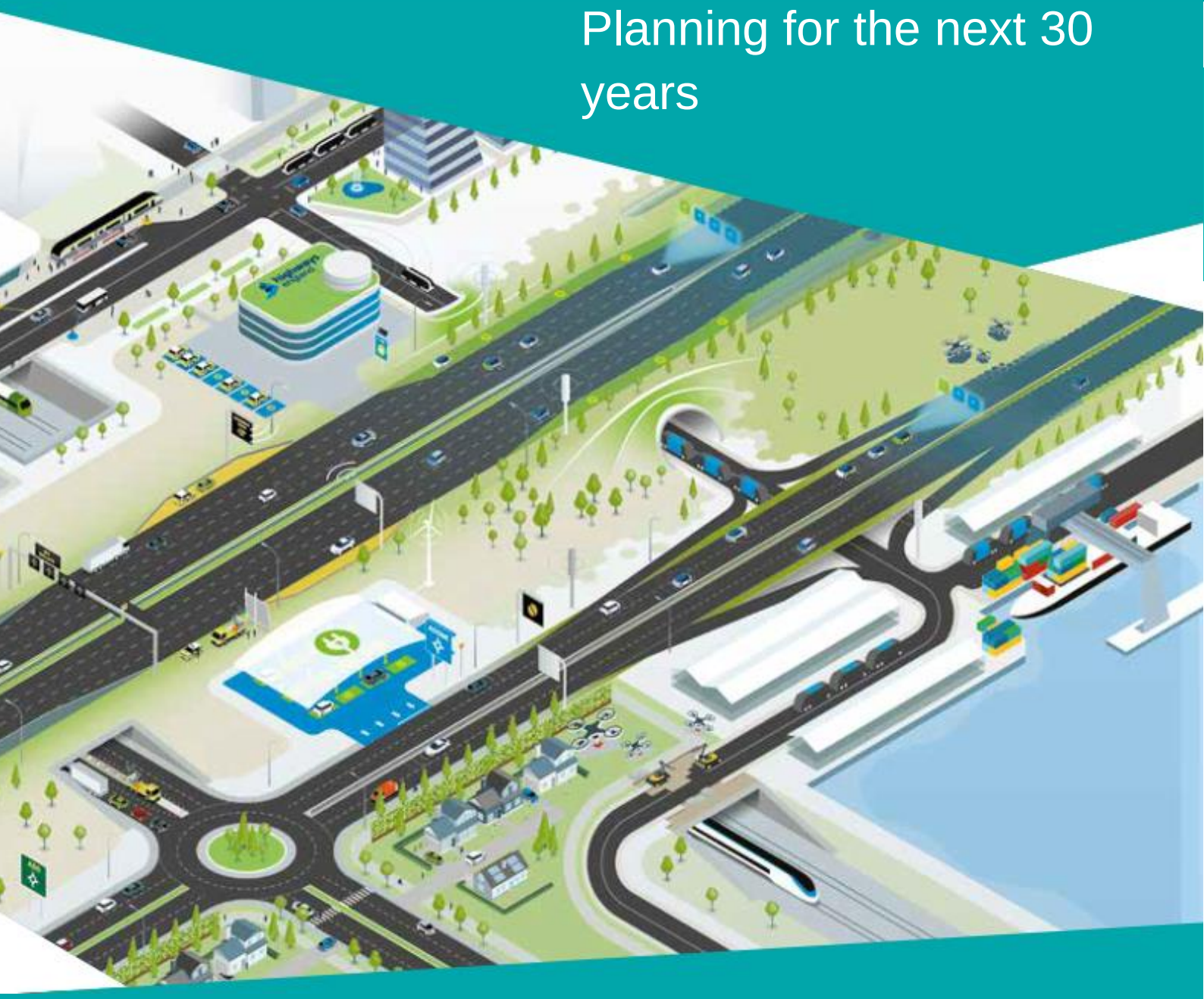
highways england

Pavements Innovation, Technology and Research Plan

Planning for the next 30 years



June 2019

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Introduction

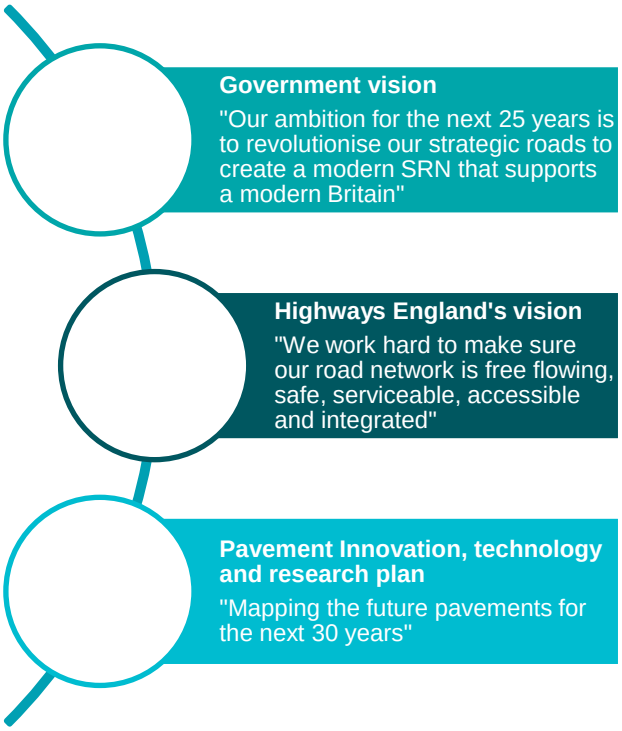
This plan for innovation, technology and research provides a method of action designed to achieve the long-term objectives of Highways England's Pavements Team.

It supports the Government's vision for Highways England and presents what the future could hold and how the network may look in terms of paving materials, construction technologies and maintenance operations.

This document aligns with Highways England's long-term strategy for the Strategic Road Network (SRN), presented in "Connecting the country: Planning for the long term", and focuses on pavements.

The future trends that will shape pavements in the next 30 years have been identified through consultation and are presented here to establish a starting point for the development of the network and provide a framework against which future activities can be gauged.

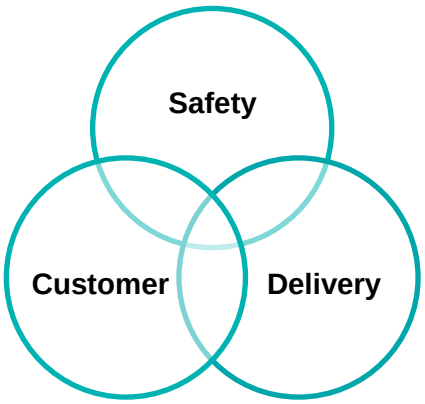
This document contains the background of the pavement strategy and Highways England's vision, together with the importance of innovation and the pavement focus research areas, with a plan for delivery.



Background

Highways England is responsible for maintaining, enhancing and operating England's SRN. The SRN is an essential part of the national infrastructure and **pavements are the most valuable asset** owned by Government.

Highways England's imperatives are 'safety', 'customer' and 'delivery'. In addition, the future SRN must be a key economic enabler, supporting vehicle technologies and maximising capacity, whilst leaving a positive environmental legacy.



The development of new materials and new technologies, inside and outside the sector, are changing the way pavements are built and maintained. Highways England is working to lead the change and be ready for what the future holds.

Highways England's Vision

Highways England believes that future investment in the SRN should be shaped by:

- Listening to customers and stakeholders
- Understanding assets and performance
- Considering Shareholder's priorities
- Planning for the long term

Work is focussed to enable a free-flowing network, with no delays, zero accidents and accessible to all customers.

Importance of innovation

An innovation, technology and research plan for pavements will help to deliver Highways England's vision, creating value for customers and stakeholders. **It is also critical to meet the economic and environmental challenges England will face over the next 30 years.** Conducting research is key to developing and implementing emerging technologies, new materials and ways of working.

Looking at the practical steps needed to be taken over the coming decades, six themes have been selected to focus research: design, materials, construction, connectivity, monitoring and maintenance.

