

GW4 Accelerating to Net Zero – achieving Sustainable Mobility

The climate emergency is an urgent and fundamental challenge, with transport accounting for a large portion of the problem. Decarbonising transport is a key strategic policy of the UK Government given transport is the largest contributor to UK greenhouse gas emissions, and has some of the most significant societal challenges to overcome, in changing behaviour and transforming our infrastructure. Government plans to meet these targets require rapid development of new technology, behavioural and societal change, and an infrastructure revolution to support this switch to sustainable mobility. Success will depend on evidence-based solutions, the use of digital and data to accelerate innovation and support operation, as well as new understanding of behaviour and demand management.

The **GW4 Accelerating to Net Zero** transformational programme is a direct response to these needs, delivering on the Ten Point Plan, enabling a green industrial revolution and providing innovative solutions to decarbonise transport. We will bring together researchers, government, industry and communities to develop and deliver sustainable and socially inclusive mobility. The GW4 South West and South Wales region has unique capabilities and complementary assets in mobility by air, rail, road and sea as well as strengths in digital innovation, the circular economy and skills development that will deliver technological solutions, provide an evidence base for positive social interventions, and drive green jobs and transformational place-based innovation that will have global impact.

GW4 will accelerate to Net Zero by reaching **further**, beyond our region and beyond traditionally distinct disciplines, decarbonising transport and enabling a green revolution; working **faster**, identifying technologies that can be adopted quickly and accelerating innovation where long-lasting, sustainable change is required; and enabling **fairer** and equitable transitions, through co-creation and tackling issues in the context of the whole system and ensuring social justice is at the centre of these transformations.

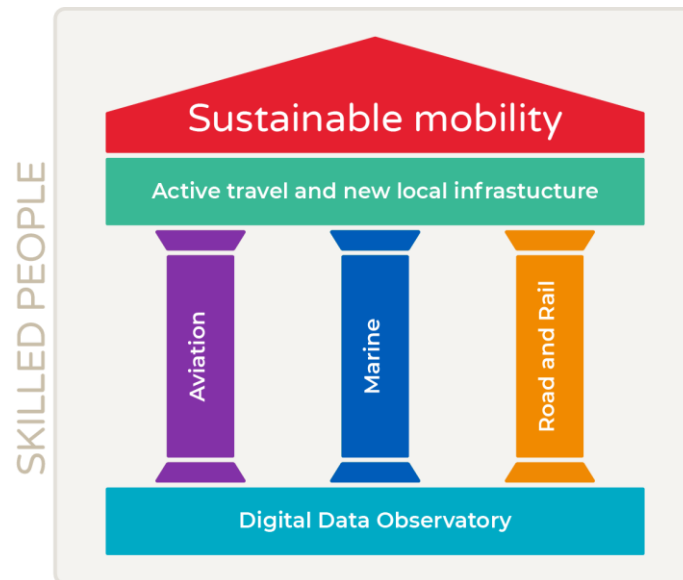
The framework of 'avoid-shift-improve' emphasises that as well as improving transport through greater efficiencies and new fuels, there is a need to consider how emissions can be reduced through a whole systems-based, interdisciplinary approach to reshaping mobility, avoiding some journeys altogether and shifting to lower or preferably zero-carbon alternatives.

A £160 million investment in the **GW4 Accelerating to Net Zero** transformational research, innovation and development programme will:

- Enable the transport and energy industries to innovate new Net Zero technology, ensuring we evolve as rapidly as possible while also considering social implications and long-term impacts, through research and innovation collaborations with key industry, academic and community stakeholders in our region and beyond.
- Deliver an understanding of the mobility needs, behaviours and desires of diverse communities across socio-economic groups, urban and rural situations, abilities and ages in order to ensure social justice and prioritise ethical and fair transitions to Net Zero. This will be done by identifying behaviour changes across our diverse region, and capturing impacts of local switches and shifts in policy and delivery.
- Identify the legislative, logistics, policy and economic components required to transform our interconnected transport systems, across air, sea, rail and road, and to realise the benefits of

shared solutions and infrastructure.

- Achieve more liveable communities and sustainable lifestyles that incorporate active travel and adopt radically different approaches to land use and infrastructure, by progressing all our ambitions through a whole systems approach.



