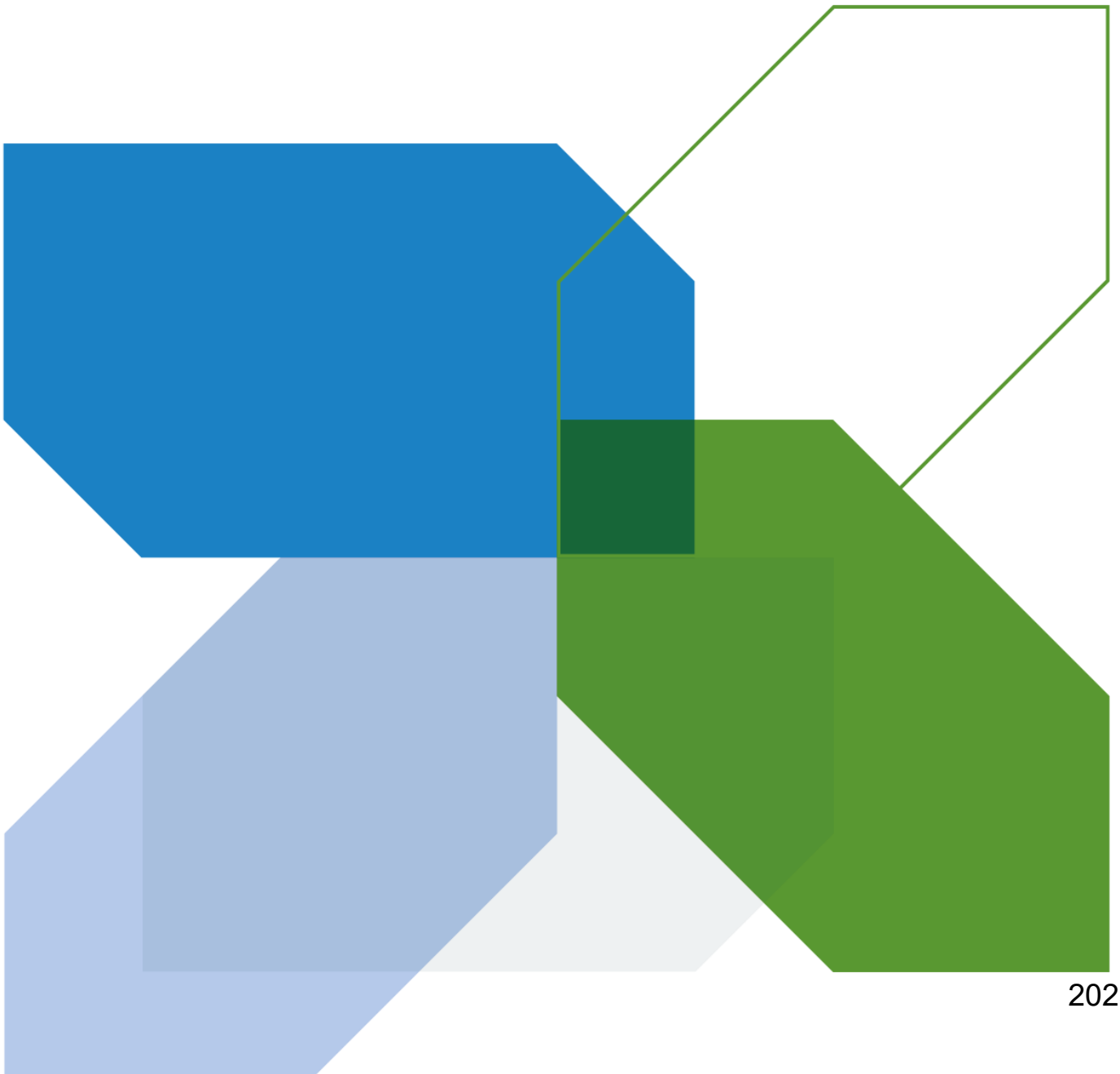
Department for Transport

DfT Science, Innovation and Technology Plan 2025

Making lasting impact with the Department's Science, Innovation and Technology System



2025

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Contents

Introduction by DfT's Chief Scientific Adviser

Transport enables people and goods to reach the right place at the right time. It underpins the UK economy, supports growth, and allows people to connect with their families and communities. Science and innovation are fundamental to achieving this more efficiently, reliably, and cost-effectively, while also making the transport system greener and more sustainable for everyone.

DfT has a rich history of successful science and innovation across all modes of travel. Ingenuity and invention have delivered impact ranging from new solutions for the electrification of the railways, to sophisticated air traffic management systems that ensure safe and efficient movement of aircraft through increasingly congested skies to new materials to create durable and safe road surfaces. These advancements collectively underscore DfT's and the UK's role as a leader in transport science, innovation and technology, continually seeking to improve the safety, sustainability, and efficiency of transportation networks. The challenges of decarbonising transport, sustaining a resilient transport system in the face of climate change whilst harnessing the opportunities presented by technology development influence the ways that we can make journeys cheaper, accessible and more enjoyable. Science advice and expertise is critical to supporting DfT and the transport sector in addressing these challenges, responding to emergencies and creating a thriving UK innovation economy.

Since the last Science Plan was published in 2021, DfT has had several significant successes. We have delivered large R&D programmes such as UK SHORE,[1] which established a new unit to tackle shipping emissions, and ZEHID,[2] the world's largest real-world demonstration of zero emission HGVs and infrastructure, advancing progress in maritime and heavy goods vehicle decarbonisation. We have supported cross government advice through the Department for Science, Innovation and Technology (DSIT) led Position Navigation and Timing (PNT) office, and engagement in programmes covering topics from quantum technologies to future construction materials. Notably, we published the first-of-a-kind comprehensive economic impact analysis for quantum in UK transport. We have established collaborative programmes with UK Research and Innovation (UKRI), through initiatives delivering critical mass expertise in Digital Twins for Transport Decarbonisation, Resilient Transport, Clean Maritime and Non-CO2 impacts of aviation.

[1] UK Shipping Office for Reducing Emissions (UK SHORE) DfT launches UK SHORE to take maritime 'back to the future' with green investment - GOV.UK

[2] Zero Emission HGV and Infrastructure Demonstrator (ZEHID) programme Government invests £200 million to drive innovation and get more zero emission trucks on our roads - GOV.UK

We have brought all DfT funded R&D activities together as a portfolio of funding to improve assurance and impact. We have supported adoption and diffusion of innovation through cohort-based schemes including the Transport Research Innovation Grants and Freight Innovation Fund competitions. And we have established an emerging technologies team to support the Department in understanding technological trends, feeding into advice and action on artificial intelligence (AI), quantum and advanced communications technologies.

The science expertise supporting DfT, from both in-house expertise and partnership with external teams is multidisciplinary and rich, covering a range of disciplines including physical sciences, social science and engineering. Our specialists in social and behavioural science, engineering, future fuels, road safety, dangerous goods, vehicle standards, traffic technology and security are embedded within policy teams to ensure close alignment between science and engineering advice and policy.

The Department is already a science-aware organisation, recognised by the Government Chief Scientific Adviser as an exemplar of a science department that effectively integrates scientific thinking into its work.[3] This Plan represents an evolution, building on DfT's existing strengths, focusing on making our science, innovation and technology activities more visible, systematic, impactful and assured, to put DfT in the best possible position to face the challenges of delivering transport for the future to be fit for the future.

As Chief Scientific Adviser, supported by the outstanding DfT Science and Engineering Profession I look forward to DfT continuing to work in partnership with industry, academia and government colleagues at a local, national and international element to ensure that we collaborate to support the delivery of an ambitious plan that ensures robust advice of the highest quality has the most possible impact on the ambitions of DfT and the transport sector. As this role transitions to new leadership at the end of 2025, I am confident that the strong foundations we have built will ensure this Plan continues to evolve and deliver lasting impact in the years ahead.

Professor Sarah Sharples

DfT Chief Scientific Adviser, 2021-2025

[3] https://committees.parliament.uk/oralevidence/14276/pdf/

DfT Science, Innovation and Technology Plan

The Department of Transport is responsible for policy, delivery, and investment. It works to ensure that everybody has access to a safe, affordable, accessible and efficient transport system that connects them to work and leisure and provides the goods and services they depend on while sustaining a growing, thriving economy.

This Plan sets out our ambitions across all areas of DfT, from teams directly working on innovation and technology policies and projects to those using evidence to inform policies and those whose work is not centred on innovation and technology but could be further enhanced by applying them. It also engages our partners—our Agencies and Arm's Length Bodies, across government, local and devolved governments, and with our external partners, including industry and academia. It underscores the vital role of science, innovation, and technology in our transport system, what we will deliver to improve and strengthen our existing systems, and how we assure that the Plan delivers its intended impact on the transport system. It recognises the part we all play in delivering these ambitions, emphasising collaboration and shared responsibility for success.

Science has broad application within transport, from physical sciences to engineering, from systems thinking to social and behavioural science. Scientific evidence from this range of disciplines enables us to drive innovation by transforming how we do things - whether through the development of new materials, the application of technology to better integrate different parts of a user journey, or the creation of advanced engineering methods for construction, monitoring and maintenance. However, innovation and the adoption of new technologies can introduce risk and uncertainty, and so our efforts must be embedded within a system that assures, sustains and supports science, innovation and technology effectively.

Science, Innovation and Technology is recognised as a strategic enabler of the DfT and Secretary of State Priorities, along with 'Data' which is covered in the Transport Data Strategy which will be updated in late 2025. The publication of this Plan comes at a time of uncertainty, opportunity and change for transport, nationally and internationally. Significant factors include:

1.1 As the UK recovers from economic disruption caused by factors including the COVID-19 pandemic, the surge in energy costs driven by geopolitical conflicts, and the recent cost of living crisis, the role of transport in this recovery is critical. Science,

innovation, and technology provide the tools to optimise transport systems, reduce costs, and enhance reliability while ensuring the economy's resilience to future shocks.

