Ricardo Quarterly Review **Autmun** 2022

RQ

A focus on the latest in innovation, sustainability and technology

RICARDO

Moving forward
How North American cities are transforming mass transit

Stemming the tide
Why COP27 is a critical test of global climate commitments

Racing green
Alternative fuels powering cleaner motorsport

MOBILITY REIMAGINED

What will the future look like – and how do we get there?

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RICARDO

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RQ is produced by LookUp Communications and published by Ricardo plc.

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RQ is Ricardo plc's quarterly magazine focusing on innovation, sustainability and technology. Each issue offers insight from within Ricardo and other leading organisations in the transportation and clean energy sectors and related industries.

MIX Paper from responsible sources FSC® C021017

RQ magazine is printed on paper certified as being in compliance with the environmental and social standards of the Forest Stewardship Council®.

RQ NEWS

Latest developments from around the global Ricardo organisation

New supply chain decarbonisation partnership

Support for companies to meet climate targets

Ricardo has agreed a strategic partnership with Manufacture 2030 (M2030), the leading supply chain decarbonisation platform. The purpose is to give companies across the value chain the confidence they need to reduce their carbon emissions.

With more multi-national companies committing to science-based carbon reduction targets, the focus in the private sector is moving from understanding retrospective performance towards accurately estimating progress.

The collaboration combines Ricardo's experience in corporate decarbonisation, net zero strategy development and product lifecycle assessments with M2030's robust supplier engagement, reporting and carbon reduction management platform. As a result, global brands will be better able to understand where Scope 3 emissions hotspots sit within their products and supply chain.

Businesses will be better placed to understand the emissions hotspots within their products and supply chain

"The United Nations has defined 2020-2030 as the decade of action," says Tim Curtis, Ricardo Energy & Environment's Managing Director, "and is calling for governments and the private sector to accelerate net zero ambitions. Our work with M2030 is extremely exciting as it will give businesses greater certainty about what they need to do and show how well they are progressing with their decarbonisation ambitions."

$20.2 million contract for additional ABS-ESC retrofit kits

The United States Army has awarded Ricardo's Defense business unit, located in Michigan, a major contract to continue delivering Antilock Brake System/Electronic Stability Control (ABS/ESC) retrofit kits. The kits are designed to improve the operating safety of the US Army's High Mobility Multi-purpose Wheeled Vehicle (HMMWV).

Prior to this award, Ricardo had previously delivered more than 11,000 ABS/ESC kits. The new contract will ensure improved safety on vehicles in the US Army's HMMWV fleet. In 2019, the Army adopted Ricardo's ABS/ESC retrofit kit into the national stock system for use with vehicles produced prior to 2019 that are expected to remain in service until 2040.

The ABS/ESC retrofit system encompasses a complete solution integrated into the HMMWV architecture including antilock braking, electronic stability control, active rollover protection, traction control and improved brake calipers, pad and rotors.

The system also introduces a crash-resistant steering column and a modern electronic network and leverages low-cost, proven components specifically designed for arduous military operations. From the outset, the system has been designed for easy upgrade to the existing fleet, thus minimising the HMMWV lifecycle cost.

'In making this investment, the US Army has shown its commitment to soldier safety by retrofitting fielded vehicles in its enduring HMMWV fleet," says Chet Gryczan, President of Ricardo Defense. "This latest award showcases Ricardo's capability to solve tough challenges for legacy systems that require a future-looking integrated solution."

Honour for management consultancy arm

The US-based members of Ricardo's strategic consulting team have been named by Forbes as a leading global management consultancy business for the seventh consecutive year.

Ricardo's strategic consulting team offers a comprehensive portfolio of management consulting services, advising leaders on high impact global strategic issues including operational challenges at every stage of the value chain.

Forbes' America's Best Management Consulting Firms is a list that recognises consultancies providing businesses with the best guidance. It surveys 7,500 partners and executives of management consultants, as well as 1,000 senior executives, who have worked with them over the last four years.

"We continue to lean on our unique value proposition of being at the cutting edge of technology in the transportation space," says Derek Schlonsky, Global President of the strategic consulting team.

Rising star of the waste sector

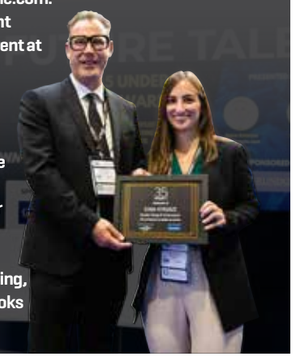
Recognition for work on the environmental impacts of waste management

Ioanna Kyriazi has been named as one of the top 35 rising stars of the waste sector for 2022 as part of the 35-under-35 awards at RWM & Letsrecycle Live 2022, a collaboration between the two leading UK events for the waste, recycling and resource industries.

The awards were organised by letsrecycle.com. The list of 35 was decided by an independent judging panel and announced during the event at the NEC, Birmingham.

The judges acknowledged the 'great success and huge effort' of all those recognised together with 'real dedication and a level of conscientiousness among the 35 which was quite amazing'.

Speaking about her win, Ioanna, a Senior Consultant within Ricardo's Energy and Environment business unit, said: "In times like these, when the environment is collapsing, I am proud to be part of the industry that looks into mitigating our society's footprint."



Automotive News award for Ricardo expert

Yansong Chen, Ricardo's Senior Vice President of Electrification Strategy and Technology, has been named one of *Automotive News*' Rising Stars 2022.

Prior to joining Ricardo, Yansong worked for independent automotive company Delphi, becoming Director of Global Program Management and Engineering. "I knew about some of the projects that Ricardo was involved in, specifically a hybrid vehicle programme," she says.

"When the opportunity came to lead the North American engineering team and, more specifically, help transform the business's electrification strategy, I was delighted to take it.

"Inspiring the next generation of engineers is also something that I feel passionately about. I've been a mentor for many years and involved in the INFORM AutomotiveNEXT Executive Committee to support up-and-coming people. I was involved with a two-week summer intern programme where over 100 students were able to access advice and support.

"I'm aware that I have a responsibility to help shape the future of mobility while also enabling future talent to have their opportunity to influence the industry."

Showcase for climate repairing technology

Funding to design, install and operate a combined heat and power demonstrator plant

Ricardo has received £3 million from the UK Government to demonstrate the effectiveness of community-scale greenhouse gas removal and clean energy using sustainably-sourced forestry waste.

The project to design, install and operate a combined heat and power demonstrator plant with a carbon negative footprint is funded through the Net Zero Innovation Portfolio (NZIP) under the Department of Business, Energy and Industrial Strategy (BEIS).

Ricardo is leading the consortium delivering the demonstrator plant. This combines an innovative carbon capture system developed by Ricardo with hot air turbine technology from Bluebox Energy and pyrolysis technology from Woodtek Engineering.

The quarter-sized demonstrator plant, which will be located at Holmsted Farm in West Sussex, will be commissioned and operational in 2023. It will show not only a highly innovative greenhouse gas removal technology that in a full-size system can generate renewable heat and electricity for up to 300 local homes and businesses, but also a realistic carbon negative technology that can significantly contribute to net zero targets.

The technology works by taking sustainably sourced waste wood from domestic timber production and then processing it in three ways: producing biochar (a product similar to charcoal); generating heat and power; and capturing carbon dioxide from the exhaust.

As well as capturing around 95 per cent of the carbon content in the wood, the technology also produces commercially marketable carbon products: the biochar can be used by farmers to enrich soil and add to animal feed to reduce ruminant emissions while the industrial-grade carbon dioxide can either be used for making low-carbon concrete or in the food and drinks industry to replace carbon dioxide derived from industrial processes which rely on imported natural gas.

