

Decarbonising Transport

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Contents

4 **The Challenge**

5 **The Road to Decarbonising Transport**

7 **Research Priorities**

8 Systems modelling to support decision making

9 Technology development, monitoring and evaluation

10 Stimulating and optimising demand & operational efficiency

11 Net zero carbon planning and audits

12 Climate adaptation and resilience modelling

13 **The Transport Transition**

14 **About TRL**

15 **Strategic Themes**



Executive summary

The UK's Green Industrial Revolution vision announced by the UK's Government at the end of 2020 requires the development of an immediate, comprehensive and well-funded decarbonisation plan. A plan built around a broader industrial strategy that considers carbon prices and other environmental, social and economic policies, positions the country in the right path to meet the UK interim carbon budgets and achieving net zero by 2050. This will require major changes to how people and goods move, implemented through a system-based approach.

TRL has a deep technical understanding of new transport solutions and their societal implications, as well as the potential changes required to associated policies and regulations, market structures and energy systems. Consideration of consumer experiences, choices and motivations is paramount to successfully manage a transition to net zero journeys that deliver environmental, societal and economic success.

TRL is a global centre of excellence in transport and innovative mobility solutions. We have an internationally recognised team of scientists, researchers and consultants who are providing solutions in:

- **Systems modelling to support decision making**
- **Technology research and development; monitoring and evaluation**
- **Climate adaptation and resilience modelling**
- **Stimulating and optimising demand & efficiency**
- **Net zero carbon planning, roadmaps and audits**

The challenge

The scientific evidence linking climate change to human activity is overwhelming. A changing climate is the most significant threat to our environment, which if unaddressed, will have far reaching and devastating implications for our planet, our societies and the global economy.

Recent research suggests that to avoid the most dramatic consequences of the climate emergency, warming should not surpass 1.5°C ¹, a very challenging target considering that the temperature in the UK has already increased by 0.9°C in the past decade². In 2019, the UK government passed national legislation that requires 'net zero' Greenhouse Gas (GHG) emissions by 2050, a challenge that will require a combination of solutions including efficiency improvements, behavioural changes and innovation.

There have been large decreases in energy emissions in the UK since 1990, but transport emissions remain relatively static (Figure 1). Transport accounts for a third of all carbon dioxide emissions in the UK³ and became the largest emitting sector of GHG emissions in 2016. Achieving net zero transport emissions by 2050 necessitates urgent action and a radical overhaul of how people and goods move. It will require significant and coordinated investment, including economies of scale to reduce the costs of existing zero carbon technologies, fundamental technological changes and breakthroughs, new supporting infrastructure, affordable public transport services and favourable policies.

To realise the 2050 obligation, we need to make progress now decarbonising even the most difficult transport modes by promoting active travel, electro-mobility (micro mobility, battery, catenary and fuel cells vehicles) and alternative low carbon fuels for rail, shipping and aviation. Figure 2 overleaf illustrates the scale of the challenge.