1.2 Climate change is challenging the performance of our transport system, making it essential that we understand the resilience of the transport system and where we need to change the way that we design and deliver infrastructure and systems to mitigate the effects of chronic changes in weather and significant weather events. Science and engineering insight can enable a systems perspective to be adopted to incorporate understanding of current and new materials and technologies to adapt current and design future transport systems to be resilient.

1.3 New technologies including navigation, sensing, integration and control systems are increasingly affordable and accessible to those delivering and using transport systems, necessitating rapid development of responsible approaches to regulation and policy to ensure that we can take advantage of the positive impacts of new technologies whilst understanding the new risks that they can present. By working to understand the capabilities and risks of new technologies we can ensure that transport systems are enhanced by adoption and diffusion of novel solutions for integrated transport, whilst maintaining safety, reliability and efficiency.

1.4 The urgency of decarbonisation continues to be a significant imperative, and transport will play a central role in supporting the delivery of Net Zero 2050 and interim carbon budgets. Domestic transport remains the UK's largest emitting sector, responsible for 29% of total greenhouse gas emissions in 2023 (rising to 36% when including emissions from the UK's share of international aviation and maritime).[4] Tackling these emissions requires the biggest changes to vehicles and energy sources in a century. Working in partnership with scientists and engineers across multiple sectors will inform our planning for adoption of low and zero-emission technologies, helping us to identify the most effective solutions for individual transport modes and for the transport sector as a whole.

1.5 Geopolitical factors – such as shifts in the distribution of global power and climate change – are creating a further level of uncertainty for supply chains and the economy. This environment may present the need to engage with difficult trade-offs, especially the need to strike a careful balance between economic openness, and national security considerations.[5] Continuing to support scientific advances in future solutions from solid state battery technologies to engineering biology will give us the greatest chance of reducing our reliance on rare materials and ensure that we have an appropriate strategy for future transport in a global setting.

Given this context, DfT must have confidence that its policies are informed by robust scientific research and enabled by clear understanding of the opportunities presented by innovation and technology to address the change needed. Science, technology and innovation enable safer, more secure and resilient transport systems against the threats and hazards of the future as well as those identified in the 2025 National Risk Register. We need to ensure that the Department has sufficient science capability and capacity to deliver its aims, clear and effective processes to connect science to policy making, and the

[4] *https://assets.publishing.service.gov.uk/media/67e3e460e8428b01705de02f/final-greenhouse-gas-emissions-tables-2023.xlsx*

[5] The Strategic Defence Review 2025 - Making Britain Safer: secure at home, strong abroad - GOV.UK

skills and processes to deliver successful innovation.[6] We must work in partnership with other sectors and government departments as appropriate, identifying areas of overlapping need, to provide the vest value for money and utilisation of critical mass centres of expertise. A strong science, innovation and technology plan will enhance the Department's ability to innovate, adapt, and lead in an increasingly complex environment, ultimately contributing to national growth and societal well-being.

The Science, Innovation and Technology Plan outlines how DfT will continue to deliver a science, innovation and technology system that ensures decisions are built on sound evidence and that our research and development investments deliver best value. It also sets out how we will support a thriving innovation ecosystem, enabling technology solutions that benefit citizens and create skilled jobs in our economy. If these aims are overlooked, there is a risk of ineffective policy, wasteful investment, and the unintended introduction of new adverse outcomes.

By embracing the opportunities to deliver new solutions through science and technology and enabling the adoption of innovation in transport systems and projects in an effective way, DfT can demonstrate and measure its impact on better, cleaner journeys and more affordable infrastructure. Encouraging industry and transport operators to work with new technologies such as AI means we can drive improved services and outcomes while at the same time supporting small businesses to grow and flourish in the UK.

This Plan lays out the current DfT Science, Innovation and Technology System and describes the next steps to ensure the pace of scientific and technological change continues to be supported in the transport sector.[7]

Through engaging with DfT policy and delivery teams, consulting the DfT Science Advisory Council and working in partnership through the Transport Research and Innovation Board, we have identified four pillars that provide a comprehensive framework for all science, innovation and technology activity from identification to wide-scale adoption. Together, these pillars form the DfT Science, Innovation and Technology System and identify areas of focus to drive excellence in the system.

The pillars are:

1. Seeing the Future: we understand and manage the future trends and future focused advancements on the horizon that will impact transport policy and the system in the future. This evidence-based approach will inform DfT and cross-government priorities for activity and investment.

2. Defining the DfT Research and Development Ambition: we invest in the targeted evidence needed and influence the sector to tackle the pressing complex challenges. This continued focus on all R&D across DfT as a portfolio will ensure that policy development is informed by the highest quality evidence which is targeted where it is most needed.

3. Delivering Science Excellence: we use robust evidence to deliver the right impact whilst ensuring best practice and value for money. This will maintain the strength of the science and engineering profession within DfT and make sure that all research,

[6] This also supports the vision and plans set out in A blueprint for modern digital government.
[7] The Science Capability Review 2019 specified that all government departments should have a clearly defined science system.

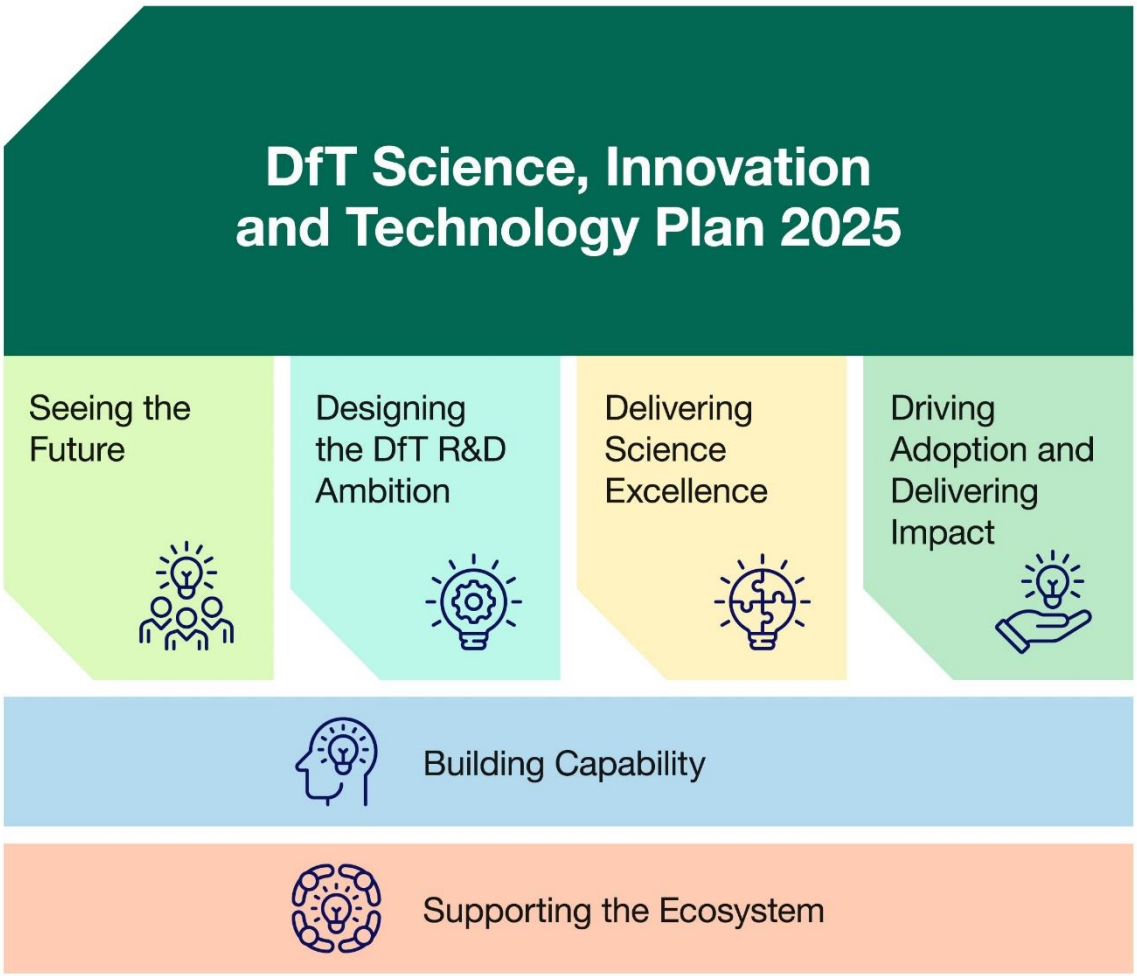
development and demonstration work is appropriately supported by expert challenge and experience of excellence in research delivery.

4. Driving Adoption and Delivering Impact: we support the adoption and diffusion of current and future innovations. This will ensure that novel solutions are able to deliver the rapid impact needed in the transport system and that we nurture a pro-innovation culture for DfT and the transport sector.

Two foundations support these pillars:

1. Building Capability: we develop and champion our scientific and technological capabilities needed to support the science, innovation and technology system across the department.

2. Supporting the Ecosystem: we engage with and support the vitality of the UK's research culture to discover the opportunities new technologies can bring to the transport system.



Case Study: Overhead line equipment research driving over £300m efficiencies

Escalating costs from the Great Western Electrification Programme (GWEP) by almost three times the original estimate, led to a drive to reduce the cost of electrification enhancement schemes as part of the decarbonisation strategy. An opportunity arose towards the end of the electrification project in Wales, at a large road bridge on the approach to Cardiff station.

In order to avoid reconstructing the bridge the challenge was to reduce clearances between the OLE contact wire and the bridge thereby avoiding costs of around £40m.

Key Facts

Network Rail, an external designer, coating and insulated bridge arm manufacturers, Siemens and University of Southampton adopting a collaborative approach, jointly developed a method of reducing electrical clearances down to as low as 20mm compared to the design standard requirements set at 270mm. An electrically insulating paint coating was applied along with surge arrestors and bridge arms to achieve a much-reduced clearance between contact wire and metal bridge over the railway.

This innovative project cost a total of £2m to conduct the research and carry out the first-of-a-type installation at Cardiff intersection bridge in 2019, where electrical clearances between the overhead line and the underside of the metal bridge were severely limited.

