



Peninsula Strategic Sub National Transport Body

Technology and Zero Emission Vehicle Study
Work package 07

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Quality information

Prepared by	Checked by	Verified by	Approved by
Dave Cowell Technical Director – Technology Services AECOM	Pete Ramsey Associate Director – Future Mobility WSP	Nick Woollett Regional Director - Transportation AECOM	Nick Woollett Regional Director - Transportation AECOM

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Prepared for:

Peninsula STB

Prepared by:

Dave Cowell
M: 07468701960
E: dave.cowell@aecom.com

AECOM Limited
3rd Floor, Portwall Place
Portwall Lane
Bristol BS1 6NA
United Kingdom

T: +44 117 901 7000
aecom.com

Prepared in association with:

WSP

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1 Executive Summary

1.1 Context

The Peninsula Sub-national Transport Body (STB) has the opportunity to influence the transformation of transport across the region through an informed vision in technology and Zero Emission Vehicles (ZEVs). This report has been prepared for the STB by AECOM with the support of WSP.

The geographic location of the peninsula region is unique and this defines and is sometimes challenging for transportation. Technology and ZEVs present real opportunities to push-forward and optimise carbon transition, more efficient transport services and accelerate the introduction of new modes and alternatives to travel.

The current transportation revolution is fuelled by technology and a mobility revolution enabled by greater exploitation of information, digital services and user choice.

1.2 The peninsula

The peninsula is defined by its people and places. Their geographic distribution, density and daily needs determine the journey modal choice. Technology has the ability to improve accessibility, provide alternatives to travel, and improve life through more efficient and sustainable solutions.

1.3 Technology imperatives

Critical to the success of any transport mode, service or solution which utilises technology are two imperatives:

Dependable energy supply and distribution networks

Robust, all-inclusive digital communications networks

These underpin all activities and without them all technology interventions will be compromised in some way. These imperatives are perpetual - transport, business and community demands may change, but the reliance on energy and communications will remain fundamental.

It is vital that Peninsula Transport embraces these imperatives in every aspect of their strategy and operations.

1.4 Technology interventions

The adoption of technology in transportation is widespread as it is in most facets of social and economic life.

For transport in the peninsula, technology can be:

- An enabler - facilitating positive change, such as a transition to low carbon transport;
- A disruptor - offering new and alternative modes of transport, from electric scooters to unmanned drone deliveries;
- An influencer – stimulating enhancements in current services, including travel on demand;
- An integrator – providing the ability to bring transport modes and services together.

Technology can also have a negative impact, whether through its absence in certain places, its affordability, or a reluctance or ability to adopt and use it. Inaction in the hope of emerging solutions will deliver desired change could delay benefits and increase pressure in the future.

A range of high-level, technology interventions, relevant for the peninsula, have been identified as part of the study. These interventions are categorised under three headings: Energy, Digital and Mobility:

Energy is needed to provide the motive power for all modes of transport, as well as energising the systems which support transport operations;

Digital encapsulates the need for data and information across systems (and the ability to share this between systems) for transport to function effectively;

Mobility covers the transport modes which are supported by technology, recognising that new mobility options are developing.

It is important to recognise that the rapid pace of change of technology means that interventions are not fixed but will need to evolve.

Peninsula action

This study provides specific technology interventions in Section 6. Section 5 outlines the key recommendations for Peninsula Transport and these are summarised here:

Energy Supply and Distribution

1. **Peninsula Transport should develop relationships**, with:
    - National Grid (encompassing the previous Western Power Distribution role as the Distribution Network Operator, DNO);
    - UK Power Networks; and
    - Private renewable energy generators and distributers.
2. **Peninsula Transport should collaborate and coordinate planned interventions to balance energy supply and demand**, could offer real benefits across transportation, including:
    - Rail Electrification;
    - Electric Vehicle charging;
    - Industrial decarbonisation; and
    - Hydrogen production, storage and supply.
3. This collaboration should **target the development of an energy supply roadmap for the Peninsula** and working together in attracting inward investment and grant funding would be a valuable investment to help plan and deliver future transport interventions.
4. **Peninsula Transport should promote involvement of public and commercial partners to conduct joint technology pilots and trial**s is also a good way to achieve mutually beneficial outcomes and test and evidence what is possible.
5. The Government's requirement for STBs to **produce regional assessments to support energy systems stakeholders and local authorities** for an effective EV charging network will be part of this shared plan.

Digital communications network

6. **Develop relationships** with:
    - Fixed, wired network operators, such as Openreach, Wildanet[1], Wessex internet;
    - Wireless (cellular and satellite) network operators;
    - Major transport providers, including Network Rail, Great Western Railway, Freight and Logistic operators, Airports, Sea ports, National Highways, etc;
    - Digital enablers, such as *superfast Cornwall*[2] and investment support such as GigabitBroadband[3] and ERDF; and
    - Ofcom, not only a regulator but also incentivises digital communications and outreach.
7. This collaboration should **target the development of a digital communications roadmap for the Peninsula.** Peninsula Transport should work with these partners to understand how digital communications will need to develop to support the transport system which could include:
    - Improvements to Road, Rail, Air and Maritime operations;
    - Efficient and sustainable movement of freight and goods;
    - Connecting and increasing the connectivity with all people and communities across the peninsula.

[1] https://wildanet.com/
[2] https://www.superfastcornwall.org/
[3] https://www.gov.uk/government/news/rural-areas-in-cornwall-set-for-36-million-broadband-boost

2 Introduction

This Technology and Zero Emission Vehicle (ZEV) study aims to address the strategic transportation challenges, opportunities, and priorities that can be enabled by technology and ZEV for the peninsula over a 30-year horizon.

The study will inform the overall Peninsula Transport Strategy, complementing the published works to date, including the 2019 Regional Evidence Base (REB), Ref [1], 2020 Economic Connectivity Study (ECS), Ref [2], and 2022 South West Freight Strategy, Ref [3].

It has been developed in in parallel with the Carbon Transition Study (CTS), Ref [4], and the Rural Mobility Study (RMS), Ref [5], because of the strong relationship between these areas of work.

This document is the outcome of several pre-curser activities, undertaken as part of the Technology and ZEV study. Transport and mobility are impacted by a range of prevailing factors which have different levels of influence. It is important to understand that technology adds further levels of influence, as outlined in an earlier *Technology and Zero Emission Vehicles Baseline Report, 2021* Ref [6]. This demonstrated how people, places, modes, organisations, journeys and over-arching policies influence travel and from this provided a structure showing how technology integrates or could be introduced for future benefit.

This study adopts several key principles, including:

1. **Technology is an "enabler"[4].** Taken in isolation, any technology intervention has limited impact, however when combined with other measures it can facilitate, enhance and add value to outcomes.

2. **Technology cuts across all aspects of the Peninsula Transport Strategy** as it affects almost every aspect of 21st century life, from transport efficiency and safety, to access to food and healthcare, scheduling movement of goods and improving productivity. For example, the power of the internet allows some of us to work remotely, order groceries, control household devices in our daily lives, but also helps us plan journeys, avoid traffic congestion or order a taxi as well as scheduling our trips on public transport.

3. **The study is technology / application agnostic** in its approach to avoid bias or over-emphasis to one technology or another. It is important to understand that not all interventions are directly related to transport but can provide underlying support for improving mobility. For example, energy storage provides resilience in energy supply to technology, from supporting EV chargers to urban traffic control systems.

4. **Three Technology themes.** Adopting 'Energy', 'Digital' and 'Mobility' as themes to simplify and structure the outputs and highlight how technology and ZEV can impact different and important aspects of the peninsula.

Energy is needed to provide the motive power for all modes of transport, as well as energising the systems which support transport operations;

Digital encapsulates the need for data and information across systems (and the ability to share this between systems) for transport to function effectively;

Mobility covers the transport modes which are supported by technology, recognising that new mobility options are developing.

5. **New technology and innovations can disrupt.** A 30-year strategic horizon must recognise that future technologies and developments become harder to predict the further ahead we look. Reflecting on the development of the internet and mobile communication and their impacts over the past 30 years is a good case study for technological disruption.

6. **Adopting a mobility-based perspective.** [5]Transportation is the act of moving people and goods, whereas mobility is the ability to freely move or be moved. Mobility encompasses modes of transport but also digital connectivity and anything which enables people to meet their transport needs. Technology is fundamental to deliver movement through different modes and motive power; however, the digital revolution is also allowing us to access more transport services, make more informed travel decisions and in some instances can provide a substitute for a journey.

This study connects with and is cognisant of national and other STB strategies and policies but places the peninsula centre stage in its thinking and outcomes. The Peninsula Transport *STB WP07 Technology and ZEV Baselining Report, 2021* Ref [6] provides more information on the approach and positioning of this work.

[4]Sarah Sharples, Chief Scientific Adviser, DfT, Institute of Engineering & Technology, 15.10.21

[5] Transport or mobility: What's the difference and why does it matter? Forum for the Future. 13.11.2019

3 Impact and influence of technology and ZEVs

Many aspects of transportation and mobility are experiencing rapid changes fuelled by technological developments, and the increasing availability of information, digital services and travel choice.

The Peninsula Transport Sub-national Transport Body (STB) has the opportunity to influence the impact of this transformation by making informed choices on policy development and promoting public and private investment in technology and ZEVs.

The Peninsula Transport STB has set out a clear vision, Ref [7], supported by five goals that technology will play an important role in achieving. ZEVs will be critical to delivering the central goal of affordable, zero-emissions transport for everyone.

The South West peninsula is unique as a consequence of its geographic location and this brings some inherent opportunities and challenges. These include:

- the diversity of places across the inland and coastal landscape;
- the characteristics of the 2m+ people who live here, half of whom live in rural or remote locations;
- the number of visitors;
- the availability of transport options; and
- the purpose of each journey.

Advances in technology can help the peninsula to meet its transport objectives. This study references a number of technology interventions designed to support mobility in the peninsula and help the STB deliver its vision, including:

- Enhancing mobility, by connecting people, systems and modes to provide greater integration;
- More resilient technology infrastructure, through introducing more localised renewable energy generation and storage;
- Decarbonisation, through vehicle electrification / improved efficiency and influencing behaviour change with technology;
- Alternatives to transport through digital solutions negating the need to travel through remote meetings to data-driven inspections and virtual reality;
- New transport modes, such as drones carrying parcels or the emergence of electric Vertical Take-Off and Landing for short haul passenger flights in the longer term.

Good mobility is important for the social and economic life of the peninsula, allowing individuals, local communities, public bodies and businesses affordable access to the things they need. Technology is increasingly able to enhance mobility through: digital services and data, improved digital connectivity, automation of systems and the electrification of motive power.

It is also important for the STB to consider how technology can help improve longer term employment prospects, whilst delivering social and economic benefits. This could be through:::

- incentivising local and national commercial investment through collaboration and a common vision;
- continuing to attract new hi-tech industries into the region;
- encouraging existing businesses to re-skill the local workforce to work with new technologies and infrastructure;
- inspiring innovation and forward thinking in public and private sector planning;

Case studies

A Lithium Extraction Plant in Cornwall is pioneering extraction of lithium carbonate, a core mineral in battery technology. Local investment will not only help combat climate change but also invests local workforce in new technologies for wider benefits

Somerset Council, in association with National Grid, have invested in a large-scale energy storage facility which improves operational efficiency, reduces carbon and improves resilience of energy supplies

Technology cuts across all five of the STB objectives, as shown in Figure 1 overleaf.