The region is unique in our engagement with aviation and maritime industries, and a leader in data and digital innovation. Combined with our expertise in road and rail, and systems and society, the GW4 South West and South Wales region can innovate, change and transform transport and mobility across the UK and the world. The GW4 Alliance brings together Bath, Bristol, Cardiff and Exeter universities who actively collaborate with our communities, government and a breadth of industries who are all essential partners, keenly engaged in driving this change. The GW4 universities make a substantial contribution to the global knowledge economy, have a combined research income over £370m, a turnover over £1.8bn, employ over 8,000 academic staff, and provide training for over 27,600 postgraduate and 79,200 undergraduate students. In the region, the aerospace, maritime and rail sectors support this bid and this proposal will integrate their own plans for Net Zero with the research and innovation of our research-intensive universities in order to harness these collective strengths.

International Leadership of the Aviation Sector

Rapid decarbonisation of aviation is particularly challenging due to the complex nature of the infrastructure required for flight, coupled with the additional challenges posed by extreme changes in pressures and temperatures at altitude and the extended journey times which mean that solutions used in other forms of transport are not easily adapted to these settings. Flights themselves represent an interconnected and critical challenge for carbon emissions including: movement of passengers and heavy goods vehicles to and from airports; airport energy consumption including off-road ground vehicles; the evolution of sustainable aviation fuels; and the materials and technology necessary for clean technology. On top of this, consumer behaviour, lifestyle changes, environmental concerns over emissions and flight paths, supply chain analysis and the multifaceted nature of the legislative and policy landscape provide additional complexity which requires an interdisciplinary collaborative approach for academia, industry and governments.

The region is home to the largest **aerospace** sector in the UK, benefitting from substantial industrial and capital investment. With an ecosystem of large industrial multi-nationals, multiple airports and innovation driven SMEs, GW4 academics are working with the whole value chain through established relationships with key partners. This is exemplified by the complementary bid for support of a South West Aerospace and Aviation Cluster submitted to the CSR by Bristol Airport with support from the West of England Aerospace Forum, GW4 universities and companies including Airbus, GKN and Rolls Royce, to drive and support sector innovation. The CSR submission from the Western Gateway proposes an Advanced Engineering Centre to accelerate Net Zero manufacturing. Complementing these proposals, our universities have proved that partnering with disruptive SMEs has been a powerful approach to deliver innovation, de-risking technological advances and ensuring wider market adoption from larger partners. Examples of these types of partnerships across GW4 include: Green Air who have a demonstrator aircraft fueled by hydrogen fuel cells; Protium who are looking at infrastructure for hydrogen refueling at Cardiff airport; and Dragonfly who are looking at technology integration of batteries and hydrogen.

GW4 universities have nationally and internationally-leading expertise in the fueling and design of aircraft and data-driven technologies, and have identified a critical gap in the current research and innovation landscape. In parallel to the sector-driven innovation needs, fundamental research is urgently required to consider the longer-term sustainability of the technology, durability and recyclability of the materials and integration of infrastructure and safety, as well as the public acceptability and adoption of the new technologies. Given the urgency of the Net Zero challenge, much of the work in industry is looking at these most immediate needs for the sector. A longitudinal perspective is not only important for the technologically-driven aspects of decarbonising the aviation sector but fundamental for understanding how the sector can act within a circular economy, the environmental psychology of customers and the implications of fiscal de-/incentives on demand which need to be coupled with their environmental impact.

To tackle such long-term, cross-sector challenges, the vision is to set up a **£40m Centre for Green Aviation** which focuses on pulling expertise from across the discipline and institute divide, building on ongoing projects that are pushing the current boundaries in technological understanding, providing data and evidence to inform and optimise long-term solutions, and working alongside our industrial partners to help shape a future sustainable aviation sector. This interdisciplinary approach must be included in the challenge to deliver rapid decarbonisation in line with the Jet Zero strategy, to achieve Net Zero for aviation emissions by 2050, and domestic airport operations and emissions by 2040.

The Maritime Environment – geographically influential

With a long coastline, deep rooted maritime history and high concentration of industry, the South West and South Wales region has world class expertise in **maritime** research, including clean propulsion. Regional maritime assets are significant and varied, spanning from small scale aquaculture to commercial and naval shipbuilding, including Devonport which is the UK's largest naval base. 95% of all import and export tonnage is transported by sea, therefore transition to Net Zero by 2050 relies on developing integrated transport systems across road, rail, marine and air, national and regional regulation, as well as management of the marine environment. It is intimately interconnected with the shore, from transportation of people and goods in and out of city ports, to co-locating vehicle emissions with high density populations. The Ocean Futures initiative led by Maritime UK is mapping the route to Net Zero, supporting the Clean Maritime Plan, and is ready to engage, collaborate and support GW4. Such work is

evident through the development of the e-Voyager, the UK's first fully electric domestic ferry as part of the UK's drive towards zero emission shipping. The Centre for Future Clean Mobility based in Exeter is helping lead development of clean maritime propulsion. And the design of hydrogen and smart local energy systems is being tested as part of the Milford Haven: Energy Kingdom project. The transition from diesel to alternative fuel including fuel cells and ammonia will be tested as part of the proposed GW4 maritime living labs.