The significant benefits of this project, which challenge critical design limits for electrification, resulted in avoidance of bridge reconstructions which would have been extremely costly, and would also have caused significant disruption to passengers.

Impact

Application of this design approach across the rail network has saved more than £115m on rail electrification expansion schemes over the last 5 years across the Midlands, North and in Scotland. The innovative solution is forecast to save a further £200m over the next 5 years for electrification enhancement schemes.

Pillar 1: Seeing the Future

Technological advancements are fundamentally changing transport in a way that has not been seen for over 100 years. From the changes to responsibilities for drivers as a result of automation to the transformation of fuels being used across the transport system, transport in the future will be very different from that of the past. In the last 25 years, the world has seen connectivity and digital technology revolutionise how we plan journeys, access transport provision and manage transport networks, and new transport solutions from micromobility to drones are rapidly emerging. There is every reason to suspect that the next 25 years will see a similar, if not greater, transformation – particularly considering the imperatives of tackling and adapting to climate change and growing geopolitical uncertainty.

Science underpins both our understanding of the future and our response to it, through the creation of new materials through physical science; engineering resilient infrastructure; developing digital tools to improve the way we design, operate and access transport services and understanding social and behavioural trends that shape the needs which transport needs to serve.

This pillar describes DfT's work to understand future trends, apply foresight to generate plausible scenarios, and survey the technology landscape for emerging opportunities and threats, prioritising the most critical for more in-depth study and response. It will ensure that DfT has access to evidence-based advice on technologies of the future, enabling DfT, its agencies, ALBs and the sector as a whole to work from a clear understanding of the roadmaps of development and adoption of new technologies. This collective and collaborative understanding, in the context of a constrained fiscal context, is critical to appropriately inform prioritisation of funding, policy and regulation.

DfT's emerging technologies and futures team uses horizon scanning to identify new technological trends which we use to build understanding and evaluate and design an appropriate response. These involve:

- Monitoring development of the fundamental technology and emerging applications through horizon scanning and expert engagement.

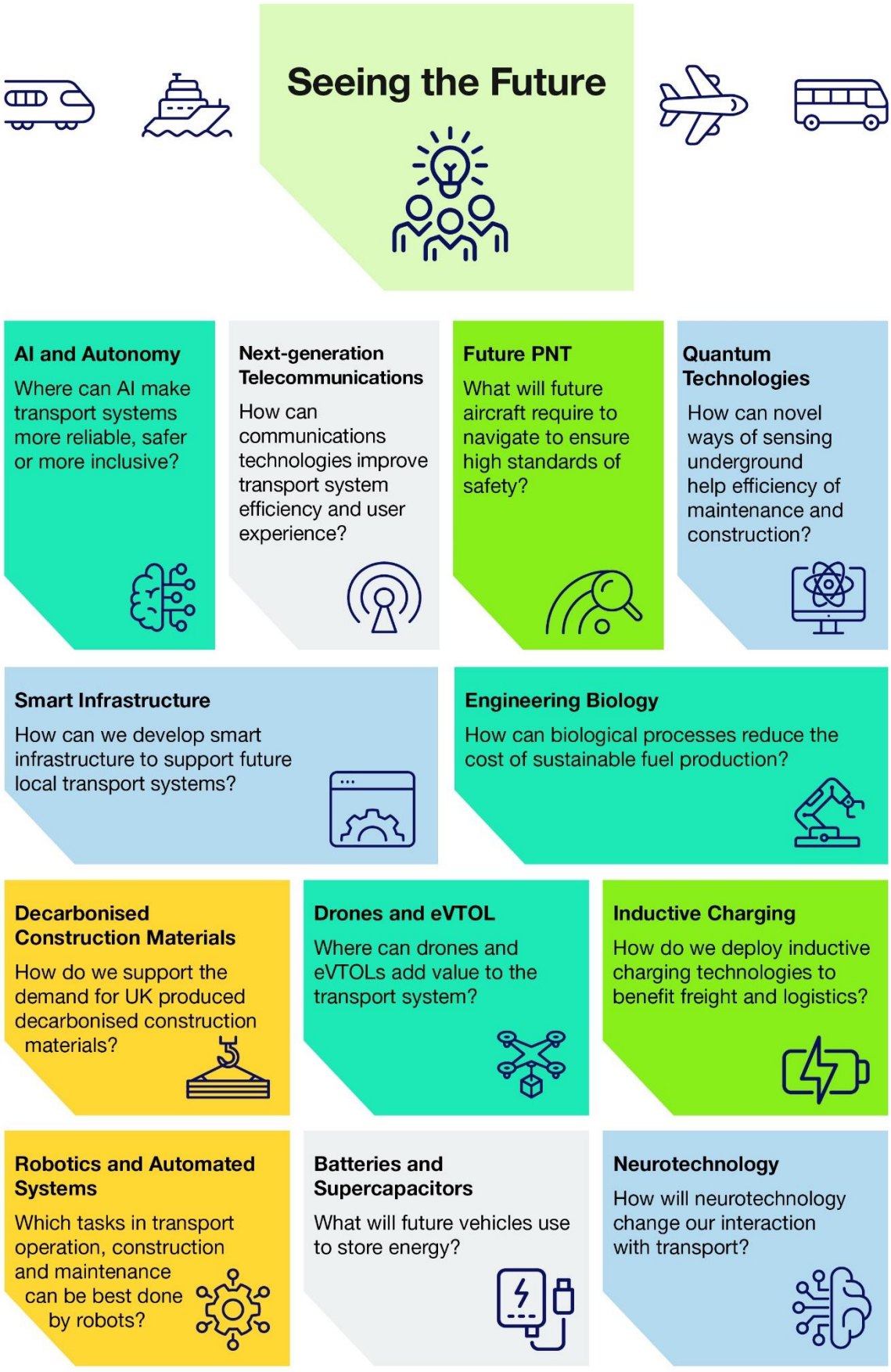
- Working with research funders to agree priorities through the Transport Research and Innovation Board and our programme of academic engagement.

- Working with actors in the innovation ecosystem to develop new approaches and solutions to support innovators develop transport products that meet DfT's needs

- Exploiting and adopting market-ready technology, removing barriers and creating pull so that technologies are embraced at a sectoral level by joining up policy makers, regulators and users.

In 2025, the current emerging technologies programme includes AI; quantum; position, navigation and timing; and future telecommunications. Further technologies will be continually added and retired from this list as technologies mature and objectives are met.

For this pillar to be successful, DfT must have access to suitable expertise, both internal capability and access to external world-leading experts, and the mechanisms which integrate this knowledge and insight into the work the Department does so that risks from new technologies are managed safely, and the significant opportunities they bring can be embraced for the good of all.



Pillar 1 **This figure shows what are the technologies of interest and how they can be applied to the transport system.**

Seeing the Future - Vision:

The UK transport system is prepared and supported to integrate novel technologies and trends as they emerge for the benefit of transport users. DfT actively looks ahead to systematically understand emerging technologies and identifies how to exploit the opportunities and advantages they offer whilst effectively managing and mitigating the risks they pose.

Within the next 3 years, we will have:

- A mature approach to technology change in DfT which systematically identifies the most impactful transport technologies as they emerge, identifies what should be done about them and communicates this broadly to align thinking. This model will allow us to take advantage of the opportunities the technologies could bring, whilst also robustly managing the risks they pose to the transport system.

- Made the consideration of future uncertainty an integral step in DfT policy making and operational decisions. Future trends, opportunities and risk information will be available to teams from the outset, leading to reduced costs of delivering the transport system and timely implementation of technology to improve the experience of transport use. Futures skills will be embedded across the department as a norm, starting with induction and continuing through the Civil Service Professions' individual offerings.

- Created the environment where the activities of the department support the maturation of beneficial technologies to improve transport whilst also driving growth. A curated set of technologies will be supported as they transition from identification to piloting and broad adoption in the transport sector.

Actions in the first year will include:

- Developing an internal technology strategy to join up thinking on the most important technologies, their potential impacts on transport and priority actions.

- Using our futures and emerging technologies capability, and work with other Teams in the Department to identify the opportunities and risks to the transport system stemming from disruptive technology-driven change in transport.

- Delivering the initial actions of the Transport AI Action Plan to drive the opportunities from AI for the transport system, safely and responsibly.

- Identifying the specific telecommunications needs of the different parts of the UK's transport network, putting connectivity at the heart of transport to and drive beneficial digitalisation.

- Supporting the Department of Science, Innovation and Technology's Position, Navigation and Timing (PNT) Framework to ensure the resilience of the transport system.

- Publishing a quantum vision which sets out how DfT sees quantum technologies impacting transport, how we intend to support their development and the uncertainty we see on that path.

- Target specific teams across DfT and it's ALBs who are particularly vulnerable to futures uncertainty because of the nature of their work and proactively offer services to build their capability. This means working with teams to understand uncertainty, communicate it effectively and embed its consideration into strategy, policy and wider decision making.

Case Study: Using AI to transform the deaf customer experience

DfT's emerging technologies work looks at how new and emerging technologies, such as AI, can create opportunities to improve the passenger experience across the different modes of transport. AI has the potential to create a more resilient transport system delivering cheaper, cleaner, and safer journeys for all.

In 2023, Innovate UK ran a DfT funded competition to accelerate innovation in the UK rail sector and enable technologies to be readily and efficiently integrated into the railway system. One of the winning projects was led by Signapse, which received funding and support to create an innovative AI-powered solution for delivering real-time transport information in British Sign Language (BSL) at railway stations. This software translates written text into sign language video using a photo-realistic digital signer, enabling deaf passengers to access translations on demand via screens and mobile devices. This innovation significantly aids rail passengers who may have difficulty hearing station announcements and communicating with staff, improving their ability to plan and complete journeys independently.

Key Facts

- The DfT funded competition 'First of a Kind 2023' was a Small Business Research Initiative (SBRI) competition run by UKRI (recently renamed Contracts for Innovation).