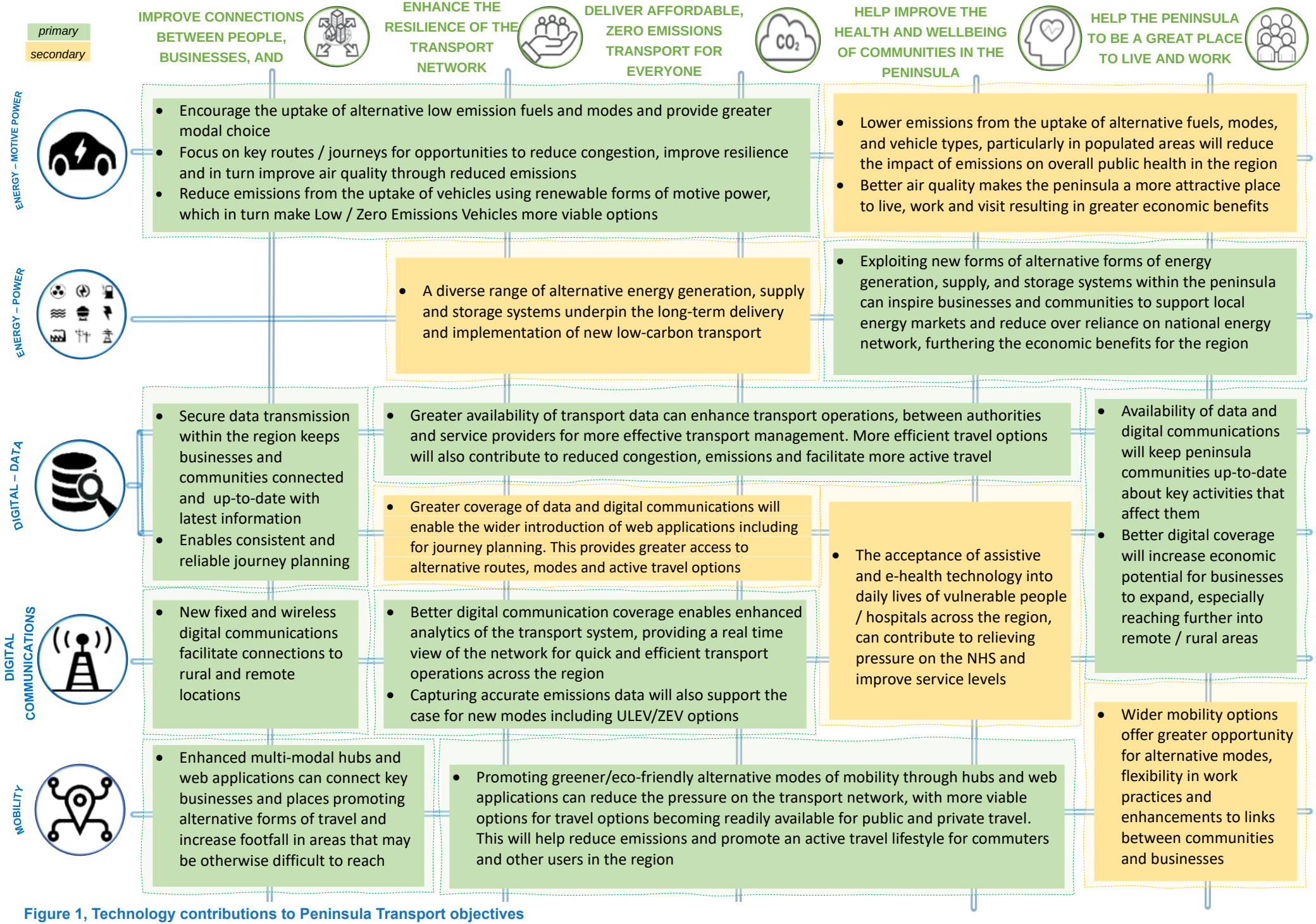


Figure 1, Technology contributions to Peninsula Transport objectives

4 Technology and ZEV context

4.1 Principles of technology

TECHNOLOGY IS AN ENABLER

It is important to recognise the role of technology as an enabler and not the driver for change. It can support social and economic change by increasing what is possible with investment. It cuts across a large number of activities and can support behaviour change.

Mobility as a Service is an example of a current growth area enabled by using existing/mature technologies, with great potential to improve as technology continues to develop and communication networks become faster and more resilient.

TECHNOLOGY IS A DISRUPTER

The technology disruptors of the past, such as the internet or mobile phones, are today's enablers. Emerging technologies such as artificial intelligence (AI), 5G mobile communications and satellite internet services have the potential to disrupt the way our current transport system operates.

Strategic transport opportunities in the peninsula include the Plymouth Freeport and Cornwall Spaceport. Technology is an important aspect of the development of these facilities, but they are also highly significant in terms of their ability to deploy technology, for example, the launch of small satellites at low cost from Cornwall.

The continued development of Connected and Autonomous Vehicles (CAVs) is heavily reliant on disruptive technologies and development will accelerate as more emerging sensing and processing technologies are embraced.

CONTINUOUS CHANGE – THE NEW NORMAL

The application of technology is a driver and consequence of constant change. The pandemic has accelerated the adoption of digital communication technologies enabling changes to the way we live, work and travel.

The adoption of technology can carry the risk of introducing social inequalities for those who cannot afford access or who live in a location where a digital network or transport options are not available.

Continuous change creates a greater reliance and trust in technology for many. Some consider this to be creating a "tele-everything" world[6]. Whilst tele-everything may not yet be the reality, home working and the greater dependency on technology for communication / business in recent times has demonstrated how technology change can be adopted and adapted very quickly.

TECHNOLOGY RESILIENCE

Technology is a fundamental part of our lives with greater reliance on its availability, accessibility, operation and swift recovery when things go wrong. This means that, without resilience, the advantages technology brings can be quickly diminished. Our digital world is dependent on the availability of high-speed services and applications which need to operate with a high level of stability. Technology systems which can be easily compromised or are unreliable are of little use.

Long term resilience of core technologies, such as energy, data and communications, will build confidence in the systems and technologies delivering transport related services and applications. Increased renewable energy generation will support the EV revolution as well as open up more viable opportunities for greener alternative fuels.

TECHNOLOGICAL INFLUENCE

The success or failure of technology cannot be considered in isolation as the external effects of the "macro environment" in which it exists and interacts has a powerful influence.

Political, economic, social and environmental changes are intertwined with technological change. National and local policies, such as Net Zero Carbon plans, will drive change and encourage the adoption of alternative fuel vehicles. The economic future can be enhanced through technological innovation, such as drone delivery to remote locations improving connections and reducing costs. The social impacts of technology are significant, from the role of smartphones to the use of digital twins to improve the planning, design and delivery of new roads and railways. The impact and influence of technology should be understood and

[6] LinkedIn The Age of Tele-Everything, Mark Pew, 02.06.2020

be a recognised component part of a strategic transport plan.

TRANSPORTATION TECHNOLOGY THEMES

Transport and mobility are about the movement of people, goods and data. Transport describes the act of movement between places, and mobility describes the ability or potential to make a journey or trip. Technology impacts and influences both.

To understand how technology can impact mobility it is important to think in terms of the key areas where technology and mobility interact. It is also important to avoid over-emphasis on one technology over another.

The three main technology themes for this study are: **Energy**, **Digital** and **Mobility**. These themes and their related services are shown in Figure 2, Thematic areas.

A large number of current and future technology applications sit within these themes, and whilst it is useful to consider how technology contributes in specific scenarios, it is unrealistic to consider every type of application. The study has therefore focussed on desired outcomes and developed a number of functional categories for each theme. These are technology agnostic but provide a structured approach to considering how technology will support the STBs goals. These categories are outlined below and can could be an entity such as a vehicle fuel/power source, or one element of the delivery of a mode, service or application:

- Energy generation, storage and distribution;
- Vehicle fuel;
- Communications;
- Vehicle connectivity;
- Data processing;
- Data gathering;
- Information dissemination;
- Asset Management;
- Electrification – new modes;
- Integrated technology enabled locations; and
- Robotics.

UNDERSTANDING MOBILITY

To understand the impact and influence that technology can have, mobility needs to be segmented, into aspects which have a defined technological influence:

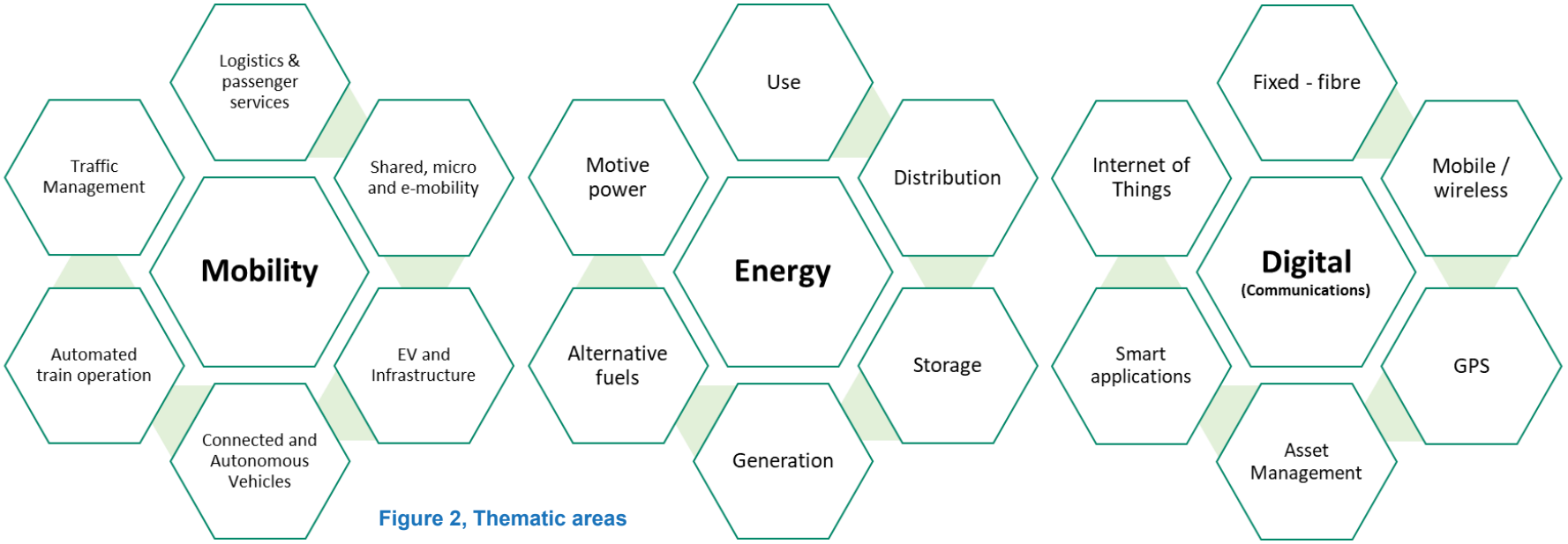


Figure 2, Thematic areas

- **Mode Sector**

There are a wide range of different transport modes; however, these can be aggregated into sectors sharing the same potential for technological influence. There are obvious differences in road, rail and air modes, but personal mobility can be used to group walking, cycling and scooters which often also link with other mode sectors as part of a journey, e.g. last mile logistics. It is important to disaggregate last-mile logistics from freight, as the context of vehicle type, size, and journey type can differ significantly. Lats mile logistics also focusses on logistics, rather than personal mobility such as eMobility. Eleven mode sectors and the aggregation of modes within each sector are listed in Figure 3.

Mode Sector	Mode definition
Digital	Digital
Personal Mobility	Walking and wheeling
	Powered & owned
	Powered & shared
	Un-powered & owned
	Un-powered & shared
Light duty car / van	owned/sole use
	shared vehicle
	Taxi/PH/ride-hailing
Heavy freight & logistics	HGV
Last mile logistics	Droids & e-walkers
Specialist	Agricultural, plant & machinery
	Other (emergency, military, etc)
Bus and Coach	Scheduled Bus
	Coach
	Community / DRT
Rail	Heavy Rail
	Light Rail
	Very Light Rail
Air	High level air
	Low level air
Maritime	Sea
Other	*Space, subterranean, etc*

Figure 3, Mode sector definition

- **Journey Purpose**

Access to technology can influence decisions to travel for a variety of journey purposes: such as commuting (choosing to work from home or from an office) and shopping (visiting the shops or using online retailers), showing the potential to reduce travel demand.

This study has considered the following journey purposes covering the typical activities of the peninsula population:

Employment: Commuting, work-related travel and transport worker travel;

Education: primary, secondary, higher, etc;

Health or social care: appointment or emergency;

Retail or services: by size/weight, local/regional, food/convenience/comparison;

Leisure or sport: limited or significant equipment, mode as leisure or sport;

Tourism: day trip, short break, holiday, mode as tourism activity;

Social interaction: local, day trip, short break, holiday.

- **Place**

Technology is generally more accessible and available in larger urban areas such as Plymouth, where digital services are commonplace and often commercially driven. In contrast, smaller rural and remote communities, such as East Prawle, face transport challenges including longer access to railways and major roads. These can also be compounded by the reduced performance of mobile and Wi-Fi networks.

An aggregated approach to defining places has been used, based on the Office of National Statistics place categories, in analysing the impact that technology can have:

Urban, combining place typologies of city, towns and larger conurbations;

Rural, combining villages, coastal and rural settlements;

Remote, hamlets and isolated dwellings, both rural and coastal.