These are described in the following sections concentrating on identifying the research needed to achieve the pavements of the future.

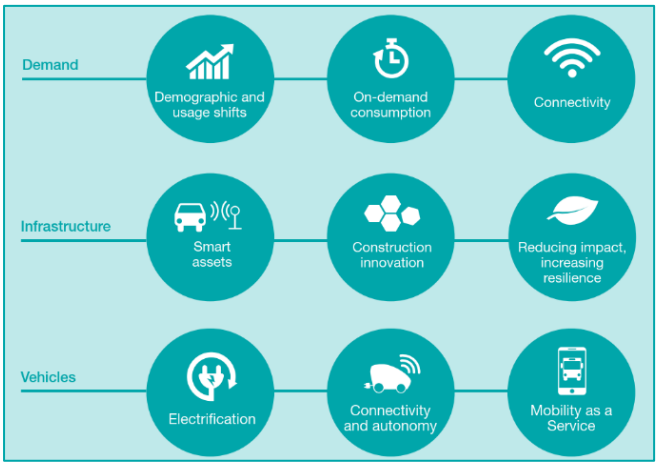
"To ensure our major roads are more dependable, durable and most importantly, are safe"

For pavements, this vision can be achieved by reducing construction and survey times, using more durable materials and mitigating hazards to customers and workers. This requires collaboration between Highways England and its contractors, suppliers, universities and the wider transport industry.

It is recognised that research in the short term has greater certainty than that placed further into the future; but this plan will provide an initial awareness of the SRN needs, making it possible to recognize the many challenges ahead, but also the great opportunities.

Future research will need to consider trends and projections in terms of:

- Demand: how will population grow, and consumption trends evolve considering connectivity;
- Infrastructure: how assets will become smart, improving construction and reducing environmental impact;
- Vehicles: from electrification to autonomy, changing the way mobility is delivered.



Innovation focus areas

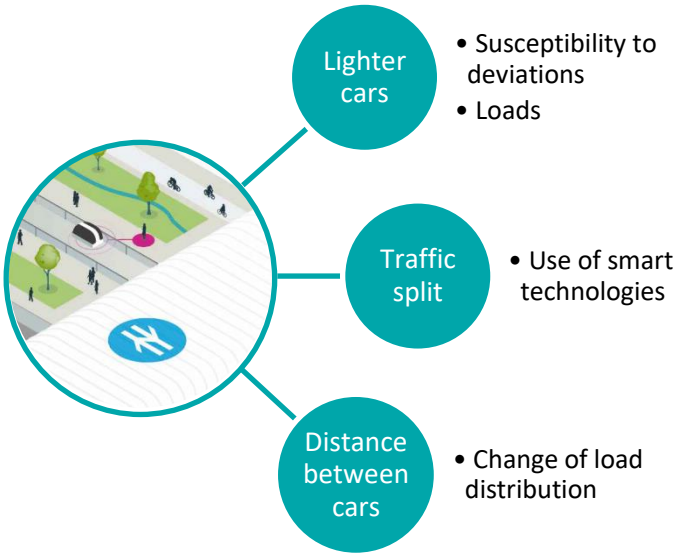
Innovation activities will be structured around the identified six themes (focus areas). These themes are interconnected, and research should consider all aspects.

1. Design

The development of innovation in this sector is strongly dependent on the technological progress in other scientific fields such as 3D printing and use of autonomous vehicles.