- This project integrated advanced natural language processing and computer vision techniques to translate travel announcements instantly into sign language.

- During this project, Signapse worked with Whoosh, a transport technology innovator, to make the solution available on-demand within their mobile dashboards, accessed via QR codes displayed either in-station or on-train. Network Rail and South Western Railway also supported them in the testing and demonstration phase.

Impact

Over 150,000 people in the UK use BSL. By using AI to expand the availability of transport information in sign language, this solution improves access to essential services for deaf passengers, promoting social mobility and a more inclusive travel experience.

Pillar 2: Defining the DfT R&D Ambition

Nothing is as constant as change. The need to adapt and respond can arise urgently, such as ensuring the transport system runs smoothly during a crisis like a pandemic. Alternatively, it may stem from growing and accumulating trends, such as an ageing population, requiring long term investments and policies that need to serve generations into the future. It may involve seeking out new opportunities, such as identifying the best way for transport to kickstart economic growth and deliver opportunities for all.

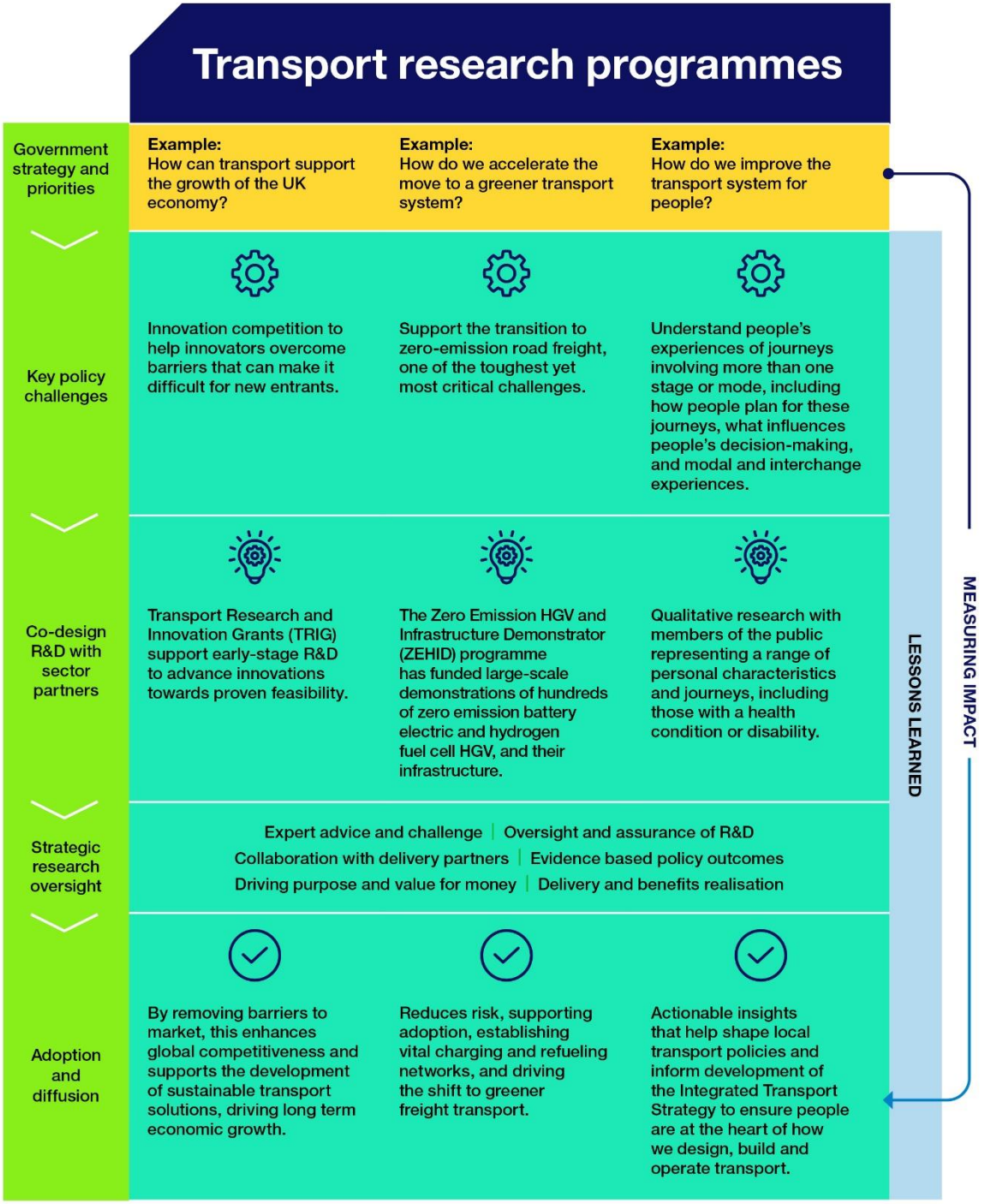
In a constrained fiscal environment, a prudent and focused approach to DfT-led R&D investment is vital to ensuring the best possible impact. R&D includes Research, Development, and Demonstration, enabling innovations to be explored, tested, and refined in both controlled environments and real-world conditions before being widely adopted. R&D plays a critical role in generating robust evidence to inform and shape effective new policies, ensuring decisions are underpinned in insight and innovation. The role of DfT funding may support the transport system by addressing market failures where the private sector alone cannot deliver solutions, leveraging industry investment to encourage collaboration, and providing a badge of recognition to new technologies as they progress through the technology readiness levels. Beyond direct funding, DfT also supports R&D by providing access to data, contributing expertise through Steering and Advisory Boards, and facilitating collaboration across stakeholders. Ensuring that funding from different parts of the transport system is complementary and mutually reinforcing helps create a healthy research ecosystem where the whole is greater than the sum of its parts.

In response to these needs, DfT designs and delivers an R&D programme that provides focused funding, support and management of a wide range of activity driving impactful research to deliver palpable outcomes for both policymakers and users of the transport network, in fields including: decarbonising transport, improving safety, enhancing the experience of transport users, addressing regional and community inequalities, transport resilience security, air quality and environmental sustainability.

DfT funding is only one small part of the overall government and industry support for transport research, development and demonstration. DfT therefore also works in concert with its Arm's Length Bodies, Agencies and other transport research funders such as UK Research and Innovation, including through the Transport Research & Innovation Board (TRIB), to have clarity over each organisation's programmes and activities. Through these partnerships we can identify where collaborative effort will reap the greatest rewards, beyond the capability of any one partner. By clearly identifying research needs and priorities we can influence the whole R&D ecosystem to ensure that we are working in

partnership with other funders, from across government, the academic research community and industry.

Having identified our priorities and programmes, we have a responsibility to apply good governance in managing investments through excellent project, programme and portfolio management skills. In 2024/25, DfT invested over £250 million in R&D, representing its largest annual R&D spend to date. Most of this funding was delivered through Innovate UK, which leveraged £189 million in match funding from industry and other partners during the 2021-4 spending review period. With such a significant investment, there is a greater need than ever to ensure robust processes, governance, and best practices are in place to maximise its value. To do this, we will get better at sharing our objectives, our plans and the results of our investment so that they attract the ideas, talents and resources of other stakeholders and investors, growing impact and capability right across the transport sector and wider economy.



Pillar 2 This figure shows how we design a transport research programme based on the priorities of the Department.

Defining the DfT R&D Ambition - Vision:

Targeted and focused transport research, development and demonstration (R&D) drives UK economic growth, enhances infrastructure and reduces cost, improves security, and informs the decisions needed to decarbonise the transport system. In DfT, we define the transport research questions and priorities at the right time and place, with the right methods and impact to get the most out of our investment.

Within the next 3 years, we will have:

- A portfolio of ambitious, targeted, and cohesive research, development and demonstration focused on support of DfT goals and aligned with the R&D programmes of DfT's Arm's Length Bodies and Agencies.

- Raised the profile of transport R&D in cross-government initiatives and worked in partnership with the DSIT, UKRI, other government departments, international counterparts, industry groups and investors, influencing and co-funding research where appropriate to ensure that transport research and innovation has value for money and delivers rapid and effective impact on the transport system.

- A consistent approach to monitoring and evaluation embedded in delivery of the R&D programmes to enable learning to inform the next steps. We will manage the transport research portfolio effectively to deliver against DfT plans and evaluate R&D impact through the policy/delivery cycle.

- Clearly demonstrated how we have used DfT R&D investment to benefit the public and grow the economy. We will have used R&D investment to influence and leverage private investment to focus upon key research challenges and share knowledge to enable academia and industry to exploit its use.

Actions in the first year will include:

- Establishing a strategic portfolio approach to managing transport R&D across the department with consistent and coordinated processes to support individual teams in procuring and funding R&D, with an accountable executive sponsor for every R&D project.

- Embedding proportionate monitoring and evaluation across the R&D portfolio, with a particular focus on large R&D investments, to develop good quality evidence on the outcomes and impacts of the department's R&D.

- Publishing an annual report summarising the outcomes of past R&D investment on the sector.

- Sustaining commitment to research integrity and meeting the Concordat to Support Research Integrity requirements by publishing outputs for all R&D projects as well as research plans for all larger scale R&D projects.

- Identifying like-minded countries for targeted international collaboration and alignment.

- Roadmaps to define the high-level objectives over the medium to long term to support UK security ambitions. Providing clarity on the direction of travel to support development of research projects, facilitating discussion and supporting equipment manufacturers to focus on long term objectives.

Case Study: UK Shipping Office for Reducing Emissions

UK SHORE is a DfT-led Programme, partnering with Innovate UK, the Engineering and Physical Sciences Research Council (EPSRC), the Connected Places Catapult (CPC) and industry to accelerate the technologies and fuels necessary to decarbonise our maritime sector. It is the first significant maritime R&D support offered by DfT and has cemented the UK as a global leader in maritime R&D, with many other countries building their own R&D programmes based on UK SHORE. At a time when the maritime sector is wrestling with the right fuels and technologies for their vessels and operations, UK SHORE provided direction and certainty which leveraged private maritime sector investment into UK R&D.