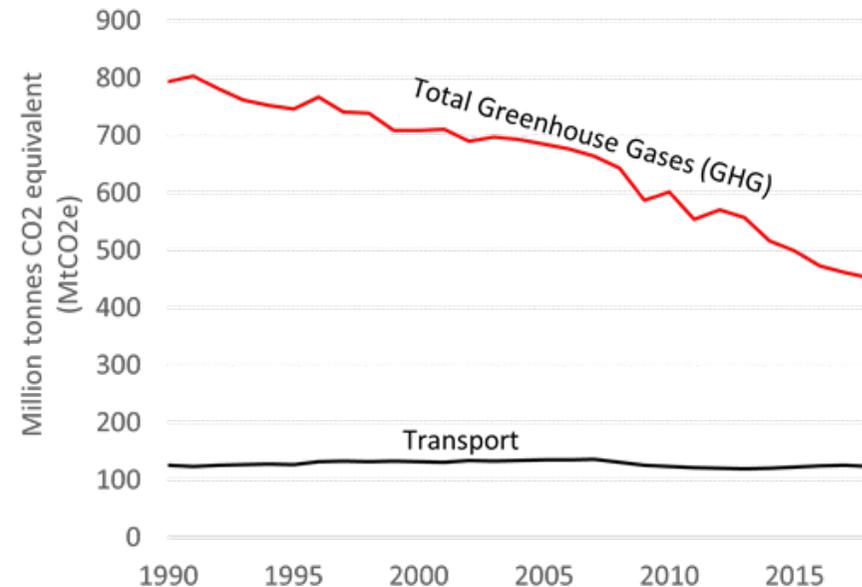
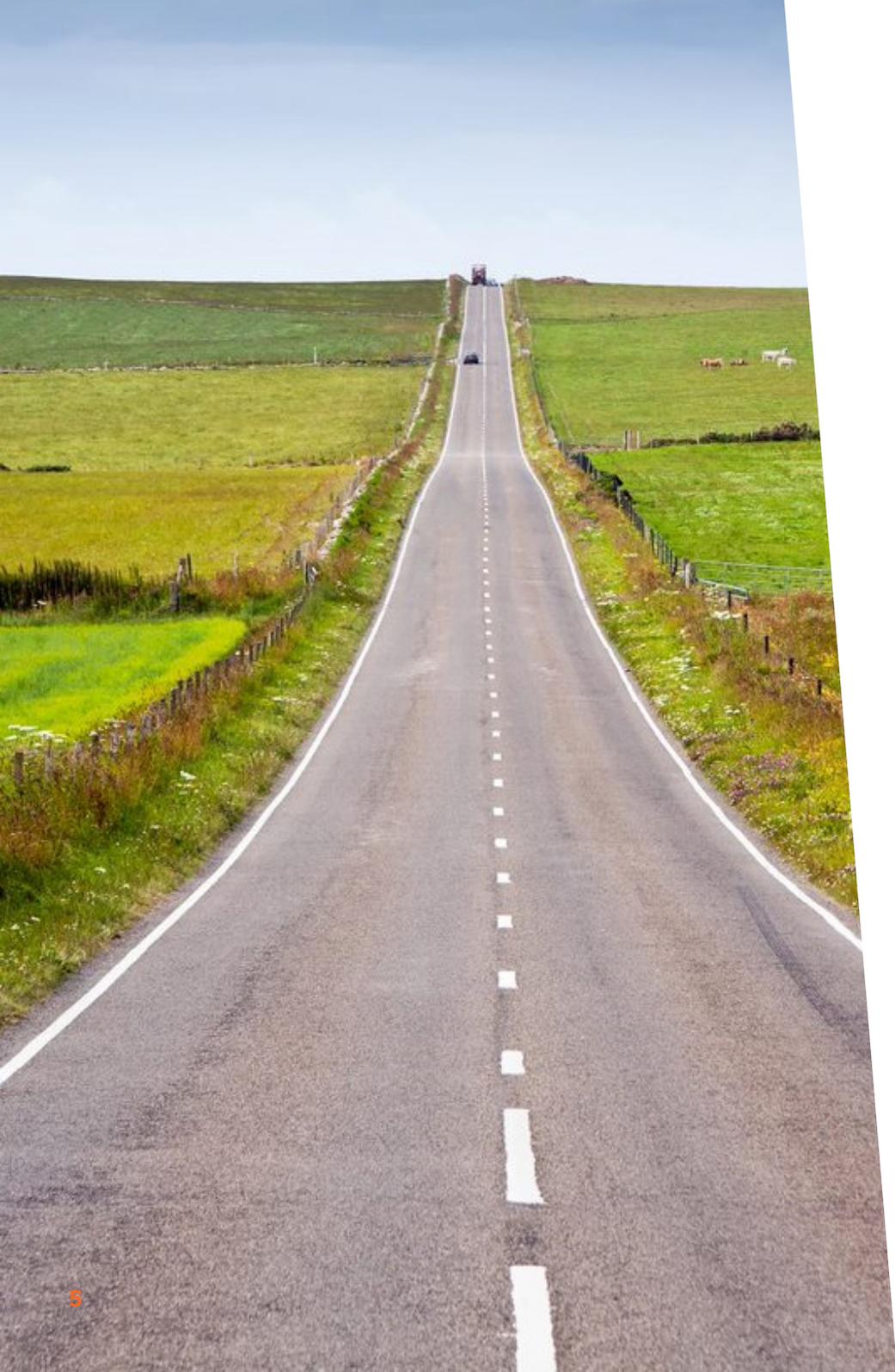


Figure 1: UK Domestic Greenhouse Gas (GHG) emissions (MtCO₂e) to 2018; total and transport emissions