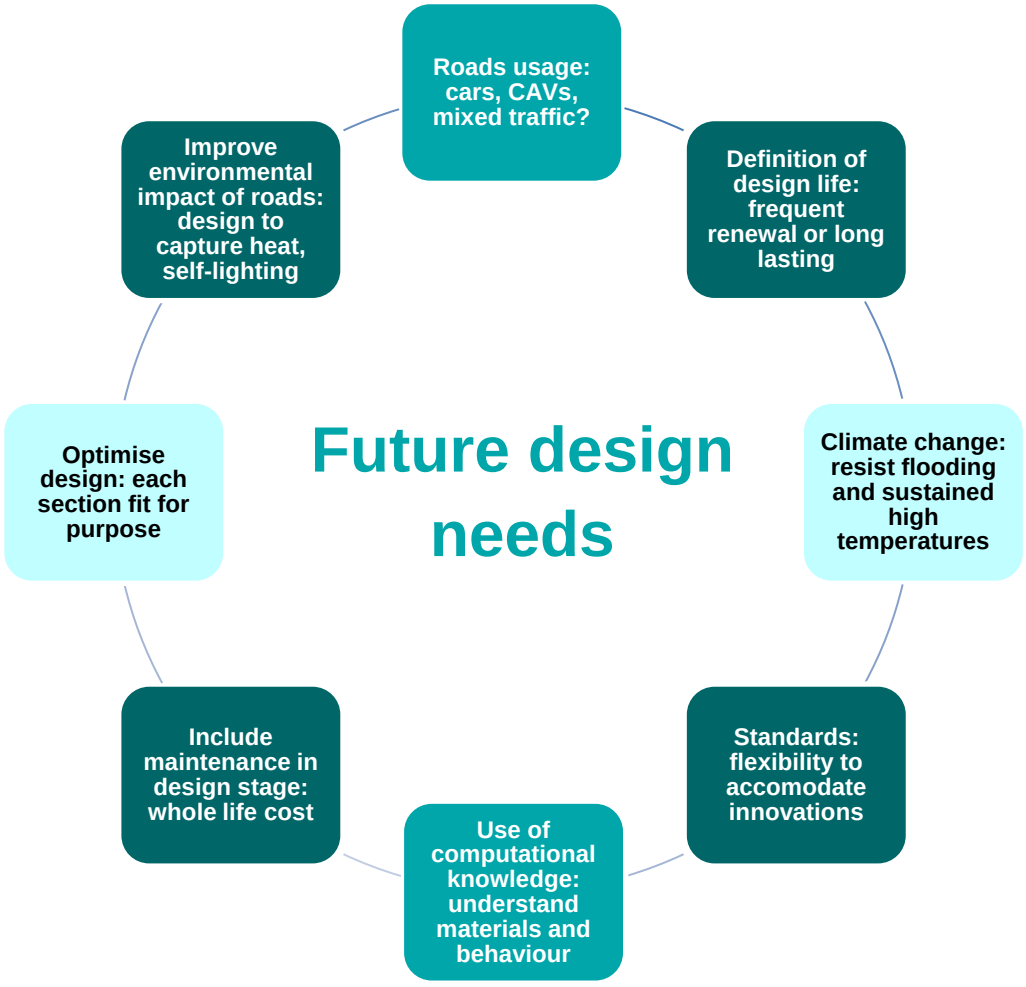
3D printing could allow the use of pre-cast concrete roads. Designers will need to understand the behaviour of these materials and be able to design durable and safe roads.

The emergence of connected autonomous vehicles (CAVs) will change traffic flows and load distribution. These changes must be considered to design pavements.



A futuristic design should consider how roads will be used in the future, the design life and maintenance requirements and how climate change will affect the performance of pavements. Investigation into these fields will be of critical importance to develop new standards fit for the future.

Environmental impact will be an important factor to consider when designing new roads or maintaining the existing ones. Optimisation of the use of materials will become of great importance and analysing the whole life cost of the asset will be key to inform decisions.



2. Materials

As in design, taking into consideration climate change and the new uses of the pavement will be key to develop the most appropriate materials.

New material trends are focusing on reducing the raw material consumption, as they are a finite resource, and reducing environmental impact.

Areas to be developed for future pavements are:

- bio-binders;
- waste materials in the mixes;
- artificial aggregates;
- pre-cast concrete;
- pollution absorbing materials.

Research will also need to focus on the reuse and recycling of these new materials, investigating how properties will change with time and reprocessing.

Optimising the use of resources will be led by the understanding of failure mechanisms, to be able to predict when maintenance is needed, using computational modelling and finite element analysis. Self-healing materials may be the future of self-sustaining pavements with zero disruption.