Key Facts

- Has supported over 300 organisations, spread across the whole of the UK, including coastal communities.
- For every £2 that DfT has invested into the R&D programme, private sector/industry has invested another £1.
- Early areas of focus have included understanding the roles for batteries, hydrogen, ammonia and other energy sources in maritime, developing on-board and port-side technologies to support decarbonisation and work on the wider maritime energy system.
- International collaboration to deliver Green Shipping Corridors, through £1.5 million for R&D with the Netherlands, Norway, Denmark and Ireland, and policy agreements with countries including the US and France.

Impacts

- Over 100 projects supported, engaging over 260 organisations from academia, industry, research, business and public sector and covering all regions in the UK.
- Bolstered the UK's shipbuilding sector, particularly small and medium businesses bringing innovation to maritime, such as the Artemis eFoiler® electric propulsion system for workboats, developed in Northern Ireland by Artemis Technologies, a spin off from the successful Artemis Racing team.
- Ten at-scale port and fuel infrastructure demonstrations working in a commercial capacity from March 2025, including electric ferries to Orkney, methanol and electric vessels supporting UK windfarms, an unmanned hydrogen Thames hydrographic survey vessel, and electric shore power at ports demonstrating greenhouse gas savings and air quality benefits.

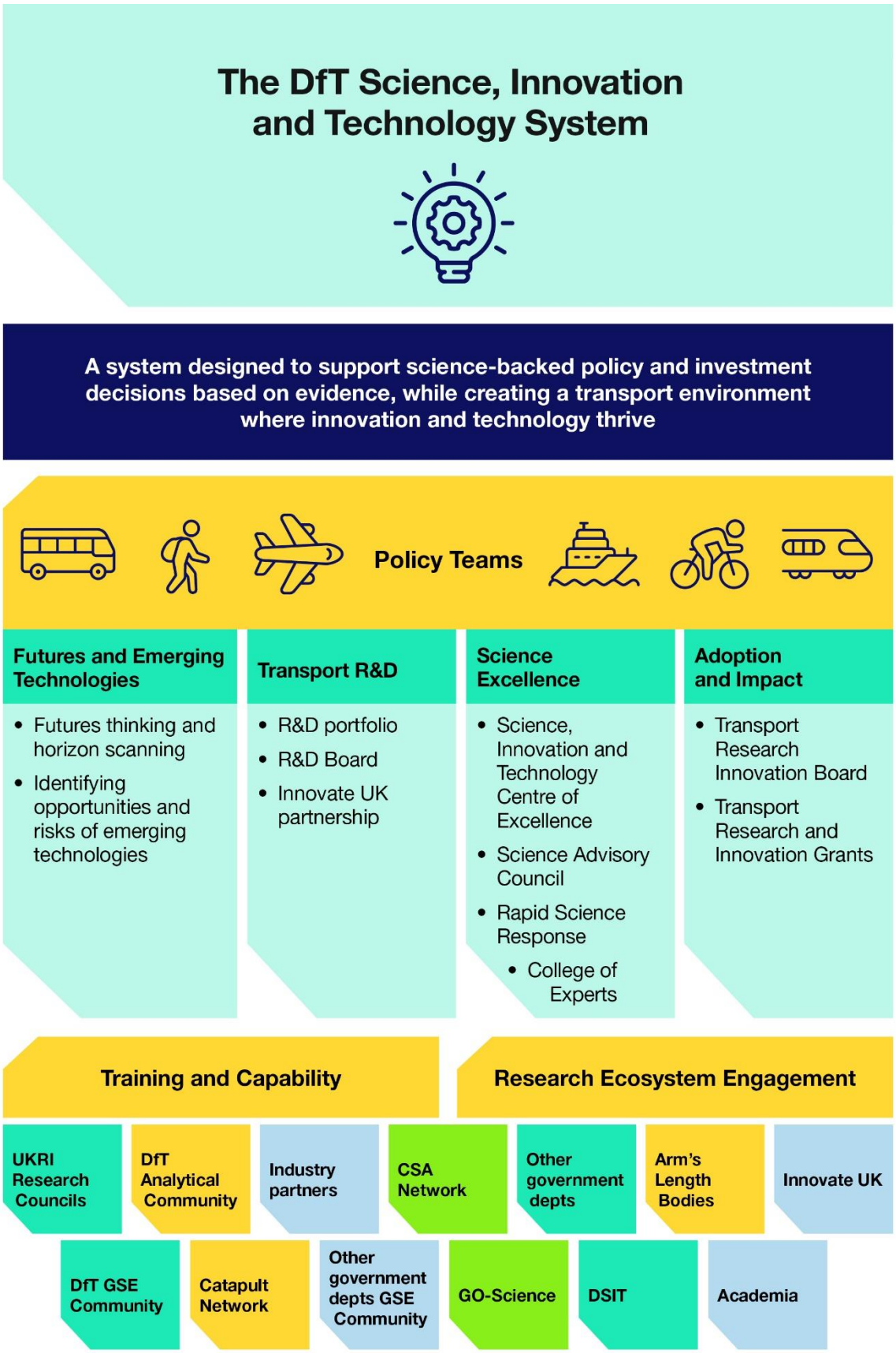
Pillar 3: Delivering Science Excellence

Transport policy and investment must be grounded in robust evidence to ensure value for money. A thoughtful and measured approach must be taken to implementing new technologies, being aware of real-world factors and unintended consequences. Transport affects all of us, and we should be assured that the government relies on robust scientific foundations for its key policy and investment decisions.

To support DfT's policy making and programme delivery, and to ensure investments deliver optimal economic return, it is crucial to ensure that they have access to the right expertise, at the right time, in the right place. This could be through peer review, independent challenge and insights from world-leading experts to inform options and provide assurance to support decision-making.

If government overlooks these aims, it may lead to ineffective policies, wasteful investments, and the potential introduction of new negative outcomes. Conversely, if DfT wishes to take an ambitious approach to the adoption of technology and innovation, it needs to have effective expert assurance to enable greater risk and reward within the transport sector, supported by a culture of curiosity, challenge and excellence.

This pillar outlines how we will provide access to the right expert capability in the right place at the right time. DfT does and will need to continue to embed scientists in teams that need a continuous source of deep and nuanced knowledge, as well as maintain support for the Chief Scientific Adviser's role of supporting DfT and its ministers. However, it will often mean providing access to external academic or industry expertise to policy teams directly, in an appropriate way, whether flexible, responsive, short term advice or on a more permanent basis.



Pillar 3 This figure shows the structure of the department's science, innovation and technology system, what support there is and the stakeholders involved.

Delivering Science Excellence - Vision:

Robust science, engineering, innovation and technology advice and evidence are at the heart of transport policy and operational delivery. DfT is supported and enabled by a strong science system and leads world leading collaborative partnerships across the sector, with academia and industry.

Within the next 3 years, we will have:

- A Department empowered by a clear and visible system to deliver targeted and focused science and engineering to support policy, innovation to create markets and technology to deliver an effective transport system and drive the UK economy.

- Clear support and knowledge management systems in place for the Department to access and leverage expertise in order to drive evidence-based policy that is underpinned by robust scientific and technological insight and challenge.

- A strong and strategic relationship with the transport R,D&D community to progress shared objectives within the transport system and proactively respond to rapid developments in the sector.

Actions in the first year will include:

- Developing a visible, focused hub for science, innovation and technology capabilities across DfT by creating a Science, Innovation and Technology Centre of Excellence in DfT.

- Clearly articulating the science, engineering, innovation, and technology internal and external advice there is to support staff, with a nominated Science and Technology Champion in each directorate in DfT to support this articulation.

- Developing a central repository of DfT research outputs to ensure long term benefits of R&D from past commissioned research.

- Delivering clear information for teams across DfT that sets out how, why, and when policy teams should access independent expert advice, supported by effective, streamlined processes to rapidly engage experts such as the DfT College of Experts, a standing group of subject leaders from industry and academia who can be rapidly engaged to advise.

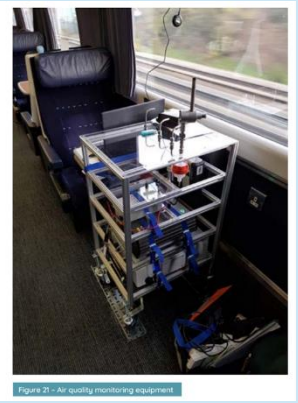
- Reviewing the R&D procurement and investment approval process, to ensure science advice and challenge in research, development and innovation projects is consistently incorporated from the outset.

- Expanding the reach of the DfT Science Advisory Council by creating more short-term focussed expert subgroups to tackle specific and immediate policy challenges whilst formalising the relationship with existing longer-term technical advisory groups and wider governance structures in DfT.

- Creating a package of best practices for the department, including a research, development, and innovation change methodology and a technology pilots and trials

guide, working in close partnership with the department's other Centres of Excellence, which will outline how technology focused policy and programmes should be designed for success and evaluated in a clear and consistent manner.

Case Study: The value of bringing in external expertise



In 2021, research funded by DfT and carried out by the Rail Safety and Standards Board (RSSB) in 2021 found elevated levels of nitrogen dioxide (NO2) and particulate matter (PM) onboard 13 types of diesel-powered trains. These findings raised concerns about air quality and prompted immediate action across the rail industry to validate the results and assess the potential health risks to passengers and staff.

To ensure the highest scientific standards and support evidence-based policy, DfT involved its independent Science Advisory Council (SAC). The council includes leading experts in air pollution and engineering, such as Professor Alistair Lewis and Professor Ricardo Martinez-Botas. It carried out an independent review of the study's methods, confirmed the findings, and advised on ways to improve air quality management on trains.

Key facts

- The SAC confirmed that NO_2 and PM levels recorded on some long-distance diesel train services exceeded indoor air quality guidelines set by the World Health Organisation (WHO).
- High NO_2 levels were mainly linked to diesel engine emissions, particularly on Class 800 bi-mode trains operating in diesel mode.
- PM came from a combination of engine exhaust, brake wear and re-suspended particles inside train carriages. These were affected by factors such as ventilation performance and passenger numbers.
- The SAC compared air quality on trains with other modes of transport, including cars and buses. It found that while some trains had higher pollution levels, others were comparable to or better than air quality at urban roadsides.
- The council stressed the health risks of long-term exposure to NO_2 and PM and recommended developing specific air quality standards for long-distance rail travel.