1. Special Report: Global Warming of 1.5°C , IPCC (2018) <https://www.ipcc.ch/sr15/download/>

2. State of the UK Climate 2019 (2020) <https://rmet.s.onlinelibrary.wiley.com/toc/10970088/2020/40/S1>

3. 2018 UK Greenhouse gas emissions, provisional figures, National Statistics, UK Department for Business, Energy & Industrial Strategy



The road to decarbonising transport

GHG emission reduction requires interim targets supported by research and innovation programmes to simultaneously create clean economic growth opportunities and a cost-efficient sustainable transportation system. The budgets for the decarbonisation of transport require a system-based approach, and a deep understanding of cross-sector synergies. This requires the modelling of long-term scenarios with divergent economic, social, political and technological trade-offs that satisfy energy demands across the economy in a way that is equitable and aligned with the UN Sustainable Development Goals.

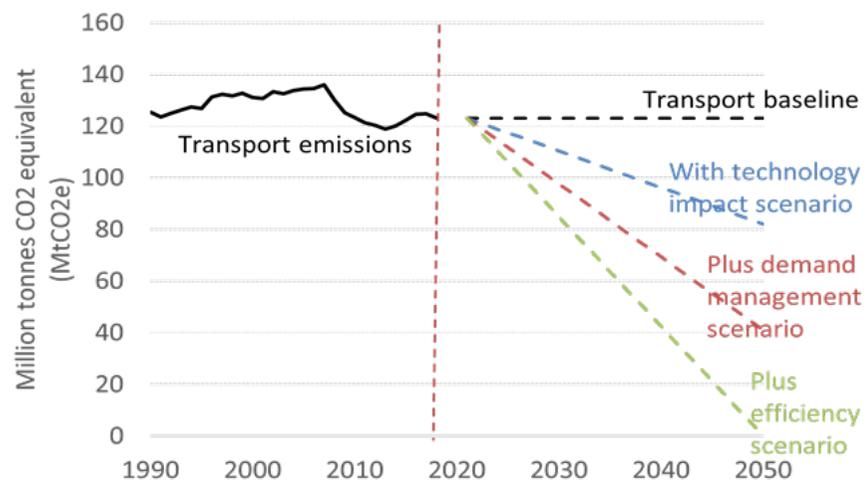


Figure 2 UK Domestic GHG emissions (MtCO₂e) to 2018 and projected transport GHG emissions to 2050 based on potential interventions – the road to net zero

In January 2020 the European Parliament endorsed the EU's 'net zero' greenhouse gas emissions objective by 2050 through its resolution on the European Green Deal⁴. All modes of transport will have to contribute to decarbonisation. To support the green deal the Commission are developing a strategy for sustainable and smart mobility⁵. It will be based on four principles:

- 1. Making the transport system as a whole more sustainable**
- 2. Making sustainable alternative solutions available to EU citizens and businesses**
- 3. Respecting the polluter-pays principle in all transport modes**
- 4. Fostering connectivity and access to transport for all**

In March 2020, the Department for Transport published a consultation report ahead of its transport decarbonisation strategy. The report spells out the size of the emissions reduction challenge that we need to overcome and how net zero emissions could be achieved. In the meantime, the UK must adapt to the climate emergency and build a more resilient transport system. While the strategic road network and some ports seem relatively well prepared for climate risks, local authority managed roads and rail may be less so, with airports tending to be more reactive⁶. National and local road investment strategies to build and maintain roads and infrastructure assets must play their part to mitigate climate change⁷ too. This means a revolutionary shift towards the use of more sustainable materials, construction and maintenance techniques, which will require the rapid development of new standards and guidance for the construction industry, designing infrastructure for circularity.

With greater use of active and public transport in cities and towns, road space can be reallocated, and more pleasant and liveable environments created. This goes in both ways, as redesigning the urban environment can lead to considerable reductions in transport demand, air quality and GHG emissions where workplaces and most services are within a short distance. Designing towns and cities where jobs, shopping, recreational and cultural needs are within 15 minutes journeys, stimulates walking or cycling and improves the equitable access to jobs and services, while reducing emissions and potentially contributing towards the economic recovery in the aftermath of the Covid-19 pandemic.