Ricardo has been collaborating with Bluebox Energy since June 2020 to deliver innovative technologies that support the transition to a low carbon future (see *RQ*, Autumn 2021 issue). This project is a further boost to the company's credentials in tackling climate change and meeting national net zero targets.

Safety assessment for UK main line

Ricardo has helped support the signalling overhaul of a key stretch of the UK's West Coast main line, a project which saw the closure of one of the few remaining manually operated signal boxes on the network.

The Macclesfield Re-signalling Project started in summer 2021, upgrading a section of the route in the north-west of England.

Just over a year later, following the completion of works that replaced more than 50 signals, staff in the Macclesfield Signal Box operated manually for the last time before control of the section was formally passed over to the Manchester Rail Operating Centre.

The project was classed as a 'significant change' on the main line, which meant an independent Assessment Body (AsBo) was required to ensure it was carried out in compliance with the Common Safety Method on Risk Evaluation and Assessment Regulation (CSM RA).

As the appointed AsBo, Ricardo Certification assessed the application of the hazard management safety risk process throughout the project, culminating in the final Safety Assessment Report.

State-of-the-art hydrogen test facility opens

Part of Ricardo's global centre of excellence

Ricardo's new hydrogen test facility at its headquarters in Shoreham-by-Sea is designed to extend the company's capabilities in zero emissions mobility solutions, as part of a global centre of excellence for hydrogen, defossilised fuels and electrified transport engineering.

The facility will provide state-of-the-art test and advanced development capabilities in both alternative fuels and electric vehicles, significantly increasing the range of hydrogen and fuel cell services and solutions delivered to customers.

It also enables Ricardo's engineers to correlate simulation and modelling tools with real life, supporting faster and more efficient design of powertrains; and can test bespoke multi-stack systems, designed and optimised for weight, cost and efficiency.

"The centre offers a one-stop shop for customers," says Matt Beasley, President of Established Mobility at Ricardo, "from design and development right through to the testing and integration of alternative fuel technologies, such as hydrogen, to support future production planning.

"We're already working with a range of customers on hydrogen and fuel cell technology, providing clean, efficient solutions which reduce carbon and emissions across several sectors."

Ricardo Engineering Prize awarded to Ricardo placement student

Rosie Reed, an engineering placement student at Ricardo's Midlands Technical Centre, has won the Ricardo Engineering Prize 2022 awarded annually to the most promising female engineering student.

Currently studying for a BEng and Integrated MEng in Mechanical Engineering at the University of Southampton, Rosie is aiming to pursue a mechanical engineering career in the Royal Navy, to which she has been committed for many years.

"After spending time in the Army Cadets and learning more about the different military careers that I could follow, I realised that the Royal Navy would offer me an opportunity to develop my passion for all things engineering. That decision also gave me the focus to apply to Welbeck Defence Sixth Form College, where I was sponsored by the Royal Navy. Following the completion of my degree and masters I'll join the Navy for an initial three years, to put all that I've learnt during my course into practical application.

"I was nominated by my university to apply for the prize and that's how my placement with Ricardo came about. It's helped to reaffirm that mechanical engineering and design is what I want to do as a career and I would definitely consider coming back to Ricardo after my time in the Royal Navy."

Rosie Reed's award recognises her "passion for all things engineering"

VIEW FROM

The only certainty is... uncertainty

Angela Johnson explains how scenario planning can help identify challenges and opportunities for future mobility

Angela Johnson is Vice-President of Ricardo Strategic Consulting. Since joining Ricardo in 1999, she has delivered projects that combine deep technical know-how with a strategic view, helping clients plan for the future more effectively. Angela's roles have included leading teams and developing relationships with private and public sector partners across the world.

Mobility in 2035 will be very different from today – from the vehicles themselves, to the infrastructure within which they operate, to the ways people access and use mobility solutions. This means that every sector will face an impact in terms of its business, financial and operational models – but also the chance to benefit from revenue opportunities as new mobility ecosystems emerge.

Planning for future mobility requires a strategic approach that acknowledges inherent uncertainty. This embraces the need to:

- Interpret innovation, such as clarifying the investment necessary to fund research and development for emerging technologies or for the creation of new supply chains to service electric vehicles.
- Factor in economic, environmental and social developments, which might include access to essential raw materials; government policies promoting a move away from the internal combustion engine; or consumer confidence and the cost of living. Some of these developments will currently be unknown.

> **THE LONG-TERM FUTURE CAN'T BE CALCULATED SIMPLY AS AN EXTRAPOLATION OF PAST TRENDS OR CYCLES**

Plausible alternative futures

Scenarios are alternative futures in which today's decisions will take effect. Scenario planning can't predict the future but it can help identify potential risks and how to counteract or mitigate their impact. It allows for an acceptance and understanding of uncertainty, while enabling businesses to build robust future strategies in spite of, around and through these uncertainties. Given the long-term future can't be calculated simply as an extrapolation of past trends or cycles, this is where scenarios become valuable.

We might ask ourselves: 'Could this happen? Could it really?' Well, we are now recovering from a pandemic, have military action in Ukraine and the world's wealthiest auto company did not exist 20 years ago, so the answer is: 'Yes, of course it could.'

Ricardo has created four scenarios from the perspective of the world in 2035:

- **'Creative scavengers'** depicts a world shaped by disruption and with only sporadic evolution. Geopolitical fractures have persisted, along with social unrest, political battles over the supply of critical raw materials and poor employment levels compounded by the deployment of artificial intelligence.
- The world of **'Technopolis'** can be summed up as 'Disrupt or be disrupted'. Rapid changes in business models, products and services, along with multiple technological breakthroughs in digital tools, energy storage and autonomy, have driven a wholesale shift to electric propulsion for personal mobility, distributed low-carbon energy and autonomous vehicles.
- **'Digitopolis'** is a comparatively stable world with abundant digital resources following groundbreaking developments in cost-effective technologies during the 2020s. Now, 'if you're not part of the digital revolution you're not part of anything'.
- Compliance is key in **'Ecopolis'**. With a tightening of legislative and financial frameworks, mobility and oil companies face a stark choice: 'Decarbonise or be penalised'. Coordinated international efforts have staved off the worst impacts of climate change, although regulation is threatening to suffocate innovation.

Each of these scenarios is a plausible alternative future in which experts drill down into the engineering detail to give a detailed and informed view of the challenges that may lie ahead.

By placing existing and future strategies into a set of scenarios you can test their robustness and identify strengths, weaknesses, opportunities and threats. If a strategy proves to be robust against our scenarios, then it will very likely be robust against whatever the future actually brings.

Sign up to receive regular insights from Ricardo's mobility and energy experts: rsc.ricardo.com/mobility-in-2035/subscribe

"OUR COLLABORATION WITH RICARDO BRINGS VALUABLE EXPERTISE AROUND COMPONENT DESIGN, SYSTEM INTEGRATION AND TESTING. THIS WILL ENABLE US TO DEMONSTRATE THE POTENTIAL OF THIS TECHNOLOGY, WITH GROUND TESTING STARTING LATER THIS YEAR AND EVENTUAL FLIGHT TESTS IN 2024"

Quebec, Canada

Alternative propulsion – ready for take-off

After the post-pandemic slump, people and goods are taking flight again. The airline industry projects passenger journeys alone to exceed 10 billion by 2050. For a sector that already contributes one gigatonne of carbon dioxide – 2.5 per cent of all global emissions – every year, that could mean a further 21.2 gigatonnes of CO_2 being released by the middle of this century.

2050 is also the year that the International Air Transport Association (IATA) has targeted for the sector to achieve net zero. But if 'green aviation' is to be possible by then, wide-ranging actions are needed both on and off the ground: from clean aircraft technologies and propulsion systems to sustainable fuels; from advances in materials, manufacturing and aircraft maintenance to more efficient airspace and airport operations.