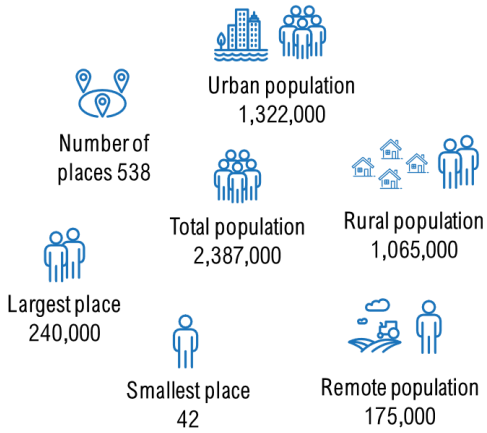


Figure 4, Characteristics of peninsula places

- **Distance**

A trip distance is the consequence of the choice of journey purpose, place and mode. Short journeys to the local supermarket or GP are part of everyday life. Journeys further afield to hospitals or retail centres in larger urban areas are typically less frequent, but important. Long distance journeys

often relate to leisure/tourism or employment trip purposes. Considering journeys in terms of short / medium / long makes sense in terms of understanding how technology can have an impact at each level.

- **Delivery Timescale**

Sound technology investments require reliable forecasts. Projections are typically based on assumptions which are not able to reliably account for technology disruptors. But market trends and short-term modelling techniques provide a certain level of confidence in projecting change over short to medium term periods. A short / medium / long term classification provides sufficient clarity in this study to indicate the likely effectiveness of technology investment.

Projection of the uptake and availability of technology is much harder as exemplified by the EV market. Our research has found industry forecasts range wildly in their estimates of share of EV in the overall fleet by 2030, from as high as 42% to as low as 6%, and an average of 20%. So the predictability and deliverability of emerging technologies, needs to be carefully considered when planning an investment.

- **Peninsula prospects**

The application of technology in transportation has typically lagged behind leading sectors, but the current digital revolution is revealing many new opportunities for transport systems.

A lot of transport related technology development tends to be urban centric. National discussions and options around mobility also seem to be categorised as urban or rural, with the Department for Transport Future of Mobility[7] Strategy illustrating this distinction. This makes sense from a population density perspective but risks missing the opportunity to join technology services up across a region like the peninsula with a mix or rural and urban land uses. Commercial / market opportunities are generally better in urban areas where the number of customers is higher. Without intervention better service provision and availability of new technologies can be expected in these areas. As the peninsula has only a small number of large urban centres it will be important to develop an effective strategy to avoid missing out on the opportunities technology provides for improving travel in the region.

Social inclusion is a key issue in the peninsula region and the introduction of new technology and the impact it has on car ownership and car use, could have both positive and adverse impacts on Transport Related Social Exclusion (TRSE). It is important that the STB may benefit from a more comprehensive understanding of the trade-offs and mitigations required.

Investment in technology is more than just systems and services. To get the best outcomes, the peninsula will need to continue to grow technology-based businesses and develop and train a workforce to support these.

4.2 Peninsula region

The peninsula's geographic position and unique environment provides challenges and opportunities. Its location means there is greater solar irradiation compared to other locations in the UK - improving the capture of solar power. The extensive coastline provides opportunities for renewable energy through wind turbines and wave/tidal power as well as being a potential location for further interconnectors with mainland Europe.

The area has some of the UK's lowest income households and the visitor economy is a major contributor for many places. Outward migration of younger adults is an issue in some areas because of a lack of year-round employment opportunities coupled with high housing costs often influenced by a prevalence of second homes.. The regional economic characteristics are studied and explored in the Peninsula Transport Economic Connectivity Study (ECS) [2], including how transport investments can support levelling up across peninsula local authorities.

The ECS study also traverses a number of different social aspects of the region. It highlights social and community factors which are influenced and can be impacted by improved mobility. It discusses how technologies, such as greater automation and digitalisation, can lead to exclusion and technology poverty challenges which impact the access to and effectiveness of transportation so technology needs to , and can, provide a positive contribution in "levelling up".

There is already a huge amount of innovation and investment in technology and transport electrification happening across the region, such as the current ERDF investment for 150 electric vehicle charge points across Cornwall in the Drive EV2 project and Bennamann partnering with local companies and organisations to trial bio-methane

[7] DfT Future of Mobility: urban strategy, March 2019; DfT Future of Transport: Rural strategy, call 2021

as an alternative energy for power generation or as an alternative fuel for vehicles.

The Heart of the South West (HotSW) Local Enterprise Partnership (LEP) is exploring opportunities to attract investment in advanced manufacturing and renewables across the region. The importance of growing and maintaining an accessible multi-modal transport network (technology and infrastructure) is critical.

4.3 Peninsula Transport Strategy Alignment

This Technology and Zero Emission Vehicle Strategy is one of seven components contributing to the Peninsula Transport Strategy. This is illustrated in Figure 5.

Technology cuts across work areas, providing a positive contribution to the delivery and success of many areas of mobility and transportation. The opportunities that technology can bring are discussed in the individual strategies:

Strategic Economic Corridor Study

This study examined three key transport corridors in the peninsula in terms of various performance metrics and conducted additional, qualitative analysis. The economic success of the region can be enhanced through the effective use and deployment of technology. Simple factors such as effective and resilient coverage of energy and broadband networks enable and deliver greater access to mobility. More information and access

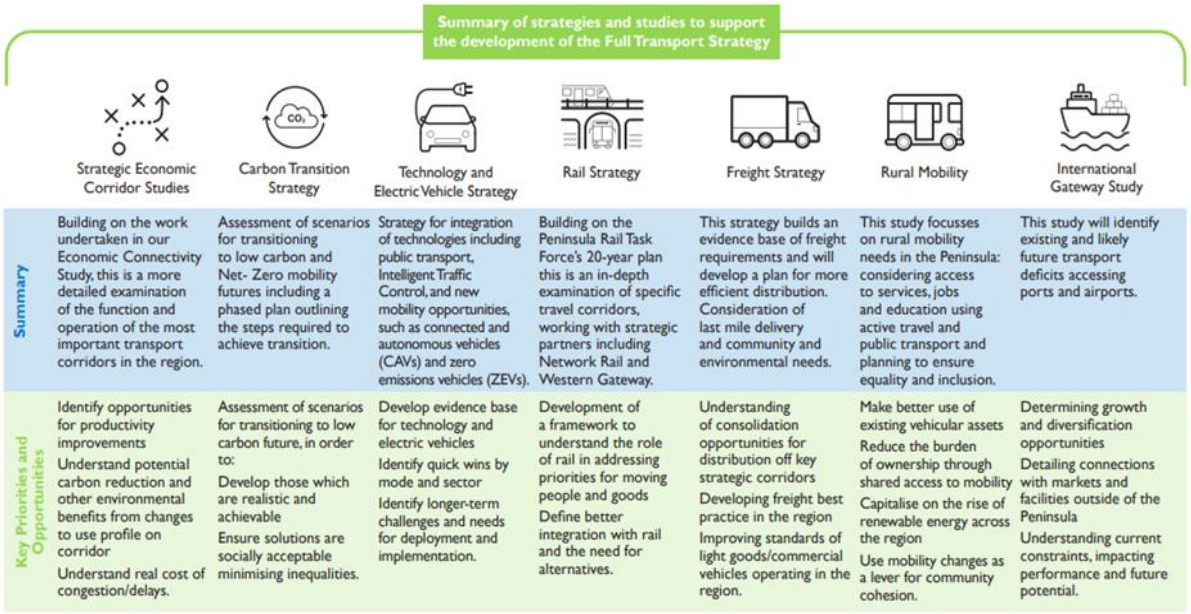


Figure 5, Peninsula strategy alignment

increase the opportunity for greater and more sustainable transport choices.

Carbon Transition Strategy

Technology is embedded within the Carbon Transition work as it relates to current and future transport emissions. It is an important contributor to delivering viable solutions and enabling behavioural change in decarbonising transport. The Department for Transport's "Decarbonising Transport – A Better, Greener Britain"[8] provides a clear directive on how technology is a necessary component and an enabler for decarbonising transport.

Freight Strategy

Road, rail, maritime and air freight are crucial to economic viability and sustainability. . Warehousing, connectivity and energy are fundamental aspects to an effective freight system. These can be safeguarded by having robust and resilient sustainable energy supply and access to accurate and real-time data. Whilst the Freight Strategy explores modal shift, multi-modal systems and connectivity, it clearly recognises and discusses technology interventions enabling decarbonisation and operational efficiency driven by alternative energy, digitalisation and data analytics.

[8] DfT Decarbonising Transport A Better Greener Britain, DfT, 2022

Rail Strategy

With a single mainline rail corridor through much of the peninsula, every opportunity should be taken to maximise use of the available capacity. Technology is crucial to do this and recent signalling upgrades are an important example of what can be achieved. Alternative energy, automation, smart ticketing, full integration of services supporting end-to-end journeys, are but a few opportunities where technology can make a real difference. Major infrastructure and service investment is centred on the service providers, who are looking to technology to deliver operational efficiencies and decarbonisation driven by ORR key performance requirements and national policies and strategies. Technology innovation and investment can have a direct impact on rail through supporting services that can influence aspects, such as modal choice and shift, and be tailored more to local needs and increasing demand.

Electrification of the mainline into the peninsula is not a short-term option, but discrete electrification packages or alternative fuels on branch lines are options which could form part of longer term strategies.

Rural Mobility Strategy

Both this study and the Rural Mobility Strategy examined the regional position of people, places, and modes using segmentation to understand the needs and wants across the region. Technology is recognised as a key enabler for rural communities to provide remote digital connectivity and connectivity across modes.

International Gateway Study

The peninsula is reliant on its own gateways such as Plymouth Port and Exeter/Newquay airports supporting people/freight movement, but equally looks to neighbouring regions to access a wider range of markets and destinations (e.g. Bristol airport and Avonmouth). Technology supports decision making, logistics and journey planning through these gateways.

5 Primary Interventions

It is important to acknowledge that any intervention or measure adopted by Peninsula Transport has to be both applicable to transport in the region, and also deliverable.

5.1 Application to the peninsula

There are many possible Technology and Zero Emission Vehicle measures and interventions which could be applied for the benefit of Peninsula Transport. Section 6 recommends interventions selected on the basis of:

- Location – balancing benefits across urban, rural and remote communities, as well as considering the diversity of economic activity across different places;
- Modal spread - enabling solutions which support and enhance the opportunities of multiple transport modes across the region;
- Equality – recognising the need for equality across users, irrespective of income, ability and location;
- Journey types – encompassing the day-to-day journeys of the different communities across peninsula, whilst recognising the huge impact of visitors to the peninsula.

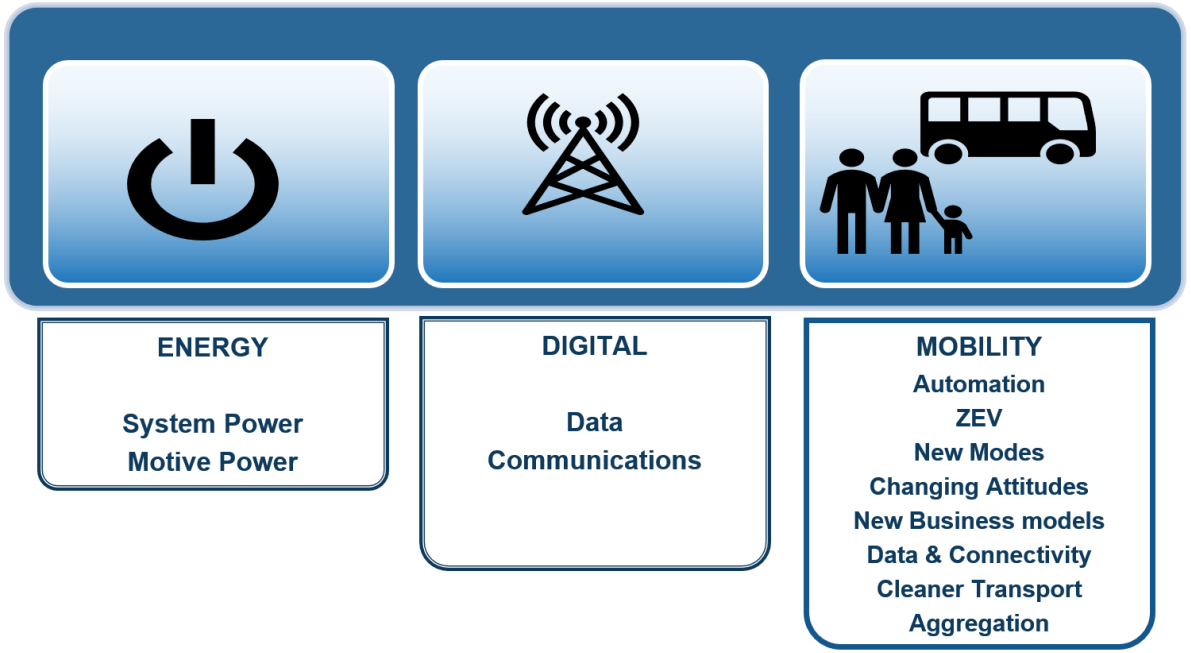


Figure 6, Technology themes

5.2 Deliverability

Time – investment decisions require time to deliver tangible benefits. Technology can help secure some rapid benefits in certain scenarios, but a long-term return on investment is important for greater sustainability and resilience;

Affordability – a reflection on the level of public and/or private investment required to deliver results is considered. Affordability can be easily influenced by local, national and international economics and should therefore be considered on a case-by-case basis at any specific point in time;

Availability – taking a straight-forward approach to technology readiness, based on market availability or maturity of concepts and products is vital to provide confidence in delivery.