The introduction of new materials will take account of safety for road users, so a focus on developing better skid resistance surfaces and more durable structures is required.

3. Construction

Potential improvement in construction techniques will be led by technological innovation. The risk is that most of these changes may be driven by technological progression outside the sector. It is Highways England's aim to proactively research in these fields to be ready for what is to come.

Automation will bring roads constructed by robots and drones, with quality tested and analysed on the go with high precision. These technologies will bring safety to workers and less disruption to customers.

Technological advancements will transform the way we collect, share and use data, using machine learning to improve construction techniques and developing technology with a quick response capacity.

4. Connectivity and digitalisation

Connectivity will improve real time data used to connect the road to the user and the vehicles.

First steps towards a connected network have been identified as:

 Analysis of modes of transport	To understand which vehicles could be used to capture data
 Engage with vehicle manufacturers	To understand how the data could be captured and the connections needed

Connectivity should also consider how pavements can evolve to collect data, analyse what data should be collected and establish who will own the data and how to use it. This will impact pavements as embedded devices, such as sensors and cameras, will be placed within the pavement.

The main barriers identified in this regard are the ownership and storage of data, and how pavement life can be affected by embedded sensors and/or cables.

In the long term, digitalisation may be used for traffic management, which will improve the road user experience.

5. Pavement performance and condition monitoring

Monitoring research will be developed around technological innovation.

The aim is to use traffic speed monitoring to aid worker safety and avoid disruption on the network.

Research in this sector will focus on:

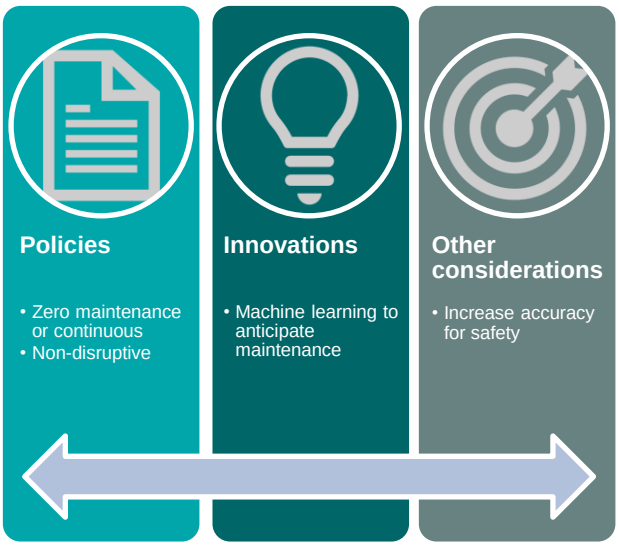
- Identifying properties to be monitored;
- Frequency of monitoring;
- Develop devices;
- Develop thresholds for the measurements.

The main challenge of monitoring is that CAVs may be more susceptible to deviations. To maintain safety, optimum road surface and marking quality must be maintained.

6. Maintenance

The way to conduct maintenance is linked to the way of constructing the roads.

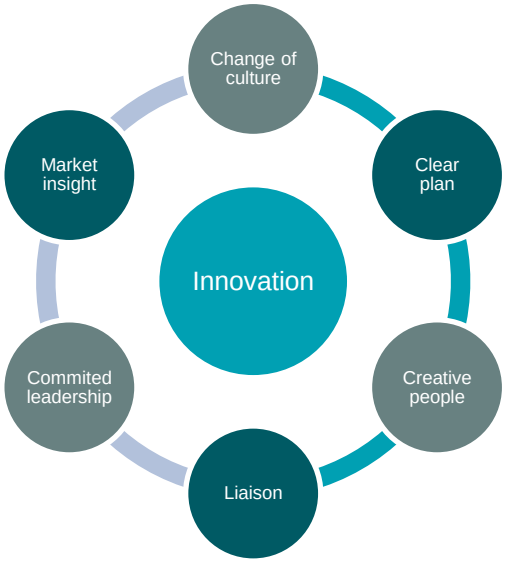
Automation, machine learning and research on construction techniques will all impact the way maintenance is carried out.