Last year, Ricardo joined Project Fresson, a consortium led by Cranfield Aerospace Solutions to develop the world's first passenger carrying airline service using hydrogen fuel cell technology (as featured in the Summer 2021 issue of *RQ*). Now, in a multi-year deal with Pratt & Whitney Canada, Ricardo's aerospace engineering team is helping to advance hybrid-electric propulsion technologies for next-generation aircraft.

The project is part of Pratt & Whitney Canada's regional hybrid-electric flight demonstrator programme. The company is targeting a 30 per cent improvement in fuel efficiency and a corresponding reduction in CO_2 emissions compared to today's most advanced turboprop engines for regional aircraft.

"Hybrid-electric technology is a core element of our strategy for continually advancing the efficiency of aircraft propulsion systems, in support of the industry-wide goal of achieving net zero CO_2 emissions for aviation by 2050," says Jean Thomassin, Pratt & Whitney Canada's Executive Director for New Products and Services.

"Our collaboration with Ricardo brings valuable expertise around component design, system integration and testing. This will enable us to demonstrate the potential of this technology, with ground testing starting later this year and eventual flight tests in 2024."

Hybrid-electric propulsion technology is particularly relevant for the future of Regional Air Mobility (RAM). Whether by maximising usage of existing airports or opening up new opportunities in geographically remote and hard to reach areas, RAM networks can make a major contribution to the sustainable mobility ecosystem. Moving people and light cargo in advanced, short take-off and landing aircraft using hybrid-electric propulsion can enhance productivity and affordability with far less environmental impact.

The deal with Pratt & Whitney Canada is a major boost to Ricardo's presence in North America. In support, the company is opening an aerospace centre of excellence in Quebec. Around 25 engineers and experts will initially be based here, applying their specialist knowledge to the needs of customers as decarbonisation of the aviation industry gathers pace.

SUSTAINABLE TRANSPORT

DRIVING FORWARD SUSTAINABLE MOBILITY

The world depends on transportation. Yet it poses some of our most pressing economic, engineering and environmental challenges. To open our special feature on future mobility, **Adrian Greaney** looks at the issues we face – and the opportunities that might emerge

Governments, authorities and agencies are now seeking to embed cleaner, safer transport behaviours for the long term

The transport sector was responsible for nearly 8.5 gigatonnes of global carbon dioxide emissions in 2019. That's equivalent to 24 per cent of the direct CO_2 emissions from fuel combustion across all sectors of the economy.

Transport demand has rebounded since the Covid-19 pandemic and the need to move passengers and cargo is likely to increase further. The number of vehicles in the world could exceed two billion by 2040. How can the sector support the goal of the 2015 Paris Climate Change Agreement and strive for net zero?

The challenge is clear. Only by taking a holistic approach to optimising transport systems with the associated energy and material supply chains, and infrastructure, will the movement of people and goods become cleaner, safer and more efficient. This means smart networks with widespread electrification, renewable fuels and a focus on efficient use of energy and resources throughout the value chain. What, then, are the key drivers for this to happen?

1 Improving air quality

Transport emissions harm both human health and the environment. This is widely understood and acted on through legislation, although today this is primarily achieved by regulating vehicle tailpipe emissions, plus regional controls such as Low Emissions Zones (LEZ) and Zero Emissions Zones (ZEZ) to promote cleaner modes of transportation.

According to the European Environment Agency, between 1990 and 2017 the transport sector in Europe significantly reduced emissions of carbon monoxide and non-methane volatile organic compounds (both by around 87 per cent), sulphur oxides (66 per cent) and nitrogen oxides (40 per cent). Since 2000, there has also been a reduction in particulate matter emissions (44 per cent for $PM_{2.5}$ and 35 per cent for PM_{10}).

Upcoming Euro 7 emissions legislation will drive further improvements in tailpipe emissions in Europe, while research is now focusing on vehicle emissions from other sources such as brakes and tyres. More fundamentally, addressing congestion in urban environments through shared mobility and smart multi-mode transport systems will also support improvements to air quality.

2 Looking beyond tailpipe emissions

According to the United Nations Framework Convention on Climate Change, more and more countries, regions, cities and companies are establishing carbon neutrality targets: 'Zero-carbon solutions are becoming competitive across economic sectors representing 25 per cent of emissions. This trend is most noticeable in the power and transport sectors and has created many new business opportunities for early movers. By 2030, zero-carbon solutions could be competitive in sectors representing over 70 per cent of global emissions.'

Emissions from the exhaust system is only one factor when considering the impact of vehicles on the environment. Life cycle impact refers to the energy and emissions (including CO_2) released to create, manufacture, transport, use and dispose of a vehicle.

According to Mike Berners-Lee, in his book 'How Bad are Bananas?', a medium-specification Ford Mondeo requires 17 tonnes of CO_2e to manufacture and 27 tonnes of CO_2e to drive an average 11,481 kilometres per year over 13.9 years, the typical age of cars at scrappage.

In future, decarbonised electricity will power vehicles with fewer carbon emissions but the manufacture of electric vehicles (EVs) will remain carbon intensive for some time, factoring in the operation of power stations for electricity supply and the manufacture of key components such as traction batteries. An EV will produce around 18 tonnes of CO_2e over its life; for a battery EV, 46 per cent of its total carbon footprint is embodied in the production, before it has travelled a single kilometre.

Any comparisons between EVs and petrol and diesel vehicles need to be made on a like-for-like basis. The emissions associated with extracting and refining crude oil to produce petrol and diesel must be considered for an internal combustion engine; likewise, the term 'zero emission vehicle' is misleading since it overlooks the full life cycle environmental impacts.

3 Global collaboration

International collaboration is critical to drive forward transformation within the transport sector. As an example, at the 2018 UN Climate Change Conference (COP24) the Governments of Poland and the UK launched the 'Driving Change Together Partnership' as a platform to promote and recognise e-mobility as an essential part of the solution to climate change.

The forthcoming COP27 (see feature on pages 21–22) will focus further on moving transportation away from traditional fossil fuels and towards electrification, with a session dedicated to discussing equitable green transport in Africa and the rest of the developing world.

4 Changing consumer behaviour

In 2020, the pandemic put the brake on vehicle emissions. The European Economic Area's air quality tracker showed that concentrations of nitrogen dioxide, a pollutant commonly associated with road transport, fell significantly where lockdown measures were implemented. During the April 2020 lockdown restrictions, concentrations of NO_2 declined by 61 per cent in Spain and 51 per cent in France.

As lockdowns eased and road traffic activity increased, urban pollution levels began to return to levels closer to those observed prior to the pandemic. However, the pandemic showed that behavioural change is possible. Governments, authorities and agencies are now seeking to embed cleaner, safer transport behaviours for the long term.

5 Adopting multi-modal transport

By optimising individual modes of transport, as well as making the transition between different modes of personal and commercial travel more efficient, integrated and seamless, citizens and businesses will be better able to choose the optimal travel mode for their journey.

This has an element of carrot and stick. On the one hand, there is a need to provide a variety of transport options, to promote them and to incentivise people to use them by highlighting their sustainability and health-related credentials. On the other, the introduction or expansion of urban access charging schemes, or fees levied on vehicles that contribute to poor air quality, can serve to drive change by compulsion.

Whichever approaches are taken, operators of our future transportation systems will be able to capitalise on the rapid advances in digital infrastructure and the availability of data resources to provide insight and optimise delivery.

While we may not be able fully to reverse the impact of the fossil fuel age within our lifetime, sustainable mobility solutions give us the opportunity to correct the course of environmental change and improve the quality of life for the next generation. Achieving this is a hugely complex challenge, requiring transformations in energy supply, infrastructure, technology and human behaviour, in a dynamic global economic climate.