4. EP resolution on the European Green Deal (2020) https://www.europarl.europa.eu/doceo/document/TA-9-2020-0005_EN.html

5. Strategy for sustainable and smart mobility; <https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-sustainable-and-smart-mobility>

6. POSTNote 621 – Infrastructure and climate change. UK Parliament POST.

7. Road Investment Strategy 2: 2020–2025. Presented to Parliament pursuant to Section 3 of the Infrastructure Act 2015

Research priorities

The Ten Point Plan for a UK Green Industrial Revolution⁸ seeks to accelerate the path to net zero by boosting the green economy and rebuilding the economic damage produced by the pandemic of 2020. Three of these points relate to transport directly and include the promotion of a low carbon hydrogen economy; accelerating the shift to zero emission vehicles; promoting active travel (walking and cycling) and public transport; and endorsing the use of low carbon fuels in aviation and shipping. The remaining points have direct or indirect relation to the future of transport too (power grids; natural environment; and green finance and innovation).

We believe that there are three main approaches to achieve “the plan” and successfully decarbonise transport:

- 1. Managing transport demand and influence behavioural changes to steer modal shift towards public transport, active travel and eliminating unnecessary trips**
- 2. Research and innovation to develop or improve low carbon technologies and sustainable, flexible and resilient energy pathways**
- 3. Improving transport operational efficiency by maximising vehicle occupancy, loading factors and optimisation of transport systems**

Given that many of the technologies and techniques that will be used by 2050 have not yet been developed, or have not been demonstrated at scale, there is a great deal of uncertainty about the future. We will need to combine many solutions to drive meaningful changes. A successful plan to achieve net zero will, however, benefit from science-based targets and informed scenario planning which should, itself, be based on the best available research and models.

Flexible and adaptable plans will be necessary to inform, support, monitor and evaluate a wide range of interventions and to guide the behaviour of individuals, organisations, networks and regions towards more sustainable practices. This will require continued and substantial investment in technological, scientific and behavioural research and development to drive uptake, breakthroughs and new knowledge creation. The plans will also have to include well-funded initiatives to yield economies of scale for the technologies that already exists to make them affordable and socially inclusive. For this reason, TRL has identified the need for five major research focus areas:

- 1. Systems modelling to support decision-making**
- 2. Technology development, monitoring and evaluation**
- 3. Stimulating and optimising demand and operational efficiency**
- 4. Net zero carbon planning and audits**
- 5. Climate adaptation and resilience modelling**

8. The Ten Point Plan for a Green Industrial Revolution (2020). London, Crown.

1. Systems modelling to support decision making

To deliver the least cost solution that minimises GHG emissions according to a set of assumptions, it is necessary to tackle transport as part of the whole energy system and consider the competing uses between transport and the power, heating, and industrial sectors. In this context, cost-efficient low carbon energy pathways are critical to deliver near net zero carbon emissions. TRL can support governments and other clients to create narratives and produce future decarbonisation scenarios.

How we can help:

- Modelling the transport system as a component of the whole energy system for a country or region
- Economic evaluation of scenarios
- Refining accuracy of existing models from energy authorities and providers
- Policy guidance and interpretation
- Guidance in the use of asPECT: a carbon calculator tool for asphalt pavements
- Feasibility studies of the outcomes of energy systems models in relation to transport energy infrastructure (e.g. recharging points, hydrogen refuelling infrastructure)
- Hydrogen economy and hydrogen systems





2. Technology development, monitoring and evaluation

We have technological solutions today that can mitigate GHG emissions from transport; however, there are still some barriers that need to be overcome. Trials are necessary to raise technology readiness levels and build customers' and users' confidence, increasing technology acceptance and demonstrate that public funding represents good value for money. TRL has considerable expertise managing and evaluating live trials. We can also offer lower-cost virtual testing with our powerful hardware in the loop vehicle simulators and digital twin. We have deep knowledge of transport supply chains and we can support organisations to co-create innovations, as well as defining their transport decarbonisation roadmaps.

How we can help:

- Co-creating and promoting low carbon transport solutions (e.g. alternative modes, digitalisation)
- Support the rise of technology readiness levels of existing technologies
- Monitoring and evaluation of low and zero emission technologies of newer mobility modes (e-scooters), light and heavy-duty vehicles (dual fuel, battery electric and hydrogen fuel cells), connected and autonomous and off-road vehicles (ports, airports, MOD)
- Supporting logistics fleets by providing detailed data analytics regarding the fuel saving performance of dual fuel, hybrids, and battery electric technologies, and drivers' efficiency
- Producing safety studies for micro and electro-mobility, as well as autonomous recharging points, hydrogen vehicles and refuelling infrastructure
- Human Machine Interface (HMI) development