Impacts

In response to the SAC's recommendations, DfT introduced a package of measures to improve air quality onboard trains:

- Engineering improvements: DfT directed the rail industry to explore technical solutions, with a particular focus on Class 800 trains. After extensive testing, the train manufacturer developed a suite of modifications. These included improving ventilation systems, upgrading air filtration, and updating engine management

software to increase the use of diesel exhaust fluid (AdBlue), reducing nitrogen oxide emissions at the source.

- Further research: DfT commissioned RSSB to carry out further work to understand the causes of poor air quality onboard trains and how design improvements could help. This included analysing the chemical makeup of PM and identifying its sources. Results were published in 2024.

- Public health exposure assessment: DfT worked with the UK Health Security Agency (UKHSA) to assess public exposure to air pollution across rail environments, including onboard trains. This work is helping to build a stronger evidence base on the health impacts of air pollution linked to rail travel.

Pillar 4: Driving Adoption and Delivering Impact

The UK has a dynamic innovation marketplace for transport, which offers huge opportunities to tackle the challenges transport faces in the twenty-first century, such as an ageing population, and the many opportunities offered by new technologies such as AI. An equally important by-product of transport innovation is the creation of skilled jobs and investment in UK companies, boosting economic growth.

At DfT, we stimulate the innovation marketplace and unlock the potential for investment in scaling and adopting new technologies and services across transport. The Department has a strong track record of investing in innovation, for example through the established Transport Research Innovation Grant programme, which is consistently oversubscribed.

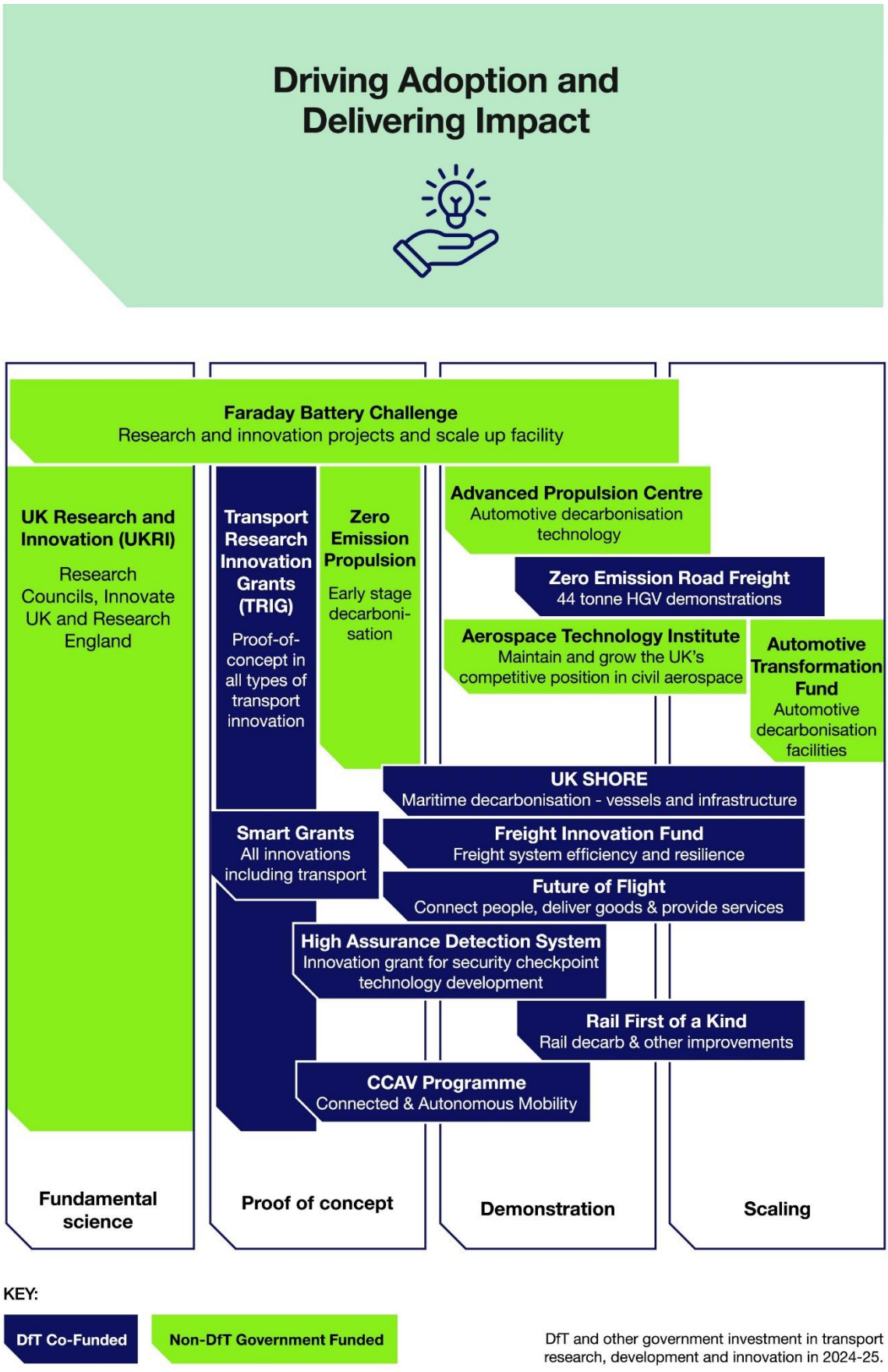
To translate those innovative ideas and early-stage technologies into real jobs, economic growth and tangible benefits for transport users, we need to understand and support innovation right through the technology readiness scale, not just at the demonstration or proof of concept stage but beyond that into scaling and diffusing new solutions so that they become part of everyday life. The transport sector has demonstrated its ability to be an 'early adopter' of technologies such as Artificial Intelligence[8] and can play a key role in supporting cross-government ambitions, including clean energy and growth, by aligning its procurement and implementation activities with other government priorities. The prize is that we deliver a more efficient, reliable, and cost-effective transport system that supports economic growth while being greener, safer, and more effective.

We will be conscious of the opportunity presented by a place-based approach to accelerating innovation. This is important because it encourages cities and regions to grow both upstream knowledge sectors, and downstream and adjacent industries, bringing partners together to create a thriving innovation ecosystem. Transport is by its nature place-based. Large infrastructure schemes such as East West Rail can, even during construction, drive growth along the Oxford-Cambridge corridor, capitalising on the world-leading expertise in those cities. The Midlands Innovation partnership brings together leading research universities to focus on real-world issues in that region. And by using major projects such as HS2, Heathrow third runway or Lower Thames Crossing to

[8] Automated Vehicles Act 2024

demonstrate the impact of technology and innovation, local industries can be encouraged to grow up alongside the new infrastructure.

Through the actions in this pillar, our aim is first to understand and then deploy the market engagement, support and incentives to create the circumstances for innovation to grow and flourish in the broader sector. This may mean supporting new technical standards, investing directly into new businesses, or looking at our own procurement to create the opportunity for innovators to thrive.



Pillar 4 This figure illustrates DfT and other government investment in transport research, development and innovation in 2024-5.

Driving Adoption and Delivering Impact - Vision:

The UK has a dynamic transport innovation marketplace, which has established mechanisms to accelerate the development, assessment and adoption of innovation (both products and services) into business-as-usual activities. DfT works with international partners, industry and academia to accelerate impactful innovation, using its influence, buying power, regulations and standards to promote market confidence and investment.

Within the next 3 years, we will have:

- Influenced the market conditions, through the use of regulations, guidance, data and standards to drive the development and adoption of impactful innovation within the key areas of the transport systems, such as automated vehicles and drones.
- Used DfT and its ALBs combined buying power to drive the adoption of cross modal innovation and influence the market to invest in impactful innovation.
- Clearly demonstrated in numbers and examples DfT's pivotal role in supporting the marketplace, guiding an active dialogue about opportunities and challenges, and leading UK innovators to achieve significant advancements in future transport systems.
- Identified a mature pathway for transport innovation for the sector, ALBs and the department, which allows the best innovations to move through the Technology Readiness Levels at pace.
- Established processes to scale, trial, and pilot early-scale technologies, accelerating progress towards clear outcomes for the transport system at both national and local levels, while mitigating risks and ensuring that technologies realise the benefits they were designed to deliver.
- Ensured the continuation of a key part of DfT's security assurance by refreshing a National Capability Testing Facility.

Actions in the first year will include:

- Strengthening relationships between DfT and the commercial sector to foster better collaboration and understand and address barriers to the adoption and scaling of impactful innovation in the real world.
- Creating a community of practice between DfT and its ALBs to share knowledge and experience in both innovation management and monitoring and evaluation of the impacts of innovation.
- Collaborating with Arm's Length Bodies and partners through the Transport Research and Innovation Board to identify and publish common priorities.
- Develop a shared programme of investment to tackle joint R&D challenges and barriers to innovation.

- A targeted investment programme to support the scaling of innovative small businesses in the infrastructure sector and the translation of research into practice.
- Sharing lessons learned and best practice for the delivery of large innovation programmes and demonstrators to shape future investment.
- Understanding that impact from innovation takes years to emerge, creating and reporting on a set of metrics to determine and demonstrate DfT's impact on sector growth and technology adoption, and what further steps DfT can take to accelerate scaling and adoption of innovation.

Case Study: Live Labs 2 to support the transition to net zero carbon local roads

Live Labs 2 (LL2) is a three-year £30 million project to help decarbonise the local highway network. LL2 is funded by DfT, but managed on our behalf by the Association of Directors of Environment, Economy, Planning and Transport (ADEPT). Local authorities were required to develop consortia involving both private sector and academic partners.

