by the lead vehicle to be simultaneously followed by trailing vehicles, and warning messages to be shared instantaneously.

Table 12: Challenges and Opportunities of Platooning

Challenges	Opportunities
Currently unproven benefits especially for shorter distances.	Improved fuel efficiency as trucks travelling closely together don't need to break and accelerate as frequently, and benefit from reduced air-resistance.
Improving safety of and implementing regulations for this to ensure safe usage.	Synchronous driving eliminating some accidents which would have occurred due to driver reaction times.
Implementing appropriate infrastructure for platooning to run on motorways.	Improved road space utilisation.
Resilience from industries and unions with jobs which will be disrupted by platooning technologies.	Reduced operating cost if drivers can be replaced.
Investment payback periods and changes to insurance premiums for haulage operators.	

Figure 15: What platooning might mean for our scenarios

Just About Managing	Lack of interventions leads to increased congestion on the SRN, leading freight companies to adopt platooning on their own terms to improve the operation of their own fleets. Some ad-hoc agreements allow multiple operators to collaborate, increasing the size of platoons. Fast-maturing technology makes this possible, and infrastructure owners respond to pressure by installing enough supporting roadside technology to enable the basic platooning functions at key locations.
Prioritised Places	The circular economies and locally produced goods create new freight demand patterns. To realise the full benefits of this, platooning is increasingly rolled out on smaller roads to cater to the more distributed local manufacturing networks. 'Freeports' increase the number of distribution depots.
Digitally Distributed	In the AV-heavy scenario, platooning is used by most freight vehicles on the SRN. Goods can be transported efficiently across boundaries.
Urban Zero Carbon	Platooning was prioritised early in the scenario to save energy over long-distance haulage. It is restricted to the SRN, taking goods between consolidation centres, with smaller non-platooning vehicles responsible for more local deliveries.

3.9 Drones

Summary:

Unmanned Aerial Vehicles, or 'drones'. Remotely piloted or autonomously flown vehicles. They are widely used in photography, search and rescue and videography already. Trials are ongoing for the delivery of medical and consumer goods, and looking further ahead, taxiing people.

Future demand may include:

- Increased expectation for on-demand consumer deliveries and the need for last-mile freight solutions from delivery hubs.
- Rapid delivery of donor blood and organs
- Demand for goods within cities is set to increase urban goods mobility demand to 17.4tn tonne-km by 2030, representing an 83% increase on demand in 2010[4]. Over 1.6bn parcels were delivered in the UK in 2016, a 16% increase on the year prior (IMRG).

Table 13: Challenges and Opportunities of Platooning

Challenges	Opportunities
Restricted airspace near airports and urban areas. Current legislation prohibits the 2018 UAV sightings at Gatwick Airport show how disruptive mis-used UAVs can be.	UAV's electric motors produce no local emissions.
Assuring the safety on the ground underneath flightpaths and of people near landing areas.	UAV's operate in a currently underutilised space – reducing their interaction with people and other transport compared to traditional delivery methods. Little or no on-route infrastructure is needed.
Current restrictions prevent flying within 150m of built up areas.	UAVs can take relatively direct routes, saving time and energy.
Security and data challenges and avoidance of mis-use.	Without the need for a human operator, a significant operating cost is eliminated.

[4] Arthur D. Little, Future of Urban Mobility 3.0, 2018

	Areas with low delivery accessibility and away from built up areas could host trials of aerial delivery. Corridors of available airspace between urban areas also present trial opportunities.

Figure 16: What drones might mean for our scenarios

Just About Managing	UAVs are used for niche and time critical deliveries in the public and private sector (health, construction, manufacturing) but the public gains little from UAVs in their day-to-day lives.
Prioritised Places	UAVs are no more common than in Just About Managing. There are, however, trials specifically to address logistic opportunities.
Digitally Distributed	Drone deliveries are increasingly common, providing 'last-mile' delivery from freight hubs and enabling consumer delivery of products 'on-demand'. UAV taxi services have proven a success internationally, and the UK begins considering where aerial routes could be implemented to alleviate ground congestion or overcome physical barriers.
Urban Zero Carbon	Drone deliveries are mostly only adopted where it leads to an energy saving compared to traditional methods, as opposed to being driven by consumer demands.

3.10 Freight consolidation centres, modal shift and intermodal freight hubs

Summary:

Freight outcomes are different in each scenario, and we have set out the key expectations that may plausibly arise. For example, it was agreed that the varying levels of densification seen across our scenarios would influence the distribution of land values which in turn would affect placement of freight hubs, distribution centres and logistics. The use of, and integration with, planning policy to promote warehouse clustering and freight consolidation centres is therefore key.

When considering the decarbonisation of freight, many of the measures outlined above should be considered in conjunction with this section. Increasing modal shift to rail freight is another avenue to reduce carbon emissions of the goods we transport. This can be achieved through planning policy to promote intermodal hubs and increases in rail capacity for freight trains. This measure should be considered and integrated alongside the energy sector and port activity, of which the North of England has considerable assets.

Last mile connectivity, capacity and sustainability is key for the delivery of goods, especially as the demand for home and office deliveries increases. Policies and technologies will be key to enable freight traffic to sustainably get in and out of urban areas, or connect across a 'larger last mile' area to more dispersed sub-urban and rural areas.

A relatively simplistic approach to representing freight demand has been used in the Future Travel Scenarios. We our currently working with our freight modelling partner, MDS Transmodal, to produce a more bottom-up representation of freight demand across each of the four Future Travel Scenarios using the GBFM.