There is no single 'silver bullet' – just the need to progress multiple paths towards a sustainable future.

Read Ricardo's 'Future of Sustainable Transport' report: automotive.ricardo.com/sustainabletransport

Adrian Greaney is Ricardo's Product Solutions Development Director

SUSTAINABLE TRANSPORT

FROM POLICY TO **GLOBAL PRACTICE**

Lorenzo Casullo explains how Ricardo's sustainable transport team is helping to decarbonise and bring innovation into mobility services and infrastructure around the world.

We advise customers on technical and policy issues and offer five key services. These are clean transport technologies and fuels; economic and environmental analysis; transport policy assessments and evaluations; regulatory advice to corporates across the sector; and the management of mobility projects, portals, programmes and competitions.

Our government customers are policymakers and regulators who have long been concerned with the negative impacts of transport in terms of air pollution and climate change. They have to find solutions that protect consumers, deliver resilience and security of supply in the face of geopolitical threats, and continue to address climate change. We carried out the technical analysis that underpinned key European Union policy measures – the EU Green Deal and the Fit for 55 package – so we have a detailed understanding of how these affect businesses and society. In the UK, we support national and local governments in their efforts to reform regulatory provisions after Brexit, to fund new and emerging technologies and to plan for more sustainable cities.

Policymakers face two additional and equally pressing challenges today. First, their response to rising energy costs, an issue which emerged prior to the war in Ukraine but has been accelerated by it. Second, the challenge of the digital transition: how to make it inclusive and maximise the benefits of digital tools in transport, such as journey planners, freight management systems and apps.

Companies and trade associations also have to implement or anticipate these regulatory trends. They come to Ricardo because we have decades of experience advising policymakers. We help them navigate this landscape and translate policy directions into potential actions for the private sector. For example, we are currently advising a global automotive business on consumer attitudes to green information, and stress testing another's life cycle assessment assumptions to show whether hydrogen or electric vehicles are more promising in terms of their environmental footprint.

Decarbonisation and net zero goals are pretty much set – it's now about how we get there. That's policymakers thinking about regulations, investment plans and incentives, and the private sector preparing for dramatic change across industries that will need new investment patterns, technologies and skills.

I lead a global multidisciplinary transport team of around 40 engineers, economists, social and natural scientists, speaking ten languages. However, you can multiply this number of team members by five when you consider all the experts we have in energy transition, electrification, battery technology and lifecycle management, emissions control and air quality. This broad knowledge base is the strength of Ricardo's proposition.

Lorenzo Casullo is Technical Director and manages Sustainable Transport at Ricardo

SUSTAINABLE TRANSPORT

CHANGING DIRECTION, **LISTENING TO THE PEOPLE**

Ricardo is carrying out a public consultation to update Malta's national transport plan.

"This is a really exciting project for us," says Lorenzo Casullo, "and a first with the Ministry of Transport, Infrastructure and Capital Projects in Malta.

"We have spent a few months now talking to citizens, businesses and policymakers in Malta. Stakeholders confirmed that air pollution and traffic are longstanding, complex challenges for this island nation. There is a strong imperative to take action, because the European Union has made solving congestion and reducing emissions a condition of the release of recovery funding.

"This isn't just about making a technical assessment. It's about understanding how a plan can be updated and implemented to address EU and national commitments for a more sustainable transport system. We are listening to residents and decision-makers, capturing their ideas and turning this into a live document which will reflect the challenges of energy transition today.

"In September we hosted a public consultation webinar which is helping to shape our recommendations to Malta's policymakers. The response was extraordinary: we expected a few hundred people, we got more than a thousand. One of the technical questions we asked is: should Malta seek to promote alternative fuels for its bus fleet, which is currently almost entirely based on diesel buses, and has great potential to shift to electric vehicles.

"This consultation is also about changing behaviour: for example, how to get people out of cars and onto public transport. We learned that the reason people are not taking the bus is due to poor service levels, not a reluctance to leave their car behind. And slow adoption of electric cars is not due to a lack of financial incentives but because there are few trained engineers on the island and a limited supply chain for spare parts.

"The consultation has played to our strengths because we needed both technical knowledge and a network of contacts to show how other geographies have tackled similar issues before. Now we want to replicate this citizen engagement model elsewhere across Europe or in other small geographies that are heavily reliant on car use and need to reduce their transport footprint."

Air pollution and traffic are longstanding, complex challenges for Malta

AROUND THE GLOBE

Ricardo works internationally to support companies, trade and development organisations seeking to create transport systems that avoid harming the environment and promote economic development.

EUROPE

A study is underway with the Federation Internationale de l'Automobile to map regulations and gauge citizens' views around e-scooters and e-bikes in European cities including Madrid, Paris and Copenhagen.

The study[1] is examining how the respective city transport authorities are managing these services and surveying hundreds of citizens to gauge their awareness of safety and environmental risks. This is the first ever comprehensive comparative review of its kind.

The Sustainable Transport team also recently completed a study for the European Parliament to check whether current policies and technologies are enough to decarbonise aviation based on EU targets. The Parliament has just published the roadmap[2].

SOUTH AMERICA

Ricardo has completed two recent projects: first, a review in Argentina for the World Bank, assessing the potential to decarbonise supply chains involving transportation of soybean, dairy and beer.

Second, in Mexico for the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the German development agency that provides services in the field of international development cooperation and education. This review is preparing the ground for e-mobility in the logistics sector in Mexican cities[3].

WORLDWIDE

The Environmental Defense Fund (EDF), a non-governmental organisation, approached Ricardo to assess opportunities to accelerate decarbonisation of medium- and heavy-duty road freight vehicles in Europe, China, India and Latin America.

The work involves mapping the different portfolios of zero-emission solutions for trucks in these regions and liaising with global experts to support and validate the findings.

"This project is a really good example of a customer contracting us because of our known expertise in transport and mobility policy as well as technologies," says Lorenzo Casullo.

More work is underway as the Ricardo team advises global companies in the transport sector on navigating the changing policy landscape on topics such as battery regulations, powertrain efficiency, feedstocks for sustainable fuels and aviation emission requirements.

[1]bit.ly/fiastudy [2]bit.ly/aviationroadmap [3]bit.ly/logisticsemobility

SUSTAINABLE TRANSPORT

MAKING CONNECTIONS

Cities across North America are doing more than investing in transport infrastructure, reports **Andrew Foulkes**. With Ricardo's support, they're rethinking the entire shape of sustainable urban mobility.

"MORE THAN PIECEMEAL REFURBISHMENT TO REPLACE END-OF-LIFE ASSETS, THIS IS ABOUT RESHAPING THE VERY PURPOSE OF THE REGION'S TRANSPORTATION SYSTEM"
KIRK KLUG, RICARDO

© Metrolinx

City officials across North America are pursuing a new transport agenda to ease road traffic out of their centres and introduce more sustainable options

Until 2020, Ricardo's focus in North America had been on automotive and aerospace.

Its rail business, however, despite a team of more than 600 engineers and technicians and an established client portfolio across Europe, Asia and the Middle East, had yet to establish a presence across the Atlantic.

Towards the end of that year, the rail team began to explore the potential for its engineering and certification experience in Canada and the USA. "We found there was a clear gap for a technical partner like us," says Kirk Klug, President, North America Ricardo Rail.

"Ricardo has a mantra, coined by our founder Sir Harry Ricardo, to 'maximise efficiency and eliminate waste'. It's a message that really resonates here. Clients respect the insight we bring but they really value the 'can do' approach. We not only deliver the research and analysis, we go on to implement and optimise the solution.

"As an international business, we bring experience and economies of scale. We can provide experts who have helped open mass transit systems in Europe, for example, or high-speed networks in Asia or freight routes on the Arabian Peninsula. North America is the right place for us to be right now."