The programme involves seven local highway authorities trialling novel approaches to reducing carbon emissions from the operation and maintenance of the local road network. Collaboration is a key pillar of the programme, both in terms of drawing on the skills and knowledge of the wider sector and academia, as well as ensuring that project outcomes and benefits are shared across the whole highways sector to help it meet Net Zero.

Key facts

The seven projects are split into four distinct groups which are looking at reducing carbon from different highway functions:

- A UK Centre of Excellence for Materials, a centralised hub for research and innovation for highways materials.
- Corridor and Place Based Decarbonisation, a suite of corridor and place-based interventions with a mix of urban & rural settings.
- A Green Carbon Laboratory, examining how highway 'green' assets can provide a source of materials and fuels to help decarbonise the highway.
- A Future Lighting Testbed, considering what assets are needed and how they can be further decarbonised across their lifecycle.

Impacts

We are just starting the third year of the project, so it is too early to say what impacts it has had. However, to give a flavour this is a summary of the Green Laboratory project. South Gloucestershire & West Sussex have teamed up with the charity Plantlife for their ‘green carbon laboratory’ examining the role that highways ‘green’ assets such as grass mowed from roadside verges can play in providing a source of materials and fuels to decarbonise highway operations, for example, using biomass from green waste to create alternative fuels and asphalt additives.

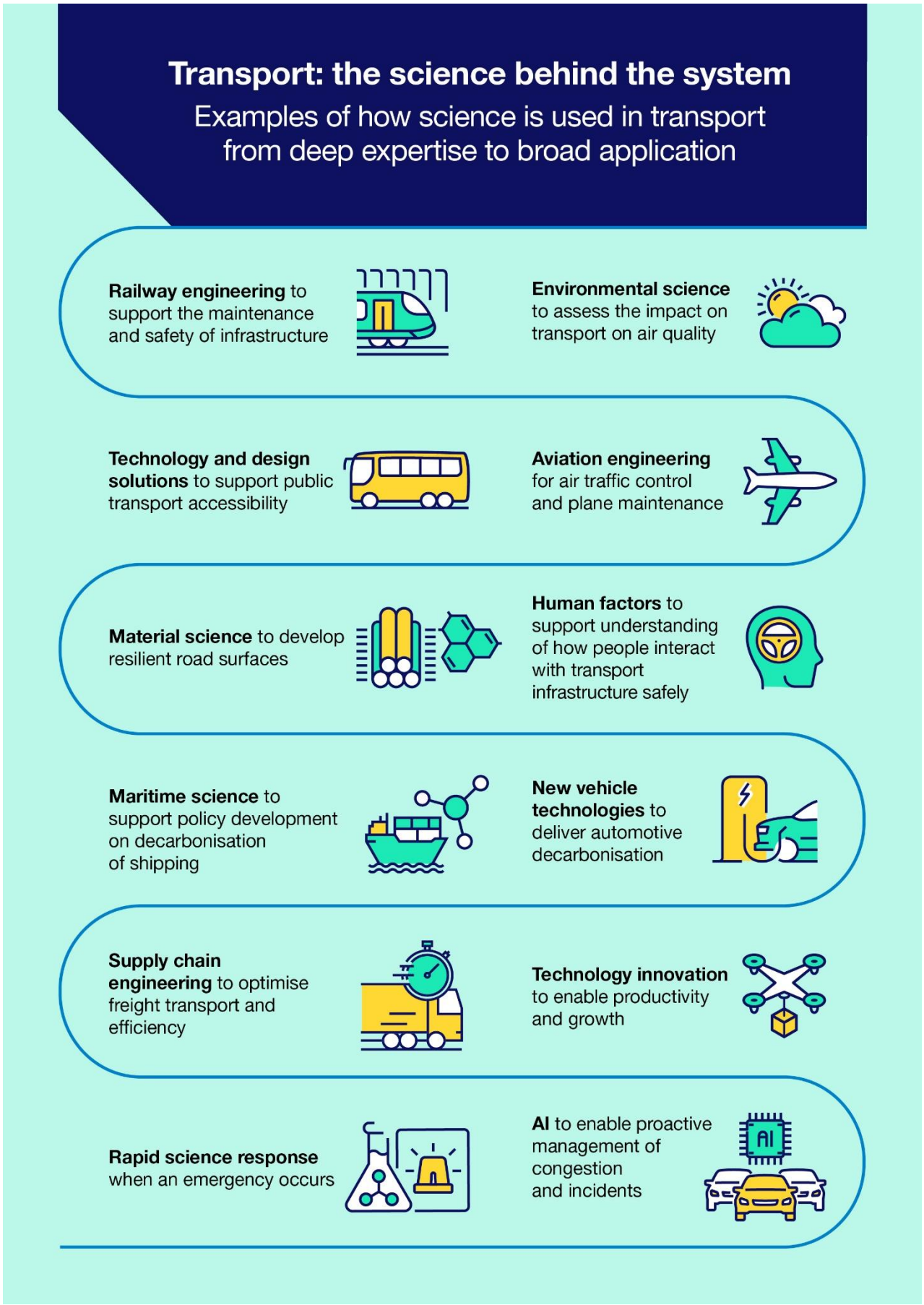
The project will also be looking at how ‘Rewilding’ can also help meet the challenge of reducing carbon on the highway network, encourage wildflowers, improve biodiversity help insects to thrive and allow the soil to store more carbon.

Foundation 1: Building Capability

This Plan sets out how science is critical to DfT, but we can only deliver a strong science, innovation and technology system through people.

We are very proud of the DfT members of the Government Science & Engineering profession we employ across the department, both in science-focused teams and other policy and analysis roles. To attract and retain capable, skilled scientists and engineers, DfT will continue to recognise and celebrate science, value their expertise, and offer attractive training, support and career progression. Whilst some policy teams will already have embedded team members who are specialists in physical science, social/behavioural science, engineering or systems thinking, other teams may need access to scientists and innovators but not have the opportunity or capacity to employ them directly. It is important that these teams understand when they need expert advice and how to commission and use it. Others may be delivering innovation programmes, or may need to understand the impact of future trends, but have little experience of working in these areas. We will ensure that non-scientists find science accessible and feel confident and supported in collaborating with external experts.

This foundation describes how DfT will support scientific, innovative, and technical capability across the department.



Foundation 1 This figure shows examples of how science and technology is used in the transport system.

Building our Capability – Vision:

DfT champions science, engineering and technology capability across the department and develops the skills, knowledge and infrastructure necessary to effectively leverage scientific and technological advancements.

Within the next 3 years, we will have:

- Have a clear capability package and career development pathway, built on Government Office for Science and the Government Science & Engineering profession best practice, that builds professional capability for all roles working in and with science, engineering, innovation and technology in DfT that has a measurable, positive impact on recruitment and retention.

- Been recognised as a leading department in using Futures and Horizon Scanning tools.

- Ensured that policy and operational areas have access to appropriate skills and knowledge to effectively purchase and manage R&D programmes, ensuring that R&D programmes are proactively managed in partnership with all relevant stakeholders.

- Developed an innovation training programme, providing a pathway for the development of Innovation Managers within the DfT and its ALBs, so that innovation management is recognised as a professional skill.

Actions in the first year will include:

- Regularly engaging with the GSE Profession led by the DfT Chief Scientific Adviser, DfT Chief Engineer, and other senior professionals across DfT with responsibility for significant Science, Engineering, Innovation and technology programmes.

- Establishing innovation courses and training programmes - skills provision and upskilling for GSE innovation leaders and early career individuals.

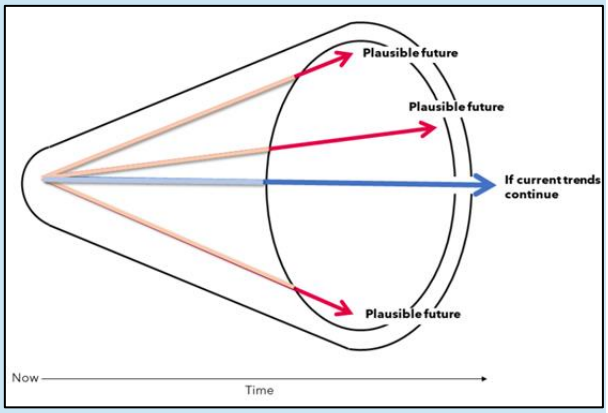
- Keeping our emerging technology and trends knowledge and skills up to date and sharing that knowledge through a wide network to stay relevant and be thought leaders.

- Building a network of Futures advocates as part of futures and technology capability building.

- Supporting new business models and establishing cross-functional teams to encourage the development of innovative products and services using the new flexibilities in the Procurement Act 2023.

- Exploring approaches to supporting development of technical careers of deep specialist scientists and engineers who are embedded within policy teams.

Case Study: The Futures and Uncertainty Community of Interest



The future can and will bring shocks to the transport system. This is especially true in recent times with technology disruption and geopolitical instability exacerbating uncertainties in today's already complex world.

The DfT Futures team aims at helping the department better understand long-term implications through embedding Futures Thinking and Horizon Scanning in its culture. Its aim is to establish a long-term mindset into the design, funding and evaluation of policy, which is at the foundation of the current government.

To support this purpose the team have created a Futures and Uncertainty Community of Interest to build capability and share best practice across key stakeholders within DfT.

The Community of Interest is open to DfT employees that have an interest in Futures and Uncertainty and want to understand more about how it could benefit their work – including through better use of methodologies, tools and techniques.

Key Facts

- The Community of Interest is open to all across the department.
- It brings external perspective and challenges and provides a safe space for learning and testing futures techniques.
- The members meet regularly to engage with external speakers. This activity is aimed at facilitating knowledge sharing and transferring latest intelligence and research across the Department.
- The members attend training sessions offered by the Futures team. This activity is aimed at upskilling officials in the implementation of Futures and Uncertainty techniques and tools found in the Government Office for Science Futures Toolkit that they can transfer to their work and their teams.

Impact

So far the team have delivered three engagement events and three training sessions and have run workshop sessions using Futures techniques to the members' teams. Driven by the mission-led approach, these teams are seeking to develop their strategy further and believe that Future thinking provides the perfect approach to look ahead to ensure their strategy is fit for purpose and for plausible futures.