How to deliver innovation

Highways England's strategy is to liaise with universities, research centres, international bodies and industry to identify opportunities and get involved in innovation and research, sharing experience, skills, knowledge and costs, providing benefits to all parties.

Early engagement and communication with stakeholders to understand focus areas for development will be key and further collaboration to support innovation will realise better pavements.



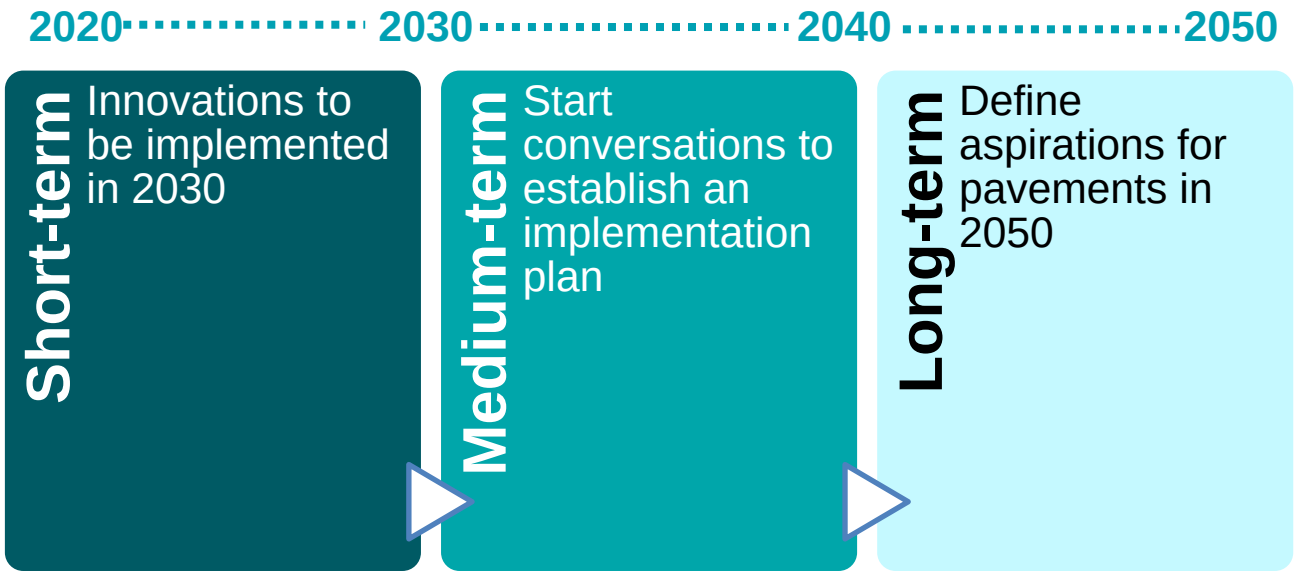
To support innovation, Highways England recognises that culture and behaviour should change, accepting that not all innovations will succeed; but using the knowledge gained to go forward.

There are three steps to innovation:

1. Strategy: set out the ambition and analyse "Why" innovation is needed and "What" needs to be investigated;
2. Implementation plan: create a plan to realise the ambition analysing "How" to innovate;
3. Delivery: implement the strategy and plan.

It is important to analyse time-scales as each innovation will have a different implementation period depending on the technological readiness level.

The focus now will be on developing those innovations that are market ready; looking at what is being done internationally. For the medium-term, focus should be on establishing the implementation plan for those innovations that will be ready in 5 to 10 years. For the long-term, defining aspirations and imagining pavements for 2050 should be the aim.



Next steps

Advances in the next 30 years are likely to revolutionise transportation. This document presents Highways England's view on how pavements should look, providing the platform to develop innovations.

Six research focus areas have been identified. These areas provide a first step to analyse what should be done now to be ready for the future.

Highways England will work closely with stakeholders to support future generations of pavements.

Innovation is about people working together to create value by implementing good ideas and new ways of thinking. Please contact:

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