Now settled into new premises in Folsom, California, Klug is immersed in the task of building on a successful initial 12 months for the business that saw Ricardo become Canada's first accredited railway Independent Safety Assessor and quickly move on to secure a succession of project wins.

A new transport agenda

Transportation throughout the region is poised for considerable investment in the coming decade.

The US Government's Infrastructure Investment and Jobs Act will see around $100 billion allocated to rail and public transit infrastructure over the next eight years.

North of the border, Canada's federal government launched its 'Investing in Canada Plan' in 2016, committing Can$ 180 billion to infrastructure programmes through to 2030, including transportation and energy systems.

While funding will be directed towards maintenance and upgrades of the standard gauge railroad that already reaches every major city across both countries, it will also be used to supplement the state or city-led programmes that are focused on keeping their local populations and economies on the move.

This is because, like many urban centres around the world, city officials across North America are increasingly pursuing a new transport agenda that aims to ease road traffic out of their centres and introduce more sustainable options, such as transit systems and the cycling and walking routes that also promote healthier lifestyles.

Nowhere is this better exemplified than in Toronto.

Metrolinx's ambition is a truly integrated network rather than simply moving trains and buses from A to B

A transformational programme

Even as the pandemic was causing ridership levels on transit systems around the world to collapse – forcing many transport investments to be paused, even cancelled – Canada's largest city was pressing ahead with the country's largest ever programme of transport investment.

'GO Transit' is the brand carried by rail and bus services across the Greater Toronto and Hamilton Region. The network is managed by Metrolinx, a crown agency of the Government of Ontario, which is also responsible for the UP Express, a rail link between Downtown Toronto and the International Airport, and PRESTO, the region's transport payment smartcard system.

Currently, the GO Transit rail system in Toronto consists of seven lines operating out of the city's Union Station and into the surrounding suburbs and satellite towns.

Infrastructure limitations mean the timetable across the network has, at best, been variable. Traffic on some routes is often geared to rush hour, while services towards Downtown notably reduce after the morning peak as the fleet is reserved for moving the workforce back out of the city at the end of the day. Furthermore, this rolling stock was aging and powered by diesel locomotives.

Nevertheless, in recent years passenger numbers had been steadily rising. Between 2017 and 2020 Metrolinx had already begun to ramp up the number of daily services and in return was rewarded with an impressive seven per cent increase in annual ridership. By the turn of the decade, the network was carrying more than 57 million passengers a year.

This increase in demand – which is expected to be sustained by the region's forecast population growth in the order of 20-30 per cent over the next 20 years – underpinned the city's business case to press ahead with various long-held plans to rejuvenate the rail network.

These plans came together as the 'GO Expansion' programme, a bold, all-encompassing scheme to deliver faster, more frequent services across the network. As well as introducing a modern electric-powered fleet, it would add new track to enable two-way, all-day services; new signalling; and more than 650 kilometres of electrification.

A few statistics demonstrate just how transformational GO Expansion promises to be: an increase in services from 1,500 trains per week in 2019 to more than 6,000; a new timetable offering services

GETTING NORTH AMERICA MOVING

Eglinton Light Rail

Ricardo was appointed as the Independent Safety Assessor (ISA) for the Eglinton Cross Town Light Rail Transit scheme in May 2022. The project will deliver an east-west light rail service across Toronto's Midtown, serving 25 stops along a 19 km route that broadly follows Eglinton Avenue. Ricardo's ISA work is at 'system integration' level, determining whether the scheme has been developed and implemented in a safe and secure manner and in compliance with industry practice for light rail transit. This role will continue throughout the planning, design, construction, testing and commissioning stages.

Finch West Light Rail Transit

The Finch West Light Rail Transit system will be a 10 km dual-track light rail line following the east-west Finch Avenue thoroughfare in northwest Toronto. It will serve 18 stations operating at street level on dedicated tracks separated from regular road traffic, with a small underground section. As the Safety and Security Auditor, Ricardo will provide a professional peer review of the project's safety and security management activities. Security preparations will also be assessed against established standards and international best practice. The Finch West Line is forecast for completion in 2023.

Ottawa

'Line 2' is a 6 km route that forms part of Ottawa's two-line 'O-Train' system. In 2020 works commenced on a 16 km extension, featuring a spur to the airport. Given the range of interfaces – new vehicles, stations and signalling – that must seamlessly integrate with the existing infrastructure, expertise was required to oversee the smooth introduction of each system. As the System Integration Verifier, Ricardo's experts will undertake a structured review of the risks and challenges ahead and prepare a detailed management plan to guide managers, contractors and suppliers through the build, installation and testing.

skyTran USA

Ricardo is the ISA for the development of skyTran USA, an elevated personal rapid transit concept. skyTran envisages a system offering two- and four-seater pods operating atop an overhead track. Using maglev propulsion, the pods travel along the track direct to the passenger's chosen destination. As well as providing high-capacity, zero-emission transportation, the system uses a small fraction of the ground space required by a typical light rail scheme.

© Metrolinx

'A SELF-FULFILLING "FLYWHEEL": THE MORE FLEXIBLE THE SYSTEM, THE MORE PASSENGERS WILL BE ATTRACTED TO PUBLIC TRANSIT'

The GO Expansion programme is about more than piecemeal refurbishment - it's about reshaping the very purpose of the region's transportation system

every 15 minutes; 40 station upgrades; and a reduction of up to 50 per cent in operating costs per kilometre.

It is a complex, multi-faceted programme of works that will need to be designed to the highest safety standards. As such, in May 2022 Metrolinx appointed Ricardo to provide safety assessment services during the design stage, helping to ensure key safety documentation – including the System Safety Plan – is in full compliance with national and international standards for risk management, operation and maintenance.

"The GO Expansion programme will be transformative for the region," explains Klug. "More than piecemeal refurbishment to replace assets approaching the end of their serviceable life, this is about reshaping the very purpose of the region's transportation system."

And it is the 'reshaping' that is key not only for the future but also for the recovery of passenger levels. This is especially so for leisure use, where weekend ridership now exceeds 2019 levels (although weekday travel during summer, as in many service economy cities, is yet to reach similar levels).

Setting a benchmark for North America's cities

"Like every major network, Toronto experienced a big drop in ridership in 2020," says Klug. "But when I visited in summer 2022, taking the UP Express from the Airport to Downtown, the trains were packed!

"Passengers are coming back. And Metrolinx deserves a lot of credit. They are very passenger-oriented. They think about customer satisfaction. They think about safety culture.

"But, long-term, Metrolinx has a broader objective than simply moving trains and buses from A to B. It is thinking about a truly integrated, sustainable network."

Metrolinx's wider plans go beyond simply moving people in and out of the central commercial area. It is also looking to improve services in the surrounding suburban districts. In other words, the spaces *between* the city's main transport arteries that are typically neglected in urban transport planning. For example, the city is constructing light rail systems, such as the Finch West and Eglington schemes [see 'Getting North America moving'], that connect outlying neighbourhoods without passing through the centre. After all, these are the journeys transit users around the world increasingly want to make.

Indeed, Metrolinx's ambition is to integrate a rejuvenated GO Transit rail service into a much broader system featuring buses, light rail, bike hire and walking routes.

In this way, transport becomes a self-fulfilling 'flywheel': the more flexible the system, with greater choice, improved frequencies and more seamless connections, the more passengers will be attracted to public transit and take more trips throughout the course of the day.

"The GO Expansion programme can be a benchmark for North America's large conurbations. Provide the options, the frequencies and the reliability, and people will use public transportation for more and more of their journeys," says Klug.