Foundation 2: Supporting the Ecosystem

DfT sits at the heart of a dynamic and diverse transport and science ecosystem. Across research organisations, universities, supply chains and start-ups, scientists, engineers, and innovators are solving critical problems and creating new opportunities. Together with our Arm's Length Bodies, UKRI and other partners across government, DfT plays a crucial role in shaping the story of transport research in the UK. By providing policy direction, addressing operational and infrastructure challenges, and offering funding, DfT helps to sustain and guide the broader transport R&D landscape. In turn, we rely on the expertise and creativity of this community to deliver the solutions needed that help us fulfil our role and achieve our objectives.

To tackle complex challenges such as decarbonising transport, enhancing safety, and cutting costs, DfT must utilise expertise from both academia and industry. This collaboration must be straightforward and efficient, making it easy for experts to engage with government. However, this valuable resource will only be there when we need it if we maintain ongoing engagement, dialogue, and support. Strong and healthy institutions must be nurtured to enable world-leading experts to flourish and develop the next generation of talent through sustained research investment.

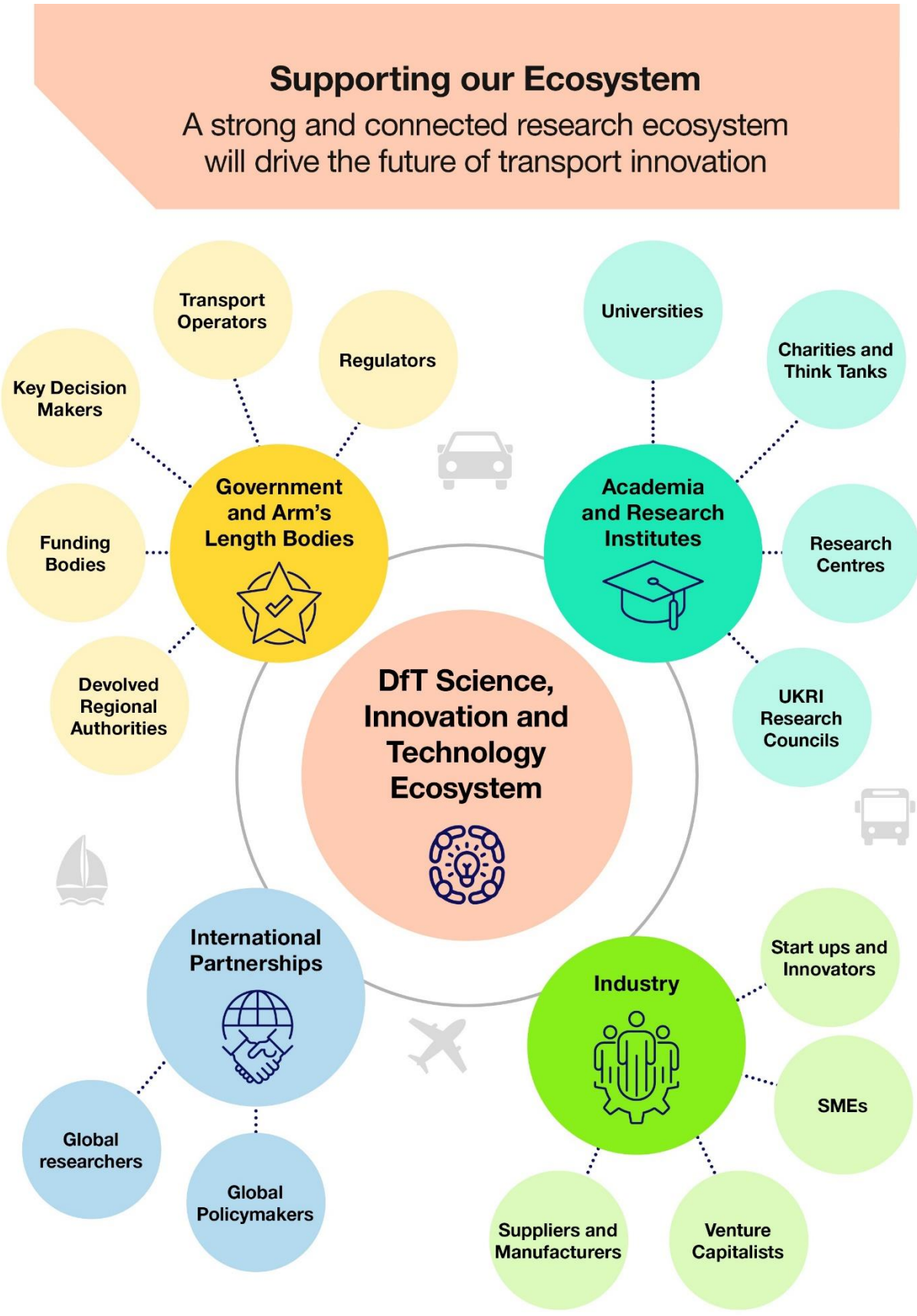
UK transport is part of a global system, and the UK must work with international partners to develop global solutions. International relationships with governments, industry and academia make a meaningful contribution to the UK's science and technology capabilities and is a key element of "soft diplomacy".

The vitality of the UK's research culture is central to the success of this Plan. DfT's direct funding is just one part of a broader ecosystem of university research, start-ups, and industry innovation that will modernise and improve the transport sector, delivering cheaper, better, and greener journeys for all. Retaining knowledge, creativity, and research investment in UK expertise is crucial to sustaining a competitive and vibrant transport sector.

The ecosystem and DfT must work together. Just as DfT needs to understand the nature of the research sector and how to help it succeed, we must also support individuals and institutions to better understand how government works so they are well-positioned to support us.

This foundation describes how teams across DfT will collaborate to lead and support the transport and science community. By nurturing a self-sustaining ecosystem built on shared

understanding and ambition, we can drive the transformation our goals demand, whilst supporting wider growth of the sector.



Foundation 2 This figure illustrates the key stakeholders in the DfT Science, Innovation and Technology Ecosystem.

Supporting the Ecosystem - Vision:

DfT successfully supports and sustains a vibrant, thriving research and innovation sector through working closely with its key partners in academia and industry to grow new talent and secure the UK as a world leader in transport research and innovation.

Within the next 3 years, we will have:

- Communicated a clear picture of government funded research for the transport sector and regularly articulated the sector's key challenges and research requirements, influencing the sector's direction to ensure effective resource use and drive increased engagement with critical transport issues.

- Collaborated with the ecosystem to create new methods to engage and partner with academic experts, supporting an exchange of knowledge and ideas across government and academia. Delivered a transparent and joined up network of experts who provide advice on current and future challenges.

- Championed the needs of the sector and supported the ecosystem to grow, including internationally, bringing in a new generation of experts and solidifying the UK's role as a leader in transport research and innovation.

Actions in the first year will include:

- Partnering with DSIT and UKRI to convene and communicate government funding research for the transport sector to the broader research ecosystem.

- Identifying and communicating future high level research and evidence requirements through an update of the DfT Areas of Research Interest.

- Creating a structured and coordinated approach to DfT's capacity in providing external advisory support for research challenges and projects, including participation in advisory boards and panels.

- Establishing long-term mechanisms for experts and academics to engage with government, building organisation-level partnerships through grant funding models, such as Catapults, and creating individual-level opportunities through secondments, internships, and collaboration with Centres for Doctoral Training (CDTs).

- Supporting experts to tackle transport's key challenges by publishing, where appropriate, advice we receive and convening ad hoc round tables for experts to engage with government officials

Case Study: The National Hub for Decarbonised, Adaptable and Resilient Transport Infrastructures (DARe Hub)

Launched in September 2023, the DARe Hub is a £10m academic research programme part funded by DfT and the Engineering and Physical Sciences Research Council over 3.5 years. The Hub is led by Newcastle University alongside the universities of Cambridge, Glasgow and Heriot Watt and is applying a 'system of systems' approach to the dual challenge of decarbonising transport infrastructure while ensuring increased adaptation and resilience to the effects of climate change. Through building a range of over 30 project partners from local, regional and national government, DfT delivery bodies, transport authorities and industry supply chain members, DARe is supporting the entire transport community in co-creating pathways and solutions to deliver a resilient, net zero system.

Key Facts

- The DARe Hub's core Work Packages explore climate resilient development pathways, open-source modelling frameworks, the physical implications of infrastructure systems performance and real-world policy impacts.
- Running throughout these Work Packages are a series of strategic priorities, which include electrification to achieve decarbonisation, improving quality of life for citizens, digitalisation of systems and construction materials.
- A ring-fenced Flexible Fund of £2m is available to researchers from UK universities to co-create small projects that complement the core DARe Hub programme, with three calls for applications launching over the Hub's lifespan.
- DfT and its delivery bodies National Highways, Network Rail and HS2 Ltd. engage with DARe regularly to ensure outputs are relevant and impactful in terms of long-term policymaking.

Impacts

The DARe Hub's vision is for climate resilient, net zero development of the transport system to be guided by systems analysis. Through the integration of a range of models, decision makers will have access to data that demonstrates how transport is performing against resilience, decarbonisation, and other objectives, now and in the future. DARe will deliver systems models that help to pinpoint vulnerabilities and quantify the risks of failure, enabling users to perform 'what if' analysis of proposed investments. This will also enable scenarios to be stress tested for the major uncertainties that will determine the performance of future transport systems, such as population growth, new materials and technologies, and climate change.

Progress and Next Steps

This Plan outlines our vision and intent for Science, Innovation, and Technology in DfT. It includes a series of actions designed to achieve our ambitions, and these actions will be tracked in a clear delivery plan for each pillar and foundation to monitor progress. The DfT Chief Scientific Adviser will be responsible for ensuring these actions are carried out.

To implement the actions, we will work collaboratively with colleagues across the department, other government departments, and key stakeholders throughout the UK. The actions have been assigned timeframes, and we will regularly review our progress during this time. After three years, we will carry out a thorough review of our strategic approach, which may include an update to this Plan.