Table 14: Challenges and Opportunities of modal shift and intermodal freight hubs

Challenges	Opportunities
Complicated Scheduling. Can be easier to manage intra-company, although significant potential opportunities from multiple companies using a consolidated system.	Reduced environmental impact by consolidating various aspects influencing the journey of goods.
Complexities of land-use planning.	Potential value for money movement of goods from origin to destination. i.e. reduced transportation costs; reduced damage costs, streamlined travel times.
Modal shift to rail will have consequences for the rail network and impacts on passenger services.	Consolidation centres and inter-modal hubs can reduce cargo handling, and so improves security, reduces damage and loss.

Risk that without intervention, technology advances may result in unforeseen and disruptive circumstances (i.e. increased road congestion or autonomous solutions not up to standard or cause safety issues).	Potential for opportunities at free ports.
Requires a consistent, harmonised approach to the regulation of access by freight vehicles and the operational of consolidation centres.	Enhanced International Connectivity of goods to and from the North of England.

Figure 17: What freight consolidation and intermodal freight might mean for our scenarios

Just About Managing	*Growth in population, employment, GVA and resulting level of freight demand:* Business-as-usual economic scenario *Climate Change Policy:* Moderate uptake in zero-emission vehicles *Freight emissions:* Slow reduction initially and does not reach net zero *Warehousing:* Dispersed *Transport mode balance:* Biased to road; typical delivery mechanisms remain *Technology:* Moderate uptake in CAVs *Road freight travel times:* 'Business as Usual'
Prioritised Places	*Growth in population, employment, GVA and resulting level of freight demand:* Business-as-usual economic scenario *Climate Change Policy:* Moderate uptake in zero-emission vehicles *Freight emissions:* Fast reduction initially but does not reach *net zero* *Warehousing:* Highly clustered with low urban freight consolidation *Transport mode balance:* Biased to rail *Technology:* Low uptake in CAVs; typical delivery mechanisms used but some new methods such as cargo bike increase for last mile deliveries. *Road freight travel times:* Slightly longer due to more dispersed population.

Digitally Distributed	*Growth in population, employment, GVA and resulting level of freight demand:* Transformational economic scenario *Climate Change Policy:* High uptake in zero-emission vehicles *Freight emissions:* Slow reduction initially but does reach net zero *Warehousing:* Dispersed *Transport mode balance:* Strongly biased to road *Technology:* High uptake in CAVs; innovative delivery mechanisms such as drones are increasingly common; but active modes (such as cargo bike) are preferred in urban settings. *Road freight travel times:* Shorter due to improved effective capacity from CAVs.
Urban Zero Carbon	*Growth in population, employment, GVA and resulting level of freight demand:* Transformational economic scenario *Climate Change Policy:* High uptake in zero-emission vehicles *Freight emissions:* Fast reduction initially but does reach net zero *Warehousing:* Highly clustered with high urban freight consolidation *Transport mode balance:* Strongly biased to rail *Technology:* Moderate uptake in CAVs; innovative delivery mechanisms such as drones are increasingly common. *Road freight travel times:* Longer, due to need to consolidate and deliver into cities.

Placemaking strategies and planning policy

Summary:

Investment in urban realm, green and blue infrastructure, cultural assets, creative industries and community spaces.

As set out within our response to the UK Government's Decarbonisation Transport – setting the challenge. The challenge is not only to decarbonise our transport system, but to do this inclusively and equitably. To this end, we welcome the inclusion of 'Place Based Solutions' as a strategic priority in the Government's decarbonisation strategy and it will be imperative that government utilises the knowledge within, and evidence bases built up by, sub-regional transport bodies and local authorities.

Many of the measures outlined in this document will succeed if they are delivered on a place-by-place basis. This is particularly relevant across the North where we see a range of urban, semi-urban, rural and remote place types. They should also align with individual approaches to place making and active travel strategies such as cycle network and 'place' strategies seen across the North. By supporting mass role out of workable solutions (suitable for the place in question), we can support future travel norms and behaviours that the public want to see made available.

The changes across our scenarios are mapped by considering the level of change and investment in planning policy.

Table 15: Challenges and Opportunities of placemaking strategies and planning policy

Challenges	Opportunities
Some concepts (such as the 20min city as seen in Melbourne and Singapore) are difficult to retrofit in existing neighbourhoods. Although something that could be tackled through planning policy over a long period.	Alignment of transport, energy, housing planning provides value for money delivery of major interventions.
Enhanced PT, Active Travel and EV charging infrastructure will have an effect on the urban realm and may even 'clutter' it. There is a potential perceived (and now real) issue about early adopters finding their technology becoming redundant and adds to clutter.	Considerations include the societal and spatial assessment of different needs of urban and rural areas.
Needs to be nationally led planning policy as local authorities will find it hard to place 'extra burden' on developers in places with low land values.	Potential for better overall results and outcomes for the public and businesses.

Challenging in more rural and remote areas.	Increases chances of delivering on major targets (economic growth, housing, decarbonisation) in a sustainable and inclusive way.
	Increases the attractiveness of an area, and the potential for more people to live, work and visit a place.

Figure 18: What placemaking might mean for our scenarios

Just About Managing	Minimal changes in planning policy with a continued focus on urbanisation.
Prioritised Places	High investment in placemaking which develop specialised local economy. Investment in urban realm, green and blue infrastructure, cultural assets, creative industries and community spaces.
Digitally Distributed	Low investment. Population increase in rural areas and suburbs, but varied results with regards to place.
Urban Zero Carbon	High investment and greater focus on the urban built and natural environment. Investment in urban realm, green and blue infrastructure, cultural assets, creative industries and community spaces, public transit and active travel.

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