"You can sense the appetite for changing travel habits between and within our urban areas. We're seeing more and more urban transit schemes given the green light, be it metro, tram, monorail or even maglev. And we're seeing authorities like Metrolinx working not just to deliver modes in isolation but looking to bring it all together." RQ

Alternative fuels

RACING TOWARDS A GREEN FUTURE

While personal transport becomes increasingly electrified, reports **Ian Adcock**, motorsport is leading the way in alternative fuels to decarbonise high performance road and race cars

While Formula E and its sibling electric race series, Extreme E and RX2e, are burnishing battery-powered vehicles credentials, motorsport from Formula 1 down is actively pursuing how traditional internal combustion engine (ICE) race and rally cars can be made more environmentally acceptable.

"There's basically nothing wrong with ICE, it's the fuel we use that's the challenge," says Phil Hopwood, Ricardo's Head of Engine and Emissions Control Products. "The whole transport sector needs to be decarbonised while balancing a range of different attributes and requirements. For high-performance road cars, liquid phase drop-in fuels which can displace fossil fuels without changing the vehicle hardware are best suited. That way we can keep the visceral engine note which appeals to enthusiasts while also tackling exhaust emissions."

From 2026, Formula 1 will use Advanced Sustainable (AS) fuels 'that must achieve a greenhouse gas (GHG) emissions savings, relative to fossil-derived gasoline, of at least that defined for the transport sector in the EU Renewable Energy Directive RED II'.

Additionally, 'The GHG savings calculation takes into account any net carbon emissions from land-use change, the energy used in harvesting and transporting the biomass and the production and processing of the advanced sustainable component.'

Moreover, the sport's governing body, the Federation Internationale de l'Automobile (FIA), is insisting that the fuels must be commercially available or from plants producing 5m³ annually.

New engine suppliers

It is this change of rules that has attracted Audi to compete in F1 for the first time as engine supplier and strategic partner to Sauber. Sister brand Porsche was, likewise, drawn to the new green formula and is also expected to be on the grid in 2026 as an engine supplier, although a deal with Red Bull appears to be off the table.

Porsche, however, has gone ahead with a joint venture with Siemens and other industrial partners to build a plant to produce nearly CO_2-neutral fuel in Punta Arenas, Chile, with production increasing from 130,000 litres this year to 550 million litres by 2026.

According to Michael Steiner, Member of the Executive Board – Research and Development at Porsche AG, e-fuels reduce fossil CO_2 emissions by 90 per cent with the first fuel being used in the marque's Mobil 1 Supercup race series from this year onwards.

"Motorsport is the best proving ground for new technology," observes Steve Blevins, Head of Engineering for Ricardo Performance Products. "There isn't so much of a budget restraint as on production car programmes and the boundaries can be pushed further."

"Not only that, but getting AS fuels in front of the public might make them question the wholesale rush to electrification," Hopwood adds.

F1 may employ cutting-edge technology designed to shave milliseconds off lap times but when it comes to AS fuels it is a little way behind the curve. Shell has teamed up with America's NTT Indycar series and its engine suppliers – Honda and Chevrolet – to develop and supply a blend of second-generation ethanol derived from sugarcane waste and other biofuels to create a fuel that is 100 per cent comprised of feedstocks categorised as 'renewable' under the applicable regulatory frameworks; the fuel enables a reduction of at least 60 per cent in greenhouse gas emissions compared to fossil-based gasoline. ⇢

Audi has been attracted to compete in F1 for the first time as an engine supplier

Left: **Porsche's new synthetic fuel production plant in Chile**
Below: **Toyota's hydrogen-powered Corolla H2 Concept competing in a category for special racing cars focusing solely on solutions for sustainable mobility**

"MOTORSPORT IS THE BEST PROVING GROUND FOR NEW TECHNOLOGY. THERE ISN'T SO MUCH OF A BUDGET RESTRAINT AS ON PRODUCTION CAR PROGRAMMES AND THE BOUNDARIES CAN BE PUSHED FURTHER"
STEVE BLEVINS, RICARDO

The second-generation ethanol will be sourced from Raízen, a Brazilian joint-venture created in 2011 by Shell and Cosan. Raízen is one of the largest sugarcane ethanol producers in the world and owner of the first commercial second-generation ethanol plant.

No compromise on performance

Both the FIA's World Touring Car Cup (WTCR) and World Rally Championship use advanced biofuel, a fossil-free hydrocarbon-based fuel, with a blend of synthetic and biofuel components supplied by P1 Racing Fuels.

The new biofuel formulation seeks to reduce the carbon footprint significantly while not compromising engine performance. It will result in WTCR drivers being powered by a bespoke fuel featuring 15 per cent renewable components for the first time. These non-fossil fuel-based components have been derived from bioethanol produced from cellulose and ligneous biomass, as well as bio-synthetic (fully renewable) fuel. This allows P1 Racing Fuels to offer an environmentally conscious and cost-effective alternative to conventional race fuel as it works towards an ambitious target of producing 100 per cent fossil-free racing fuel for its partners.

Eliminating greenhouse gases doesn't start with burning the fuel within the car's engine but how the fuel is produced in the first instance, argues John Hughes, Ricardo's Chief Engineer for hydrogen engines, with three main sustainable fuels pathways available: bio fuels using biomass feedstock from waste; bio fuels derived from a synthetic process such as steam reforming; and e-fuels using green hydrogen and captured carbon. Some argue that pathways which produce carbonaceous fuels don't achieve a reduction in CO_2 but simply reuse what is already in the atmosphere in a virtuous circle but, at least, they aren't adding to the total of GHGs.

The potential of hydrogen

One power source that motorsport, like original equipment manufacturers (OEMs), has considered but never really got to grips with is hydrogen. However, that was given a boost earlier this year when Toyota entered a hydrogen-powered Corolla H2 Concept in the 2022 Eneos Super Taikyu series STQ class, a non-competitive category for special racing cars focusing solely on developing solutions for sustainable mobility.

Eschewing fuel cells, Toyota opted for a modified ICE. In the six months from May's opening round to the final meeting in November, engine performance was improved to levels comparable with petrol engines, with power increased by 24 per cent, torque by 33 per cent and successful control of abnormal combustion. Key issues to be addressed this year included improvement in the car's driving range and a reduction in refuelling time.

"Hydrogen is a great fuel in terms of energy density when measured on a mass basis," explains Hughes, "but storage is more of a challenge, using either pressurised tanks at up to 700 bar or cryogenic tanks to store in liquid phase at temperatures close to absolute zero, both of which present issues for competition cars. There's also the need for special seals, to prevent seepage, and a care point on the use of metals within the fuel system to reduce the risk of embrittlement. Still, a combination of fuel cells and an ICE might make a compelling argument for endurance racing which could trickle down to high-performance road cars."

While motorsport technology can, and does, transfer to production cars, especially in the higher echelons, whether the path it is beating on AS fuels will convince legislators that battery electric vehicles are only an answer rather than the answer remains to be seen. RQ

[1]Article 29, Section 10(c) of Directive (EU) 2018/2001 for biofuels, and Article 25, Section 2 for RFNBO

BACK ON TRACK?

COP27 SHARM EL-SHEIKH EGYPT 2022

Sujith Kollamthodi explains why COP27 is a critical test of the global community's response to the increasing urgency of climate change – and how Ricardo is playing its part

This year marks the 30th anniversary of the United Nations Framework Convention on Climate Change (UNFCCC). It's also seven years since the Paris Agreement was signed at the 21st Conference of the Parties (COP21), after which almost every country has committed to keep the rise in global average temperature to well below 2°C, and ideally 1.5°C, above pre-industrial levels.

To achieve this, countries decide by how much they will reduce their national emissions each year. They communicate these targets to the UNFCCC in the form of 'nationally determined contributions' (NDCs), which are revised every five years.

COP26, held in Glasgow last autumn, was the first test of this mechanism. Sadly, the planned emissions cuts outlined in NDCs were way off track if global warming is to be limited to the agreed level.