5.3 Technology themes

These factors are not independent of each other or political, economic and social influences as illustrated in Figure 2.

5.3.1 Zero emission vehicles

Current figures suggest the roll out of charging infrastructure across the peninsula is roughly following the national trend, but this obscures some challenges around charge point delivery including:

- understanding the real needs of EV users in the region;
- a lack of availability of off-road residential parking;
- unattractive commercial models for private investment;
- electricity network capacity and grid connection issues;
- a geography and road network which means longer than average travel distances; and
- the large number of rural and remote locations.

The Government's "Taking charge: the electric vehicle infrastructure strategy"[9] captures these challenges and places specific demands on STBs to deliver their vision.

The challenge for the STB is how to coordinate and corral different EV charge point providers, from major transport operators and local authorities to commercial charging network service providers. Challenges which need to be addressed include: sourcing funding, planning consents, National Grid and DNO capacity and cost pressures driven by the rising cost of living.

The STBs local authority members and co-opted members provide an excellent starting point for discussions around coordinating a way forward.

5.3.2 Connected and Autonomous Vehicles

Autonomous vehicle technology continues to improve and trials and pilots are ongoing around the world. The reality is the impact of this technology in the peninsula will not be significant in the short-medium term.

Recent trials on platooning[10] of Heavy Goods Vehicles, on the M5 out of the South West was an initial step toward autonomy on UK roads but highlighted limited and conditional gains. Minimal improvement in fuel efficiency, little impact on driver workload and yet potential risks at motorway junctions show more work has to be done to make a real difference.

Connected Intelligent Transport Systems, C-ITS, provide the real stepping-stone to the future of autonomy. C-ITS systems are increasing in adoption within new vehicles today, from adaptive cruise control to automatic sign recognition, all supporting the driver. Greater connectivity between the vehicle and the roadside is having an increased impact. Safety systems such as eCall automatically reports an incident and provide a voice link between the vehicle and an emergency operator. Such connectivity is also supported through mobile phones being used as 3rd party devices providing applications such as journey planning, through Waze[11] or electric vehicle charge points through Zap-Map[12].

However, these systems are generally dependent on reliable communications platforms, between vehicles and with the roadside to be able to provide new services. Whilst 5G cellular based services are increasing, especially designed to support large numbers of connected devices, the roll out is proving to be a challenge and also very much focussed on large urban conurbations. This compromises the availability to all transport sectors, rural and remote communities and the services that could be offered.

The services are very much driven by the vehicle manufacturers and high-profile service providers with little or no influence from road operators. Services which can be offered are also commercially driven which again focusses on areas of greater population density.

Peninsula Transport must recognise the importance of supporting 5G deployment or alternatives to ensure rural and remote communities are not digitally isolated and that a good baseline of communication infrastructure is available for the region's traffic and transport operators and users .

5.4 Technology imperatives

Critical to the success of any transport mode, service or solution which utilises technology are two imperatives:

- **Dependable energy supply and distribution network**
- **Robust and all-inclusive digital communications network**

These underpin all activities, and without them all technology interventions will be compromised in some way. These imperatives are perpetual - transport, business and community demands may

[9] Taking charge: the electric vehicle infrastructure strategy, DfT, March 2022

[10] TRL HelmUK Trials, TRL, 2022

[11] Waze

[12] Zap-map

change, but the reliance on energy and communications will remain fundamental.

5.5 Energy supply and distribution

Industry, society and transport have a high dependency on energy to sustain our current daily activities. Electricity is increasingly becoming the energy of choice because of its role in decarbonisation, the increased availability of renewables, greater efficiency savings over other sources and an over-arching transformation of consumer systems to electricity.

The increasing demand for electricity, especially through vehicle electrification, is placing an increase in demand for supply and distribution. It is imperative to have a dependable energy system to maintain transport services and the systems that underpin it. Temporary interruptions to supply can have a consequential impact on transport, not just for motive power, but also the underlying systems and services which support the transport system, such as ticketing and information systems, control and signal/message systems and more importantly safety critical systems. The ability to sustain an electricity supply is crucial for consistency of service.

The growing demand for electricity driven by measures to support carbon transition, such as transportation electrification, increased use of electricity as a source of industrial and residential heating and for operations, has created a higher dependency on the local distribution network, the national grid and energy generation supply network.

The vulnerability of the electricity ecosystem has been highlighted with outages caused by storm damage, inconsistency of supply due to power system operational pressures as well as the physical and electrical performance limits of the current systems.

A sustainable, reliable, flexible and resilient energy supply and distribution network is needed for:

- Transport electrification, especially road and rail;
- Facilitation of new energy generation technology, such as electrolysers to produce hydrogen and synthetic fuels;
- Upholding communications and data systems, data centres and transmission systems which underpin the digital world on which we rely now and will become increasingly dependent on in the future;
- Maintaining and balancing supply in line with demand so that transport is not compromised, by upholding, tracking and facilitating the decarbonisation journey to net zero.

A high-level analysis of the potential impact of energy generation, distribution and storage on the eleven primary mode sectors is illustrated in Figure 3.

Peninsula action

Utilities are fundamental to the success of transportation across the region so there is a need to:

Peninsula Transport should develop relationships, with:

- National Grid (encompassing the previous Western Power Distribution role as the Distribution Network Operator, DNO);
- UK Power Networks; and
- Private renewable energy generators and distributers.

A recent collaboration between National Grid and Western Power Distribution has seen homes and businesses sell green energy back into the grid through Centrica's Cornwall and Isles of Scilly Local Energy Market[13]. The combined energy generation from multiple installations act as a single mini-power plant for the local energy network. The combination of commercial foresight and intelligent use of technology provides a blueprint for more similar installations providing a localised network of flexible smart grids across the region. This could be extended or duplicated across the region especially where there are energy generation opportunities available through transport hubs and estate.

Peninsula Transport should collaborate and coordinate planned interventions to balance supply and demand, could offer real benefits across transportation, including:

- Rail Electrification;

[13] https://www.cornwallislesofscillygrowthprogramme.org.uk/projects/local-energy-market/

- Electric Vehicle charging;
- Industrial decarbonisation; and
- Hydrogen production, storage and supply.

Developing a peninsula energy supply roadmap and working together in attracting inward investment and grant funding would be a valuable investment to help plan and deliver future transport interventions.

Conducting joint pilots and trials is also a good way to achieve mutually beneficial outcomes and test and evidence what is possible.

The Government's requirement for STBs to **produce regional assessments to support energy systems** stakeholders and local authorities for an effective EV charging network will be part of a shared plan.

5.6 Digital communications network

Society has become increasingly reliant on digital communications to facilitate daily activities and yet there is still a significant population across the peninsula who are not digitally connected or have to rely on community hubs and services to gain high speed connectivity. Transport is experiencing a greater dependency on data and digital services. Data enhances the performance of current transport systems and operations but is also important in developing new modes (using new techniques such as Artificial Intelligence and data mining) as well as facilitating behavioural change.

It is vital that the data ecosystem is able to grow and provide resilient coverage of the whole population of the region. This will support the economic growth of the peninsula and the transport infrastructure and operations which are needed for the movement of people and goods. Robust data systems are needed to:

- Facilitate emerging transport modes, such as drone couriers;
- Enhance existing modes, such as through Mobility as a Service, and Travel on Demand services to remote communities;
- Widen access to transport services for all, including emerging ride-sharing and community short-term car hire (including electric vehicle hire)[14];
- Extend the opportunities to avoid travel, especially for accessing healthcare, through e-healthcare services.

Peninsula action

Develop relationships with:

- Fixed, wired network operators, such as Openreach, Wildanet[15], Wessex internet;
- Wireless (cellular and satellite) network operators;
- Major transport providers, including Network Rail, Great Western Railway, Freight and Logistic operators, Airports, Sea ports, National Highways, etc;
- Digital enablers, such as *superfast Cornwall*[16] and investment support such as GigabitBroadband[17] and ERDF; and
- Ofcom, not only a regulator but also incentivises digital communications and outreach.

Peninsula Transport should understand how digital communications will need to develop to support the transport system which could include:

- Improvements to Road, Rail, Air and Maritime operations;
- Efficient and sustainable movement of freight and goods;
- Connecting and increasing the connectivity with all people and communities across the peninsula.

Connecting Devon and Somerset[18], CDS, is a local government-led partnership helping "deliver next generation broadband infrastructure to areas where the market has failed to invest". This is similar to Superfast Cornwall, where collaboration with programmes such as CDS presents opportunities to digitally connect with a wider customer base, but also provides access to wider funding streams and local organisations facing similar challenges to Peninsula Transport.

[14] https://www.co-cars.co.uk/
[15] https://wildanet.com/
[16] https://www.superfastcornwall.org/
[17] https://www.gov.uk/government/news/rural-areas-in-cornwall-set-for-36-million-broadband-boost
[18] https://www.connectingdevonandsomerset.co.uk/

6 Technology and ZEV interventions

In section 5 the study has highlighted the technology themes that are presented throughout the report. From these themes two imperatives emerge which provide direction for Peninsula Transport:

- **Dependable energy supply and distribution network**
- **Robust and all-inclusive digital communications network**

Whilst the imperatives provide direction for long-term planning, , Peninsula Transport needs to take specific actions. Whilst the study has adopted an agnostic approach to technology, it is at this point where more specific technology interventions and recommendations are explored. These interventions seek to:

- Provide specific STB direction
- Support the three main technology themes and the two imperatives
- Expand on current experience within the peninsula region; and
- Promote local commercial benefits

The study has specifically selected measures on this basis, highlighting examples or case studies of interventions recently trialled or adopted in the region, and described in Appendix A.2.

6.1 Technology Interventions

The breadth of impact and influence of technology outlined in section 3 and 4 is clear and Peninsula Transport can take positive actions to support sustainable, resilient and progressive transportation across the region.

The interventions have been categorised under the three headings: Energy, Digital and Mobility to simplify and structure the outputs and highlight how technology and ZEV can impact different and important aspects of the peninsula.

It is important to recognise that the rapid pace of change of technology means that interventions are not fixed but will need to evolve.

The interventions are set out in sections 6.2 to 6.8 (and summarised in Figure 7), and whilst not exhaustive, they have been selected through the research and engagement on this study in order to support the STB's strategy development and implementation.

These interventions have been selected because of their relevance to the region, and building on the experience and knowledge gained through trials and applications within the peninsula.

The case studies, see Appendix A.2. provide background evidence and references, including:

- Description of the project/case study;
- Applicability to the peninsula and the strategic vision;
- Objectives of the project/case study;
- Implications and impact;
- Benefits which could be derived;
- Timing, when outcomes could be realised.

Reference	Technology Imperative	Technology Sub Theme	Proposed Intervention	Supporting Use Case
6.2	Energy	Motive Power	Alternative Fuels - Local Rail services	Electric Agricultural vehicles
6.3	Energy	Power Generation	Renewable Power Generation - Wind/solar/tidal/bio/ hydro renewable production	Smart Grid enabled wind turbine
6.4	Energy	Power Storage	Energy Storage - Power storage network	Somerset Battery Storage
6.5	Digital	Communications	Fibre backbone	NRTS / 5G Pathfinder
6.6	ZEV	ZEV	EV Charging Hubs	
6.7	ZEV	ZEV	Peninsula Community Centred Charging Network	EV network
6.8	CAV	CAV	5G – vital step to autonomy.	C-ITS enablement

Figure 7, Technology interventions

6.2 Energy | Motive Power | Alternative Fuels : Local Rail Services

The Challenges:

With a single mainline rail corridor through much of the peninsula, every opportunity should be taken to maximise use of the available capacity. Electrification of the mainline into the peninsula is not a short-term option, but discrete electrification packages or alternative fuels on branch lines are options which could form part of longer term strategies.