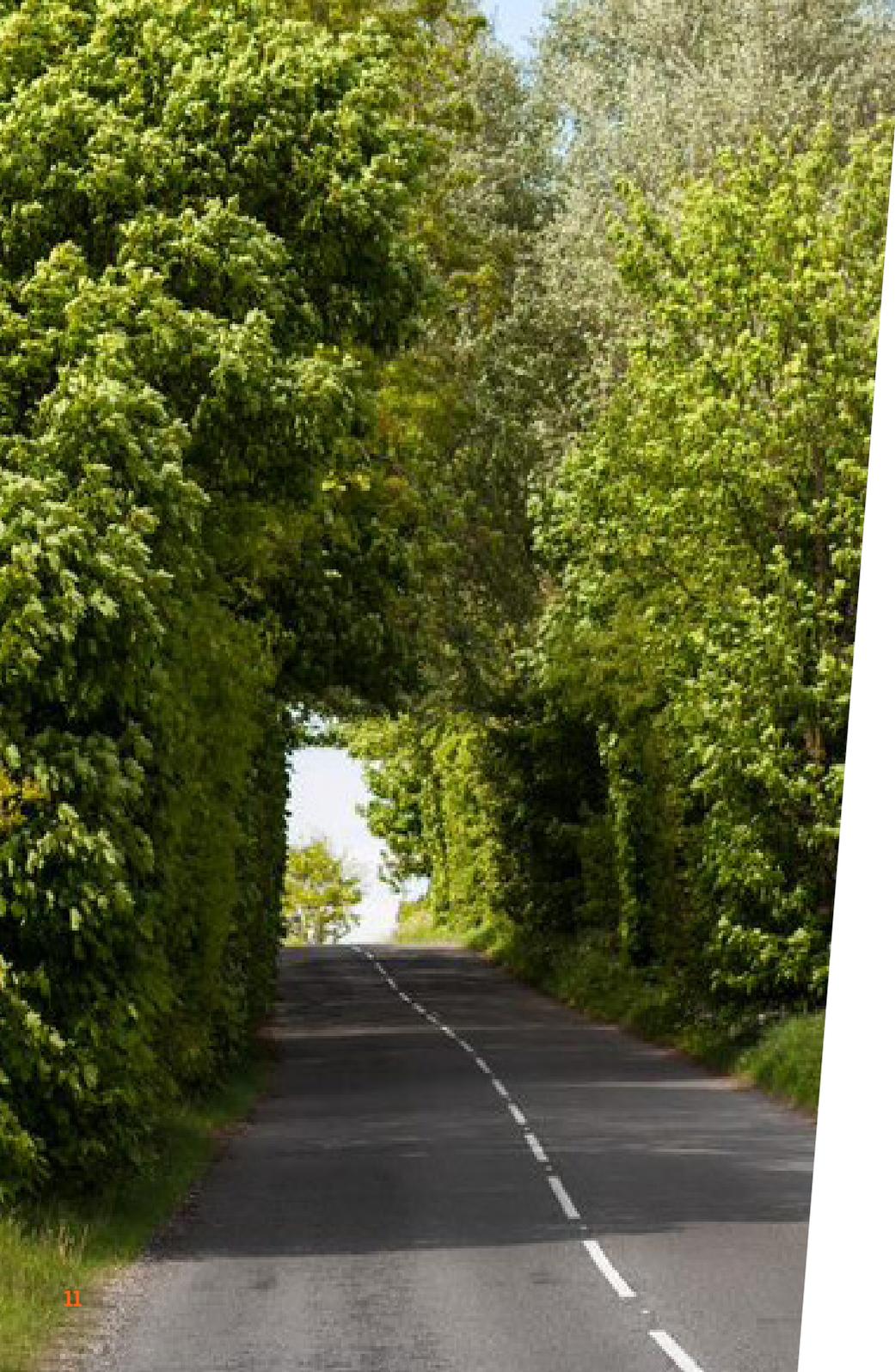
3. Stimulating and optimising demand & operational efficiency

The best approach to mitigate GHG emissions is to avoid their generation in the first place and this can be done by reducing demand for journeys and goods. This may involve influencing behavioural choices, shifting more users to active travel or public transport, and increasing occupancy and loading factors. Other solutions include the optimisation of passenger transport and logistics systems. At TRL we also work on new business models (e.g. Mobility as a Service, mobility credits) and we provide delivery service plans for local authorities, construction logistic plans as well as running monitoring and evaluation programs to ascertain the benefits of different schemes aiming at improving transport efficiency.