COP26 president Alok Sharma declared that while 1.5°C remains alive, 'its pulse is weak'. A report published last year by the Climate Change Committee, to which Ricardo contributed, showed the UK lagging behind on its key goal of 78 per cent cuts to greenhouse gases by 2035.

The Glasgow event ended with a call for revised NDCs no later than COP27, taking place in Egypt in November.

'COP26 PRESIDENT ALOK SHARMA DECLARED THAT WHILE 1.5°C REMAINS ALIVE, "ITS PULSE IS WEAK"'

The months following COP26 saw devastating floods in Pakistan

Women in Chad forced to seek clean water long distances from their village

> **"THE WORLD MUST USE THIS OPPORTUNITY TO SHOWCASE UNITY AGAINST AN EXISTENTIAL THREAT THAT WE CAN ONLY OVERCOME THROUGH CONCERTED ACTION"**
> ABDEL FATTAH EL-SISI, EGYPTIAN PRESIDENT

New threats and challenges

In the months following COP26 the world saw unprecedented heatwaves and wildfires in Europe, devastating floods in Pakistan and a 'megadrought' in the American Midwest – all evidence of the growing frequency and intensity of climate catastrophes.

COP27 will also be held under the shadow of war in Ukraine, with its devastating impacts on energy, food and supply chain security. Some countries have used the conflict to step up their efforts to decarbonise and improve energy efficiency; others, however, have reverted to seeking new fossil fuel sources as a short-term solution.

Adaptation to and mitigation of climate impacts will be high on the COP27 agenda, as they were in Glasgow. These priorities resonate with Ricardo's mission. From energy transition to improving climate resilience, solar-powered rail to hydrogen fuel cells, the business is actively contributing to key pathways towards net zero.

Funding the cost of change

The topic that is likely to dominate discussions in Egypt is another with which Ricardo is closely involved: climate finance.

COP27 takes place in a climate-vulnerable country on a climate-vulnerable continent. Egypt has sought to position itself as Africa's climate leader and use its role as host to advocate for developing nations that have contributed comparatively little to global greenhouse gas emissions but are badly affected by the consequences of climate change – and lack the finance to take action.

Ricardo advises governments, donors, development banks and international institutions in areas such as climate investment planning and financing the implementation of NDCs; capacity building and strengthening national institutions to access climate finance; identifying where public finance is best placed to leverage private sector funds; and tracking and evaluating climate finance flows.

Among the projects Ricardo will be promoting at COP27 are the Climate Finance Accelerator [see page 23] and Climate Services for a Net Zero Resilient World *[see below]*. These are valuable tools to help achieve the COP27 target of a shift from 'pledging to implementation at scale and on time'. The world, as Egypt's President Abdel Fattah El-Sisi puts it, must use this opportunity to "showcase unity against an existential threat that we can only overcome through concerted action".

Find out more about Ricardo's climate change services at: ee.ricardo.com/climate-change

Sujith Kolamthadi is Ricardo Energy and Environment's Director of Strategy and Innovation

CLIMATE SERVICES FOR A NET ZERO RESILIENT WORLD (CS-NOW)

CS-NOW is a £5 million programme running until 2025 to produce the research and transformative advice, digital data and tools informing the UK Government's strategy for a low-carbon future.

Ricardo is leading a consortium of universities and research institutes working not only to ensure the UK can respond to the impacts of a warming planet on its own infrastructure but also to provide models for how the UK can reduce carbon emissions globally.

At home this includes visualising data to make it more accessible, transparent and user friendly to help regional and national authorities understand and respond to impacts. Internationally, CS-NOW is helping nations reduce their carbon footprints while building resilience and protecting their populations.

THIS MUCH WE KNOW...

BLANCA FERNANDEZ AND FLORIANNE DE BOER

Blanca Fernandez is a Principal Economist working on environmental policy and climate change economics. **Florianne de Boer** is a Principal Consultant advising on international climate change policy and carbon and energy regulation.

BF: Climate action depends on effective collaboration. That's collaboration between governments, project developers, investors and both private and public sector organisations at every level. It's the same within Ricardo – I work very closely with Florianne and and other colleagues with expertise across many topics. I specialise in climate finance and climate policy, air quality, transport, energy, waste and the circular economy. My recent work is on the supply and demand side of climate finance, particularly in Latin America – helping countries understand their investment gaps and come up with strategies to meet their targets for mitigation and adaptation.

FdeB: I focus on analysing existing policy tools and how they perform internationally, with the emphasis on Latin America and Asia. Blanca's team and mine have grown rapidly over the last two or three years, which shows how important this area of work now is for Ricardo. We provide expertise to governments, donors, development banks and institutions all round the world.

FdeB: We work together on the Climate Finance Accelerator (CFA), which is a cross-team project within Ricardo's Energy & Environment business unit. Its aim is to help eight middle-income countries create a pipeline of bankable low-carbon climate projects. Then, once a pipeline is in place, to match the projects with financing options. We help with capacity building to develop the projects and organise events to showcase them to potential investors. We also involve policymakers in the process to highlight any barriers that exist and how these could be overcome by influencing a country's regulatory environment.

BF: The CFA is is delivered by a consortium that includes Ricardo. It's part of the UK's efforts to support climate action and began with a successful pilot in Colombia, Mexico and Nigeria. Among the propositions that developed during this phase were a new approach to financing rooftop solar at scale in Mexico; a programme to enhance micro-finance for agricultural smallholders in Colombia; and a financing plan to stop flaring and deforestation in Nigeria.

> **"WE PROVIDE EXPERTISE TO GOVERNMENTS, DONORS, DEVELOPMENT BANKS AND INSTITUTIONS ALL ROUND THE WORLD"**
> FLORIANNE DE BOER, RICARDO

BF: The Accelerator has now expanded to include Egypt, Pakistan, Peru, South Africa and Turkey. We have a very good relationship with key institutions in all eight countries, typically the Ministry of Environment, sometimes the Ministry of Finance and the Embassy. In Colombia we are currently trying to embed the CFA into the country's governance structure through a dedicated Department of National Planning. This will position the CFA as the project pipeline to help Colombia meet its climate targets.

FdeB: By bringing together governments, project developers and finance providers to build capacity across the climate finance supply chain, we can unlock a steady flow of funding to enable the projects to go ahead. Countries are then better placed to turn their Nationally Determined Contributions (NDCs) – their post-2020 climate policies, measures and financial commitments made as part of the Paris Agreement – into Climate Investment Plans.

BF: Turning non-binding NDCs into actions is not straightforward and levels of understanding remain low. The sooner countries start incorporating their planned actions into national budgets rather than seeing them as items that can be set aside, the easier it will be for countries to start implementation.

Find out more about the Climate Finance Accelerator at: ee.ricardo.com/climate-finance-accelerator

THE AIR FORCE

Ricardo is leading a pioneering project to measure and report corporate air pollution. *RQ* finds out more

Many companies measure and report their greenhouse gas (GHG) emissions. For some it's a legal requirement; others do so to obtain industry certification; more make the effort because it's part of their corporate ethos.

However, this is not the case when it comes to the wider emissions associated with air pollution. Current frameworks focus on measuring and reporting GHG emissions only.

"Very few businesses have voluntarily gone further, viewing air pollution as an urban or health issue and the responsibility of local or national government," says Honor Puciato, Principal Consultant in air quality at Ricardo.

Closing this gap is the aim of a project being developed by Ricardo; Impact on Urban Health, which is part of the Guy's & St Thomas' Foundation, a group of organisations with the mission of health equity; and the Clean Air Fund, a body striving to create a future where everyone breathes clean air.