The Solution:

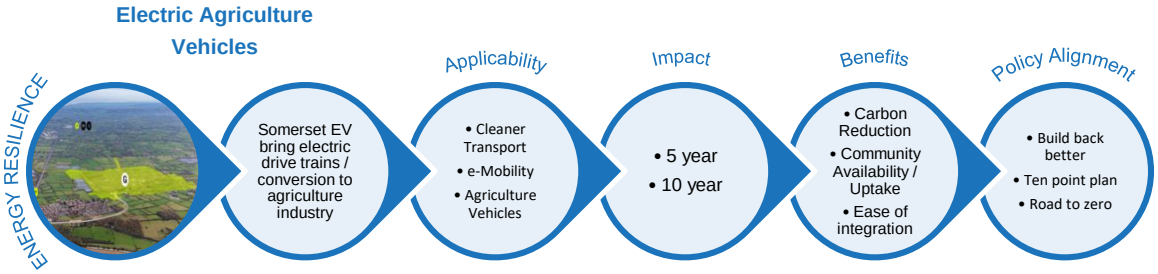
There are many alternative energy options available to support rail services, including 3rd rail and overhead electrification, battery powered traction, low carbon oil substitute fuels (such as HVO, biofuels [19] [20]and biomethane), and then there are emerging options with a growing market in supply of Hydrogen, and synthetic fuels and locomotives. With these and more traction fuel options available, as well as a large number of branch line routes which present different challenges , there is an opportunity to encourage adoption by opening the region's rail network as a rail pilot / sandpit for new traction power trials.

The Benefits:

- Attracting national attention
- Early adoption of alternative, low carbon fuels
- Encouraging local industry to support new / innovative technologies
- Progressive outlook for local residents and commuters

Related use case: 6 The introduction of "Electric Drive Trains" for agricultural vehicles in local workforce.

This approach could be translated to conducting electric or alternative fuel trials for railway traction, using lines and corridors within and across the peninsula.



[19] https://cleantechnica.com/2021/11/10/batteries-biofuels-not-aluminum-hydrogen-will-fuel-the-airlines-of-the-near-future-part-3/
[20] https://illuminem.com/illuminemvoices/da425f02-b452-4d08-9962-ba5d793be6bd

6.3 Energy | Power Generation | Renewables power generation: Solar / wind / tidal / wave / bio / hydro

The Challenges:

The growing demand for electricity driven by measures to support carbon transition, such as transportation electrification, increased use of electricity as a source of industrial and residential heating and for operations, has created a higher dependency on the local distribution network, the national grid and energy supply network. The vulnerability of the electricity ecosystem has been highlighted with outages caused by storm damage, inconsistency of supply due to power system operational pressures as well as the physical and electrical limits of the current system.

The move to EVs, plans to increase electric bus fleets and the requirement to move away from fossil fuels across all transport modes will increase demand on the peninsula network meaning that transportation will become more susceptible to supply failures without concurrently improving the electricity supply and distribution network. Power companies also focus efforts to restore supplies after failure on the areas with greater population density.

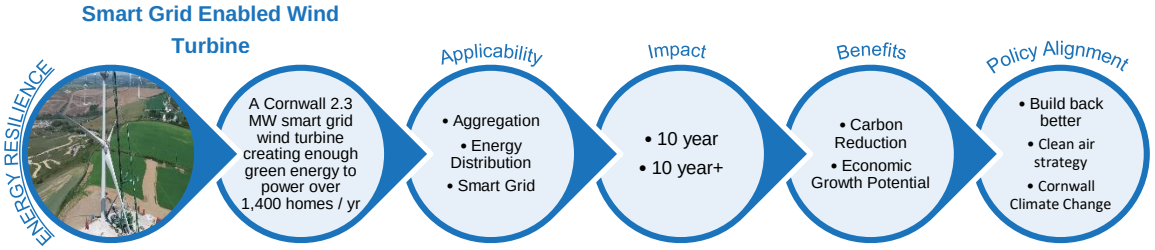
The Solution:

Working with Western Power Distribution, now called National Grid, and local renewable energy companies, Peninsula Transport can act as a facilitator of collaboration between transport service providers and the energy supply chain, and actively encourage the installation of a network of smaller renewable energy generation sites. Strategically placed to support key transport electrification nodes (bus depots, railway depots and stations, rural and remote EV charging locations) localised supplies can bolster the existing network, supply green energy and provide greater security of supply. The choice of renewable energy can be selected to meet local conditions, such as exploiting current wind, solar and bio-fuel solutions already
applied across the region.

The Benefits:

Shorter distribution of electricity

Greater reliability of supply



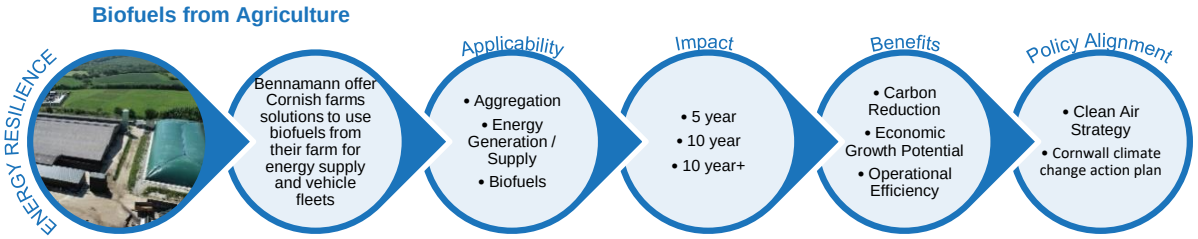
Enhanced continuity of supply

Supports decarbonisation

Reduced operational costs

Less vulnerability

Related case 3 & 4 The exploitation of smaller generating units can, when combined, provide greater benefit to the region. Larger installations may compromise existing distribution network capacity and infrastructure, whereas localised generation, at the point of use will reduce the potential need for upgrades.



6.4 Energy | Power Storage | Energy storage network

The Challenge:

The increasing demand for electricity, including through vehicle electrification, is putting increased pressured on supply and distribution. There is both a temporal and a quantitative dimension to these increasing pressures. It is imperative to have a dependable energy system to maintain transport services and systems. Temporary interruptions to supply through supply or distribution have an impact on transport, not just for motive power, but also the underlying systems and services which support the transport system, such as ticketing and information systems, control and signal/message systems and more importantly safety critical systems. The ability to sustain supplies and increase resilience is important.

The Solution:

A network of energy storage centres, strategically located to provide sustainable energy targeting small or large areas:

- Small battery storage centres in local communities can provide a resilient electricity supply for rural community EV charge points. Energy storage could allow grid capacity compromised communities access to rapid charging facilities, where a slow charged battery can have the capacity to rapidly charge an EV.
- Larger battery storage centres, around major transport hubs, or possibly co-located with renewable energy generation (i.e. solar farms, bio-methane generators) can provide short-term resilience to power outages as well as optimise the use of renewables
- Adoption of alternative energy storage solutions, such as pumped hydro, may be suitable in certain scenarios across the region, depending on the location, geography and potential generating capacity.

The Benefits:

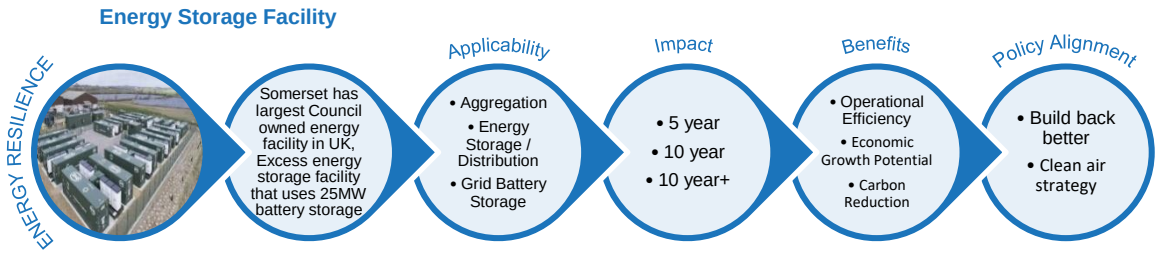
Improved transportation resilience

Remote and urban applications

Optimisation of renewables

Improved network performance through reduced supply interruptions

Related case 3 & 4 The introduction of more, smaller storage units can, when combined with renewable generation, provide greater benefit to the region. Storage offers greater resilience and consistency of supply, vital to maintain public transport services, especially when in times of need.



6.5 Digital | Communications | Fibre Backbone

The Challenge:

There is an understandable increase in demand for high-speed digital services, and transport is highly dependent on gathering and processing real time data to be able to provide timely and accurate information for operations and customers alike. Many rural and remote areas across the south west and in particular the peninsula region are compromised in terms of fibre-based communications and wireless/mobile network coverage. Low population areas do not attract investment potentially creating “digital poverty” especially in rural and remote locations. Even when services are available, network performance is usually significantly lower than larger towns and cities. Time and investment is needed, which compromises the speed of delivery of new services.

The Solution:

A fibre-backbone is needed to provide high speed services at the point of need to everyone, irrespective of their location. It is vital to provide accessibility to transport users, support local business and the economy as well as providing a real alternative to travel. Working from home is a major challenge without a communications system which is reliable and of adequate performance. Peninsula Transport can support the efforts of its members, LEPs and service providers to obtain funding, develop viable business cases and models to expand the fibre network across the region.

The Benefits:

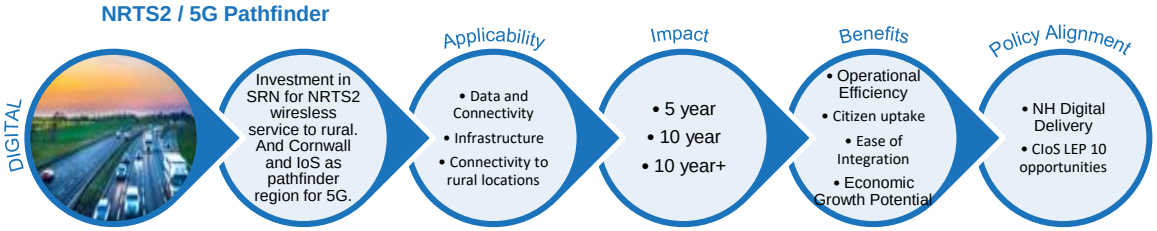
Long term backbone

Foundation to support future wireless services

Avoids technology and digital poverty

Opens opportunities to avoid travel

Related case 8 Recognition that communication cannot be reliant on one technology or another, there is a need to provide options where coverage is limited and yet there is a need to ensure there are options available wherever you are. National Highways approach demonstrates that until 100% fibre coverage is possible alternatives need to be provided without compromising future redundancy.



6.6 Mobility | ZEV | EV charging hubs

The Challenge:

EV charging infrastructure needs to be deployed to meet the current and predicted trend in uptake and use of EV across the region. The EV population will increase dramatically on a seasonal basis as more visitors travel to the region and will need to charge up whilst here. The shorter their stay, the greater the need for more rapid charge points at key transit and destination locations across the peninsula. There is currently not a coordinated approach to the provision of an EV network, nor an understanding of visitor needs which could lead to under or over investment, gaps in provisioning, and the potential to disrupt the tourist economy if visitors turn away due to lack of chargers.

The Solution:

EV rapid charge hubs are a common solution to cater for larger numbers of EVs in “transit”. The Peninsula Transport STB is ideally placed to provide a holistic view of the future demand of the region, develop a more regionalised approach to charging to meet throughput of visitors (leisure and commercial).

Funds are being available for local authorities to improve charging infrastructure to meet local needs. The Rapid Charging Fund will support the strategic road network to ensure electricity capacity is not a constraint on the rollout of a long-distance, ultra-rapid charging network. It will fund a portion of the cost of upgrading the electricity grid at strategic locations where it is currently prohibitively expensive to do so. The National Highways Energy Storage Systems (NHESS) project is supporting motorway service area sites where the current electrical capacity is limited. National Highways will procure and install battery energy storage to support the installation of ultra-rapid electric vehicle chargers. The scope of the projects is focussed on the motorway network and whilst unlikely that they will have much direct impact in the peninsula region, Peninsula Transport is well positioned to influence National Highways and their supplier to locate rapid chargers close to, if not within the region. This would help transit into and out of the region.