The marine environment with its substantial offshore wind, tidal and wave energy resources and testing facilities, is fast developing significant new power generation. Our region is set to be the biggest site in Europe for offshore floating wind energy and new developments in tidal energy in Wales are set to be the largest in Europe. The region therefore offers a unique opportunity for the UK to become a world-leader in maritime energy capture. Investment in a new living lab, a distributed **£40m Centre for Sustainable Maritime**, to complement the work of the Offshore Renewable Energy Catapult and the WaveHub, Fabtest and Marine Energy Wales META marine renewable test facilities, offers an opportunity to comprehensively grow the sector as well as an exciting opportunity for extensive off-setting by harnessing our natural assets and the potential of offshore renewables.

Coastal communities often have concerns and challenges that are distinct to both rural and to urban environments. Indeed, rural and coastal areas often suffer hidden deprivation, where there are strong links to high levels of ill health and disease. Our ambition to enable transitions that can improve society gives us the mandate to build better health, wellbeing and quality of life into the solutions that will deliver Net Zero across our region. Living labs across some of the key ports and harbours of the GW4 coastal region, e.g. Plymouth, Avonmouth and Cardiff harbours, will investigate how investment in smart energy solutions of these transport hubs combined with energy-generating technology close to coastal communities, can offer opportunities to secure fair transitions to Net Zero, directly contributing to Government ambitions for 'levelling up' in its fullest sense. These living labs will adopt a systems approach, and facilitate the development and integration of decision intelligence data in the maritime supply chain and the operation of ports, for example by determining the vehicle routing, facility location, warehousing and logistics in more efficient and sustainable ways.

Road and Rail – transforming the inland infrastructure

Our geographical and demographic diversity, of rural and urban, affluence and deprivation interface with the region's transport networks, especially rail. Notably much of the planned mainline rail electrification west of Bristol has not taken place which will impact the transition to Net Zero. The region's infrastructure for both passenger and freight, and recent expansion of the rail network, including reinstatement of defunct lines, are important assets for transition towards Net Zero rail and shifting freight away from the road network. There are timely opportunities for GW4 researchers to engage with the £150m investment in track and rolling stock testing Global Centre of Rail Excellence (GCRE) located in South Wales, the Wales Innovation Network and the UK Rail Research and Innovation Network to deliver significant change in this sector that enables a fairer transition towards Net Zero.

Electrification of the network is providing a feasible solution for achieving this sector's Net Zero aims but raises questions around power, for example national electricity mixes and alternative energy sources in regions where connection to the network is infeasible. We are proposing a **£30m GW4 Rail Research Hub** at the planned GCRE site which will enable large-scale testing to investigate the effects of this significant load on the grid, local integration of renewables, alternative power sources including ammonia, hydrogen and hybrid solutions, electricity

storage and associated charging and recyclability as well as challenges around the capacity of electrified engines in relation to the transport of freight at high speed.

Digitalisation has the potential to enable transformative advances in all aspects of rail travel, from asset management to improving the passenger experience. With the ability to trial new infrastructure including signaling, as well as a full station environment, excellent links with other modes of transport including road, sea and aviation, and the potential to collocate with other transport sector testing facilities, GW4's rail hub will provide a unique ability to research aspects related to the integration of the transport system. These will include the sharing of digital information for timetabling, optimising freight/passenger movement, ticketing and issues relating to cybersecurity. We therefore propose investment in building a digital twin of the South West rail infrastructure which will establish the potential for continuous or intermittent electrification using a combination of direct-wire supply, battery powered trains and recharging stations.

With a unique capacity for long-term continuous testing, the GW4 rail hub will facilitate the development of solutions in all aspects related to a whole life approach of rail operation, maintenance and decommissioning including durability, monitoring (usage, condition), range (particularly for alternative fuels), human factors (driver fatigue and user experience), safety (lightning, insulation, ammonia usage), repairs (structural health monitoring) and recyclability.