The project is examining how to increase corporate levels of measuring and reporting of emissions relating to air quality pollutants, with the focus on $PM_{2.5}$, PM_{10} and NOx [see 'Dishing the dirt']. "This," says Guy Hitchcock, Ricardo's Technical Director for Low Emission Strategies, "represents an important step-change in environmental reporting.

"It's a well-established practice for businesses to gather GHG emissions data from their internal processes, production activities or supply chain logistics. Proactively reporting on corporate air pollution emissions as well will be a way to demonstrate strong environmental, social and governance values. It will appeal to socially responsible investors and consumers. Businesses will get a truer picture of their contribution to ambient air pollution. And, of course, it will help to improve the quality of life for everyone living and working nearby."

Tiered approach to reporting

The first output of the partnership was a pilot scoping study, published in June. "We found from our engagement with businesses," says Puciato, "that they are very keen to understand their air pollution emissions better, to identify the actions that could be taken to reduce their emissions and to learn how they can report these emissions alongside their GHG emissions."

The study concluded that there are established methods for calculating air pollutant emissions that could be used for reporting. "The basic approach to calculating GHG and air pollution emissions is the same," Puciato explains. "It's an amount of activity multiplied by an emission factor. However, the nature of the activity data and emissions factors for air pollution calculations are more complex and potentially require more layers of data to be collected by an organisation."

The study recommends a tiered approach:

- **Tier 1:** a simple methodology based on fuel use and fuel-based emission factors that should allow air pollutant estimations to be calculated within existing approaches to GHG data collection.
- **Tier 2:** introducing some elements of technology into the emission factors where this data is available. This kind of data is already collected for some GHG calculations, especially for better estimation of non-CO_2 gases.
- **Tier 3:** including the most detail around technology and operating conditions. Here, the data required will be beyond what is normally used for estimating GHG emissions.

"I believe the tier 1 approach is within the capability of almost every company," suggests Hitchcock. "Then, as they develop the data needed for tiers 2 and 3, their figures are likely to be more accurate and will enable detailed improvement actions to be reflected in the reporting results."

Building on enthusiasm

A willingness among businesses to understand their impacts on air pollution is one thing. What will it take to make it happen?

To understand what might incentivise companies to report their air pollution emissions, Ricardo carried out a survey with responses from 189 organisations across a range of sectors. While the key finding was that some form of regulation, similar to that relating to GHG reporting, would be the strongest driver for compliance, clarity around the potential benefits of reporting will be an important factor in attracting businesses into the scheme.

With funding from Impact on Urban Health and the Clean Air Fund, work is now underway to develop guidance on how businesses can report their air pollution emissions and a platform to share this information and lessons learnt. So what will success look like?

Hitchcock wants to attract at least one membership organisation such as Logistics UK or the CBI to promote the scheme to its members; ten businesses trialling the materials and website in the pilot stage; and 20 companies signed up to start reporting from year two.

Then, as the project moves into the implementation phase, Hitchcock's measure is to grow the number of organisations signed up to at least 50 with positive feedback on the benefits for business. And, undoubtedly the most important success factor of all – actions in place to start reducing corporate air pollution emissions.

Businesses wanting to improve their ESG and sustainability performance, better understand their air pollution contributions and help develop this pioneering reporting framework can take part in the pilot scheme. Register at: ee.ricardo.com/corporate-air-pollution-footprint-pilot-scheme, where the pilot study 'Company reporting of air-pollutant emissions: A scoping project' can be downloaded.

DISHING THE DIRT

- **$PM_{2.5}$** and **PM_{10}** is fine particulate matter – tiny solid particles and liquid droplets suspended in air, comprising nitrates, sulphates, organic chemicals, metals, soil or dust particles and allergens. The figures refer to their diameter in micrometres. Long-term exposure can affect lung function and worsen medical conditions such as asthma and heart disease.
- **Nitrogen oxide (NO_x)** pollution occurs when nitrogen oxides are released as a gas into the atmosphere during the combustion of fossil fuels. Nitrogen oxides readily enter the lungs and can cause inflammation of the airways and increase susceptibility to respiratory infections.

RICHARD IN BRIEF

Title: Global Technical Expert – Sustainable Engines
Background: Master's degree in Engineering Science, University of Oxford; PhD in Engine Research, University of Brighton; joined Ricardo in 1999 as Development Engineer in the Gasoline Engines department; Chair of the Powertrain Systems and Fuels Group board for the Institution of Mechanical Engineers since June 2022

"IT'S IMPORTANT THAT WE ADVOCATE FOR A GENUINELY TECHNOLOGY-NEUTRAL APPROACH TO SUSTAINABLE TRANSPORT"

A day in the life...

RICHARD OSBORNE

Helping to shape the future of sustainable mobility

I've just returned from the Aachen Colloquium in Germany. This is a long-running and highly regarded annual gathering of automotive experts to present future mobility technologies and concepts. The Colloquium has traditionally been engine-focused but this year's event was one of the the first since rebranding as the Aachen Colloquium for Sustainable Mobility – a significant repositioning that clearly reflects the challenges and imperatives we face as engineers.

I posted on LinkedIn that I was looking forward to discussions at Aachen, among other topics, on 'zero-impact emissions' – a phrase that prompted several comments. I used it carefully, to mean emissions at a level that has no impact on human health.

Zero-emission vehicles don't exist and never will – there will always be greenhouse gas emissions at some point in their lifecycle. The term 'zero-emission' is commonly used to refer to tailpipe emissions only. For me, that's problematic. It's just one part of the story.

Some might say that particular ship has sailed but I haven't given up because I think precision in the language we use is vital. A consumer should not be misinformed that their very heavy battery electric SUV, for example, is a zero-emission vehicle. The reality, though, is that we are now moving close to having vehicles that produce emissions at a level with zero impact on human health. This is a very positive story to tell.

I joined Ricardo straight from university, working on the development of gasoline combustion systems. I'm still doing some of this more than two decades later in my current role as a Global Technical Expert. We are developing new gasoline engines for OEMs right now.

Ricardo has always benefited from talented technical experts but my appointment as the first with 'global' in their job title in 2014 was an attempt to connect operations around the world more effectively. My initial remit was gasoline combustion, which changed to sustainable engines in 2021. I look after the sustainable liquid fuel portfolio covering traditional and advanced biofuels and also e-fuels, which are fuels in gas or liquid form produced from renewable or decarbonised electricity. My role is a blend of project delivery, business development and technical advocacy.

There's so much work going on within the company around hydrogen that I'm involved with this as well. We have projects underway on heavy duty and off-highway hydrogen engines – a very active area of research that particularly excites me.

Effective advocacy requires an external as well as an internal profile, so I was thrilled to be appointed Chair of the Powertrain Systems and Fuels Group (PSFG) board for the Institution of Mechanical Engineers (IMechE) earlier in 2022. I've been a member of this board for several years – it's one of several within IMechE and the group has a membership of many thousands worldwide. We run regular subject-specific conferences, seminars and webinars – on Powertrain Systems, or Turbochargers and Turbocharging, for example – and my role includes helping to shape IMechE policy on these constantly evolving topics.

The PSFG used to be called the Combustion Engines and Fuels Group – it has undergone the same kind of transition as the Aachen Colloquium. As well as engine specialists we now embrace battery and fuel cell specialists. It's important that we advocate for a genuinely technology-neutral approach to sustainable transport.

I'm also aware that, in a very small way, I'm following in the footsteps of Ricardo's founder. In 1944, Sir Harry Ricardo was elected President of the Institution of Mechanical Engineers. I hold the PSFG chair for three years and believe it shows the value Ricardo places on professional recognition for its engineers through bodies like IMechE. It also helps place Ricardo to the fore in shaping the future of sustainable transport by providing thought leadership to members of the world's pre-eminent professional body.

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RICARDO

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