The Local Electric Vehicle Infrastructure (LEVI) scheme aims to further support the rollout of electric vehicle infrastructure across England. The fund is open to local authorities and is designed to encourage large scale commercial investment and enable the local provision of EV infrastructure. Peninsula Transport can provide strategic direction and support, and use its strength to lever commercial collaboration for local benefit.

Peninsula Transport is working on a specific EV charging infrastructure strategy, developing a consolidated approach to understand both the supply and demand in order to meet the infrastructure requirements of the region. There is collaboration with other STBs and opportunities to share EV deployment planning tools as well as benefiting from lessons learned in other areas.

The Benefits:

Supporting inward investment

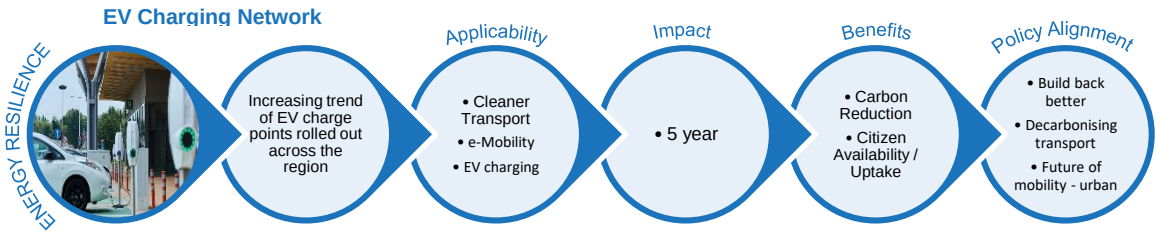
Recognising and supporting visitor economy

Supporting local journeys and communities

Faster route to implementing a rapid charging network

Avoids EV poverty

Related case 5 there are several examples of councils in the region developing individual strategies, deployment plans to match European or government funding.



6.7 Mobility | ZEV | Peninsula community centred EV network

The Challenge:

Current figures suggest the roll out of charging infrastructure across the peninsula is roughly following the national trend, but this obscures some challenges around charge point delivery including: understanding the real needs of EV users in the region; a lack of availability of off-road residential parking; unattractive commercial models for private investment; electricity network capacity and grid connection issues; a geography and road network which means longer than average travel distances; and the large number of rural and remote locations.

The Governments “Taking charge: the electric vehicle infrastructure strategy” captures these challenges and places specific demands on STBs to deliver their vision.

It is important to recognise the value of rural and remote communities and the need to support transport to and from these locations. Working from home, more digital-based working as well as the desire to work and live in a less-urban environment illustrate the increasing value of rural communities.

The Solution:

A community led, local charge point model based on a geographic-cellular approach is one way of distinguishing the needs of local communities and disaggregating those areas, especially urban centres, which attract more commercial investment. This “cellular” approach would group remote and rural locations within a geographic area but with similar identity. The concept helps define the short-term EV infrastructure requirements and establish a framework to adapt to an ever-changing behavioural, economic and technological landscape in the future.

To do this Peninsula Transport STB will need to:

Understand the local problem – by engaging and empowering local communities, e.g. district/parish councils, to canvass understanding local EV issues such as affordability of EV to their residents, the availability and need for community charging, and location specific technical issues such as limited DNO capacity. Taking a community lead will also build a wider understanding of attitudes to EV, shared mobility and other transport options which could influence future behaviours.

Drive investment – offering a hub/central resource and local leadership to bridge communities, share innovation, issues and resources, and provide greater leverage to inspire / attract outside investment, and the ability to devolve local ownership/governance of infrastructure to communities.

Deliver innovation – the region is already leading on alternative fuels and alternative low carbon energy options, such as bio-methane powered EV chargers in Cornwall, or associating large scale battery storage in Somerset with eCar Clubs, taxis, or community charge hubs.

Centralise operational management – by coordinating community charge cells, shared mobility (car clubs), other modes, closer and enhanced National Grid relationship for accelerating charging deployment, community energy rates for primary residents at public charge points, linking to local renewable energy generation; ongoing EV data analysis. This could be a sub-sector of a “South West Net Zero Hub”.

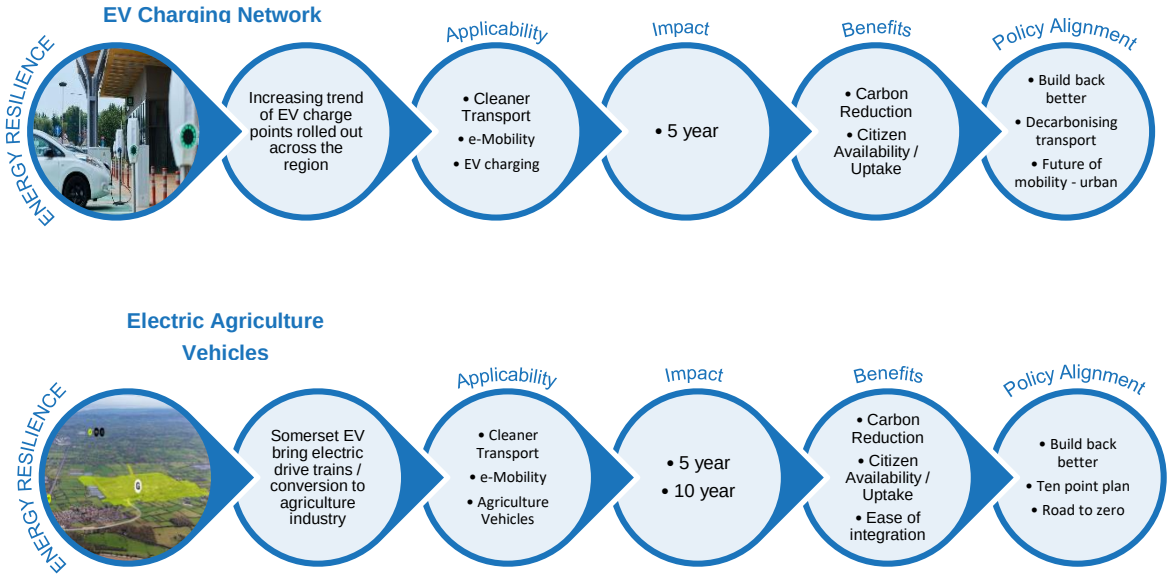
A consolidated Peninsula Transport EV strategy should be developed from the excellent work done by the region's authorities and the commercial charge point service providers who have already invested in the region. The specific and unique travel and transport requirements of the peninsula should be examined from a "local needs" perspective due to the seasonal variations in journeys and the extremities of places (especially remote locations) which will need access to chargers.

The Benefits:

Meeting national demands with a peninsula centric network, in a cohesive manner. Early engagement will allow investment to be better targeted and more proportionate to local needs.

- Location specific solution
- Cater for seasonal variation in demand
- Closer links with other imperative actions and interventions

Related case 5 This approach places options at the heart of the solution.



6.8 Connected and Autonomous Vehicle | C-ITS enablement

The Challenge:

Autonomous vehicles are a predicted feature of the future of transport, from driverless cars to automated trains and drones. Autonomy is no longer a picture in tomorrow's world but an emerging reality as technology advances and safety systems become more resilient. Vehicle regulation is being dealt with at a National, European and Global level, the UK government is encouraging local technology development to promote UK research and our experience to be at the forefront of this transport revolution. So what can Peninsula Transport do to make sure they are ready for connected and autonomous vehicles?

The challenge is that connectivity and autonomy trials are very much focussed around urban and the strategic road network, with no guarantees of outcomes meeting local needs. Niche technologies, applications and pilots, whilst attracting national interest, have very little legacy benefits for a region like the peninsula. The region is not at the heart of UK vehicle manufacture, automotive research and engineering, but it is the home of some leading technology companies who are supply chain partners in the development of vehicle technologies.

The Solution:

Connectivity and autonomy are emerging, but they will be heavily dependent on effective digital communications across the strategic, major and local road networks. 5G may be designed for high numbers of connected devices, but without comprehensive network coverage the ability of vehicles to take advantage will be severely compromised.

Peninsula Transport should look to develop a digital strategy to see high speed digital, and especially wireless, communications delivery across the region. A network which is capable of providing the data capacity, speed, availability and resilience to support connected vehicles and ultimately autonomous vehicles.

The Benefits:

Providing the communication backbone for future connectivity not only enables early implementation of delivery of benefits as technology penetrates the market, it also supports wider transport applications and improves service and community access to digital applications.

It is also important to recognise that this is not a turnkey solution which can be delivered in the short-term but will require long-term planning as well as collaboration across the transport and communication sectors. The strategic benefit will support more efficient and better management of highways and those that use peninsula roads, from freight to public transport. Whilst connectivity is easily associated with highways, it is also important to recognise that other modes and transport sectors have their own demands and will also benefit from improved digital services, including rail and maritime.

Related case 8

Appendix A

A.1 Glossary

A.2 Use Case Studies

A.3 References

A.1 Glossary

ACRONYM	Description
BEV	Battery Electric Vehicle
CAV	Connected and autonomous vehicles
CNG	Compressed Natural Gas
E-bikes / e-scooters	Electric bikes / scooters
C-ITS	Connected Intelligent Transport Systems
EV	Electric Vehicle (generic)
FCEV	Fuel Cell Electric Vehicle
GHG	Green House Gas
ICE	Internal Combustion Engine
LPG	Liquefied Petroleum Gas
LNG	Liquid Natural Gas
LA	Local Authority
MaaS	Mobility as a Service
PHEV	Plug-in Hybrid Electric Vehicle
TDM	Travel Demand Management
ULEZ	Ultra-Low Emission Zone
ZEV	Zero Emission Vehicle
BEV	Battery Electric Vehicle
STB	Sub-national Transport Body

A.2 Use Case

The following case studies have emerged from research into the many different technology interventions considered in this report. They represent a peninsula-specific selection of current and ongoing technology plans, trials, and interventions which could have and effective contribution to support Technology and ZEV for Peninsula Transport.

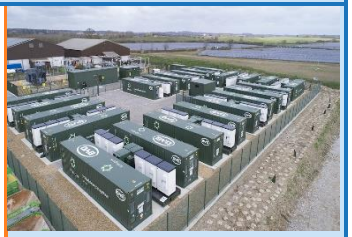
1. Somerset Energy Storage Facility

Somerset, Taunton
June 2020

Description

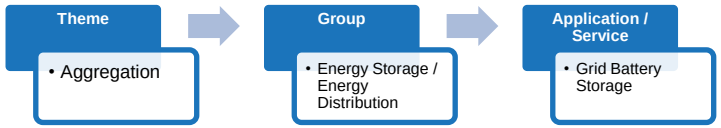
In order to meet national goals of reducing carbon emissions by 2030, Somerset council has invested c.£ 9.8 million in developing one of the most innovative green technology initiatives; the largest council-owned energy storage system in the UK which is an excess energy storage facility that uses 25MW battery storage.

***Partners**: Somerset Council / National Grid*



Somerset Energy Storage Facility

Applicability



Objectives Met

Alignment with **Regional** and **National** / **International** policies, the key ones include:

1. Build Back Better Strategy (2021)
2. Clean Air Strategy (2019)

Approach

Renewable energy technology is driving the shift towards decentralised energy distribution. Centralised energy systems were built to distribute electricity from fossil fuel generators in particular locations, renewable energy resources are widely spread, therefore the more renewable generation is deployed the less centralised the grid will become.

This facility will provide power management assistance to the National Grid, by storing the excess energy made by solar panels and wind farms in the facility and then resupplying to the National Grid to stabilise the system or when there's high demand.

Energy created by solar panels and wind farms is unstable and often wasted at a time when they can produce more electricity than needed. This excess energy will be able to be stored in the facility that has been created in partnership with Somerset-based Opium Power and resupplied to the National Grid when there is high demand or a requirement to stabilise the system.

Implication

1. Difference in the price of the electricity when bought at low demand and when it is sold at high demand, and it is this difference which provides a return on the investment,
2. Contractual payments from the National Grid for the services provided by the battery system.
3. The returns will help protect the wide range of services our communities receive from the council, as well as create opportunities to fund community projects.
4. The site will also supply essential balancing services to the National Grid to help keep the power network stable and safe.

Benefits *(according to DfT future of Transport)*

1. Operational Efficiency
2. Economic Growth Potential
3. Carbon Reduction

Time: High impact in Energy for short term (5 years) and long term (10 years), and very long term (10 years and above).