Furthermore, a **£10m investment** will enable the main railway stations in the whole GW4 region to get involved via **Rail Living Labs** by building on existing initiatives such as the West of England being one of only four Future Transport Zones in the country. These living labs will test the implementation of outcomes from the GW4 rail hub at the GCRE on a larger scale including social practices of mobility, enabling a better understanding of demand for mobility and how we can see changes in mobility decision making - including integrated transport ticketing solutions, fiscal de-/incentives focus and the provision of SMART mobility infrastructure linking transport hubs - working closely with local communities and with a focus on user and community engagement. Research will focus on how these innovative rail transport hubs will be key in the regeneration of our urban areas and will help the 'levelling up' of the region. They will support the region in its agenda of 'building back better' by taking advantage of changing mobility patterns resulting from an increase in working from home, reduced car traffic, improved wellbeing, and revitalised local shopping and living patterns.

Rural areas present a particular challenge for Net Zero in the mobility sector given their dependence on cars as an accessible and relatively affordable mode of essential transport necessary to access food, education and work. For example, newly electrified railways in Wales could be powered by community-owned solar and battery storage located next to railway lines, or extended through use of hydrogen fuel cells. Our region is home to (i) the world leading Institute for Advanced Automotive Propulsion Systems (IAAPS), a centre of excellence for research, innovation, enterprise and education, supporting the future direction of the automotive industry, and (ii) the Centre for Future Clean Mobility which is driving development of clean powertrains for construction, heavy work and defence vehicles.

Digital Technologies – underpinning our understanding, driving our innovation

As a region, we have taken a leading role in developing digital technologies that are transforming people's lives and driving social change. We will build on our digital capability by developing a **£40m mobility data observatory**, creating an environment built on real-world data collection through surveys and capturing behaviour utilising innovative digital technology

in order to understand and test how changes in policy and investment decisions influence behaviour, attitudes and emissions across society, drawing on a breadth of regional expertise.

Our 'transport digital twin' will model our whole systems using sector performance against Net Zero targets, generating insights and understanding that will enable new and effective innovations. This is fundamental to understanding the systemic impacts of ideas and innovative solutions. Embedding digital models into our whole systems approach will ensure potential solutions can be tested in a simulated environment and help us to understand why different solutions work more effectively in some settings compared to others, and to design more suitable interventions. This will be essential to deliver effective and efficient transformation that can be secured through mutually beneficial cross-learning. These ambitions that deliver an integrated model for a sustainable mobility infrastructure will require embedding new technology to provide new data streams and rapid insights from the living laboratories and centres proposed.

Conclusion – achieving sustainable mobility

The GW4 Alliance is uniquely placed, combining the synergistic decarbonisation, climate and atmospheric modelling and monitoring, risk and mitigation research excellence of our four institutions. Our collective research expertise brings collaborations in energy, through the Supergen Networks and Offshore Renewable Energy Hub, with expertise in propulsion (IAAPS) and clean mobility (Centre for Future Clean Mobility), the High Value Manufacturing Catapult National Composites Centre, and a whole system approach integrating road, rail and aerospace through via the Decarbonising Transport through Electrification (DTE) Network+ which is reinforced by our partnerships with global industry leaders and local innovative SMEs. The Centre for Climate Change and Social Transformations is a nationwide programme led predominately from the Universities of Bath and Cardiff, providing the expertise to support the real solutions needed for the wholesale change and reimagined living that will be required to deliver a green industrial revolution. The Global Systems Institute, based at the University of Exeter, aims to achieve a future for humanity as an integral part of a life-sustaining Earth system. The University of Bristol is home to the top Aerospace Department in the UK, in both research (REF2014) and teaching (Good University Guide), as well as the Cabot Institute for the Environment. These established centres of excellence are reimagining how we can live differently and better, in ways that meet the need for rapid emissions reduction.

Equally we have established relationships with local and Welsh Government, Local Enterprise Partnerships, NGOs, charities, and community groups and have citizens assemblies established. Working with the established industrial regional excellence, we are ideally placed to rapidly implement this research and innovation. The bid interfaces clearly with the West of England Combined Authority City Region Sustainable Transport Settlement proposals and proposal for a Bath Net Zero Campus. The South West and South Wales region provides an ideal living laboratory for Net Zero, with strong multi sector buy-in, significant and unique opportunities for exploration and test of socially equitable transition to Net Zero, in both urban, city, rural and marine settings. Our geography covers two national governments, a combined authority, two health systems, and includes areas with among the highest and lowest deprivation rates in the UK, making it ideally placed to deliver rapid change to drive levelling up within a Net Zero context and provide solutions that can be applied across the UK and the world. Investment at scale, in these areas of focused opportunity, will ensure we are able to lead the way in enabling the UK **to Accelerate to Net Zero: further, faster and fairer.**