How we can help:

- Stimulate behavioural changes to promote modal shift towards active travel and public transport (e.g. provide reassurance on viral transmission risks)
- Co-creation, deployment, monitoring and evaluation of innovative policy interventions (e.g. mobility credits schemes)
- Transport modelling: optimise transport flows, last mile logistics, new mobility options, MaaS
- TRIO our tool to optimise rail scheduling operations
- Simulation of efficiency initiatives in our London digital twin
- Support heavy duty fleets to minimise emissions by providing operational efficiency advice





4. Net zero carbon planning and audits

Many local authorities have declared a Climate Emergency and must align their carbon emissions with interim carbon budgets and the 2050 net zero decarbonisation targets. We can help governments and transportation bodies to maximise their opportunities by developing zero carbon plans at different time scales. We can support clients assessing and mitigating the environmental, social and economic impacts of transport schemes, transport modes and low carbon technologies.

How we can help:

- Carbon audits
- Net zero carbon plans, strategies and technology roadmaps
- Environmental and strategic impact assessments
- Business and economic models: stochastic modelling, business cases, general or partial equilibrium models of new technologies or transport supply chains
- Life-cycle analysis of transport materials and zero emissions technologies
- Guidance and best practices on circular economy for transport infrastructure and construction materials

5. Climate adaptation and resilience modelling

Climate change is a global issue that will affect every country in the world in many ways (physical, social, financial, political). A global and coordinated effort is necessary immediately to mitigate these impacts, and to avoid the disruption of transport services and infrastructure. TRL has developed models to assess the resilience of transport systems and has produced guidelines and platforms to recommend adaptation good practices.

How we can help:

- DeTECToR is a platform that assesses the likelihood, frequency and severity impact of future climate change scenarios on transport infrastructure (road, rail, shipping, aviation)
- Support following ISO 14090/14092 (climate adaptation and decision making for local governments and communities)
- Climate resilience and adaptation of planned developments e.g. Adaptation Reporting Power (ARP) reviews, evaluation of new transport hubs
- Platforms to share climate adaptation good practices





The transport transition

In 2021 the TRL Academy will be launching a new academic service to support the public and private sectors, and other academic institutions in the new aspects of the zero-carbon transport transition. Our world leading experts will provide cutting-edge training on topics such as:

- Hydrogen economy, hydrogen systems policy, new business models, supply chains, infrastructure needs, hydrogen safety
- Electro-mobility, policies, nexus energy-transport systems
- Air quality, noise and GHG emissions modelling
- Circularity of transport infrastructure materials
- Human factors of semi-autonomous vehicles
- Safe and fuel-efficient driving for commercial fleets
- Data analytics in transport
- Simulation of vehicles

About TRL

Our mission: Creating clean, easy, efficient transport that is safe and reliable for everyone

TRL is a team of expert scientists, engineers and specialists working together with our clients and partners to create the future of transport.

- We publish software that helps the world's largest cities, and many smaller towns too, reduce pollution, carbon footprint and congestion with advanced traffic management, better road design and good asset management
- We conduct leading edge research into infrastructure, vehicles and human behaviours which enables safer, cleaner, more efficient transport
- We deliver detailed incident investigation, structural survey and other high value field services to help clients to improve the service they give their customers
- We work with universities and other partners to invest in basic and applied research that will underpin future needs
- We have built, with partners from government and industry, the Smart Mobility Living Lab: the world's first physical and virtual testbed in a global megacity (London) that lets companies test new mobility products and services safely on live public roads
- Established in 1933 as the UK government's Road Research Laboratory, the renamed TRL was privatised in 1996 and today has more than 1000 clients in many countries. Our headquarters are in Crowthorne House, near Bracknell, and we have offices in Birmingham, Edinburgh, London, Germany and India

Transport Research Foundation (TRF)

The TRL group of companies is owned by the Transport Research Foundation: a non-profit distributing company that enables our experts to give independent advice without influence from shareholders or finance companies.





Strategic themes

TRL is strategically investing, producing disruptive research and delivering innovation linked to these strategic themes:

**Environment &
Decarbonisation**

**Automation in
Transport**

**Transport for
Sustainable
Development**

**Digitisation of
Transport**

**Transport
Safety**

**New
Mobility**

For more information on these themes: trl.co.uk/strategy

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