2. Cornish Lithium Extraction Plant / Geo^3

Cornwall
2022

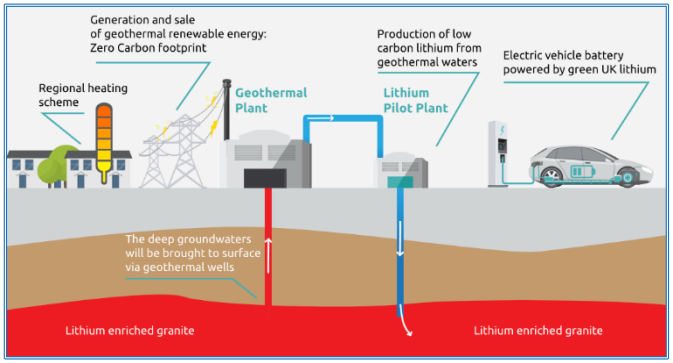
Description

Pioneering pilot lithium extraction plant in collaboration with Geothermal Engineering Limited (GEL). The GeoCubed pilot plant will use Direct Lithium Extraction (DLE) technology to recover lithium from geothermal waters at GEL's United Downs Deep Geothermal Project in Cornwall. The UK Government has invested in the project through the Getting Building Fund. This investment supports a £4m collaboration between GEL and Cornish Lithium.

***Partners**: CIOS LEP / HM Government / Cornish Lithium / GEL*

Cornish Lithium

Applicability



Theme	Group	Application / Service
• Aggregation	• Energy Generation / Energy Supply	• Gigafactory / Li-ion batteries

Objectives Met

Alignment with **Regional** and **National** / **International** policies, the key ones include:

1. Build Back Better Strategy (2021)
2. Clean Air Strategy (2019)
3. Cornwall Climate Change Action Plan (2019)
4. Cornwall Climate Emergency (2019)
5. Getting Building Fund

Approach

Renewable energy and low carbon technologies are vital to help combat climate change. Lithium is a key enabler due to its use in battery technologies, for electric vehicles (EVs) and grid storage of energy.

1. First semi-industrial lithium brine production facility in Europe.
2. The pilot plant will then be used to demonstrate that lithium hydroxide, a key component of lithium-ion batteries used in electric vehicles, can be produced in Cornwall from naturally occurring geothermal waters with a net zero carbon footprint.
3. Lithium filter technology as the "technological enabler" of this clean lithium mining project, demonstrating the feasibility of sustainable mining for the future.

Implication

There is potential for lithium mining in Cornwall with exploration yielding positive results. Mining and manufacture of Li-ion batteries locally presents the opportunity of reducing carbon emissions from those stages of the product lifecycle, as well as boosting the local economy.

Benefits *(according to DfT future of Transport)*

1. Economic Growth Potential
2. Carbon Reduction
3. Operational Efficiency

Time

High impact in Energy for short term (5 years) and long term (10 years), and very long term (10 years and above).

3. Bennamann - Using Agriculture for Biofuels

Cornwall

Description

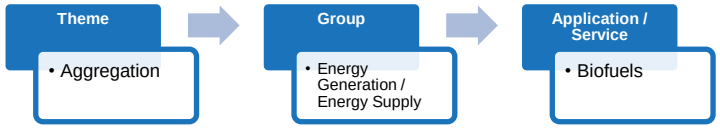
Agriculture accounts for 21% of Cornwall's carbon emissions. Cornwall Council owns 58 of the 427 dairy farms in the county, all of which have open slurry lagoons emitting methane into the atmosphere. Clean energy company, Bennamann developed solutions for small, off-gas-grid dairy farms. Their ongoing projects include:

- Energy independent sustainable farming
- Mobile Off-grid EV Charger With Bioheat
- GREEN fuel created from slurry off Cornish farms used to power CORMAC fleet

***Partners**: Cornwall Council / CIoS / Bennamann / Corserv*

Bennamann / Farm Slurry

Applicability



Objectives Met

Alignment with **Local**, **Regional** and **National** / **International** policies, the key ones include:

1. Clean Air Strategy (2019); zero carbon fleet by 2030.
2. Cornwall Climate Change Action Plan (2019)
3. Cornwall Climate Emergency (2019)
4. Cornwall and Isles of Scilly Growth Programme's 'Energy Independent Farm' project
5. Energy Independent Farm research and development project (part funded by European Regional Development Fund)

Relevance

Many Cornish farms are unable to participate in the biomethane market due to the entry costs associated with scale and having no mains gas connection. The projects aim to address that challenge by supporting a technological solution, to eventually progress towards being more commercial.

- **Energy independent sustainable farming** – maximises the use of on-site renewable energy resources in combination with animal waste, such as cow manure, to supply all the energy needed for the farm.
- **Mobile Off-grid EV Charger With Bioheat** – programme to develop and demonstrate technologies that will enable fugitive methane sourced from farm manure slurry to be used to deliver rapid EV charging in rural locations (without access to the power grid).
- **GREEN fuel for CORMAC fleet** – A £1.58 million biomethane pilot funded by the Cornwall Council that equips farms with new, fully covered slurry lagoons capturing 100% of the biogas produced. Bennamann extracts and upgrades the biogas, taking away liquified biomethane. It then pays the Cornwall Council for the biomethane and sells onto Corserv, a Council-owned organisation managing the CORMAC fleet. Eventually, all 77 of the Council's road maintenance trucks will run on farm-produced green energy.

Implication

Energy independent sustainable farming

1. Off-grid and reduce operational costs
2. Net zero carbon energy products (biogas / biofuel), which also provide additional income
3. Improved sustainability of farmland management practice
4. Lower operation costs and reduced pollutants
5. Enable rollout to scale across Cornwall and Isle of Scilly, and the UK and rest of world.

Mobile Off-grid EV Charger With Bioheat

1. EV charging in rural locations

2. Green house emission reductions and Zero carbon bioheat
3. Scale EV infrastructure to meet demand without need for power-grid connection / investment for gird upgrades

GREEN fuel for CORMAC fleet

1. Zero carbon fuel and carbon neutral
2. Opportunities for farmers to diversify their income streams
3. Reduced farmer operational costs

Benefits *(according to DfT future of Transport)*

1. Carbon Reduction
2. Economic Growth Potential
3. Operational Efficiency

Time

High impact in Energy for short term (5 years) and long term (10 years), very long term (10 years and above).

4. Cornwall Smart Grid Enabled Wind Turbine

Cornwall 2020

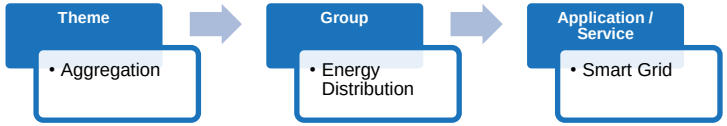
Description

Cornwall Council have installed a 2.3-megawatt (MW) smart-grid wind turbine that is creating enough green energy to power over 1,400 Cornish homes a year and helping to cut carbon emissions.

***Partners**: Cornwall Council*

Smart Grid Enabled Wind Turbine

Applicability



Objectives Met

Alignment with **Local**, **Regional** and **National** / **International** policies, the key ones include:

1. Build Back Better Strategy (2021)
2. Clean Air Strategy (2019); carbon neutral 2030.
3. Cornwall Climate Change Action Plan (2019)
4. Cornwall Climate Emergency (2019)

Relevance

A part of Cornwall £17m flexible energy trials and is part of an EU-funded trial and forms part of energy company Centrica's innovative Cornwall Local Energy Market (LEM) which aims to help increase the amount of renewable energy that can be deployed by managing the electricity network more efficiently. Over three years, the Cornwall Local Energy Market saw 310MWh of power traded successfully, with greenhouse gas savings of nearly 10,000 tonnes a year as a result.

Implication

The smart grid-connected turbine will:

1. Help Cornwall better manage its energy supply
2. Reduce Cornwall's greenhouse gas emissions by more than 3,300 tonnes a year over the next two decades

Benefits *(according to DfT future of Transport)*

1. Carbon Reduction
2. Economic Growth Potential

Time

High impact in Energy for the long term (10 years) and very long term (10 years and above).

5. Electric Vehicle Charging Network

Cornwall / Somerset / Devon

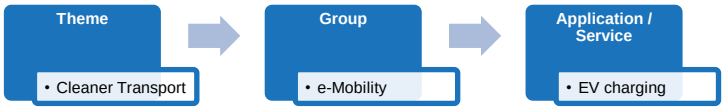
Description

There is an improving trend of EV charge points availability across the region, with the following:

- Cornwall Council is working with SWARCO's E.Connect network to provide charge points. Cornwall to rollout 150 new EV chargers with £2.9m funding.
- Somerset West & Taunton to extend electric vehicle charging in its car parks
- Devon Cutting-edge 'rapid' Electric Vehicle (EV) charge points have now been commissioned for public use at three council car parks in South Hams and Teignbridge

***Partners**: Cornwall Council / Somerset Council / Devon Council*

Applicability



Objectives Met

Alignment with **Regional** and **National** policies, the key ones include:

1. Build Back Better Strategy (2021)
2. Decarbonising transport: setting the challenge (2020)
3. The Ten Point Plan for a Green Industrial Revolution (2020)
4. Energy white paper: Powering our net zero future (2020)
5. DfT Future of Mobility - Urban Strategy (2019)
6. Clean Air Strategy (2019)
7. Road to Zero strategy (2018)

Implication

1. Reduced air pollution
2. Reduced carbon emissions and achieving carbon neutrality by 2030
3. Reduced vehicle noise in electric vehicles at low speeds in urban centres
4. Reduced motoring and fleet costs
5. Improved income generation from charge locations in busy locations

Benefits *(according to DfT future of Transport)*

1. Carbon Reduction
2. Citizen availability / uptake

Time

High impact in Energy for the short term (5 years).

6. Electric Conversion for Agriculture Vehicles

Somerset

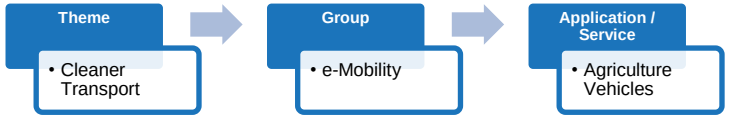
Description

Somerset EV was created with the aim of bringing electric drive trains to the agricultural industry. They offer Quad Bike and UTV Electric Conversion, Electric Conversion Consulting, And Tractor and Agricultural machinery conversion.

Partners: Somerset EV

Somerset EV

Applicability



Objectives Met:

Alignment with **Regional** and **National** policies, the key ones include:

1. Build Back Better Strategy (2021)
2. The Ten Point Plan for a Green Industrial Revolution (2020)
3. Somerset Council Electric Vehicle Charging Strategy (2020)
4. Exeter Transport Strategy (2020)
5. Cornwall Climate Change Action Plan (2019)
6. Clean Air Strategy (2019)
7. Road to Zero strategy (2018)

Implication

1. Reduced motoring and fleet costs
2. Reduced carbon emissions and achieving carbon neutrality by 2030

Benefits (according to DfT future of Transport):

1. Carbon Reduction
2. Citizen availability / uptake
3. Ease of Integration

Time

High impact in Energy for the short term (5 years) and long term (10 years).

7. Royal Mail Drone Delivery Trial

Isle of Scilly
2021

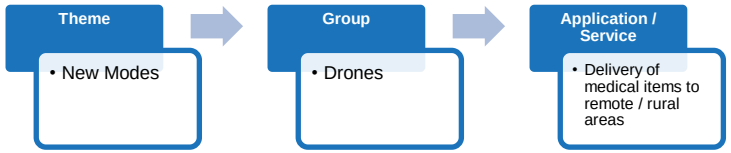
Description

Royal Mail is the first parcel carrier in the UK to deliver mail to a UK island using an autonomous flight that flies out of sight of an operator during a 70-mile journey. This involved a trial for a month, where a drone delivery service delivers PPE, Covid-19 test kits and other small items of mail from the UK mainland to the Scilly Isles. Royal Mail delivered its first parcel using a drone in December 2020, when it sent a package to a remote lighthouse on Scotland's Isle of Mull.

***Partners**: Cornwall Council / Isle of Scilly / Royal Mail*

Royal Mail drone delivery

Applicability



Objectives Met

Alignment with **Regional** and **National** policies, the key ones include:

1. Build Back Better Strategy (2021)
2. Drone deliveries and seamless end-to-end journey routing could connect UK's rural towns and communities (2020)
3. DfT Future of Mobility: Urban Strategy (2019)
4. Future of Transport: Rural Strategy
5. Clean Air Strategy (2019)
6. Road to Zero strategy (2018)

Relevance

The drone is a large, twin-engine uncrewed aerial vehicle (UAV), manufactured in the UK (by Windracers) that are designed to deliver supplies to people in remote locations and able to fly in poor weather conditions including fog. Parcels are to be flown to the airport by an unmanned craft that can carry up to 100kg of mail at a time. The items will then be flown by a smaller drone to delivery points around the Isles.

VTOL and aviation may have potentially large energy demands (for passenger and significant load carrying) and impact where they land.

The drones will rely on comms to have real-time connectivity to operate efficiently.

Implication

1. Reduced motoring and fleet costs
2. Reduced carbon emissions
3. Improved operation efficiency
4. Better connections to remote locations

Benefits *(according to DfT future of Transport)*

1. Carbon Reduction
2. Operational Efficiency

Time: High impact in Digital for the long term (10 years) and very long term (10 years and above).

8. Highways England NRTS2 / 5G Pathfinder region

Highways England / Cornwall / Isle of Scilly

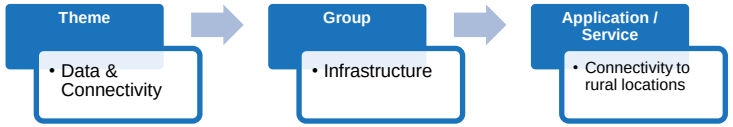
Description

National Highways has a £27.4 billion investment budget in the strategic road network (SRN) between 2020 and 2025 shows an unprecedented scale of ambition. As part of this ambition includes making available a new NRTS2 (National Road Telecommunications Service) wireless service for schemes where there is no existing fibre cabling. This is important for remote and rural areas.

***Partners**: National Highways / CIoS / Darwin Innovation Consortium*

NRTS2 / Pathfinder region / Darwin Consortium

Applicability



Objectives Met

Alignment with **National** policies, the key ones include:

1. National Highways Digital Delivery (2021)
2. CIoS LEP 10 Opportunities towards a local industrial strategy

Relevance

There are a host of reasons for poor rural coverage, which essentially reduce to geography, pricing effects, and business mode.

The NRTS2 service can be combined with CIoS LEP ambitions of d using Cornwall and the Isles of Scilly as a pathfinder region to pilot the rural deployment of 5G technology.

This may also be supported with Darwin Innovation Group, Virgin Media O2, Amazon Web Services and others are trying out a technology that instantly switches between 5G and satellite connectivity, this is being testing ubiquitous coverage in Cornwall. With the aim to produce a Darwin device to be sold to car companies that want to ensure their cars are never untethered from the network. It might also interest emergency services and other industries seeking to remotely control their devices.

Implication

There are regional and national motivation to enable rural areas to benefit from better services, reduces the digital divide and ensure the gap doesn't widen as 5G becomes more ubiquitous. As rural areas migrate from 2G/3G to 4G/LTE and eventually 5G, advances in technology can be rolled out to improve communities and peoples' lives.

Support for use cases:

1. **Enhanced broadband use cases**
    a. 5G hotspots – Cloud
    b. Virtual Reality & Augmented Reality – Cloud AR/VR, HD streaming
    c. In-vehicle infotainment – Video conferencing
2. **IoT use cases**
    a. Autonomous vehicles – Driving aids, Platooning, Autonomous driving
    b. Drone Applications – Field mission (agriculture), Logistics, Safety and Emergency interventions
    c. Tactile Internet – Remote surgery, Remote Health monitoring, Remote Education, Remote working

d. Industry 4.0 – Predictive maintenance, Advanced manufacturing, Environmental monitoring

Benefits *(according to DfT future of Transport)*

1. Operational Efficiency
2. Citizen Availability / uptake
3. Ease of Integration
4. Economic Growth Potential

Time

High impact in Digital for the short term (5 years), long term (10 years), and very long term (10 years+).

9. Using Digital Twin for Strategic Road Network

National Highways 2020

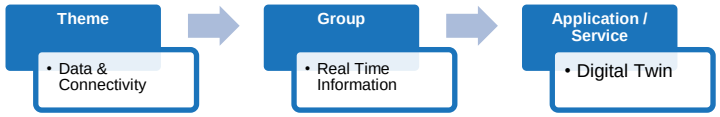
Description

As part of National Highways Digital Roads strategy, they have ambitions of increasing the use of 'digital twins' to improve the design and test the strength of the Strategic Road Network (SRN) for road users and operators.

***Partners**: National Highways / Cornwall*

National Highways Digital Roads

Applicability



Objectives Met

Alignment with **National** policies, the key ones include:

1. National Highways Digital Road (2021)

Relevance

A digital twin is a digital representation of a physical entity and its operation that can be queried. This will enable simulation of assets and improve ability to design, construct, operate and maintain with safety, customer, and environmental outcomes at the forefront.

Implication

The digital twin in combination with other digital tools can support:

- Intelligent asset management – enable predictive asset management. Better coordination of roadworks and the deployment of connected and autonomous plant will improve efficiency and reduce customer journey disruption.
- Digitally enabled design – Scheme designs, and long-term planning is based on fit-for-purpose data and enabled by digital tools. This enables safer, more efficient, and greener outcomes.
- Modularised and standardised approaches – Use of offsite fabrication and modular construction is increased, and components are standardised. This improves safety, reduces carbon emissions, and minimises disruption.
- Enhanced operational capability – Greater automation and network adaptability is enabled through the use of data and sensor technology. When the unexpected does happen, customer safety is enhanced, and traffic is managed efficiently.
- Digitally enabled workers – access to accurate, up to date and consistent information, enabling them to do work more efficiently and more safely.
- Information provision – providing accurate, consistent, and close to real time journey information through preferred digital channels.

Benefits *(according to DfT future of Transport)*

1. Operational Efficiency
2. Data Interoperability
3. Ease of Integration

Time: High impact in Digital for the short term (5 years) and long term (10 years).

10. Air Quality Monitoring at Key Locations

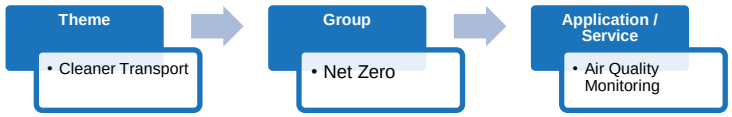
Somerset / Plymouth

Description

Air quality monitoring sensors have been placed in Somerset and Plymouth. Air quality monitoring sensors can now be placed at key locations where there is suspected to be high emissions (such as urban centres), at sensitive locations (such as hospitals, schools) or mobile air quality monitoring.
As of 2020, there is only one automated pollution monitor in Somerset, with the only other automated monitors at the moment are in Bridgwater, located on the major transport routes and checking particulate pollution levels as part of the Hinkley Point C nuclear power station project. Particulate pollution is not currently monitored elsewhere in the county.
Controlled Frenzy in collaboration with Elixel and funded by Plymouth City Council. Created wearable prototype hardware measuring particulate matter in the air with real time online analysis and mapping system.

***Partners**: Somerset / Plymouth*

Applicability



Objectives Met

Alignment with **Local**, **Regional** and **National** / **International** policies, the key ones include:

1. Clean Air Strategy (2019); carbon neutral 2030.
2. Decarbonising transport: setting the challenge (2020)
3. Plymouth Climate Emergency Action Plan (2019)
4. Somerset's Climate Emergency Strategy (2019)

Relevance

There is greater awareness of climate change and the impacts, alongside national goals of reducing emissions and achieving carbon neutrality by 2030. Data from sensors at key locations will help identify areas of high emissions in real time, and allow measures to be placed quickly in order to achieve emission targets.

Implication

Benefits *(according to DfT future of Transport)*

1. Carbon reduction

Time

High impact in Digital for the short term (5 years).

11. Platform for Journey Planning

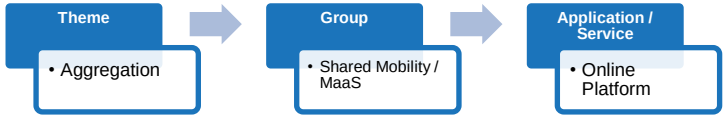
Description

There is an increase in the number of platforms to be used for Journey Planning in and across regions, these platforms can be used to promote Mobility as a Service (MaaS) and boost the use of shared mobility / sustainable forms of travel. Some examples include,

- Carshare Devon is a free journey matching website.
- TravelWest - links to a range of car sharing websites to help you find a suitable person to share your journeys with across the West of England.
- Other apps in the UK - include trainline (allows journey planning and the purchase of tickets or travelcards for bus, train, and tram services), Moovit, Whim, Google Maps.

***Partners**: West of England / Devon*

Applicability



Objectives Met

Alignment with **Local**, **Regional** and **National** / **International** policies, the key ones include:

1. DfT Mobility-as-a-Service (MaaS): acceptability research (2020)
2. DfT Shared mobility: user attitudes
3. DfT Future of Transport: User Study (2020)

Relevance

The implementation of a platform which incorporates Mobility as a Service can offer transport services into a single mobility service, offering diverse menu of transport options to meet a customer's request, including Ride-hailing services , shared mobility (ride-, car- or bike-sharing) / e-mobility (e-scooter).

Also, MaaS can offer added value by using a single application to provide access to mobility with a single payment channel instead of multiple ticketing and payment operations.

MaaS can be complemented with forward thinking mobility options offered by councils. For example, Plymouths Mobility hubs by 2023 with plans to install 50 Journey Hubs. This is in order to make travelling around the city cleaner and greener by encouraging commuters to use low carbon modes of transport. Each hub will provide EV charging points, e-bikes, EV car club and links to public transport.

Implication

1. Cost savings - contribute to shift include more affordable transportation options
2. Personalization & Optimization - tailors it rides to the needs of customer.
3. Simplified Payment - offering a subscription model and pay-as-you-go model
4. Healthier Citizens
5. Convenience
6. Reduced Congestion
7. Safety
8. Sustainability

Benefits *(according to DfT future of Transport)*

1. Citizen Availability / Uptake
2. Operational Efficiency

3. Economic Growth Potential
4. Data Interoperability
5. Active Travel

Time

High impact for the short term (5 years), long term (10 years), and very long term (10 years and above).

12. Plymouth Freeport

Plymouth 2021

Description

Plymouth City Council led a partnership with Devon Country and South Hams District Council as well as the Heart of the South West (HotSW) LEP on a bid to become a Freezone which would include sites at Devonport South Yard, Langage Energy Zone and Sherford Business Park. This freeport will unlock millions of pounds of funding, with aims to create space for businesses to import goods and materials, add value to them (by manufacture), and export them and leverage Plymouth's marine innovation strengths to attract big marine sector tech companies.

***Partners**: Plymouth City Council / Devon Country and South Hams District Council*

Plymouth Freeport

Applicability

Objectives Met

Alignment with **Regional** and **National** / **International** policies, including: Maritime 2050: navigating the future

Relevance

The aim of the freeport in Plymouth is to support businesses and create new jobs. Through allowing the tax-free zone, trade is promoted. This could encourage larger traffic and more demand for autonomous solutions as freight may benefit from CAV operation at these types of busier ports.

There are also Smart Ports that are being considered in the UK port cities and other regions globally. Catapult states that these ports could benefit the UK maritime industry in multiple ways. It states: "Technology enabled, active management of freight vehicles coming into the city could also be used to reduce peak-time congestion on the surrounding road network, improving resident transit times and reducing air pollution created by idling trucks queued outside the port."

Implication

As part of the bid the city can see:

- Commitment to high tech marine innovation with a focus on carbon zero technology.
- Up to 1,000 new jobs created in the first two years.
- Up to 9,000 new jobs over the next 10 years.
- Up to 50 new apprenticeships and 10 internships every year by 2027.
- More than 70 local businesses to benefit from the scheme, forecasted to bring in over £100m investment in the next six years.

The freeport could increase cargo traffic around in the peninsula region. The modern Intelligent Transportation Systems (ITS) technology could be utilised to better manage such traffic increase, and comms will be an integral part of the ITS, especially the upcoming Cooperative-ITS. It could also encourage larger traffic and more demand for autonomous solutions as freight may benefit from CAV operation at these types of busier ports.

Benefits *(according to DfT future of Transport)*

1. Economic Growth Potential
2. Operational Efficiency

Time: High impact for the very long term (10 years and above)

A.3 References

REF

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